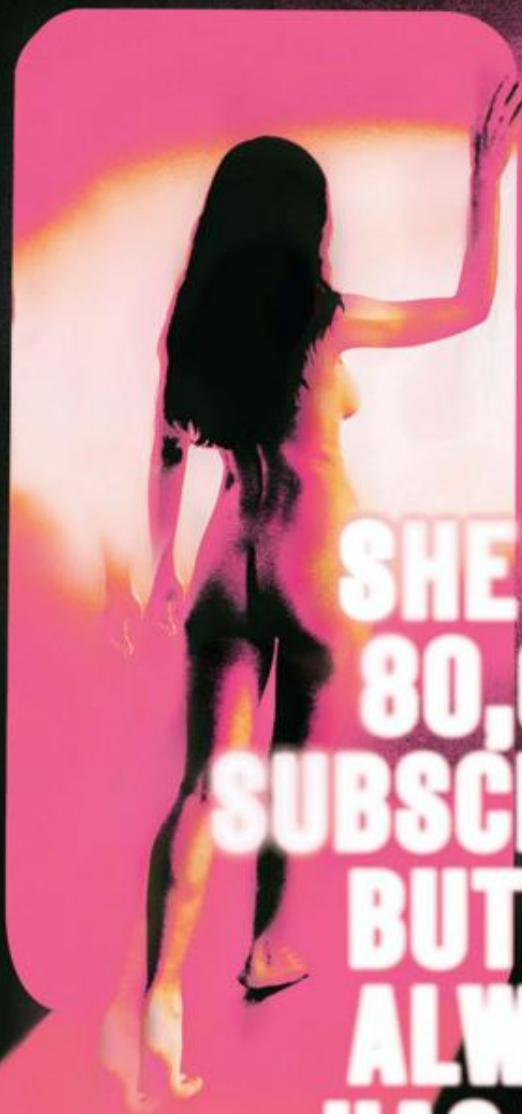


YOUR ONLINE  
GIRLFRIEND  
IS A ROTATING  
CAST OF LOW-  
PAID WORKERS.

I BECAME ONE  
OF THEM.

BY BRENDAN I.  
KOERNER



**SHE HAS  
80,000  
SUBSCRIBERS,  
BUT SHE  
ALWAYS  
HAS TIME  
FOR YOU.**

# Wired Magazine, Monthly Edit

[Tue, 02 Jul 2024]

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## **Audacious Plan to Map the Ancient World Before It Disappears**

[Peter Guest](#)  
[Backchannel](#)

Mar 26, 2024 3:00 AM

# The Mayor of London Enters the Bullshit Cinematic Universe

It all started with an asthma attack. Now Sadiq Khan finds himself at the center of a global conspiracy.

Photograph: Tom Cockram

It's a slate-gray Tuesday morning in January, and Sadiq Khan is marching through Camden Market trailed by a caravan of officials, press officers, and the hulking presence of his Metropolitan Police protection unit.

The mayor of London bustles with a sleeves-rolled-up, CEOish energy. The 53-year-old is short—famously so—but bantamweight trim, sharp-suited but approachably tieless. When he pauses in front of a row of arcade claw machines to take questions from local media, he answers fast, in full sentences—lawyerly and reasonable—dropping his “t”s and “g”s in a way that was once a popular affectation of British politicians but which in Khan’s case is authentically South London.

In contrast to the shambolic upper-classness of his predecessor in City Hall, Boris Johnson, Khan is something of a throwback: a politico of the Tony Blair era. But the questions show how much has changed. The subjects are a jarring mix of the hyperlocal and the geopolitical: Can he comment on a fatal bus crash in Victoria? How will he help small businesses through the cost-of-living crisis? Should a “Chinese” transport company be allowed to run the Elizabeth Line? What is his view on Israel’s bombardment of Gaza?

This article appears in the May/June 2024 issue in the UK. [Subscribe to WIRED.](#)

Photograph: Tom Cockram

Khan hangs around for an hour, swapping affable banalities with traders and colleagues—on vegan food, vinyl records, dogs—and recording a video to announce a new policy on small business funding. It's a routine stop; mundane, even. Khan's banter with jewelry designers and record stall owners has a scripted feel, the gentle fictions of small politics. It's a sharp contrast to the Sadiq Khan discussed on social media and on the conspiracy-inflected right-wing channels that dominate political coverage in the UK.

Since the UK's highly divisive 2016 vote to leave the European Union, the country's political discourse has spun wildly off center. The economy is in deep decline, the cost of living has spiraled, and public services are [collapsing](#)—water deregulation has left Britain swimming in a moat of its own [excrement](#). The national conversation has been dominated by the Conservative government's cartoonish policies and culture wars over gender, “wokery,” and climate change. The ruling party has abandoned the political center ground to govern from the fringes. In doing so, it has thinned the membrane that separates the mainstream from the dark currents of far-right extremism and misinformation that flow online.

In that bullshit cinematic universe, Khan is a recurring character, a unifying figure for a dissonant global coalition of racists, conspiracists, anti-vaxxers, and climate change deniers. There's a fictional Sadiq Khan who lives on the internet and in the heads of the far right, and a fictional London that he runs—a “Londonistan” given over to migrants, extremism, and knife crime; a dire warning of the cost of liberal leftist rule. This is partly why Khan needs that police protection. Threats to his life are routine now, part of the violence that has returned to British politics for the first time in decades.

Photograph: Tom Cockram

Last summer, one of Khan's flagship policies—a benign pollution reduction measure—was fused with the global conspiracy, sucked into a nightmarish mass delusion about climate authoritarianism, and co-opted by populist culture warriors to justify a rollback of [carbon emissions targets](#). The chaos that ensued shows how the drip of online conspiracy and radicalization,



driven by algorithms and exploited by opportunists, has warped political discourse in democratic societies. It is now much harder for elected leaders to manage the compromises needed to keep cities—and countries—together and functioning. That battle is becoming ever more one-sided, fueled by conspiracy theorists and cheap and convincing deepfakes. Khan's bid for reelection in May will be the UK's first major vote in this strange new world, a precursor to a national election happening some time this year—and, quite possibly, a warning sign of how dangerous the merging of populism, extremism, and technology has become.

It started innocuously enough. In 2014, [Khan ran the London Marathon](#). While in training, he found himself breathless and wheezing—more than a man in his forties should have been. His doctor diagnosed him with adult-onset asthma. Khan admits that he'd previously had little passion for environmental causes. The diagnosis started him on a journey of revelation.

At the time, he was in his second term as the Labour member of parliament for Tooting, the area of South London where he'd grown up—the son of a bus driver and a seamstress who had emigrated to the UK from Pakistan in the 1960s. He'd already spent more than a decade combining his career as a human rights lawyer with an unglamorous, poorly paid role as a local councillor—the lowest rung of elected office.

In 2016, [he ran for mayor](#). He leaned into his origins in his campaign—a local boy who reflected the diverse reality of London in the 21st century. While his Conservative opponent was accused of using [racist dog whistles](#) to try to turn Hindu and Jewish communities against the Muslim candidate, Khan's message of consensus won him the mayoralship. Six weeks later, the UK veered the other way, voting to leave the European Union. After Khan took office, he spoke out against then-presidential-candidate Donald Trump's proposed ban on Muslims entering the US, sparking a rolling spat with Trump that continued for years. Soon, Trump-supporting US media was [amplifying stories](#) about knife crime in London and mocking the mayor. Khan was more focused on something that was *actually* harming thousands of his constituents.

Air pollution contributes to the early deaths of an estimated [4,000 Londoners a year](#). According to City Hall, 99 percent of the capital's



residents live in areas that fail to meet the World Health Organization's guidelines for pollution from small, dangerous particles known as [PM2.5](#). Public health experts warn about a buildup of invisible conditions, limiting children's development and causing early deaths. Kids exposed to high air pollution have smaller lungs and higher blood pressure. King's College researchers estimate the economic cost to London in treatment and lost working hours to be as much as [£3.7 billion \(\\$4.7 billion\) a year](#).

Most of the pollution [comes from cars](#). The roots of the problem are in London's geography and the compromises made by previous generations of politicians and urban planners. Since the 1920s, plans have been made and scrapped for an expressway around the city center. Instead of a single road, the capital's main arteries—the North and South Circular—are a patchwork of urban streets where 21st century traffic is jammed onto aging infrastructure. Going clockwise, the southern half starts in the old docklands in the east of the city, running through warehouse districts now given over to the hipster overspill of Shoreditch and Deptford, to banker pads and “golden brick” investment properties. It loops southwest, heading through suburbs that have been slowly agglomerated into the urb, clusters of sewage works and bus depots and the low-rise residential hinterlands of South London: Lewisham, Dulwich, Streatham. At Brixton, in the south, an air monitor set up over the high street often hits the annual legal limits of nitrogen dioxide [before the end of January](#).

“Everyone knows a kid with asthma. Everyone does,” says Jemima Hartshorn, founder and director of Mums for Lungs, which launched in Brixton in 2017 and campaigns to reduce the amount of traffic on inner-city roads. It was partly the group's lobbying that inspired Khan's administration to focus on schools in its attempts to understand and tackle air pollution. “A lot of our schools were built in Victorian times,” Khan says. “And subsequently, for the last 100 years roads have been built outside the schools. So when kids go and play in the playground they breathe in poison.”

So, starting in 2019, City Hall invested in new monitoring tools, [including backpacks](#) with air quality monitors and GPS tags that were handed out to

primary school children. Pollution data was made publicly available so that citizens could see for themselves how bad things were.

The data revealed not just the scale of the problem but also how unevenly distributed it is, in a city where about half of households don't own a car. "It's those least responsible who are dying, those least likely to own a car: Black, Asian, minority ethnic, because they live on main roads rather than side roads," Khan says. "These environmental issues are also [health justice issues, social justice issues, and racial justice issues](#)."

Addressing the problem would mean asking or compelling generally wealthier, whiter people to change their behavior to benefit everyone. And it threatened the sanctity of car ownership, which has been associated with British reactionary conservatism since before the terms "culture war" and "woke" entered the country's political lexicon. But Khan was hopeful that most people would be happy to compromise for the greater good. "It's difficult because there's a lot of noise being made from the extremes," he says. "But people in the middle just want to know what's going on, what the evidence is, and so forth."

"It's those least responsible who are dying. These environmental issues are health issues, social justice issues, racial justice issues."

Khan [dusted off an old proposal](#) from his predecessor, Johnson, to charge the most polluting diesel and petrol vehicles a fee to enter the very center of the city—a small area that had already been covered by a congestion charge [since 2003](#). When it was launched in 2019, the scheme was given the blandly descriptive title of the "Ultra Low Emissions Zone," or ULEZ. Two years later, it was expanded to fill the area bounded by the North and South circulars. According to Transport for London, [1 million vehicles](#) enter that zone daily, but TfL estimated that only [14 percent](#) were old or polluting enough to actually be subject to the charge. Khan introduced a "scrappage" scheme to help drivers replace their old bangers with newer, cleaner vehicles. Mostly, he says, people were concerned until they realized they wouldn't actually have to pay.

Photograph: Tom Cockram

By February 2023, nitrogen dioxide emissions had fallen by 46 percent in Central London and by [21 percent in the expanded ULEZ area](#). That, Khan says, means 4 million residents breathing cleaner air. There were protests—including one, in April 2023, attended by [notable conspiracy theorists](#)—but they were largely small, local affairs. Air pollution campaigners were almost unanimous in their support. The scheme was due to expand further to cover London’s outer limits in August 2023, encompassing [another 5 million people](#). It felt like the battle had been won. But something weird and violent was simmering out of sight.

The reality of the mayorship is that crises are often thrust upon the city. Britain’s biggest political rupture of the century so far, Brexit, was imposed on London (largely against its will—[a majority of Londoners voted Remain](#)), disrupting communities, wrecking businesses, and cutting off a flow of young migrants from Europe. Khan calls Brexit “an aberration.” The reason the mayor needs a view on the war in Gaza is that its aftershocks play out on London’s streets—in [protests and counterprotests](#), in rising antisemitism and Islamophobia.

At the same time, the UK’s decline is magnified on London’s streets. A cost-of-living crisis has sent households and companies to the wall. [Homelessness is rising precipitously](#). Public services are crumbling. Holding the city together is hard enough without people trying to make the cracks bigger. But the nature of conspiracy and misinformation, and the binaries of modern politics, means things that should be unifying—like a quest for cleaner air—suddenly aren’t.

In June 2023, Boris Johnson, who had resigned as prime minister the previous September, also [quit his seat in Parliament](#), jumping before he was pushed amid an investigation into his conduct in office. That triggered an election in his former seat, Uxbridge and South Ruislip, on the outer edge of London, and inside the soon to be expanded ULEZ area.

Polling suggested that Labour had a good chance of winning the seat from the ruling party. But the Conservative candidate, Steve Tuckwell, ran on a platform opposing the expansion of the ULEZ zone. He held on to the seat by just [500 votes](#), but in the circumstances it felt like a much bigger victory. The government’s media machine seized on the ULEZ narrative, taking the

opportunity to divert attention from its rolling omnishambles. Right-wing commentators pushed the idea that emissions restriction was “wokeness”; the imposition of elite concerns on the embattled working class.

ULEZ found its way to conspiracy groups on Telegram, where it merged with well-established fantasies about elites using environmental concerns as cover to impose their will on the masses. The pandemic unleashed a cloud of virulent conspiracy theories centring on vaccines, 5G, mind control, and Bill Gates. These overlapped with older “elite control” and antisemitic tropes about shadow governments, with a racist conspiracy theory that alleges white Europeans are being deliberately displaced by immigrants, and with newer, internet-native conspiracy communities, like QAnon, whose central belief is that an elite cabal of Satan-worshipping pedophiles runs the US via a “deep state.” By the middle of the pandemic, this new meta-conspiracy had a name: The Great Reset.

Online conspiracy groups habitually cross-pollinate in this way. Just as commercial brands try to jump on trends, conspiracy influencers work to attach their big idea to new conspiracy fads or to some news event that can be shoehorned into their narratives. Often, they’ll look for international examples that can provide what researchers call “social proof” for their ideas. American commentators looking for “proof” of social collapse will point to knife crime in the UK (despite the fact that London’s homicide rate is less than half that of New York’s); those looking to demonstrate the socially corrosive impact of emissions targets will highlight farmer protests in the Netherlands.

This can lead to some bizarre moments, where global figures suddenly direct their enormous audience to somewhere ill-prepared for the attention. In early 2023, influential alt-media commentators, including the Canadian psychologist Jordan Peterson, boosted a [conspiracy about “15-minute cities”](#)—an innocuous urban planning concept based on providing services to residents close to where they live. In the bizarre world of the conspiracy theorist, the 15-minute city was reimagined as a plan by shadowy elites to force us all to stay in our neighborhoods, depriving us of our freedom of movement. Soon, protesters including members of the [1990s pop band](#)

[Right Said Fred](#) descended on Oxford to oppose the city's traffic control measures on the basis that they were a gateway to tyranny.

Social media algorithms drive the madness. When mainstream media and politicians start using the same terminology as the conspiracy groups, it can drive a flywheel of attention. It also helps to have a unifying figure who brings together multiple conspiracy constituencies. Which is how Sadiq Khan—liberal, left-wing, Muslim—got sucked into the vortex.

“He is a tool that's used as a way of eliding two battles that otherwise have very few things in common: The hatred of Muslims and the desire not to take action on climate change,” says Imran Ahmed, CEO of the Center for Countering Digital Hate, an advocacy group. “He's an enemy, a figure they can use to bring them together. It allows them mutual amplification, succor, support ... It's a way of cross-fertilizing extremism.”

When mainstream media and politicians start using the same terminology as the conspiracy groups, it can drive a flywheel of attention.

ULEZ is now an established franchise of the conspiracy. A [cursory search for the term on X](#) brings up a parade of far-right and conspiracist accounts, pushing climate lockdown conspiracies related to the “Great Reset,” including restrictions on movement and bans on meat and car ownership. “If you saw some of the banners, there were some really disparate issues,” Khan says.

The fury wasn't just online. Groups of vigilantes who call themselves “Blade Runners” now roam the outskirts of London, destroying the license-plate-recognition cameras that have been set up to monitor vehicles entering the ULEZ. By November 2023, the Metropolitan Police had investigated [nearly 1,000 incidents of vandalism](#). In December, two men in their sixties were arrested for allegedly [using an improvised explosive device](#) to blow up a camera in the [London suburb of Sidcup](#).

Campaigners against air pollution have been subjected to incredible levels of abuse. Supporters of ULEZ or 15-minute cities [get sent images](#) from Soviet gulags or Jewish ghettos in Nazi-occupied cities on social media.

“It’s really scary,” says Hartshorn, the air pollution campaigner. “I am significantly more careful about who I tell where I live.”

Political violence is returning to the UK, bursting out of the morass of conspiracy and extremism online. There is at times a Blairish elusiveness to the way Khan talks—broadcastable sound bites, reversions to cliché, and a genial caution in the phrasing of his answers. But as we talk about the loss of the rational center, he leans in to interrupt. “Look, I was mates with Jo Cox,” he says. “She was one of my best friends.”

In 2016, Cox—a Labour member of parliament for the northern constituency of Batley and Spen—[was murdered by a white supremacist](#) who subscribed to the Great Replacement theory. In 2021, [Conservative MP David Amess was murdered](#) by an Islamic fundamentalist who had become radicalized online. “I’ve got a protection team. I live it every day, the consequences of this, the violence,” Khan says. “What I will not allow is to be cowed by those threats, because that’s what they want. They want for me to be scared.”

Khan insists he’s an optimist. Despite the “hysteria” and the culture wars, he believes there’s still a middle ground where people can be persuaded with facts, where conflict can be resolved with discussion. Biden beat Trump in 2020, he points out; the moderate Emmanuel Macron saw off a far-right challenge from Marine Le Pen in France.

On the other hand, the Islamophobic politician Geert Wilders is close to power in the Netherlands after winning the most votes in elections in November, running on a nativist, anti-immigration, climate-skeptic platform. Trump is ascendant again in the US, and the British government has made clear that it’s planning to fight a general election in 2024 by [doubling down on hard-right policies](#).

In fact, the UK government seemed to take inspiration from the ULEZ spin cycle. The prime minister, Rishi Sunak, announced a list of “common sense” policies, which included rolling back a fictional “meat tax” and ruling out forcing households to divide their recycling into seven bins—[something that had never been seriously under consideration](#). In September, Sunak announced he was [“slamming the brakes on the war on motorists,”](#)



attacking speed limits and traffic reduction measures, before rolling back net-zero emissions targets, including delaying a planned phase-out of new diesel and petrol vehicle sales in the UK. In January, [The Guardian reported](#) that government ministers had cited [15-minute cities conspiracies](#) around freedom of movement when making transport policy.

Nervous of the backlash, Khan's own Labour party, which is likely to defeat the Conservatives in a general election this year, shelved climate spending targets after distancing itself from the ULEZ policy. "The misinformation was accepted by all the parties except the Green Party, and so it became normalized," Khan says. "My concern with addressing climate change, or addressing air pollution, or these sorts of green issues, is that politicians may be vacating the pitch because they've learned the wrong lessons."

It's hard not to interpret this as a victory for bullshit. Populist politicians have co-opted the language of conspiracy—the Old Etonians and Oxbridge graduates who make up much of Britain's ruling class now rail against elite control. In February, the former cabinet minister and Conservative Party grandee Sir Jacob Rees-Mogg [gave a speech decrying](#) the "international cabals and quangos telling hundreds of millions of people how to lead their lives." Former prime minister Liz Truss shared a stage with Steve Bannon to attack the "deep state" that she claims brought her down after 44 disastrous days in office. Lee Anderson—a prominent Conservative MP and, until January, the party's deputy chairperson—said in a TV interview that Islamists had "got control of Khan and got control of London." Anderson was eventually suspended from the party.

Khan's Conservative opponent in the mayoral election, Susan Hall (who has made scrapping ULEZ a major pillar of her campaign), is [a vocal supporter of Donald Trump](#), retweeted a post on X [referring to London as "Londonistan,"](#) and alleged that [Jewish Londoners were frightened by Khan's "divisive attitude,"](#) sparking [rebukes](#) from Jewish groups and anti-racism charities.

Khan says it's too early to call the fight. "If you vacate the pitch, then you've got people with messages that are basic lies who will occupy that space," he says. He comes back to that slogan several times during our conversations. Asked what politicians can do to steer the discourse away



from algorithmically driven rage cycles, he talks about his belief in the fundamental decency of people. All he needs to do to prevail in May's election is to win the argument, he says—"The public is never wrong."

But that optimism feels brittle. He has no agency—few levers to pull. Like many politicians, Khan is trying to reason with a maelstrom of unreason. The real decisions about the future of democratic discourse are being made in California, or not being made at all. The tech companies whose algorithms helped spread and popularize conspiracy theories have slashed thousands of jobs, including many responsible for protecting integrity. Increasingly, they're following the lead of Elon Musk's X and taking a noninterventionist approach to political misinformation.

At the same time, the proliferation of artificial intelligence tools has made it far easier to author massive bot campaigns or create convincing deepfakes. Research in January found more than [100 deepfake advertisements of Rishi Sunak](#) being used to promote investment scams on Facebook. [Faked audio of opposition leader Keir Starmer](#) berating his staff spread on X in October last year. In November, the UK's [National Security Council warned](#) that AI could amplify the existing dangers of misinformation during an election or help foreign powers interfere with the process. Khan says that the UK has to urgently consider new laws to confront the risks. "We need to act now, not once the horse has already bolted," he says.

Although the UK government has occasionally said it would put in place rules to tackle misinformation on social media, it hasn't. "I feel like I can't overstate how bleak it is," says Kyle Taylor, founder of Fair Vote UK, an NGO that works on election security and reform. "We had years and years and years for governments to do something. And they have just not done it."

Disinformation isn't always about favoring a particular side. It helps hostile authoritarian states like Russia—or domestic authoritarians like Trump—undermine the foundations of governance, causing people to lose faith in democracy itself. "The objective is to get a society to the point where nobody knows whether something is real or not, and therefore, that society cannot function," says Taylor. Sometimes chaos is the only goal.

Photograph: Tom Cockram

There was an awful perfection to the [Sadiq Khan deepfake](#) when it inevitably arrived. It began circulating on X on November 10, the eve of Remembrance Day, a sacred event in British public life as the nation honors those killed in combat since the First World War.

The atmosphere leading into this solemn day was unusually tense. A march in support of Gaza had been scheduled for the same day. Government ministers wanted the Metropolitan Police to stop it from happening. Suella Braverman, then the home secretary, [wrote a controversial op-ed](#) that alleged the march was “an assertion of primacy by certain groups—particularly Islamists.” Far-right groups—emboldened by Braverman—announced their own march.

In the fake recording, an authentic-sounding version of Khan’s voice could be heard calling for the ceremony at the Cenotaph war memorial in London to be called off in favor of the Gaza rally. “I don’t give a flying shit about the Remembrance Weekend,” the voice said. The mayor, it said, controlled the police.

The message pressed every button on England’s paranoid fringes: an insinuation of support for Hamas, an apparent denigration of British history and memory by a Muslim left-winger, and a sense of backroom deals being done. A secret woke plot that plugged straight into the grand online conspiracy that unites the far right, anti-vaxxers, and climate deniers.

On November 11, far-right groups gathered in Westminster, drinking, chanting, and preparing to “protect the Cenotaph” from a march happening a few miles away. When the attack never came, they took matters into their own hands, fighting the police for the right to defend a monument to peace from an anti-war protest. Large groups charged barricades; masked soccer hooligans shot fireworks into police lines at head height. Two officers were hospitalized. [More than 120 people](#) were arrested.

The Sadiq Khan deepfake didn’t cause the violence, but it added to a general sense of chaos—of control slipping away, the center crumbling. “We can’t overstate the grave danger this new technology poses to our

politics and democratic freedoms,” Khan says. “The legitimacy of elections and the very viability of our democracy is at stake if we allow these deepfakes to be misused and weaponized.” But the grim truth about politics in the AI era is not that one deepfake will change the course of an election, but that the existence of sophisticated, commodified lies will unravel people’s trust in everything they see and hear. The triumph of bullshit over fact.

With an election in May, Khan’s support for ULEZ has left him at the mercy of powerful forces that he can’t control—a tornado of exhaust smoke and black mirrors, a cacophony of bullshit. It reverberates far beyond the South Circular. The UK will vote this year; so will India, Mexico, South Korea, Ghana, and four dozen other countries. The US goes to the polls in November. We’re all in the vortex now.

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By [Dexter Thomas](#)

[Backchannel](#)

Feb 1, 2024 6:00 AM

# ‘Over Time the Trust Will Come’: An Exclusive Interview With TikTok’s CEO

A few weeks ago, Shou Zi Chew sat down with WIRED to tell us how he’s trying to make TikTok better. Is the company’s CEO for real—or just a really good politician?

TikTok CEO Shou Zi Chew at the company’s first-ever live music festival, in Mesa, Arizona, in December. Photograph: Lenne Chai

Before I sit down to talk to TikTok CEO Shou Zi Chew, he apologizes for the noise. The evening’s guests have been doing sporadic sound checks all day: Peso Pluma running through his opening number, Offset ad-libbing over a backing track. I passed by throngs of One Direction fans to get into the park (Niall Horan for \$25 is a solid deal). This isn’t where I imagined I’d be talking to the head of the most influential social media app on the planet, but the only way I could get on Chew’s calendar was by meeting him at [TikTok’s first-ever music festival](#)—a sold-out, two-stage program at the Cubs’ training facility in Mesa, Arizona.

The Big Interview

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The location makes no sense until you realize that for TikTok, location doesn’t matter. Only numbers do. The whole festival will be streamed exclusively on the app, for free (highlights would later air on Disney+ and Hulu); it’s the digits on the top left of everyone’s phone screen tonight that will be the ultimate metric of success or failure for this event.

I'm also here because it seems like Chew never really got to introduce himself on his own terms. When he stepped in as TikTok's CEO in mid-2021, there was little fanfare; the official @TikTok account didn't even make a TikTok about it. Instead, Chew's introduction to the wider public took place during a barrage of questions at a [congressional hearing](#) in Washington, DC, last March. "It was a circus," a TikTok employee tells me, speaking under condition of anonymity. "[They didn't even let him talk.](#) They had the attitude of 'You're a Chinese spy, and we're gonna beat the shit out of you.'"

This is a bit over-the-top, but the sentiment can't be wholly dismissed. Three things can simultaneously be true: First, that China's government openly watches its citizens and an app with origins there will naturally raise a red flag in many countries, especially in the US after parent company ByteDance was [caught tracking journalists](#) there in late 2022. Second, that people have been handing over increasing amounts of data for years, including to companies like Uber and Facebook (both of which have also reportedly tracked journalists), and [any company collecting so much user data should be heavily scrutinized](#). And third, that [thinly veiled anti-Chinese xenophobia](#) has become a reliable part of the US political playbook.

TikTok has made a show of addressing the first two issues: During the hearings, anyone listening heard Chew promise to move all of its US data to US-based servers, though some TikTok employees say that [some US data is still being shared with their parent company](#). At best, Chew's promise has been slow to deliver in full. The company has less control over the third issue: It is hard to imagine that the app will ever be "non-Chinese" enough for, say, the governor of Montana, whose reason for [banning TikTok in the state](#) was to "protect Montanans' personal and private data from the Chinese Communist Party." (A federal judge has since temporarily blocked the ban.)

Chew seems to have the right temperament to keep TikTok in various governments' good graces. He gives off none of the abrasive "tech bro" energy of his peers, instead exuding the folksy persona of someone perpetually running for town mayor: a handsome, charming man who seems

genuinely curious about everyone he meets—savvy enough to know who evening headliner Cardi B is, but not quite savvy enough to know that he was supposed to remove the white baste stitches from his blazer before wearing it to the event.

He's quick to steer any potentially dicey conversation to a story of a user he met in whatever locale suits the current situation—deftly rattling off how many followers one user or another gained overnight, how many items were sold after a shop went viral. He remembers faces and names, and he visits small businesses. He (or his comms team) even arranged for tacos from AZ Taco King, a local TikTok success story, to be [conveniently delivered during our interview](#).

When I ask Chew who he looked up to as a kid, he doesn't name music or sports stars, but Lee Kuan Yew, the founding prime minister of Chew's home, Singapore. Lee is widely credited with lifting the country from poverty into an economic powerhouse over his 31-year tenure. He has also been called a “benevolent dictator.” He'd be an obvious North Star for a certain sort of politician; less so for the head of a social media company that got started with selfie dance videos.

But let's be clear: TikTok is no longer in competition with other social media companies, especially if your metric of success is *immersion*. It outclasses every other app in this regard. [X is chasing away advertisers](#); TikTok integrates them. Meta has promised a [metaverse](#) where we create, work, shop, and play. With TikTok, it's already here—no headset required. YouTube is a good place to post videos, but not to *make* them; TikTok not only lets you post videos, but its in-house editing app rivals expensive pro-level software.

An entire culture is rising up of users to whom it doesn't occur to leave the app for, well, anything. TikTok's true competition, then, is the politics of each territory in which it operates. And Chew's newest strategy seems to be taking his stump speech on the road, virtually and IRL. ByteDance is spending millions on lobbying, yes, but Chew is also ramping up his charm offensive, making TikToks [on his own account](#) (@shou.time), encouraging users to tell everyone about how much they love the app.

I should mention that I was an early user of the app, downloading it right after it became available. I have covered TikTokkers who were using the app for positive impact, and I know people whose lives changed forever after a single post—whether an in-joke about local weather or humanizing stories about incarcerated people. Some of these same users also say that being TikTok-famous has made them anxious, that they feel obligated to make the same kind of videos over and over lest the algorithm punish them. This all makes me think about how, while Chew has been pressed on TikTok's security practices, he hasn't had much to say about how dependent global pop culture has become on the app. That's something we should think about as TikTok continues to extend its influence over how we experience culture, including food, music, and fashion. [On Tuesday, Universal Music Group announced that it would [not renew its licensing agreement](#) with TikTok, which could result in music by artists like Taylor Swift and Drake vanishing from the platform.]

TikTok has irreversibly bent our culture's trajectory, but that doesn't guarantee it'll be around to reap the benefits. (India banned the app long ago, and it's under growing scrutiny in a handful of other countries.) It has walked the political tightrope this far, but any bad PR could knock it off. Maybe that's why TikTok's chief comms officer—who used to work in US politics herself—made a show of recording my conversation with Chew with her phone.

The overprotectiveness isn't surprising, of course. TikTok knows Chew can't play the game in quite the same way many of his Silicon Valley counterparts do (taunting the media, for example, will always be off-limits for him). Instead, he has chosen a gentler kind of evangelism, telling people that things really are nicer in his walled garden, if only they'll give the app a chance. And that the garden will be even nicer if we all produce more content.

*This interview has been edited for length and clarity.*

**Shou Zi Chew:** Almost every time I visit a new city, I try and meet a few creators. And then I follow them on my TikTok. So it becomes like a friendship, sending messages, and we just stay in touch.



**Dexter Thomas: That is cool.**

It's really fun, yeah. [*Chew pulls out his phone.*] Follow me, I'm @shou.time. I'm going to follow you.

**OK.**

This is you, right? [*reading from my first post*] Uh, your caption says, "This is a terrible app."

**Well, I didn't like it back then because it was all Musical.ly kids. My opinion has changed.**

You have only two comments on this post. OK. You should post more.

**I should. But right now, here we are in Mesa, Arizona, at the first live TikTok concert. Why Mesa?**

Well, the weather is fantastic this time of the year.

**I guess, but why not Los Angeles? Why not New York? Is this a soft launch to see if it works?**

With the first time, you make sure you manage your expectations, right? It is important that the event goes smoothly. The whole point was, how do we make the best of technology offline, online?

**I also hear you're sponsoring the Met Gala.**

Yeah.

**Why?**

Why not? Did you see the press release about it? It's very cultural. Fashion is an incredibly important part of TikTok. Louis Vuitton has 12 million followers on our app.

**I think the world doesn't know much about you as a person. So let's leave TikTok alone. Who is Shou Zi Chew?**

Oh, who am I? I grew up in Singapore. I was born there, my great-grandfather moved there many years ago. I had a typical Singaporean childhood. I wanted to see the world, because Singapore is fantastic, but it's tiny. So I went to the UK for college. I joined Goldman Sachs, worked there for a couple of years, met an internet entrepreneur who started an investment company to invest in Facebook. So I joined him, and through that I met the guy who founded ByteDance. And in his earliest iteration, the idea was so simple, but so powerful. So I met him in 2012, and ... [*The door opens and a couple walks in. They are the owners of AZ Taco King.*]

**Taco King:** Sorry to interrupt. We're dropping off food.

**Chew:** Oh, hello! Nice to see you. I promised you if I were in Phoenix, I was going to look you up. Thanks for bringing the food. I'm looking forward to trying this. And have you started using TikTok Shop?

**Taco King:** We're trying. I've just been having a little bit of trouble, and obviously I've been really, really busy.

**Chew:** That's awesome. If you need any help, just tell our team. [*Turning to me*] Sorry about that. Do you want to grab some food? It looks amazing, right? [*We both start eating the tacos. They are pretty great.*]

**Did you play video games as a kid?**

Oh, a lot. I still play video games.

**Really? What do you play?**

Well, I still play *Clash of Clans*. I recently played *Diablo IV*.

**How are you awake right now? Every friend I know who plays *Diablo IV*, I don't see them for days.**

At some point you start to pace yourself a lot better. I had my first Nintendo set when I was maybe 5 years old, and my first 286 computer very shortly after that. I'm born in the '80s, which means that—

**We're the same age.**

We're the same age. So you know what I'm talking about. When you were born, it was all analog. You still had that phone with that curly wire, you remember that? And then video games were sort of invented during that time. So I grew up digitally very native.

**I would say you and I, maybe we're more digitally fluent. We're not native. We remember the time before the internet. People younger than us are native.**

I consider myself native. I remember getting my first dialup internet connection. Remember that beep? I remember getting online for the first time. I remember that very clearly.

**What did you do?**

Oh, well, we started searching for ... I think my first thing was to search for artists, the musicians that you care about. Sheryl Crow, I think.

**Sheryl Crow?**

She was popular at that time.

**Well, we're at a music festival, so let's keep talking music. Who else were you listening to as a kid?**

Back in the '90s, the radio was the most important distribution channel, and the discoverability of music was more or less constrained to what you heard on the radio.

**But did you have any favorite artists?**

I really liked Green Day. It's a '90s band.

Chew at the music festival at the Chicago Cubs' training facility in Mesa, Arizona.

Photograph: Lenne Chai

**Right. I'm interested in how you see TikTok fitting into the music space. There are musicians who've blown up on TikTok overnight. But there are a lot of musicians who've publicly said things like, "My label is making me make TikToks. I used to be able to concentrate on albums; everything is being shortened to a 15-second clip." Or that they feel pressure to put something in their song that will go viral.**

The key thing the recommendation algorithm has done is lower the barriers of people discovering music. I think that in itself is the most fundamental and powerful change. So in the past, if you had a very good song, it was difficult for many people to hear it, to be honest. But now, there are so many examples of people just posting a song that they write on TikTok and it goes viral. I think the net positive that we bring to the industry, of course, is this lowering of the barrier of discoverability.

**You think what you're doing is a net positive?**

Definitely. It means new talent coming into the market. They have a good song. The chances of you getting heard by many people now are much higher.

**Remember the song "Video Killed the Radio Star"? This discussion reminds me of that. The perception is, it used to be if you were musically talented, that's all you needed. With music videos, you needed to be talented and pretty. Now with TikTok, you need to be talented *and* pretty *and* social media savvy (or work with someone who is). I hear what you're saying about it lowering the barriers. But what do you say to artists who say TikTok is ruining music?**

I don't think so. You mentioned you have to be social media savvy. It's actually not really true. If you look at some of the songs that have taken off on our platform—I'll show you a few examples. So if you look at the way Paul Russell did it ...

**Oh, I mean, I've seen people who have been successful at it.**

Look, the cost of producing a TikTok like this is actually not very high. And to the point of whether we have truncated songs to 15 seconds, a lot of

times it actually drives people to want to discover the music more. So I'm not very sure that it's 100 percent cutting people's attention span. A lot of these songs then become proper hits on *Billboard* charts, on the radio. There's so many of these examples. I think Gayle had a huge hit last year as well. You know that song, "abcdefu"? Consumers are consuming things slightly differently. Of course that will mean that people have to adapt to this new way that the consumers are demanding to consume. But generally speaking, I think it unleashes more creativity. And if you look at the music industry as a result of TikTok, I think it's thriving more than ever.

**I think that's the key there, what you just said: "have to." Because this new platform exists, musicians and artists do have to adapt. This is the new norm. You *have to*.**

**TikTok Comms Officer:** [*interrupting*] You don't *have to*.

**Chew:** I think a lot of them are. So Cardi B's going to perform today. She's adapted very well. She had a number of campaign sessions she did on TikTok over the year, and it's really, really successful. Charlie Puth as well, he's performing here today. He shows people how he makes his music. It's amazing how talented this guy is.

**It is amazing.**

Fans want to know how the music is made. They want to know about the thought process, the creative process. And this is the key thing. They don't want this to be overproduced. They want this to be super authentic. And one of the key things that you will find on TikTok is that most of the content, everything I just told you about, has to be really authentic. If you try to make it very polished or very refined, it's not going to be that organic. People will see through this.

**I can see both sides. I definitely also hear the pressure from a label saying, "Fans want authenticity, but they want this *specific kind of* 'authenticity.'" It creates pressure. I've seen a musician argue that we wouldn't have had Radiohead if they had to come up in the TikTok era. Thom Yorke's an unusual dude. I don't think he would've been down**

**to make a TikTok to say, “Hey everybody, join me on my musical journey to make this song.”**

If you’re talking about the more classic songs, we have also had many examples. Remember the Ocean Spray guy a number of years ago?

**Right, yeah.**

What was that song? “Dreams.” Fleetwood Mac. It went back into the charts again as a result of that video.

**But totally randomly. You can’t predict that.**

It’s a feeling. It’s that moment in time, and it captures the feelings of the cultural zeitgeist. A lot of these things, you can’t engineer it. This is organic. Our role as a platform is to provide the three things: the window, the canvas, and the bridges to connect. And then these things will emerge organically. You have things like BookTok, people sharing about books, 200 billion views. You have people sharing science content. It’s this mesh of diversity. That’s what we’re trying to achieve. There’s so many people around the world with talent, and we have just opened up the pool for more people. For creativity to emerge, you need to have that kind of competitive, I guess, competitiveness of ideas.

**Music is a tough business. It’s almost a cynical joke at this point, an artist posting something like, “Hey, I got a million streams on Spotify. Thanks, everybody, I’m going to go buy a burrito.” Somebody’s making money, but it doesn’t seem to be the artists. Where does TikTok fit into how artists are going to be able to continue to make their art?**

That’s a great question. We are always thinking about providing more tools for musicians and other creators and users to be able to connect with their base. One of the reasons we’re doing this event—and by the way, super excited about this festival—it’s not only about the people who show up today, it’s about the livestreaming. I’m certain that we’re going to reach a lot more people online through the app.

**Than in person?**

Than we are offline, yeah. By a significant difference. Have you discovered a new song on TikTok?

**A couple. I can think of one, specifically. But I'm pretty sure he didn't make any money on it.**

Well, we are also developing new tools that allow partnerships with Apple and others. Initially the focus was on discoverability, but then as that sort of becomes more and more established, we are creating new channels for artists to be able to find some monetization opportunities, including connecting directly to, say, Apple Music to do that.

**It seems that, of all the social media platforms out there, TikTok is truly the one in the spotlight right now. Why do you think that is?**

Well, I think we are probably one of the youngest ones. As in, we are the most recent ones to emerge onto the scene, and we do bring a different proposition with discoverability. I think trust has to be earned in every company. As you grow and have more and more users and nonusers who are looking at your platform, you just have to earn their trust. I actually see this as an opportunity for us to explain ourselves.

**I don't want to relitigate the congressional hearings. But I watched them, and the main topic, of course, was China. China, China, China. A lot of fans of TikTok thought it was unfair and posted TikToks making fun of it. Have you seen the edits of you answering questions and looking confused?**

Yes. *[laughs]*

**What do you think?**

It was important that we showed up at the hearing. It was important that we answered the questions, which is what I tried to do. But some of these moments, you never know when the moment becomes a meme like that.

**Did you have any inkling that a politician asking you about TikTok connecting to the home Wi-Fi was going to be funny to somebody out**



**there?**

No. I was genuinely trying to answer the question.

**Have you felt that there is an unfairness or an extra scrutiny of TikTok because of the origins of the company?**

To a large extent, yes. I think it's one of the reasons we have a bigger trust deficit than most other companies. Maybe our trust starting line is behind other businesses, but I also think that there are very serious approaches that we've taken to try and earn that trust and to close that gap. I talked about this during the congressional hearing—you know all this, this is all public information, we built a project to address those concerns. We actually spent a lot of time understanding them. There were concerns about data security, there were concerns about transparency of our code. We have not only talked about it, we have actually put this into action. We built a project where we put all data into a third-party environment, through Oracle. It's a setup that is unprecedented, and no other company that I know of has established this. If you're fundamentally addressing all these concerns, then over time the trust will come.

**Speaking of trust, let's talk about moderation. There are truly terrible things on basically every app, because there are truly terrible things basically everywhere.**

There are truly terrible things that people *try to post*.

**Is there something that you think TikTok is doing better than other apps to address that?**

I think I just want to focus on ourselves. We have invested a tremendous amount in terms of not only the technology to help us moderate content but also evolving the policies, the community guidelines. We have invested in a lot of people to help us with content moderation. We have worked with many experts out there.

Photograph: Lenne Chai

You've heard of [Algospeak](#)?

Yes, I've heard of it. Yes.

**What do you think about it?**

It's difficult as a technical challenge. But I believe it's something that can be overcome with advances in technology. I'm optimistic.

**Algospeak exists, I'd argue, for good reasons. I can give you an example. [*I show him a TikTok.*] This is somebody talking about the conflict in Israel and Palestine. There's a perception that TikTok won't let him say this stuff, so to get around it, people are saying things in the comments like "Thanks for these beauty tips" or "That's a great recipe" in order to fool the algorithm into thinking this TikTok is about something else. It seems like there's a lot of people on the platform who are trying to fool the algorithm.**

The overarching thing that we're trying to do here is to keep the community safe and inclusive for everybody. There's always freedom for users to express themselves if it doesn't violate any of our guidelines. As you can imagine, this is a very complex role, and our trust and safety team is always looking into making sure that the content on the platform is not violative.

**I suppose the question I'm asking here is, what do you think of the fact that a culture has arisen that is constantly trying to evade things?**

I think as long as there have been rules, there have been people trying to bypass the rules. I think what is really important is to make sure that the spirit of what we're trying to do is well understood, and the spirit is, "Look, we're trying to create a platform for creativity and for joy."

**But to that end, both creators and commenters feel the need to dodge what they think are censors.**

Right.

**So how do you view that?**

I need to understand specifically what you are trying to say. Look, what do we mean by “dodge the censors”? If they’re saying something that is actually hate speech and it violates the spirit of the platform ...

**Let’s say in this case it’s not. Somebody is saying, “Hey, I think this is really important. You all should pay attention to what’s happening out there.” But then feeling like TikTok won’t like this.**

Oh, no, but I think the guidelines are clear on what we do and what we don’t do. If you’re talking about a small group of bad actors who are trying to find a loophole, then our role will always be to stop that. If you’re saying there are a lot of people who don’t understand our rules, well, I actually don’t think that’s the case.

**I’m not sure that’s the problem here, that people don’t understand ...**

**TikTok Comms Officer:** You can appeal.

**Chew:** Yeah, you can appeal.

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**For an example, news outlets have had to, at times, avoid saying things like “Somebody was killed” when it’s a fact. You’ll see respected outlets avoiding certain words, or even using words like “unalived.” These aren’t people doing bad things. These are just people trying to communicate.**

I think I understand the question better now. Clearly we prioritize safety very seriously, as you can imagine. And some of it could be us being overly protective, a mis-moderation leaning on the side of being careful. Sometimes we have taken something down as an abundance of caution. The position of moderation is very important. It’s not only getting the violation rates down, it’s reducing overmoderation, which happens. It’s a price you have to pay, and you have to find the right balance. You mentioned certain words like “kill” or “death” that will trigger the content moderation rules.

It's taken down out of abundance of caution first, and then if you appeal against it ... it's not a good user experience. I understand that. It gives users the wrong impression of what your guidelines are trying to achieve.

**I think in particular, it gives a lot of users the impression that if they have a less popular or minority opinion, that opinion isn't acceptable.**

I just want to clarify that the community guidelines are comprehensive in covering what we think is OK or not OK. And a lot of times it will take time for people to understand that that is how we moderate. That is how policies are built, that is how tens of thousands of moderators are doing their jobs. You've got to give them something to do their jobs, and that's the set of guidelines. Everything cascades from that.

**Let's move to the shift to longer videos. TikTok just ended the creators program, which is how a lot of people made a living; now it's paying only for videos over a minute. There are creators who got very, very good at making short videos, and that skill set is not as applicable now. What's your pitch to creators who are feeling like, "We made this, we made you what you are, and now you've changed the rules"?**

There are a lot of users who want to see the amazing UGC [user-generated content] that everyone has been creating for the last five, six years. That doesn't go away. But as more and more people join, there will be a diverse demand for new things, and that's where some of our efforts in encouraging slightly longer videos come from. It doesn't take away from the existing ones, because that's the way the recommendation engine works. It just adds to more integration.

**You're paying only for the longer videos.**

A lot of it is because longer videos require more investment in time to be created, and it is an area where it's still relatively small compared to the rest of the UGC platform. But we are always thinking of ways forward. Not everybody is here to make money, to be clear.

**Of course.**

But for those who want to explore more opportunities, we've created a whole series of things to allow people to try that. [Livestreaming is one of them.](#)

**Right.**

I take, obviously, all this feedback very seriously. I'm not trying to diminish it, I'm just saying that I hear that feedback, and I think what's important for us is that we don't mistake launching a program for de-emphasis on anything else. It's not like that. The community who has always been with us, creating all the wonderful dancing and singing content, this underpins everything we are. It underpins us because it's creativity and it's joy. I cannot emphasize enough how important the base is to us and how deeply we care about giving them the best experience possible. I've met many creators, by the way, across many countries, in France, in the UK, in this country, in Indonesia, Singapore, even as far as Kazakhstan. There's always a group of users who've been there since 2017, 2018, 2019. In all our work internally, I want to assure that group that they're incredibly important to us and we are not pursuing something at the expense of them.

**Actually, the dancing reminds me of something. Have you seen that researchers from Alibaba have released a paper saying that they used data that had been scraped from videos of popular TikTok dances and used that information to create an engine that shows ... [*Chew looks puzzled*] Oh my gosh, you haven't seen this?**

Nope.

**Oh, you should see this.**

OK.

**The researchers at Alibaba [used a data set of scraped TikTokkers doing dances](#) and used that data to create an engine that will allow them to animate anything. These are users who have gotten big themselves, and they've given quite a lot to your platform, and now an outside actor is pulling data from your platform.**

It's public data, though.

**It's public data, but I bet a lot of people wouldn't want their dance to be used in somebody else's data set.**

I think it's a complex topic about how we deal with public data that's been used for somebody's private training sets. I'm paying a lot of attention to this topic. There are a lot of debates about this, as you can imagine. I don't have any immediate response to this. This is something I need to go back and look into more deeply, because it's an evolving discussion.

**Is there some protection you can offer to users to say that the content you upload here will be used on this platform and not scraped by some third party?**

I would need to look into that.

**OK.**

Because in the past, if you publish something publicly, it's in the public domain. It's out there.

*[Note: After this conversation, a public relations staffer introduced me to TikTok's head of security and asked me to repeat what I'd said about the scraping paper. He said this was the first he'd heard of it and thanked me for telling him about it.]*

**I know that our time here is limited, and the concert is going to start soon, so one more. You've had to answer a lot of criticism about your app and your practices. From your perspective, what do you think is the biggest thing that people have misunderstood about TikTok?**

I think the biggest gap in understanding is between users and nonusers. This is the biggest gap.

**Really?**

Yeah, that's the biggest gap. Every time I meet a user, I feel like the level of understanding and the conversations that we have are significantly different

than with someone who's never used it before. People who use it really understand it.

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Dec 5, 2023 6:00 AM

# The Spy Who Dumped the CIA, Went to Therapy, and Now Makes Incredible Television

Joe Weisberg—the geopolitically entangled, heavily therapized creator of *The Americans* and *The Patient*—is the trickiest character he’s written (so far).

Photograph: Vincent Tullo

“Did you learn things in CIA training about withstanding interrogation that are going to make it harder for me to interview you?” I asked Joe Weisberg, creator of the TV espionage drama *The Americans* and onetime CIA agent. He looked momentarily startled, as though he’d expected this to be easier. Good, I had him where I wanted him: off-balance. I saw him taking my measure. Then he laughed affably, but I mistrusted the affability, since I knew from his own books that affability is among the qualities the CIA recruits for: people who can get other people to trust them, or at least want to have lunch with them.

I suppose I had certain fantasies about interviewing an ex-spook (was he equally profiling me? more skillfully?), no doubt the result of having read too many John le Carré novels. As it happens, reading le Carré had a lot to do with propelling Weisberg himself to [spycraft](#). Sure, he knew it was a fantasy world being depicted, but it was still a world he felt he belonged in. There was also his consuming obsession with bringing down the Soviet Union, which unfortunately for his career aspirations was soon to collapse on its own.

Weisberg, who is 57 and on the short side, has a sharp, possibly even hawkish visage along with an invitingly squishy-liberal midsection, which in combination externalize the essential duality in his being, one that's both shaped his life story to date and yielded one of the most complex married couples in television history, the Russian sleeper agents Elizabeth and Philip Jennings. [\*The Americans\*](#) aired on FX from 2013 to 2018, but everyone I know seems to be compulsively binge-streaming it lately—maybe the fear that your neighbors are plotting to bring down democracy somehow resonates again with the mental state of the country? Loosely based on the FBI's 2010 arrest of a network of Soviet spies living under assumed identities in the US, the series springs at least as much from the depths of Weisberg's psyche. Elizabeth, a cold warrior to her core, is, Weisberg says semi-jokingly, him pre-therapy; the détente-curious Philip is him after.

Therapy also figures significantly in his more recent limited-run series, *The Patient*, created with his writing partner Joel Fields (they were showrunners together on both series) and starring Steve Carell as a shrink horribly unlucky in his clientele. Something haunts me about both these shows, and not just because they feel like case studies in American paranoia. At a time when most scripted television specializes in moral preening—trafficking in sentimentality, pandering to liberal do-gooderism, leaving us feeling better about ourselves and the world—Weisberg's shows put you through a merciless psychological and spiritual wringer. They're willing to leave you floundering.

So what about those interrogation-evading techniques? I pressed Weisberg. We were chatting in his downtown apartment, the top two floors of a century-old building—gracious entryway, high-ceilinged rooms, also a rental and steep third-floor walkup with an inoperable buzzer. (“Joe doesn't have fancy taste, he's not acquisitive, he's not super interested in money,” says his brother, Jacob.) Decorative touches include his late mother's porcelain eggcup collection, a row of family photos (some “off the record”—Weisberg is divorced and has a teenage daughter), the residues of successive hobbies—photography, painting, cooking—and a wall of serious-looking books. The vestibule is devoted to an extensive high-tech

backpack collection: his only consumerist passion is an unequivocally nerdy one.

What I really wanted to know was what he'd learned about getting inside people's heads—knowing what your adversaries are thinking, using their desires against them. It's what's so seductive about le Carré: his operatives aren't just spies, they're master psychological strategists. As are Philip and Elizabeth Jennings, always knowing the precise right play: who's dissembling, where's the weak spot. Does CIA training give you a leg up at that kind of thing in later life? Does it make you better at grasping dark human complexities, thus at writing layered and contradictory characters?

It turned out I had it backward. The secret to writing success goes deeper than on-the-job training. It requires a willingness to pursue your monomanias wherever they lead. It requires, Weisberg eventually divulged, *finding a good enemy*. “When I was younger, having an enemy gave me a purpose, because the purpose is to fight the enemy,” he told me. “It's hard to describe how alluring that was. If you have an enemy, everything makes sense.” There it was: scratch the affability, uncover a gladiator. If I wanted to understand Weisberg, and maybe human creativity generally, I realized I'd have to understand the symbolic function of *The Enemy*.

Photograph: Vincent Tullo

In the Cold War years, a good enemy wasn't hard to locate. Though only 14 when the Soviets invaded Afghanistan and not especially political, Weisberg was outraged over the brutality and injustice of the war and saw the mujahideen (some factions of which would become the Taliban) as heroes. Maybe it had to do with his father reading aloud nightly from the Russian classics to Joe and Jacob—Tolstoy, Turgenev, Gogol, Dostoevsky—from when he was 5 on, meaning that the romantic world of imperial Russia was lodged deep in his imagination. Maybe it was the Sunday school inculcations about the oppression of Soviet Jewry. Either way, his fantasy life—he'd been writing novels from the time he was 12—became devoted to saving innocents from repression, and what he knew more than anything was that America needed to liberate the freedom-loving people of Afghanistan.

In college, ever more convinced that the USSR imperiled world peace and ever more drawn to the thralls of absolutism, he became—despite having grown up in an ardently liberal household—a Reagan devotee. Switching his attentions from literature to become a history major focused on Russia, he wrote a senior thesis asking if the Soviet population supported their government's leadership. (He now wonders if his entire career since has been devoted to rehashing that paper.) At Yale, conservatives were then in short supply, at least among the student population, and being vocally pro-Reagan had its social disadvantages. Even if he didn't identify as a *social* conservative, rumors circulated among friends back home that he'd become a racist. In an office-hours meeting with a writing professor he'd thought he was on friendly terms with, she suddenly blurted out, "You can be such an asshole!" He was baffled, but maybe he also *was* a bit of an asshole. "You do nasty things," he'd later write about his pre-therapy self. "You behave in strange ways when your feelings are obscured from you. You don't have the tools to do anything else."

The Soviet obsession continued post-graduation: he studied Russian, went to Leningrad to study more, got a job in Chicago helping Soviet émigrés find jobs. Bored, one day he called the CIA to request a job application. After 18 months of tests and interviews, he started training at the agency's semisecret compound in Langley, learning to fire weapons and detect surveillance. (That was the exciting part; less thrilling was a six-week classroom slog memorizing the bureaucratic ins and outs of the CIA.) He met guys, rough guys, who while operating in Afghanistan had grown beards and donned traditional robes, riding around on horseback with the mujahideen. Though afraid of horses, and though the Soviets had by then left Afghanistan, this was the career Weisberg wanted.

As far as interrogation-withstanding, he recounted the day when trainees were kidnapped from their barracks, blindfolded, put in a truck, then taken into a room and questioned. If you wouldn't talk, they made you stand in awkward positions. He doesn't think he really learned much, other than a phrase one of the trainers wore on his hat: "Admit nothing, deny everything, make counter accusations." "I may do that," he said, apropos our interview. The other takeaway was to always have a cover story prepared.

Weisberg left the CIA after three and a half years, still feeling positively toward it, he says, though a review of his 2008 novel [\*An Ordinary Spy\*](#) in the CIA's house organ, *Studies in Intelligence*, suggests otherwise. "A nasty and poorly executed look at our world," snarls the reviewer, a veteran CIA agent specializing in counterintelligence. Quoting a le Carré character's statement that what spies do—however unscrupulously—is vital to the "safety of ordinary, crummy people like you and me," the reviewer insists this is a truth "few people in the intelligence profession would dispute."

*An Ordinary Spy* disputes precisely that. The first-person account of Mark Ruttenberg, a bookish, sweaty, newly minted CIA case officer not entirely unlike Weisberg, it's also rather a takedown. Mark, though no Lothario (he hasn't had sex for a year), ends up in bed with Daisy, an embassy worker he'd been trying and failing to recruit. And is then left in deep shit after she imparts a useful piece of postcoital intel. Unfortunately for Mark, this is not the daring world of sexy spies familiar from movies and airport paperbacks; the real CIA (as depicted in the novel) is a rule-bound bureaucracy where crossing lines or bedding a "developmental" gets you summarily fired. Weisberg's other realist gesture was covering the pages with blacked-out redactions—his having worked at the CIA meant the book did actually have to be vetted by its publications review board (as would every *Americans* script)—the effect of which is a sly indictment of institutional ass-covering about a botched operation.

Overall, the novel struck me as far more cynical about the mission of the intelligence services than even le Carré tends to be. When I pressed Weisberg about the cynicism, he said he thinks le Carré is skeptical about the goals of espionage while still respecting his characters' competence; his own book, he acknowledges, is cynical even about the competence. For both, the cost of intelligence gathering means not infrequently wrecking informants' lives and livelihoods, and sometimes getting them killed. For le Carré it's a necessary trade-off; in *An Ordinary Spy* the value of any intelligence gained is minuscule, also entirely unreliable. If you're a case officer in the field, a shockingly high percentage of your informants are lying to you, and there's frequently no way to tell. One of his main characters, another CIA agent, gets scammed by an 11-year-old.

The novel didn't sell a lot of copies, but Hollywood loves spies, Weisberg had sort of been one and could also write dialog, which led to a well-known agent approaching him about writing for TV. Weisberg sold a show about a CIA station in Bulgaria to FX, which didn't get made but led to relationships with producers at DreamWorks, which led to him writing some episodes of their sci-fi show *Falling Skies*. When the Russian illegals were arrested in 2010, the DreamWorks producers called and said, Do you want to do a show about this? Weisberg spent a couple of weeks wandering around and thinking about it, and decided the story should be set in the 1980s and be told from the point of view of the KGB spies. And it should be about a family. Weisberg was by then a father himself, and something that had stuck with him from his CIA days was how many people there lied to their kids about what they really did for a living.

After Weisberg wrote the *Americans* pilot and it got picked up, he joined forces with the more experienced Joel Fields to co-executive produce the series. Weisberg describes working with Fields—son of a rabbi, studied moral philosophy in college—as transformative. Fields is also the product of a lot of talk therapy; the two soon realized that they wanted to make a show where the drama derives less from plot twists than how the characters navigate them emotionally. When I asked Fields about their creative coupledness—what I really wanted to know was what they fight about—he said they used to joke on *The Americans* that like Philip and Elizabeth, they had an arranged marriage. They're also both too conflict-averse to fight.

Photograph: Vincent Tullo

Among their goals was having the spycraft be as realistic as possible, and much of it is entirely real. One of their consultants, an expert on the Soviet illegals, had a personal collection of KGB gizmos and gadgets—the actual stuff that actual spies used. Even the props were marinated in history, the same history that had fired Weisberg's obsessions, which I suspect somehow filters into the emotional texture of the show.

His political trajectory still puzzled me, though. In my youth, people who needed a geopolitical enemy looked for foes closer to home: US imperialism, capitalist pillage. They swung left, not right. Maybe Joe was wilier—it's not like becoming a CIA agent was something kids of Chicago

lakefront liberals were encouraged to do, especially when your parents are active in local Democratic politics and your lawyer-dad works part-time for the ACLU, and your mother ...

Yes, let's pause to discuss Joe's mother—though I come late to the undertaking, as her story was previously related by Malcolm Gladwell in a 1999 [New Yorker article](#) (“Six Degrees of Lois Weisberg”) and his subsequent mega-bestseller [The Tipping Point](#). “Everyone who knows Lois Weisberg has a story about meeting Lois Weisberg,” opens Gladwell. Chain-smoking, coffee-addicted, frizzy-haired, five-foot-nothing, Lois was the type of person Gladwell calls a “connector,” someone with a weird genius for sweeping people from entirely different worlds into their orbits. Somehow Lois knew everyone—Lenny Bruce, Dizzy Gillespie, Ralph Ellison, Isaac Asimov. Gladwell's theory is that people like Lois may actually run the world.

I count myself a beneficiary of the Lois effect, having casually known Joe's one-year-older brother Jacob since back when I used to write for *Slate* in the 2000s. As its boss, and being Lois' offspring, Jacob regularly convened assorted *Slate* writers for meals and occasionally far-flung outings, which included once beckoning me, maybe 20 years ago, to Lois' Chicago apartment for a family dinner when he was in town, where Joe was also in attendance. This was in his post-CIA malaise—he'd taken a leave to help care for his dying father, briefly returned, then resigned. (He didn't want to live abroad, he says now.) I recall him being remote and difficult to talk to. Someone I know who met him around then describes him as “vaguely desperate.” His father's death had torpedoed him; soon after, he entered therapy, urged by his brother and friends. (When I reminded Joe that we'd met once long ago, he claimed to remember, though I chalk this up to the Weisberg affability.) These days Jacob, alongside Gladwell, runs Pushkin Industries, a podcast company.

Now it was my turn to summon Jacob to dinner, to grill him about Joe. Joe was not a happy child, I learned, an outsider at school—“a little awkward or funny-looking,” said Jacob, quickly backtracking to add that “funny-looking” was unfair. He just wasn't comfortable with kids his age, thus lonely, also the outlier in the family. All Joe wanted was to read comic

books and watch TV; his bibliophile father hated television so much that he may have once said, depending on which Weisberg brother you ask, that it was worse than the atom bomb, and permitted only two hours of it per week.

Jacob, who describes himself as a far less interesting person than Joe, didn't have conflicts with their parents, and didn't much want to watch TV. To him it seemed like a wonderful family life. "I accepted the terms of the imprisonment pretty well," he said. When Joe went into therapy and started characterizing their homelife as difficult and repressive, Jacob's initial reaction was, "What? I was there too. It wasn't like that."

Jacob told me that Lois was the kind of mother who'd say, "Why don't you go join the circus?" I assumed she'd meant it in a cruel-mom way, as in "You don't like your dinner, go join the circus." No, she'd meant it literally, I learned from Joe. Lois was then in charge of special events for the city of Chicago, and when the Ringling Brothers circus came to town, Lois (being Lois) had gotten to know the guy in charge and one night during dinner said, "Joseph, I think you should join the circus." He was in his teens. She said she'd introduce him to someone who could probably find him a job and take him with them when they left, which would be an amazing experience. "She was right that it would have been a great experience," Joe says now, "though also wrong and crazy." He'd always seen it as a funny and benevolent story, but later wondered if there was also a part of her that wanted to get rid of him. "I think one has to face that interpretation of the story too."

One late summer afternoon, Weisberg and I met at a midtown tourist museum called [Spyscape](#), which gauges its visitors' potential spy abilities via a series of interactive exhibits and tests. Long on what's known in writers' rooms as "hangability," Weisberg gamely played along, though barraged with a lot of whooshing sound effects and flashing lights upon entering asked, "Does the fact that these are making me nauseous mean I wouldn't be a good spy?"

What was great about this field trip was that the museum promised to do my job for me: construct a profile of the person I was supposed to be profiling. We were tested about whether we were good liars, good at



detecting lies, and willing to take risks. In “Special Ops” we were faced with an infernally complicated challenge involving pushing a lot of glowing white buttons on a wall while dodging a meshwork of laser beams.

Weisberg leaped athletically to the task, determined to beat that day’s record, exclaiming afterward, “I thought that looked dumb, but it was great!” Squirting himself with Purell at one of the stations thoughtfully located around the museum, he joked, “Here’s where you really fall down in their assessment—if you use the hand sanitizer.” In the “Surveillance” exhibit we had our first fight, over Edward Snowden, about whom Weisberg was decidedly negative and I insisted had been a patriot.

Then it was time for Weisberg’s spy evaluation. “You have high emotional intelligence, which helps you understand people in social situations, and are empathetic,” pronounced a creepy omniscient robot. “You take risks after careful consideration,” it added. “Joe Weisberg, you are going to be an intelligence operative!” This didn’t thrill him. “The real question is, do I want for it to say that I’d be a good spy or a bad spy?” he mulled. “The truth is I don’t want to be a good spy anymore.” But maybe old habits die hard. On his personality assessment, when asked if he was willing to be unethical if it would help him succeed, he’d rated himself a 1, the lowest score. Asked if he’d say anything to get what he wants, he’d given himself a 2. “Obviously that’s what you’d say if you were saying anything to get what you want!” I pointed out.

After all, he was the one who’d earlier said that the whole thing you learn to do in the CIA is manipulate people. Is unlearning that really possible? The question of who was manipulating whom had been a meta thing in our conversations from the beginning, with jokey badinage about the power of interviewers and the vulnerability of their subjects. Not long after our field trip, Weisberg—a foodie who spends much of his free time patrolling lower Manhattan in quest of Chinatown’s most electrifying dumpling—suggested by email that we hop on the Long Island Rail Road to Flushing, Queens, for “sour fish”; he knew a restaurant that served a half dozen varieties. The accompanying photo displayed a bowl of lethal-looking chilies the size of hand grenades. I wrote back: “Fearing unflattering portrayal, profile subject poisons unwitting profiler with capsaicin overdose.” Weisberg rejoined a second later: “Pathologists were shocked to discover the poison delivered

simultaneously with a subcutaneous patch and ingested along with, judging by the contents of the victim's stomach, sour fish."

He was funny, I was charmed, but then so was poor lonely Martha Hanson in *The Americans*—secretary to the head of the FBI's DC counterintelligence unit—skillfully charmed by Philip in a great demonstration of what a powerful interpersonal weapon nerdy vulnerability can be. Spoiler alert: it doesn't end well for Martha.

*The Americans* rode to acclaim by enacting such interpersonal paranoias on the historical stage, the complication being that sometimes the enemies we create are indeed out to destroy us, and sometimes our side is worse. Just as Weisberg would become torn about who the geopolitical villains really are, so will viewers be torn about Philip and Elizabeth. Yes, they're stealing American secrets, seducing and exploiting the locals, ruthlessly exterminating anyone who gets in their way, but they're also idealists with hopes and depths. They love their kids. A friend I had breakfast with the other week, who was midway through watching the series, was agonized about how they could have gone through with one particular assassination (an elderly woman). He fretted about whether the show had finally crossed a line for him, then conceded that the line had already been crossed when Elizabeth murders a sympathetic Black woman whose life she'd already destroyed after fake-befriending her to get information, and the show just assumes you'll go along with it.

Sometimes going along *was* tough. I myself argued with both Weisberg and Fields about Elizabeth pimping out her daughter to her KGB handlers. Happily, they're entirely nonproprietary about their own interpretations of characters and plotlines, including when I queried them (separately) about how monstrous so many of the mothers and mother-surrogates seem. Fields joked that he needed a time-out to call his therapist; Weisberg pushed back a little, saying of the most supremely monstrous mother—Sam's, the titular patient-kidnapper of *The Patient*—that though she's definitely complicit in his crimes, he believed in a mother who couldn't turn her kid in no matter what. (Or urge him to join the circus, I thought.)

Photograph: Vincent Tullo

When Weisberg and Fields came up with the idea for *The Patient*, it was Fields who was initially intrigued by serial killers. Weisberg wasn't, but they kept talking about it, then figured out that Sam, played by Domhnall Gleeson, was in therapy: he wants to *change*. Then they had the idea that he kidnaps his therapist, and now it was a show—also a merciless examination of how unfree all us benighted humans are, manacled to our stupid psychologies and impediments, even when not literally manacled in a basement. “You hope your plot puts your characters into situations that bring things out that are surprising and you’ll see depths you get to plumb, and this was really like that,” Weisberg said. They have a shared ability to excavate a remarkable amount of submerged stuff from their psyches, and transpose it into commercially viable TV. Fields says that sometimes, months later, one of them will say of a plotline or twist, “Oh my God, our subconsciouses did that,” and the other will say, “That wasn’t subconscious on my part, I thought you knew we were doing that.” Then they’ll laugh.

It was therapy that gave Weisberg the ability to write characters with complex mental lives—he wouldn’t have been able to, he says, until realizing he had one himself. Which meant coming to terms with how much of a false front he’d put on throughout his life, and how much he’d been hiding from himself. He started thinking that his childhood identification with the repressed Soviet citizenry was a way of externalizing his anger about repression in his own family. Trained from the crib to quash all negative feelings, he couldn’t go to war against his parents, but he could work to destroy a Soviet leadership busy choking off the free expression of its citizenry. Having an enemy, in other words, helped him avoid facing his own dark side.

Not that it’s ever so easy to shelve an obsession. In his intermittently memoirish 2021 book, *Russia Upside Down: An Exit Strategy for the Second Cold War*, Weisberg contends that he (and we) had fundamentally misunderstood the Soviets. The KGB was remarkably uncorrupt, the Bolsheviks were the party who’d put a stop to the pogroms, and the Soviets had ended the Holocaust, beating the Nazi army back through Eastern Europe. Yes, Jews suffered horribly under their rule, but many were also members of other groups that Stalin was purging and brutalizing, from intellectuals to party elites. These many reversals and correctings-of-the-

record make an odd reading experience, like watching someone in an MMA bout with his own former beliefs and punching himself a lot in the face. This effort to get it right, intellectually and emotionally—to come to terms with history and its crimes, to see around your own blind spots—seems both noble and poignantly impossible.

Blind spots: what to do with them? Weisberg and I had disagreed in a friendly way about therapy. His idea is that you get to a more authentic version of yourself, mine is that you just come up with a better cover story. We're always staging our personas, trying to get people to buy the latest one. He semi-concurred—our stories about ourselves change over time; we all want things from other people and try to get them. It's what's so interesting about Philip and Elizabeth, I said—that they've been trained to use that “authentic” part of themselves to manipulate people. That had been his own training, Weisberg reflected: Tell the truth as much as you possibly can, even with the foreigners you're running as spies. Everyone he talked to at the agency said, about the people they were most manipulating, that their feelings for them were entirely genuine. They loved and cared about them.

But what about all the less palatable motives, the things you don't say to your colleagues? Rewatching the *Americans* pilot, I was struck by the degree to which revenge figures in numerous plotlines and vignettes; *The Patient* too is fundamentally about Sam's need for revenge. Is that a big theme for you? I asked Weisberg. “Not consciously,” he said after a pause. It was probably more that violence and terror were big things for him, that from a young age his isolation, sadness, loneliness, mixed with comic books and American culture generally, all funneled into a very violence-centered fantasy life. “And when there's a lot of violence, you're going to have vengeance plots, it's going to be a part of how you tell those stories.”

“So revenge is just the occasion for violence?”

“I think that's right,” he said. “Though I can't rule out that in five years I'll realize how vengeful I am.”

Weisberg remains convinced that every American's ideas about Russia are psychological projections, though given recent events—the Ukraine invasion, the blatant assassinations and poisonings of Putin's critics—he

wonders if he'd seen the potential for rapprochement too optimistically. But he's also over his former optimism about America as a beacon of hope for the world. Having once thought, "We don't invade, take over, and colonize—we liberate," the realization that he'd gotten it so wrong on Iraq (he was pro-invasion) was a painful turning point. He looks back now on those fantasies of fighting and nation-building and wonders what the fuck he was thinking. The US shoulders some not insignificant portion of responsibility for the Ukraine war, he also now says, given NATO's expansion toward Russia's borders: "Any nation would feel threatened and fight back. Certainly we would have." This was startling to hear from an ex-cold warrior, but being susceptible to extreme political swings could also be, I was coming to understand, the putty of great creative bravura.

We'd been talking during the writers' strike, so Weisberg and Fields weren't working on anything together at the moment. Weisberg was using the downtime to work on a novel. When I asked if he was cultivating any new obsessions for his next act, he said there was something he kept pitching but had so far gone nowhere. The backpacks.

He wouldn't say more about the idea but agreed to walk me through his collection, pointing out the pockets on one, the mesh on another, the special sunglasses holder. "Look at that material and the color scheme!" He reeled off the manufacturers of various zippers and buckles. "Just try that zipper pull," he enthused, zipping a zipper back and forth. I agreed it was a very smooth pull.

I asked how many backpacks he had in total. He said he didn't want to answer that, but also he didn't know. I tried surreptitiously counting them but gave up after discovering a second layer underneath the first, along with a bunch of smaller ones. "Don't you lose stuff in all these pockets?" I asked. "I don't really use them," he replied. "I just like having them. I want to feel that I *could* use them."

I did my best impersonation of a shrink: "That's quite suggestive."

"Yes, it's odd," said Weisberg. "What does it suggest to you? Is it obvious what it suggests?"

“Well ... like ‘baggage’?” I was thinking of those mental health fascists on dating sites who demand “No baggage” of potential mates. Yet here was someone who loves his baggage and its many secret compartments (even when empty) and plumbs them for a living, I thought enviously, wondering if I should try to love mine more.

“So that’s it for the backpacks?” I said.

“Well, that’s as much as I’m going to show you,” he replied.

Later I asked Weisberg whether he still needed enemies or if therapy had cured him of all that. He said he’d never thought he had enemies in real life (this seemed like a 180!), then rethought the question: “There’s a lot of passion. And a lot of hatred. And, of course, a lot of judgment. And a lot of effort to destroy.” I could have said “Destroy what?” but left it there, thinking that, as with his riveting onscreen alter egos, people are most profusely themselves when their cover stories are a little glitchy.

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By [Hemal Jhaveri](#)

[Backchannel](#)

Nov 28, 2023 6:00 AM

# ***Rebel Moon* Director Zack Snyder on Violence, Loss, and Extreme Fandom**

The director manages to game the system and keep his soul while doing pretty much whatever he wants. Right now that means trying to make his *Rebel Moon* space opera into a Netflix mega-franchise.

Photograph: Dan Winters

more taxidermied animals live in Zack Snyder's office than seems normal. A lioness. A beaver. A duck. Also a wide collection of axes, swords, and guns—the weapons used to fell the wild beasts, maybe? The effect should be unsettling, but it isn't, because Snyder himself is warm, chatty, accommodating. And the space, tucked into a mountainside in Pasadena, California, turns out to be less a man cave than a fan cave: Snyder's shrine to his creative life. The swords and guns are merely props from his movies, like Babydoll's katanas from *Sucker Punch*. The photo of Wonder Woman above the sofa, where she's holding a few severed heads? Huge and sepia-toned, it's oddly alluring.

The Big Interview

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Being in Snyder's office, in fact, is a bit like watching one of his many stylized shockfests: The violence is so exaggerated it ends up feeling not only harmless, but fun. That is, of course, why his legions of fans show up. Think of the 300-style bloodbaths, the discomfiting opening of *Watchmen*. Or any number of scenes from the [director's cut of \*Justice League\*](#)—which,

at [four hours long](#) and wrapped up in tragedy both personal and professional, ranks among the most authentic, auteurist comic book movies to date.

Now, Snyder is adding to his canon of large-scale sci-fi with [Rebel Moon](#), a galaxy-spanning space opera about a band of misfit outlaws. His first franchise movie as a director since *Justice League*, the film marks the start of a new era for Snyder. Well, newish: It'll still be big, bloody, and violent. With comic book sagas no longer the assured juggernauts they once were, Snyder has an opportunity to move unencumbered by the chains of existing IP. *Rebel Moon* will launch on Netflix with a two-hour PG-13 version, to be followed at a later date by, yes, a three-hour, hard-R director's cut. This is the sweet spot, Snyder tells me. He's happy to play the studio game if it means he also gets what he wants.

It's a vision for his career he's happy to dig into, and we do, but as much as Snyder likes looking ahead, he also has a habit of flicking back to the past. As we talk, he jumps up repeatedly to show me one piece of memorabilia after another. We flip through the sleeves of a rare vinyl *Justice League* soundtrack (\$400 on eBay). We page through Snyder's carefully bound, unproduced screenplay for *The Fountainhead*. (We talk about Ayn Rand way more than expected.) Then it's on to the original storyboards for *Watchmen*, which are crisp, artfully clean. When we get to the scene where Rorschach fights the guys in the hallway, Snyder does a little *pink-pink-pink* sound as he mimes shooting a gun.

The longer we talk, the more old themes resurface, and by the time Snyder comes across his high school yearbook ("Never forget who you are and never neglect to express it," writes Mr. Brown, his algebra teacher), I am deep into a Snyder nostalgia tour—even as he insists he's not the nostalgic type. Somehow, I know what he means. Snyder is reflective about his career, but he's not weighed down by it. There's no Martin Scorsese-style hand-wringing about the old days of cinema or the sanctity of movie theaters. He just makes cool shit and wants to talk about it. Snyder is a businessman as much as he's an auteur, clear-eyed, calm. If there's violence in him, it's artfully buried.



**Hemal Jhaveri:** I want to take a minute to acknowledge that, for a lot of people, I am in the inner sanctum. [*Points to Wonder Woman photo on the wall.*] Holy moly. That is gorgeous.

**Zack Snyder:** That's the original. My friend Steve Berkman took this before we hired Patty [*Patty Jenkins, who directed the [two Wonder Woman films](#)*].

**Wow, do people know this exists?**

The dorks know it exists. When I started it, I wanted a Wonder Woman that was not necessarily naive. Not necessarily, like, a virgin. Actually, there's one line in the *Wonder Woman* movie that I originally wrote. When they're on the boat and talking about, like, the treatises on sexual pleasure, she says [*to Steve Trevor*], "You wouldn't like it because it concludes that men, though important for reproduction, are not necessary for pleasure." That was my contribution.

Zack Snyder at his home in Pasadena, California. Photograph: Dan Winters

***Rebel Moon* also has a strong female lead—Kora, this former soldier. Who is she, to you?**

The movie is not a naive fantasy. She's a soldier. The trauma of being a soldier is a big part of who she is, and the trauma is really a lot of what shapes her. She's a powerful female character, but she does have a lot of flaws. In this case, she's got a lot to discover about herself. She's powerful, she's savvy in the universe. But emotionally, that's where she needs to grow.

**Does she grow?**

There is this whole thing of her feeling unworthy of redemption, but she has a taste of it, and she gets to this place where she can live a life.

**What was crucial here about taking *Rebel Moon* to Netflix?**

They understood from the beginning, “Oh, you’re gonna want to do a director’s cut.” The director’s cut was a prerequisite for making the movie for the first time ever, so my joy at making the two-hour PG-13 version was much greater.

**Is there maybe even an advantage to having that separate PG-13 version?**

It allowed the R-rated version to be more out there. It’s an interesting, mythological sort of place that I have found for myself. The way I make the movies now is that I have this concept of the director’s cut. I think nearly every movie I’ve made, except for *Man of Steel*, has a director’s cut, maybe two director’s cuts. Unlike my friends who make movies—

**Name names.**

Well, like [Chris \[Nolan\]](#) and, I don’t know, maybe Todd Phillips. These are the people that I run into. Chris, as a filmmaker, is probably the person I would be closest to, as far as like, you know, calling them up.

**Is it because you both make really long movies?**

He produced *Man of Steel*. I worked with him closely through that process, and that kind of just bonded us.

**Sure, but how is it that you get to make two versions of your films while Christopher Nolan never gets to put out his extended cut of *Oppenheimer*?**

Well, and Chris doesn’t need to. I have cultivated this other system where I, in a lot of ways with the director’s cut, asked for more than I have any business asking for. I realized that there was a commodity in just, “You know what I really wanted to do?” Then I do that. It’s been my experience that all the director’s cuts I’ve ever done are considered better movies than the theatrical versions. Critics or whoever, they’re just like, “Well, the director’s cut is better.”

**That was certainly the case with *Justice League*.**

To be honest, I have never seen the theatrical Warner Bros. cut of *Justice League*. I've heard a lot about it. My wife [*the movie's producer, Deborah Snyder*] was forced to watch it.

**Has streaming changed how you make films, then?**

It's a different sort of vibe. On the streamer, though, you have to be careful with the opening of the movies because the barrier for entry is really easy. But also the barrier for leaving is very easy. The balance is a lot more difficult on a streamer than in a theater. I normally open the movies with a very hard opening, right? I want to break the barrier. All those movies, *Watchmen*, *Dawn of the Dead*, have very intense openings.

**You're clearly trying to unsettle people with your work.**

I am and I love it. I believe the most satisfying sort of cinematic journey is the one that you don't expect. It's the turn you didn't see coming. It's being a little uncomfortable or being taken to a place that you wouldn't normally get to.

**A common complaint about your movies is that they're always so dark and violent. Is that valid?**

Maybe, but it's just because that's the art I like, I guess? The things that make me excited or interested, it tends to be a little bit more hard-hitting. My favorite movies, you know, really kind of fucked me up.

**Speaking of, I see a lot of katanas and axes on the wall. There's also, like, a bearskin over there.**

That's a lion.

**Oh my God.**

[*Snyder gets up and we walk over to it.*] I pulled her out of a dumpster. We found her, and she was behind this woodshop.

**So you didn't skin her yourself.**

I didn't, no. They had thrown it away. And I was like, wow, this is so rude. You put a lioness in the trash? I pulled it out and I found another taxidermist, had it cleaned and washed and refelted and everything. So she has a second life.

**You also have a lot of guns.**

Those are fake. That's a prop. This musket is real. My wife got me this brown Bess, it's from the Revolutionary War.

**Do you think filmmaking has become too sanitized?**

I do. I do.

**You think we're getting a little too conservative?**

I do. But you know, movies cost a lot of money. It's hard to do.

**You're such a realist.**

The whole thing to me is like, how do I trick the system?

**So you're just gaming it.**

You have to game it. If you don't, you end up with nothing. You end up really having to bury your soul, you just rip your heart out. Then you put it on the auction block. You put the movie out, it becomes a consumer product. You yourself become a consumer product. That's the thing that I think can be really difficult for filmmakers. That's the price of the transaction. That can be painful.

Photograph: Dan Winters

**You had such a strong hold on the DC Extended Universe, you had your whole plan, and it didn't really work out the way you wanted it to—they've handed the keys over to James Gunn. How do you process letting something that was so meaningful to you go?**

The big, the most cathartic thing was *Justice League*. My *Justice League* experience was the hardest in what was happening with me personally and what was happening professionally. All of it was really painful and difficult and made me wonder about the why of the whole thing. Like, what's the end game?

There was a real crisis. Like, I was trying to make something as best I can. I was called upon for a skill set, but in the end there was all that second-guessing. Also in my personal life, I'm confronted with, you know, probably the most painful thing I can think of.

**Your daughter Autumn's death by suicide. Which happened at the tail end of *Justice League*, right?**

Yeah, during postproduction, and I found no solace in the work. The life I created for myself was of no comfort to this other experience. You know, if we're honest with ourselves, in what we pursue, we hope that pursuit will have some catharsis for us in the struggles that we have in our lives. And I just think that was the darkest time, because I felt like I turned to the thing that I love and it turned its back on me as well.

**Do you mean the work wasn't giving you solace? Or are you referring to your relationship with the studio?**

I think it might have been the studio, but also it was the work itself. Where I was with the project, and my relationship with the studio, that experience offered me nothing. Any kind of healing was impossible, and so therefore I had no interest in continuing with it.

That was a real break for me. You live under this illusion that your art, and the way you express yourself, is a kind of therapy that you can always rely on. And then when the rubber hits the road, you're like, oh, no, it's not helpful at all.

**Grief is deeply debilitating. What actually brought you back to moviemaking?**

The fan movement of wanting to know what *Justice League* was supposed to be, that was cathartic. Because [the making of *Justice League*] was that exact same thing that had betrayed me. And then being able to dedicate the movie to Autumn.

**Let me pull at that thread, because your name now is associated with the downsides of extreme fandom. These days, internet shorthand for aggressive bullying in fandom is, like, “Snyder Cut fans”—many of whom actually were harassing people and posting vitriol online.**

Look, there’s tons of toxic fans, and I don’t condone that behavior. But for every toxic fan, there were legitimate and ridiculous and really, incredibly dark attacks on me, my family. I’m not justifying any bad behavior, but also, I’m in this conversation with this fandom, where I have tried to make the work as best I can.

**On top of everything, your work is so polarizing. Nearly every article about you says something to the effect of, “whether you love or hate his movies.” How do you make sense of that?**

It’s weird that people care that much. That they would hate the movies. I’m more interested in the analysis of what draws that kind of ire. The fandom has emerged in this strong way. They’re not casual. I make movies with the motivation to create something for the fans where they get to care about it as much as possible. That’s the sort of bargain that I’ve struck.

**Are you somebody who’s hopeful about the future?**

Very much so. Yeah, very, very hopeful. I try to live for the moment as much as I can, but I really—I’m always excited.

**It sounds like you’ve figured out how to exist as an artist while still understanding the commercial nature of what it is you do.**

I think that a lot of people don’t realize that there’s kind of two worlds that exist for us. It really has taken a while for me to really understand that. You can have it both ways and not compromise one way or the other. You know what I mean?

**I think so, yeah ...**

Do you see *The Fountainhead* over there? My way is not the Howard Roark-ian way of doing it. [*Snyder gets back up and grabs a beautiful custom-bound copy of his unproduced Fountainhead screenplay. It looks very, very long.*] Do you know the Ayn Rand novel?

**I know it.**

Howard Roark would never have built two buildings. One for you, one for me. He's about no compromises. To make a studio movie is a compromise. But I've gotten to this place where I can, wide-eyed, create a bespoke experience for two different markets at the same time. I don't know of any other filmmaker who can do it. I can do both.

Zack Snyder at his home in Pasadena, California. Photograph: Dan Winters

**Are you still interested in theatrical releases?**

I am. I don't know that having a movie in the theaters necessarily serves a streaming release. I think the verdict is out on that.

**What's your verdict?**

I don't think it does. But I do think, obviously, if you make a movie for the theaters, that's an incredible experience. I saw *Barbie* in the theater. I saw *Oppenheimer*. Those were great. I want to do that. I like that.

**You seem to have no work-life balance.**

There is no work-life balance. Absolutely you're right. Deb and I don't try for it.

**Don't you ever feel the need to tap out for a little while?**

I haven't yet.

**Your wife said that she nudged you in the direction of pottery.**

Yeah, I was playing too much *Fortnite*. I'm pretty good at *Fortnite*, actually. But it was also, you know, 3 in the morning, and my wife is like, "Are you seriously playing *Fortnite* at 3 in the morning against some 12-year-olds?"

### **Do they know that you're Zack Snyder?**

No, I don't think so. My skin is Mr. Meeseeks, from *Rick and Morty*. Anyway, if you've been killed by Meeseeks, that could have been Zack Snyder.

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*This article appears in the December 2023/January 2024 issue. [Subscribe now](#).*

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[Andy Greenberg](#)

[Backchannel](#)

Nov 14, 2023 6:00 AM

# The Mirai Confessions: Three Young Hackers Who Built a Web-Killing Monster Finally Tell Their Story

Netflix, Spotify, Twitter, PayPal, Slack. All down for millions of people. How a group of teen friends plunged into an underworld of cybercrime and broke the internet—then went to work for the FBI.

ILLUSTRATION: JAMES JUNK, MATTHEW MILLER; GETTY IMAGES

Early in the morning on October 21, 2016, Scott Shapiro got out of bed, opened his Dell laptop to read the day's news, and found that the internet was broken.

Not *his* internet, though at first it struck Shapiro that way as he checked and double-checked his computer's Wi-Fi connection and his router. *The* internet.

This article appears in the December 2023/January 2024 issue. [Subscribe to WIRED](#). Illustration: James Junk and Matthew Miller

The *New York Times* website was offline, as was Twitter. So too were the websites of *The Guardian*, *The Wall Street Journal*, CNN, the BBC, and Fox News. (And WIRED.) When Twitter intermittently sputtered back online, users cataloged an alarming, untold number of other digital services that were also victims of the outage. [Amazon](#), [Spotify](#), [Reddit](#), [PayPal](#), [Airbnb](#), [Slack](#), SoundCloud, [HBO](#), and [Netflix](#) were all, to varying degrees,

crippled for most of the East Coast of the United States and other patches of the country.

Shapiro, a very online professor at Yale Law School who was teaching a new class on cyber conflict that year, found the blackout deeply disorienting and isolating. A presidential election unlike any other in US history loomed in just under three weeks. “October surprises” seemed to be piling up: Earlier that month, US intelligence agencies had jointly announced that hacker breaches of the Democratic National Committee and Hillary Clinton’s presidential campaign had in fact been carried out by the Russian government. Meanwhile, Julian Assange’s [WikiLeaks](#) had been publishing the leaked emails from those hacks, pounding out a drumbeat of scandalous headlines. Spooked cybersecurity analysts feared that a more climactic cyberattack might strike on Election Day itself, throwing the country into chaos.

Those anxieties had been acutely primed just a month earlier by a [blog post](#) written by the famed cryptographer and security guru Bruce Schneier. It was titled “Someone Is Learning How to Take Down the Internet.”

“Over the past year or two, someone has been probing the defenses of the companies that run critical pieces of the internet,” Schneier, one of the most highly respected voices in the cybersecurity community, had warned. He described how an unknown force appeared to be repeatedly barraging this key infrastructure with relentless waves of malicious traffic at a scale that had never been seen before. “These probes take the form of precisely calibrated attacks designed to determine exactly how well these companies can defend themselves, and what would be required to take them down. We don’t know who is doing this, but it feels like a large nation-state. China or Russia would be my first guesses.”

Now it seemed to Shapiro that Schneier’s warning was coming to fruition, right on schedule. “This is *the attack*,” he remembers thinking. Was it “the big one?” he asked himself. Or was it perhaps a test for the true “big one” that would hit on November 8? “Obviously, it has to be a nation-state,” Shapiro thought. “It has to be the Russians.”

For Shapiro, the internet outage was a kind of turning point: In the months and years that followed, he would become obsessed with trying to understand how someone could simply stamp out such a large swath of digital connectivity across the world, who would do such a thing, and why. But meanwhile, a little less than 500 miles west of Shapiro's Connecticut home, in the town of Washington, Pennsylvania, another sort of observer was watching the attack unfold.

After a typical sleepless night at his keyboard, 19-year-old Josiah White sat staring at the three flatscreen monitors he'd set up on a workbench in a messy basement storage area connected to the bedroom he shared with his brother in their parents' house. He was surrounded by computer equipment—old hard drives and a friend's desktop machine he had offered to fix—and boxes of his family's toys and Christmas tree ornaments.

For weeks, a cyber weapon that he'd built with two of his young friends, Paras Jha and Dalton Norman, had wreaked havoc across the internet, blasting victims offline in one unprecedented attack after another. As the damage mounted, Josiah had grown accustomed to the thrills, the anxiety, the guilt, the sense that it had all gotten so absurdly out of hand—and the thought that he was now probably being hunted by law enforcement agencies around the world.

He'd reached a state of numbness, compartmentalizing his dread even as he read Bruce Schneier's doomsday post and understood that it was describing his own work—and now, even as a White House press secretary assured reporters in a streamed press conference that the Department of Homeland Security was investigating the mass outage that had resulted directly from his actions.

But what Josiah remembers feeling above all else was simply awe—awe at the scale and chaotic power of the Frankenstein's monster that he and his friends had unleashed. Awe at how thoroughly it had now escaped their control. Awe that the internet itself was being shaken to its foundations by this thing that three young hackers had built in a flurry of adolescent emotions, whims, rivalries, rationalizations, and mistakes. A thing called Mirai.

# Part One

Illustration: Joonho Ko

None of the three young men who built Mirai fit the profile of a cybercriminal, least of all Josiah White, who could lay perhaps the most direct claim to being its inventor. Josiah had grown up in a rural county an hour south of Pittsburgh. He was the youngest of four children in a close-knit Christian family, all homeschooled, as his mom put it, to better “find out how God had created them and what he had created them to pursue.” She describes the thin, dark-haired baby of the family as a stubborn and independent but unusually kind child, who would sit beside the new kid in Sunday school to make them feel welcome.

Josiah’s father was an engineer turned insurance salesman, and the family lived in a fixer-upper surrounded by woods and farmland. As early as he can remember, Josiah followed his father around the house while he tinkered and made repairs. In 2002, when he was 5, Josiah was delighted to receive for Christmas the components of an electrical socket. Later his parents gave him a book called *101 Electronics Projects*, and he would beg his mother to drive him to RadioShack, arriving with a shopping list of breadboard componentry. Before he was 10, he was advising his father on how to wire three-way switches.

Josiah’s father would take him along to their church’s “car ministry,” where they’d repair congregants’ cars for free and refurbish donated vehicles for missionaries. Josiah would stand in the corner of the shop, waiting for the foreman to give him a task, like reassembling a car’s broken water pump.

Josiah reveled in impressing the adults with his technical abilities. But he was always drawn to computers, cleaner and more logical than any car component. “You give it an input, you get an output,” he says. “It’s something that gave me more control.” After years of vying for time on his family’s computer, he got his own PC when he was close to his 13th birthday, a tower with a Pentium III processor.

Around the same time, Josiah's brother, seven years older than him, figured out how to reprogram cell phones so they could be transferred from one telephone carrier to another. Josiah's brother started to perform this kind of unlocking as a service, and soon it was so in demand that their father used it to launch a computer repair business.

By the time he was 15, Josiah would work in the family's shop after school, setting up Windows for customers and installing antivirus software on their machines. From there, he got curious about how HTML worked, then began teaching himself to program, then started exploring web-hosting and network protocols and learning Visual Basic.

As wholesome as Josiah's childhood was, he felt at times that he was being raised "on rails," as he puts it, shepherded from homeschooling to church to the family computer shop. But the only rules he really chafed against were those set by his mother to limit his computer time or force him to earn internet access through schoolwork and household chores. Eventually, on these points, she gave up. "I sort of wore her out," he says. She relented in part because a hands-on understanding of the minutiae of computing was quickly becoming essential to the family business. Josiah, now with near-unlimited computer time, dreamed of a day when he'd use his skills to start a business of his own, just as his brother had.

In fact, like most kids his age, much of Josiah's time at the keyboard was spent on games. One of them was called *Uplink*. In it, the protagonist is a freelance hacker who can choose between two warring online movements, each of which has built a powerful piece of self-spreading code. One hacker group is bent on using its creation to destroy the internet. The other on stopping them. Josiah, not the sort of kid to do things in half measures, played through the game on both sides.

Illustrations: Joonho Ko

immersing himself in that cyberpunk simulation—and learning about famous hackers like Apple cofounder Steve Wozniak and Kevin Mitnick, who had evaded the FBI in a cat-and-mouse pursuit in the 1990s—cultivated in Josiah's teenage mind a notion of hacking as a kind of secret, countercultural craft. The challenge of understanding technical systems

better than even their designers appealed to him. So did the subversive, exploratory freedom it offered to a teenager with strict Christian parents. When he googled a few hacking terms to learn more, he ended up on a site called Hack Forums, a free-for-all of young digital misfits: innocent explorers, wannabes, and full-blown delinquents, all vying for clout and money.

On the internet of 2011, the most basic trick in the playbook of every unskilled hacker was the denial-of-service attack, a brute-force technique that exploits a kind of eternal, fundamental limitation of the internet: Write a program that can send enough junk data at an internet-connected computer, and you can knock it offline.

The previous year, for instance, the hacker group Anonymous had responded to the refusal by Visa, Mastercard, PayPal, and Bank of America to allow donations to WikiLeaks by urging its plebes to bombard the companies' servers with data requests, creating so-called distributed denial-of-service attacks that briefly took down the companies' online services. But most DDoS attacks were less principled: the constant AK-47 cross fire of the cybercriminal internet's internecine wars and vandalism.

On Hack Forums, many hackers ran their own "booter" services that, for a few dollars a month, would launch denial-of-service attacks against anyone a customer chose—often online gaming services, to troll or sabotage rival players. Users and admins of booters talked casually of "hitting off" targets, or worse, "holding off" a service or a single user's connection, repeatedly bombarding it to prevent it from coming back online.

Some booters launched attacks from botnets, collections of thousands of unwitting users' PCs, hijacked with hidden malware to form a lemming-like swarm of machines pummeling a target with data. Other booters used "reflection" or "amplification" attacks: If a hacker could find an online service that would respond to a query by sending back a larger chunk of data than the request itself, they could spoof the origin of their question so the service would send its answer to a victim. By bouncing a stream of thousands of questions off a server, the hacker could bombard the victim with its responses and vastly multiply their attack's firepower.

Josiah, fascinated by the cleverness of those tricks, was naturally determined to understand them at their deepest level. He stumbled upon a blog post from a cybersecurity blogger describing a reflection attack that used the servers of the online first-person-shooter game *Quake III Arena*. Ping them with a simple “getinfo” or “getstatus” request, and the servers would send back information that included the usernames of the players on the server and the map of the level they were playing on—an answer that was nearly 10 times as big as the question and could be directed at any spoofed IP address a hacker chose.

The post was intended as a warning. It cautioned that this kind of attack could be used to take down a service with as much as 23 megabits per second of bandwidth, a pipe that seemed enormous to Josiah on his 1.5-megabits-per-second home DSL connection. A competent programmer exploiting the problem, the blog post’s author wrote, “can easily create a full-fledged attack suite in a lazy afternoon.”

Josiah took this as a challenge. He cobbled together a simple script to perform the attack and posted it to Hack Forums under his handle, “Ohnoes1479.” He asked only for anyone who used it to give him an upvote “if its good ☺” to increase the prestige of his forum profile.

Josiah didn’t think too much about the morality of his creation. After all, it took a computer offline only temporarily, right? More of a mischievous hiccup than a crime, he figured. He couldn’t use it himself anyway, because his home internet connection didn’t allow the IP spoofing the attack required. Still, as other hackers on the forum—some of whom he suspected ran their own booter services—asked questions about how to use the program and even requested feature updates, he was happy to help.

Mostly, like the technical wunderkind he’d once been in his church’s auto shop, he aimed to impress. “I wanted to make something cool,” he says. “And I wanted respect.”

in that anarchic Hack Forums scene, Josiah soon found a kindred spirit, a user who called himself “moldjelly.” In the offline world, his name was Dalton Norman. He was a teenage hacker just a year older than Josiah who was far more in touch with his rebellious side.

Like Josiah, Dalton had grown up with an engineer for a father. His dad led the maintenance team for a skyscraper in New Orleans, where the family lived. And like Josiah, Dalton had a natural technical talent. As a preteen, he wrote cheating mods for video games that he presented on his own YouTube channel in a squeaky voice. He and his father would work in their spare time on his dad's souped-up Chevrolet Monte Carlo, which had so much horsepower that Dalton remembers the feeling of its exterior twisting as it accelerated. He says he inherited that same drive to push technology to its limits.

But far more than Josiah's, Dalton's childhood was tinged with adversity. As a small child, he had struggled with a stutter that deeply scarred him. He remembers his family laughing at him at the dinner table as he labored in vain to pronounce his younger sister's name. "It was awful and kind of contributed to me just being in my room and having low self-esteem and trying to raise it by being super good at something," Dalton says.

By the end of elementary school, to Dalton's relief, the stutter had faded away. But just as it seemed like he might enjoy a normal adolescence, his life was disrupted by misfortune on a far larger scale: Hurricane Katrina. Dalton's family evacuated to Mississippi and didn't return for more than five years. In exile one state over, Dalton found himself at a "culty" Christian private school, where students prayed before class and, as he remembers it, a math teacher assured him that Barack Obama was the Antichrist. "When I wouldn't pray or do any of that," he says, "I would get shit for it."

Dalton wrote his first program when he was 12. It was a spam tool that he used to torture a teacher he disliked, wrecking her inbox. He says he carried out his first denial-of-service attack not long after, targeting his school's network from within.

While connected to the school's Wi-Fi, he flooded its router with junk requests until the entire intranet collapsed. "It's easy to take down a network when you're inside of it," he says. Ironically, as Dalton describes it, he had gotten enough of a reputation for IT know-how that school staff asked for his help fixing the problem. He stopped his attack script, unplugged the router, plugged it back in, and showed the school



administrators that it magically worked again. During another attack, however, he says he overheated the router so badly in its poorly ventilated closet that it was fried.

In his early teens, he remembers watching *The Social Network* and taking exactly the wrong message from the movie: Rather than feeling cautioned by the film's fictionalized origin story of an icily amoral Mark Zuckerberg, Dalton was profoundly inspired. "That movie basically changed how I viewed the world," he says. "It's like, with a laptop and a great idea, you can take control of your life and build something cool."

After a failed attempt to launch his own social network—he had no idea how to gain users and no budget to advertise it—he returned to hacking: He wrote a keylogger program, designed to snoop on a victim's keystrokes after infecting their PC via thumb drive. He also found his way onto Hack Forums. Soon he was running his own booter service, hiring other hackers to handle customer service so he could focus on finding new methods to amplify his attack traffic.

It was around this time that Dalton encountered Josiah, who was, he says, the smartest hacker he'd ever met. The two teens soon moved off Hack Forums to talk regularly on Skype and then later TeamSpeak, another internet conferencing service. In those conversations, Dalton eventually used his real name, while Josiah went by "Joey," a thin veneer of a pseudonym. They enjoyed competing with each other to find new denial-of-service amplification tricks. In a friendly rivalry, they'd stay up into the early morning hours, plumbing the internet for eclectic servers that they could use to multiply their attack traffic dozens and eventually hundreds of times over.

In those late-night cyberattack sessions, the two hackers say, they would typically set up their own website for target practice, or use a friend's, so that they could measure the size of the traffic they were blasting at it. At times they would clock attacks of more than 100 gigabits a second, they say—more than 4,000 times as big as the 23-megabit attack that had initially amazed Josiah. Very often they would knock their target website offline, along with the server of the hosting service it ran on, causing downtime for an untold number of other websites too.

By this time, Josiah admits, he'd become mildly intoxicated by the power of the tools they'd learned to wield, though he still considered himself a kind of innocent, exploratory hacker. "I was stupid, and I was just angry sometimes, and I wanted to see damage, at points," he says. "But it wasn't my primary motivator—for a while."

Dalton, who was already running a for-profit attack service, had no such illusions of innocence and admits—a little proudly—to using his growing arsenal of booter artillery on any Hack Forums rival who sufficiently annoyed him. In some cases, he boasts, he would "hit people off so hard" that their internet service providers would cut the victim's connection for 24 hours to avoid further collateral damage. "It was a lot of power," he says. "If someone was bullying or being an asshole, then yeah, they went offline for a while."

Illustration: James Junk, Matthew Miller

both teenagers managed to hide these dalliances with illegal hacking from their families. But for Dalton, the consequences soon spilled violently into his physical world.

It began when he discovered that someone who worked for his booter service, an older kid to whom he'd foolishly given his real name, had been stealing their profits. He fired the guy. A few days later, Dalton and his family were sitting around the dinner table when a team of police officers in bulletproof vests burst through the door, screaming at everyone to get on the ground. The cops pointed shotguns at Dalton and his terrified parents and siblings, barking orders and questions.

It turned out that the police had received a spoofed 911 call. The caller had warned that Dalton had shot his mother and was now holding the rest of the family hostage. Dalton had been "swatted," targeted with the most dangerous retaliatory measure in the toolkit of nihilist teen hackers. When the police realized there was no hostage crisis, Dalton explained to the cops and his parents that an angry kid online had inflicted this situation on them—leaving out the part about his booter service. As a measure of the skewed risk assessments of his teenager's brain, his biggest fear during the entire incident was how his furious parents would punish him. He was grounded.

Dalton says the real lesson he drew from the incident was to tighten his operational security, no longer telling anyone in the hacking world his real name—except Josiah. “I trusted no one except for Joey,” he says.

In the midst of all this, when Dalton was 15, another kind of calamity struck: His stutter came back. He says it happened when he met another stutterer at his high school. Somehow, the event triggered his brain to start tripping up his speech all over again. And the change seemed to be permanent. All the difficulty he’d had speaking as a small child, along with all the anxiety and shame that came with it, flooded back. It was, he says, “a nightmare.”

Like many stutterers, Dalton found workarounds for the arbitrary lexicon of words that would halt his speech, substituting others to hide his disability. But names, which allowed no substitutions, were particularly tough. At one point, to get out of gym class, he volunteered with his high school’s tech office and found that the job included delivering laptops to students. He remembers standing in front of a classroom trying to say a student’s name as the entire class laughed at him. Even his own name was often impossible to get out. “It broke me,” he says. “But afterward, I was just like, ‘I don’t care what other people think. Fuck it.’”

Dalton’s stutter, he says, drove him into cybercrime with a renewed fervor. He cut ties with real-world friends, retreated to his computer, and focused his energy on hacking. His skewed teenage logic kicked in again, telling him to abandon any hope of a normal life or legitimate career. “I thought, ‘No one’s gonna hire me because I can’t talk. How am I going to get past an interview when I can barely say my name?’” Dalton remembers.

He had, he told himself, no other option. “I have to find a way to make this blackhat thing work out.”

Of the Three young hackers who would go on, together, to be responsible for the biggest DDoS attacks in history, Paras Jha came to that path from the most innocent and childlike place of all: a love of *Minecraft*.

Born in Mumbai, Paras was less than a year old when his family emigrated to the US, where they eventually settled near central New Jersey. His

parents demanded academic perfection, and Paras was gifted enough to easily deliver. Too easily, in fact: For years of elementary and middle school, he would read entire textbooks as soon as he got them, he says, then never study them again and ace every test.

At the same time, Paras was aware that he had a paradoxical problem with focus. He remembers being in third grade and disassociating as a teacher spoke to him, tracing out her face in the air with his finger. That teacher later suggested to Paras' parents that he be tested for attention deficit disorder. Coming from a culture that stigmatized such a diagnosis, Paras says, his family was skeptical of the teacher's warning. His mother and father filled out the school's evaluation for learning disabilities; it came back negative, and he was never treated.

Over Skype, Josiah told the others that he was launching the attack. Across the internet, Paras could hear the tap of the Enter key on Josiah's keyboard. And the world stopped.

As Paras grew older, his scattered mental state meant he often forgot school assignments, and his strict parents would respond by grounding him. To pass the time, he gravitated to computers. His beloved video games were forbidden on weekdays, so he would spend hours playing with Microsoft's Visual Studio, teaching himself to program.

By his early years of high school, Paras had become obsessed with *Minecraft*, an immersive online world that essentially presents a blocky, lo-res, nearly infinite metaverse. More than playing the game, however, Paras was drawn to the possibilities of running his own *Minecraft* world on an online server. He would host mini-games of tag or capture the flag, endlessly tinkering with his server's code to modify the rules. He loved to join his own world, turn himself invisible, and then observe how players responded within the universe he controlled and changed at will. It was like watching 8-bit ants with human intelligence move around his very own ant farm.

Paras soon discovered he could make thousands of dollars using his coding skills to build modifications and mini-games for other *Minecraft* administrators. In fact, it turned out that the *Minecraft* ecosystem supported

its own surprisingly high-stakes industry. Players paid small fees for access to perks and upgrades on their favorite servers, and administrators of the most popular worlds within that decentralized metaverse made as much as six figures a year in revenue. All of that money meant this innocent-seeming industry had developed a surprisingly ruthless dark side. *Minecraft* servers came under constant barrage from booters' DDoS attacks, launched by aggrieved players, competitors, and trolls. Many paid thousands of dollars a month to DDoS protection firms that promised to filter or absorb the attack traffic.

One day, Paras found himself in a Skype group chat with an acquaintance who also ran a *Minecraft* server. This person was determined, for reasons Paras can no longer remember, to take down a particular rival's world. Paras read along as the acquaintance asked another member of the chat for help—a figure by the name of LiteSpeed, who had attained a certain infamy for his denial-of-service wizardry.

Josiah had changed his handle on Hack Forums from Ohnoes1479 to this less-cute moniker about nine months after he'd joined the site, and these days he carried himself online with significantly more swagger. He was happy to oblige.

Josiah, Paras, and a few friends all entered the target *Minecraft* world, apparating into its blocky landscape full of hundreds of other players' lo-res figures. Then, over Skype, now in a voice chat, Josiah told the others that he was launching the attack. Across the internet, Paras could hear the tap of the Enter key on Josiah's keyboard. And the world stopped.

Instead of going dark or returning an error message, the universe hosted on the server that Josiah had knocked offline simply froze, as each player was suddenly disconnected and confined to their own computer's splintered version of it. Paras marveled at how he could move through that world and see other players paralyzed where they stood, or floating in midair.

That frozen state lasted for 30 seconds before the world crashed entirely. To Paras, it was a hilarious magic trick. "It felt like a secret superpower almost," he says. "Even though it wasn't me who did it, it was cool to just be in the know about what's going on."

He became friendly with Josiah and found that this talented hacker was happy to take down practically any target server that Paras asked him to, mostly just for sheer amusement. Josiah also seemed to be surprisingly open to sharing his knowledge. Having moved on from the amplification attacks he and Dalton had experimented with early on, Josiah now carried out his attacks with a botnet of thousands of computers around the internet that he'd infected with his own malware, exploiting a security flaw in the web-hosting software phpMyAdmin to turn the underlying servers into his personal army.

Later Josiah would switch to wielding an even more powerful collection of Supermicro servers that he'd hacked via a vulnerability in their baseboard management controllers, chips meant to allow an administrator to remotely connect to a server and monitor its performance. The attacks he was triggering were soon so powerful that he and his friends had difficulty even gauging their strength: Everything they'd hit with it—the best-protected *Minecraft* servers, even their own measurement tools—would immediately fall offline.

Paras wanted this superpower too. Josiah was happy to help him troubleshoot his DDoS attack code and even offered thousands of computers from his own botnet for Paras to test it on. “Instead of just pressing the button, I wanted to say I had *made* the button,” says Paras. Soon he was a relatively sophisticated botnet herder with his own DDoS zombie horde.

By 10th grade, to his parents' dismay, Paras had begun to struggle in school as subjects became more complex and his disaffected-prodigy tactics reached their limits. But online, where he went by the handle “dreadiscool,” he embraced his new godlike capabilities with roguish abandon, knocking off targets on the slightest whim. He and another friend would even sometimes find the phone number for a company that hosted certain *Minecraft* servers, call their business line from a burner number, and verbally taunt them as Paras launched a DDoS attack that ripped their machines offline.

Somehow, the rule-following, high-achieving kid from a strict immigrant household had become a rampant online vandal. But at that point, Paras

says, it was never quite clear to him—or Josiah, or Dalton—how serious the consequences of their attacks might be. They were, after all, still just taking some computers off the internet, right? “Like, the servers come back online,” Paras says. “You wake up the next day and you go to school.”

At other times he would almost check himself, coming to grips with his spiraling behavior. He remembers sitting in the bathroom of his parents’ house just after taking down one of the biggest *Minecraft* servers, Hypixel, and realizing that if he kept going, he was bound, sooner or later, to get arrested. “Don’t get sucked into it,” he told himself. “Don’t get sucked into it.”

Illustration: Joonho Ko

paras got sucked into it. They all did. In particular, Josiah, the Christian homeschooler who’d once kidded himself that he was a harmless hacker-explorer or a Wozniak-style prankster, had taken a rapid, step-by-step slide into moneymaking cybercrime. Under his LiteSpeed handle, he’d begun selling his amplification techniques to known booter service operators for a few hundred dollars a customer, spending most of the money to rent servers in remote data centers to further his hacking. He reverse engineered Skype’s code to find ways of extracting users’ IP addresses, the identifiers for their home internet connections that could allow them to be directly DDoSed. Soon he was selling this IP-extraction tool on a per-use basis to his fellow hackers and booters.

When one of his friend’s would-be victims bragged that he couldn’t be hit offline because he had a dynamic IP address that changed every time he rebooted his home router, Josiah figured out he could use a traceroute command to see the IP address of every router between that target and his internet service provider. So he and the friend started hitting the computers farther upstream in that network, going after the bigger arteries that fed data to and from his computer instead of the capillaries that linked to his home machine, until all of those routers were unresponsive too. This indiscriminate tactic, as far as they could tell, took out the internet service for the target’s entire town, all just to prevent him from dodging their attack.

Each step, Josiah says, felt small enough that, like the mythical boiling frog, he barely noticed the change in moral temperature. He'd found something he was very good at—better than perhaps anyone he knew. And he wasn't, he told himself, carrying out hardcore cybercrime like breaching networks or stealing credit card data. Another Hack Forums user reassured him that the FBI cared only about botnets bigger than 10,000 computers, a story he naively accepted. "I rationalized a lot of it away," Josiah says. "The pot was boiling."

in early 2014, when Josiah was still 16 years old, he dialed the temperature up another fateful degree with the creation of a powerful new form of botnet. It began when a friend pointed out to him that home routers, aside from making good targets for DDoS attacks, could themselves be hacked and potentially turned into botnets' zombie conscripts. In fact, many routers still used an old protocol called telnet that allowed administrators to remotely configure them, sometimes without the need for any authentication or else requiring only default credentials, like the password "admin." All those routers represented countless thousands of hackable devices, in other words, waiting to be taken over and added into Josiah's army.

The catch was that the routers were small, simple gadgets that used cheap, low-performance embedded-device chips—not the kind of system that most hackers were accustomed to exploiting. But Josiah was never one to be daunted by the task of learning the arcane details of a new machine. He started from scratch, learned to write the native language of routers' ARM chips, and built a compact piece of malware that could be installed over telnet onto the relatively dumb devices to make them obey his attack commands.

The routers' operating systems didn't normally allow software to be installed on them. But Josiah figured out that they did have an "echo" command that could write out any line of text that you typed into a new file. He used that command to copy his code, line by line, into a file small enough to fit into the routers' few megabytes of memory. The feat was the equivalent of assembling a model ship inside a 12-ounce bottle. He called the code Qbot.



Qbot was Josiah's first foray into hacking the so-called internet of things, the vast universe of internet-connected devices beyond traditional computers, from security camera systems to smart appliances, that would turn out to be ripe for exploitation. Even in this first, crude attempt, it was immediately clear that Qbot was a potent new weapon.

Josiah could see the power he'd stumbled into: There seemed to be many thousands of vulnerable routers online that Qbot could commandeer. He was initially more careful with this creation than he'd been with his previous coding projects, keeping Qbot's code private and sharing it only with his friends: Dalton, Paras, and a few other young hackers who had formed a loose network and hung out on Skype and TeamSpeak. But Josiah made the mistake of also giving the code to one other contact. The guy went by the name "vypor" and, Josiah says, had a reputation for trading in other hackers' secrets as a means of impressing more talented acquaintances. Vypor immediately began trading Qbot for favors and clout with, it soon seemed, his entire contact list.

When that betrayal became clear, Dalton retaliated on Josiah's behalf by hiring a rapper through the gig-work service Fiverr to record a profanity-laden track brutally mocking vypor's lack of coding skills. The diss track was uploaded to YouTube. Vypor immediately responded by threatening to swat all of them: Dalton, Josiah, even Paras, who had only recently joined the group.

All three of the young hackers were terrified of being swatted—or swatted again, in Dalton's case. They agreed that their best bet to protect themselves was to knock vypor offline and hold him off as long as possible. If he couldn't reach a VoIP service to spoof a call to the police, their short-term reasoning told them, he couldn't swat anyone. Maybe they could at least enjoy the weekend before he brought armed police to their doorsteps.

So all of them, together, bombed vypor with every DDoS tool they had. For days, they repeatedly hit not only his home connection but also routers two and three steps upstream, using Qbot and every other botnet and amplification technique they'd learned to wield. The three believe they probably blasted vypor's entire town off the internet, though they never got

confirmation aside from seeing the entire chain of network devices stop responding to their pings.

Regardless, the attack seemed to serve its purpose. Vypor disappeared from the scene and never bothered them again.

Illustration: Joonho Ko

allison nixon, who would become one of the first security researchers in the world to fully understand the dangers posed by weaponized routers and internet-of-things appliances, had no idea who Josiah White was. But she knew LiteSpeed.

At the beginning of her career in New York a few years earlier, Nixon had worked the night shift in the Security Operations Center of Dell's SecureWorks subsidiary, essentially as the cybersecurity equivalent of a patrolling night watchman. A petite, hoodie-wearing security analyst in her early twenties, she monitored the company's clients' networks for attacks in real time and investigated them just enough to know whether to escalate to someone more senior. "Kind of a grind," she remembers.

But she was curious about where all these daily, wide-ranging hacking attempts were coming from. So in the long stretches of downtime between alerts, she started googling and was amazed to discover Hack Forums, a platform on the open web where young digital deviants were bragging about their attacks and brazenly selling their toolkits. She found booter services especially shocking: how publicly, and cheaply, these miscreants sold a kind of cyberattack that could cost companies millions of dollars a year and often made her and her colleagues' lives hell. Many of the young hackers doing this damage could even be identified, thanks to their rash public posting, sloppy operational security, and the frequent "doxing" of rivals—digging up and outing another hacker's real identity. But no one seemed to be doing anything to stop them.

As Nixon lurked longer on the forum, she could see that most hackers on the site weren't actually developing their own techniques. Instead, almost all of their tools seemed to trickle down from just a few skilled individuals. LiteSpeed was one of them. His attack amplification tricks and bot infection

tools had established him as a kind of Hack Forums alpha, an unmistakable standout in the scrum. “Sometimes you kind of get a gut feeling when you’re tracking someone that they’re going to blow up in one way or another,” she says. “I knew I wanted to keep an eye on him.”

Nixon says the more senior researchers on SecureWorks’ counterthreat team had little interest in DDoS attacks, which were considered primitive compared to the cutting-edge intrusion methods that they focused on. But Nixon was fascinated by the anarchic *Lord of the Flies* world of young hackers building an entire cyberattack industry, seemingly with no repercussions or even notice from law enforcement.

Nixon partnered with a university researcher and began testing out booter services on Hack Forums, barraging a guinea-pig target server with waves of junk traffic. Some of the attacks topped 30 gigabits a second, easily enough to knock someone offline or cripple a website.

By 2014, Nixon had quit the security operations center and taken a job hunting hackers full time, but she couldn’t let go of her DDoS obsession. At a meeting in Pittsburgh of cybercrime fighters, called the National Cyber-Forensics and Training Alliance, she stood before a room of several dozen researchers, academics, and law enforcement officials. With the participation of an internet service provider that had just presented its DDoS protection plan, she demonstrated that she could click a button on a booter website and launch a cyberattack at will—a daring move in front of a crowd of federal agents and prosecutors.

One agent from the FBI’s Pittsburgh field office, named Elliott Peterson—a former Marine from Alaska who’d recently led the landmark takedown of a Russian-origin cybercriminal malware and botnet known as GameOver Zeus—was particularly impressed. He and Nixon talked about the booter problem. She pointed out how freely the services operated, how many of the culprits were identifiable, and how powerful any intervention in that world might be. And she shared her growing sense that, if the larger problem were left unchecked, it would pose a serious threat to the operation of the internet.

for Josiah, the conflict with Vypor was a wake-up call. He felt he'd narrowly avoided watching his secret hacking hobby burst into his peaceful family life. For more than a year, he backed away from Hack Forums and let his LiteSpeed handle go dormant. But he continued to chat with his friends Paras and Dalton, and the three of them began sharing a rented server for coding experiments and internet scanning, which they referred to as the Fun Box.

Paras, meanwhile, continued his free fall into hacker nihilism. In the fall of 2014, he started college at Rutgers and found himself alone and unmoored. He had looked forward to delving into the study of computer science and was appalled to learn that he would have to enroll in other kinds of courses that, to him, seemed like months of wasted time and tuition. Even the computer science exams, to his horror, had to be taken with pencil and paper. "I absolutely hate college," he texted a friend. "There is absolutely nothing for me here."

He sank into a malaise and gained weight, sometimes eating a large Papa John's pizza in one sitting. He couldn't sleep at night and often couldn't find the motivation to get out of bed, much less go to class. Aside from his roommate, he had little social contact in the real world—certainly nothing that could compare to the rich, battle-tested friendships he'd built online.

"We'll do it a few times," Josiah remembers thinking. "We'll cause trouble for a little bit, and then we'll just forget about it. We'll stop."

Paras was particularly frustrated to find he couldn't even get into some of the computer science courses he wanted to register for: Third- and fourth-years got first dibs, and only once their registration round was over did second- and first-years get a chance to choose from the leftovers.

But Paras soon realized he had just the superpower to right this injustice: He could use one of his botnets, built mostly of vulnerable home routers, to blast the entire registration system offline until it was his turn.

He took a trollish delight in tormenting the institution that he felt was tormenting him. Under the Twitter handle @ogexfocus, accompanied by a picture of a ghostly mask, Paras publicly taunted his target. "Rutgers IT

department is a joke,” he wrote in a public manifesto, bragging, after three attacks in succession, about crushing the university’s network “like a tin can under the heel of my boot ... I’m fairly certain I could run circles around all of you with my eyes closed and one leg amputated.”

When dreaded exams rolled around, he tore down Rutgers’ network again to delay them, buying himself a few more days of miserable procrastination. Later, he took the network down to prevent his parents from seeing his increasingly horrendous grades. “I was feeling very frustrated—I guess with myself—and lashing out,” he says.

On one occasion in the spring of 2015, Paras totaled the Rutgers network so thoroughly that he had to text Josiah to ask him to continue the attacks on his behalf. “Admiral can you execute my command?” he wrote in the jokey, naval-themed slang they’d developed. The outages persisted long enough that some Rutgers students later demanded a tuition refund.

Paras enjoyed the sense of control the attacks gave him, watching their cascading effects on the university the same way he’d invisibly watched players respond to his tweaks of *Minecraft* worlds years earlier. But when the attacks were over, his problems were still there. By his second year, it was clear to Paras that college wasn’t working for him.

Around the same time, he had started batting around an idea with Josiah that seemed like a way out: What if they founded their own startup offering DDoS protection, to defend paying customers from exactly the sort of attacks that they had become so expert at launching?

To Josiah, it made perfect sense. He understood DDoS attacks on a deep technical level—he had, in fact, built or at least used many of the attack tools that other DDoS protection firms were combating daily—and Paras had built a reputation as a skilled programmer, particularly among *Minecraft* server administrators, who might be a good initial customer base.

Paras borrowed \$10,000 from his father, and he and Josiah used it to cofound a company: ProTraf Solutions, short for “protected traffic.” They had seen other firms struggle to defend customers from new forms of DDoS, and they were sure they could do better.

It wasn't so simple. After launching ProTraf, they realized their potential customers didn't often shop around for DDoS protection. Typically, they didn't feel the need to switch providers unless the one they already had was failing to shield them from an attack, which occurred only rarely. Meanwhile, the bandwidth Josiah and Paras had rented on servers around the world—the cushion they would use to absorb attack traffic aimed at customers—was quickly eating through their capital.

Soon they came to an idea. Only when customers were actually knocked offline would they consider switching to ProTraf. Maybe the two young partners just needed to hurry this process along. “We could wait for one of these outages,” Josiah says, “or we could *cause* one of these outages.”

They agreed: They would use their own DDoS attacks to hit off their competitors' customers—just enough to get their own fully legitimate business on its feet, of course. “We'll do it a few times,” Josiah remembers thinking. “We'll cause trouble for a little bit, and then we'll just forget about it. We'll stop.”

Illustration: James Junk, Matthew Miller

Josiah and Paras began building the new attack botnet they'd use in what would become—whatever story they told themselves—a kind of DDoS protection racket.

The two teenagers used Josiah's old Qbot code to reinfect a new army of thousands of routers and started wielding it to target their rivals' clients—all *Minecraft* servers—easily obliterating their protections. For a while, this veiled extortion scheme actually worked. More than a dozen *Minecraft* administrators, desperate to get back online, did switch to ProTraf, paying \$150 or \$200 a month each.

It still wasn't enough. They'd expanded too quickly, buying infrastructure that was eating up their capital faster than their revenue could replenish it. And they found that when their attacks stopped, some customers switched back to their competitors—perhaps because they sensed that the attacks, timed so closely to the launch of this new startup, had been a little too convenient. “People had their suspicions,” Josiah says.

Josiah was still working at his family's computer repair business as he struggled to get ProTraf on its feet. When he wasn't helping customers there, he resorted to making phone calls to drum up sales. He figured if his father and brother could pitch customers and build a business, so could he. But no one who picked up the phone wanted to listen to this fast-talking teenager selling a mission-critical security service. The calls were dead ends, and Josiah came to loathe making them.

Just around a year after launching, in the late spring of 2016, ProTraf was flaming out. For Josiah in particular, the company's looming death was hard to accept. His parents had been so proud of his business ambitions: He seemed to be making good on his enormous potential, following in his family's entrepreneurial footsteps. Was he really going to admit that he'd already failed? He felt trapped and ashamed.

So Josiah began to consider other sources of cash flow. A friend from the hacker scene had been impressed with his rebuilt collection of Qbot-infected routers. He asked whether Josiah might be willing to build a new DDoS botnet. If so, he would have customers lined up to pay thousands of dollars in bitcoin for access to it.

Josiah suggested to Paras that they could accept the offer and build a new, even bigger botnet, renting slices of its attack power to the highest bidder in a last-ditch attempt to keep ProTraf alive. It would essentially mean turning the company from a protection racket into a front for their new, real business: selling cyberattacks as a service.

"Sounds ill ey gahl," Paras joked. *Sounds illegal.*

"Eh," Josiah wrote back. "Kinda."

Illustration: Joonho Ko

to build the chief weapon of their secret DDoS-for-hire sideline, Josiah and Paras started from scratch. A few years had passed since Qbot's creation, and they both had a few new ideas of how to infect and commandeer a vastly larger collection of internet-of-things devices.

In the time since Josiah's original Qbot code had leaked—thanks to Josiah's old friend vypor—the hacker community had been steadily upgrading it. Some versions had now been redesigned into “worms”: Infected routers would automatically scan for other vulnerable devices and try to hack and infect them, too, in a self-spreading cycle. But when Josiah and Paras examined those newer botnet systems, they seemed inefficient and unreliable. Someone else's hacked router was an unwieldy vantage point from which to find vulnerabilities in new machines. Plus, that decentralized setup made it slow and difficult to upgrade their bot software.

So instead, they designed a more centralized, three-step structure. Their infected machines would scan for other hackable devices—using a new system they say was as much as a hundred times faster than the bootleg Qbot worms they'd previously seen—and then report the vulnerable gadgets they found to a “loader” server, which would hack the machines via telnet to install their malware. Then a separate command-and-control server would shepherd those malware-infected bots, periodically sending new commands for which targets to attack.

Paras and Josiah were surprised to discover just how powerful this new automated zombie recruitment process turned out to be. Josiah remembers leaving the system running overnight and waking up to find 160,000 freshly brainwashed routers ready to do his bidding—far more than he'd ever controlled before.

When he saw the scale of what they were building, Josiah's plan—raise some money with a few cyberattacks, then return to ProTraf and go straight—began to seem like a wasted opportunity, a waste of his talents. “This is cool,” he remembers thinking. “This is innovative. No one else is doing this.”

As their botnet's size exploded, Josiah suggested to Paras that they would be able to rent even small fractions of their firepower to attackers for \$2,000 or \$3,000 a month, easily topping \$10,000 in monthly revenue.

“Lol,” Paras wrote back. “And how big does the armada have to be.”

“That wont be a problem,” Josiah responded.



seeing their botnet grow so deliriously large so quickly had now triggered in Josiah an old impulse, purer than any profit motive. “What are the limits here?” he began to ask himself. “How far can we spread this thing?”

Naturally, he turned to his old friend Dalton, who had always shared that urge to push the technological envelope. Josiah and Paras agreed to cut Dalton in on shared control of their growing creation, letting him sell access to a part of it through his own booter service. In return, Dalton would contribute his hacking skills to finding new populations of devices to add to their horde.

To maximize their malware’s footprint, Dalton began to plumb the teeming vulnerabilities of the internet of things. He dug up tens of thousands more gadgets across the world with unpatched flaws, machines that went far beyond home routers: Smart appliances such as online fridges, toasters, and light bulbs all became part of their agglomerated mass of raw computing power. All these eclectic digital objects had the advantage of being relatively greenfield territory. While countless hackers vied for control of traditional computing devices, like PCs and even routers, many of these newer devices remained untouched by malware and uncontested.

Surveillance cameras’ digital video recorder systems, with hardware capable of processing large video files, turned out to be especially strong new recruits. Some scans even turned up more exotic hackable devices, like internet-connected industrial cement mixers and municipal water utilities’ control systems. (The three hackers say they did avoid hacking those industrial devices for fear of being mistaken for cyberterrorists.)

They settled into a workflow. Dalton would scan for new species of exploitable devices and write code to infect them. Josiah would refine Dalton’s code and create software to take control of new additions to their menagerie of networked gadgets.

Paras, meanwhile, focused on the administration software that ran on their command-and-control server—its own complex programming task as their botnet grew to nearly 650,000 devices. He sensed that the scale of their creation would soon draw attention, and he took it upon himself to create a trail of misdirection to hide their identities from public scrutiny. To

advertise the botnet, Paras created new sock-puppet accounts with names like OGMemes and Ristorini on Hack Forums, Skype, Reddit, and Jabber. He then created a collection of fake “dox” linked to those handles—the posts that hackers typically use to out rivals’ real identities, but in this case all pointing at people whom Paras had chosen as patsies.

To make their connection to the botnet’s command-and-control server harder to trace, Josiah found a vulnerable server in France that they could hack and use as a jump point, connecting to that hacked machine only through the anonymity software Tor, which made it look like that computer’s owner was the real mastermind. The machine was actually a “seed box,” a server left online to continuously trade in pirated movies over the BitTorrent protocol.

The French server, in fact, was filled with anime videos, a subject Paras knew something about. He was a fan of the psychedelic animated Japanese show *Mirai Nikki*, in which a teenage outcast discovers he’s part of a battle royal among 12 owners of magical cell phones, and eventually—spoiler alert—uses his phone’s powers to become the god of all space and time. The show, Paras had texted a friend, “literally defines the genre of psychological thrillers.”

Paras knew that the file name for their program, now running on an ever-increasing base of hundreds of thousands of devices worldwide, would soon be a subject of notoriety. So in keeping with their work to pin the botnet’s creation on a random anime collector, he chose a suitable name. All the better that it also evoked a cyberpunk superweapon brought back to the present by a time-traveler, an instrument for which the world was wholly unprepared: *Mirai*. In Japanese, it meant “the future.”

to allison nixon and any other security researcher observing it from the outside, the advent of Mirai initially looked less like the rise of a new superpower than the start of a world war—one where the battlefield was the internet’s multitudes of insecure gadgets.

In 2014 and 2015, the years leading up to what she would call “the battle of the botnets,” Nixon began noticing that groups of nihilistic young blackhats with names like Lizard Squad and vDOS were picking up LiteSpeed’s

leaked Qbot code and then selling access to their own hordes of zombie devices, or using them to terrorize and extort online gaming services. So Nixon, who around this time started working at the security firm Flashpoint, created “honeypots”—internet-connected simulations of vulnerable devices designed to be infected by the hackers’ bot software, acting as her own spies amid the botnets’ ranks. The result was a real-time intelligence feed revealing the booters’ commands and intended targets.

It was in early September 2016, while monitoring those botnet honeypots, that Nixon and some colleagues spotted an intriguing new sample of code that was infecting routers and internet-of-things gadgets: the one the world would come to know as Mirai.

This new code seemed capable of detecting when it was running on a honeypot instead of a real device and would immediately terminate itself when it did. So Nixon and her coworker ordered a cheap DVR machine off of eBay, connected it to the internet, and watched the device—they nicknamed it the “sad DVR” due to its life of victimization—get infected over and over again by Mirai and its competitors.

In fact, unbeknownst to Nixon, Mirai’s creators were by then locked in an escalating turf war with vDOS, a competing botnet crew, which had built an especially large army of hacked machines using an updated version of Qbot. Both the Mirai and vDOS teams had designed their bot software to identify and kill any program that appeared to be their rivals’, and the two botnets began vying for control of hundreds of thousands of vulnerable machines, like warlords repeatedly conquering and reconquering the same strip of no-man’s-land.

Soon the Mirai crew and vDOS resorted to anonymously filing abuse complaints with the companies hosting each other’s command-and-control servers, forcing them to build new infrastructure. At one point, a company called BackConnect, which had been hosting Mirai’s server and was run by acquaintances of the Mirai team, came under a DDoS attack from the vDOS crew. To Nixon’s shock, BackConnect responded by using a so-called BGP hijack—the highly controversial tactic of essentially lying to other internet service providers to misdirect a wide swath of traffic—to effectively pull vDOS’s command-and-control server offline.

Soon, Paras, Josiah, and Dalton got tired of the endless tit for tat. They reprogrammed Mirai, allowing it to sever the telnet connections on the victim devices—thus making them harder to update but shutting out vDOS and any other rival from easily reinfecting those machines. That seemed to do the trick: To the Mirai team, it appeared vDOS had given up. (In reality, their adversaries had been questioned by law enforcement and later arrested.)

Nixon remembers the feeling she and her team of researchers had as they watched Mirai win that war and come to dominate the internet's mass of vulnerable devices. Once, that messy landscape had been infected with a rich diversity of malware species. Now, for the first time she had ever witnessed, all of that malevolent code seemed to go quiet as Mirai's superior infection techniques took hold of hundreds of thousands of networked devices across the globe. "From our perspective, it was like this new apex predator was prowling the savanna, and all of the other animals had disappeared," says Nixon. "From that point forward, we were on the hunt for this monster."

For much of the cybersecurity research community, the purpose of this gargantuan botnet still remained unclear. They couldn't know that Josiah, Dalton, and Paras had opened Mirai for business and put its services up for sale—that the monster Nixon was hunting was, itself, on the hunt for its first victims.

From left to right: Bruce Schneier, Elliott Peterson, Allison Nixon, Brian Krebs, and Scott Shapiro.

Illustration: James Junk, Matthew Miller

## Part Two

Illustration: Joonho Ko

For Brian Krebs, September 22, 2016, was an inconvenient day to become the target of the most powerful DDoS botnet in history.

A construction crew had been replacing the siding on Krebs' rural house in Northern Virginia all morning. The incessant hammering was freaking out his dog, who responded as if barbarians were laying siege to their home. Krebs worked as an independent investigative reporter and security researcher—one of the best known in the cybersecurity industry. He had no workplace to escape to. "I was already losing my mind," Krebs says.

It was only a little later that day, Krebs says, that it started to become clear that his dog was not wrong. He was, in fact, under siege. And the barbarians were winning.

Two nights before, Prolexic, the service that provided his DDoS protection, had warned him that something was amiss. His website, KrebsOnSecurity, had been hit with an attack that peaked at a mind-boggling 623 gigabits a second, according to Prolexic's measurements. The company had never seen an attack even half that big. But it had heroically managed to absorb the traffic, the Prolexic rep told Krebs, and his site had stayed online.

"Holy moly. Prolexic reports my site was just hit with the largest DDOS the internet has ever seen," Krebs tweeted that night. "Site's still up. #FAIL."

Krebs prided himself on his work hunting cybercriminals, a role in which he was nearly peerless in the world of journalism and one that had made him plenty of enemies. He'd been swatted by a target of his investigations and once had someone ship dark-web heroin to his house in an attempt to frame him. DDoS attacks from aggrieved subjects of his reporting were nothing new. But taunting the source of this particular attack, he now realized, had perhaps been ill-advised.

For two days, he continued to get notices from Prolexic that the massive DDoS was still going. In fact, whoever was barraging his server had

persistently switched tactics throughout that time, firing new forms of data designed to be harder for Prolexic to filter out, or targeting machines further upstream. “These guys were real bastards,” Krebs says. “They were throwing the kitchen sink.”

Amid all this, more than 36 hours after the attack had begun, a member of the work crew at Krebs’ house managed to kick his satellite dish, knocking out his home’s internet connection. He tried to tether his computer to his cell phone, but its bandwidth was too spotty. And the attack kept coming, an overwhelming, sustained tsunami of malicious ones and zeros.

Krebs was still struggling to get online on the afternoon of the 22nd when he got another call from Prolexic. This time the company told him, in polite but clear terms, that he’d better find a new source of DDoS protection. They were dropping him. One of the biggest DDoS defense firms in the world could no longer handle the scale of the data torrent barraging his site.

Krebs got in his car and drove to a local business’s parking lot to try to find a stable Wi-Fi connection for his laptop. From there, he called his web-hosting provider to warn that, without Prolexic’s layer of defense, it was about to get hit with an unfathomable wall of digital pain. He suggested that rather than allow all its customers to be taken offline, it should instead configure his website to point to a nonexistent IP address, essentially routing the attack traffic—and anyone trying to visit his site—into “a hole in the ground.”

The hosting company took his advice. [KrebsOnSecurity.com](http://KrebsOnSecurity.com) instantly dropped offline. It would remain that way for days to come, as Mirai loomed, seemingly ready to obliterate the site again the moment it resurfaced.

For Krebs, being successfully censored by cybercriminals was a wholly new experience. “Someone just took my site offline,” Krebs remembers marveling. “And there’s nothing I can do about it.”

Josiah, Dalton, and Paras had unlocked their superweapon, and already it seemed there was almost nothing on the internet that could withstand it.

When Krebs tweeted that his website had been hit with “the largest DDoS the internet has ever seen,” he was almost right. Mirai had actually struck the French internet provider OVH around the same time with an attack that had reached the even more shocking volume of a terabit per second. The botnet’s hundreds of thousands of hacked devices had also quietly KO’d a web-hosting firm and a *Minecraft* service in August with attacks that were nearly as large but had gone mostly unnoticed by the security world.

Within just a few months of launching their fully operational Death Star and making it available for hire, the three hackers—all still too young to legally drink alcohol—had assembled a small but devoted collection of clients. A fellow hacker who went by the handle “Drake” allegedly acted as a kind of sales rep: He would periodically hit off arbitrary targets as a form of marketing, to demonstrate Mirai’s bristling firepower to potential paying customers. One such patron, who claimed to be in Russia, had rented Mirai to launch attacks against rivals in the cybercriminal web-hosting world, knocking out his adversaries’ sites. Their most frequent user seemed to be a hacker in Brazil, who repeatedly and inexplicably rented access to Mirai to fire off attacks at the network of the Rio Olympics, at one point bombing it with more than a half-terabit per second of traffic.

Paras himself used Mirai a couple of times against his old whipping boy, the Rutgers IT department, mostly just for vengeful fun. On another occasion he briefly tried using it for straightforward extortion against one of their former ProTraf customers, slamming a *Minecraft* server with a Mirai attack and then demanding a bitcoin payment. In an attempt to make the connection to ProTraf less suspect, he even copied his own ProTraf email address as a recipient of the ransom note. The company didn’t pay. Josiah disapproved of Paras’ extortion attempt, and they never tried it again.

It was their Brazilian customer, Paras says, who had decided to DDoS Krebs into oblivion. Paras woke up that day, read news stories about the monumental attack on Krebs—by far the most high-profile Mirai victim to date—and instantly felt a mix of excitement and dread in the pit of his stomach. “This had better not have been our botnet,” he remembers thinking. He checked their user logs. “It was our freaking botnet.”

After the Brazilian's earlier attacks on the Olympics, Paras and Josiah had decided this user was perhaps a little too reckless in his targeting. They'd attempted to limit his access to Mirai, ending his sessions after just 10 minutes. But Paras saw that the nihilistic Brazilian had simply manually restarted the attack on Krebs' site again and again throughout the night—and he was still going.

Paras messaged Josiah and Dalton, and they jumped onto an emergency call on a private, encrypted VoIP server. They all agreed: Annihilating the website of a very well-known journalist had crossed the line beyond helpful marketing into a kind of attention they didn't need—the kind that got you arrested. “You don't want to poke the bear,” says Josiah. “This was a pretty big poke.”

By this point, too, they were all 19 or older. They were adults, carrying out an extremely visible criminal conspiracy. The heat Mirai was now bringing them, they began to realize, wasn't worth it. And despite all the chaos it had caused in its early months of life, Mirai had made only a small fraction of the money Josiah hoped it would: about \$14,000 worth of cryptocurrency in total. Even the biggest DDoS attacks in the world were, for their perpetrators, a relatively cheap commodity.

They had only just launched this world-shaking creation. Now they already needed an exit strategy. It was Paras who, a day or two later, suggested a new idea. Their “Russian” customer had, despite renting occasional access to Mirai, suggested to him that DDoS was a bad business. Not enough money. Far too noisy. He'd advised they instead consider partnering with him to use their botnet-building skills for a much stealthier and more lucrative opportunity: click fraud.

Put all those hijacked machines to use quietly clicking on pay-per-click web ads instead of pummeling victims, Paras explained, and they could make tens of thousands of dollars a month by invisibly defrauding advertisers, a far less disruptive form of cybercrime. Josiah and Dalton agreed they should start to transition away from the cyberattack-for-hire industry and into this more respectable black-market business.



But they couldn't quite bring themselves to kill their monster just yet. Instead, Paras and Josiah, who held more control of Mirai's targeting than Dalton, attempted to add the IP address for [KrebsonSecurity.com](http://KrebsonSecurity.com) to a block list that would at least end the attack—though they'd find in the days to come that their efforts to restrain their least predictable customer had failed again.

Regardless, by that point it was too late. Josiah was right. They had poked the bear. Now it was wide awake.

elliott peterson was sitting thousands of miles to the northwest in the FBI's Anchorage, Alaska, office when he read the news that Brian Krebs, a journalist whose work he knew well, had been wiped off the face of the web.

He was shocked to learn that an attack could hit Prolexic—a firm owned by the internet giant Akamai, whose entire business model depended on handling giant flows of traffic—so hard that it could essentially jam one of the biggest digital conduits in the world. And all to silence a journalist. Peterson knew that he'd just witnessed the start of a new era. “All of a sudden, the world woke up to the fact that someone's throwing around a terabit of traffic,” he says. “No one was ready for that.”

Two years had passed since Peterson had seen Allison Nixon's live booter demonstration at a Pittsburgh cybercrime conference. He'd since returned to his native Alaska, taken up an assignment at the FBI's smallest field office, and turned it into an unlikely hub for takedowns of botnet and booter operations. Just days earlier, he'd learned of the detainment in Israel of vDOS's two administrators, the rival hackers with whom the Mirai crew had recently been at war. Peterson had been involved in the investigation of vDOS for months. The resulting bust was, in fact, the real reason that Mirai had definitively won that rivalry.

Now Peterson was disturbed to see that the takedown had only cleared the field for someone wielding an even bigger weapon. He knew he would need to take on this case, too.

Working from his cubicle in the “cyber atrium”—a glass-roofed enclosure that houses the handful of FBI agents focused on cybercrime inside Anchorage’s brutalist, red-brick federal building—he started digging. He and Nixon had helped create an industry working group called [Big Pipes](#) that dealt with DDoS attacks, and he immediately learned from contacts there that Akamai had been hit by a mysterious new botnet called Mirai.

Even in the midst of Krebs’ unfolding crisis, Peterson understood that for the Anchorage office to take on this new monster, he’d first have to get over a legalistic hurdle: He needed to prove that either its victims or creators were in Alaska. Krebs and Akamai were thousands of miles away. So he realized that he would have to somehow find Mirai-infected devices in his own state. Luckily, by this point, there were hundreds of thousands of those infected devices online, a digital pandemic that reached nearly every country in the world.

Meanwhile, Peterson could only watch helplessly as Krebs’ website was held offline by Mirai for more than 48 hours. Only then did Krebs finally manage to get it back up with the help of a new DDoS defender: Google. The web giant had recently expanded a pro bono DDoS protection service called Project Shield to a wider array of users, and it was eager to prove that it could withstand the internet’s biggest attacks.

Within two hours of KrebsOnSecurity coming back up, it received another blast from Mirai. The site’s IP address had changed, Paras says, so his and Josiah’s block list didn’t prevent their Brazilian customer from relaunching his attack. But this time the site stayed online.

Google reached out to the FBI, and with Krebs’ permission, the company eventually shared a list of IPs that had been the sources of the Mirai attack traffic. Peterson and his four-person team began to comb through it. Sure enough, he could see in the data that Mirai had infected devices across Alaska, along with practically every other state in the country. He started tracking down the Alaskan device owners, trying to explain to them in phone calls that their routers and security camera systems had been unwittingly turned into cannon fodder. Finally, Peterson got a break: He managed to persuade the owner of a hunting lodge in the town of Ketchikan

to unplug its malware-infected security camera DVR and ship it to Anchorage to be dissected and used as evidence.

Peterson had found his Alaska victim. He launched an investigation to hunt for the hackers behind Mirai.

Illustration: Joonho Ko

after serving in the Marines but before joining the FBI, Elliott Peterson had served as a “dean of men” at a college in Michigan. In that job, he had helped kids with emotional problems and substance abuse issues, essentially acting as a guidance counselor and mentor. It was an unusual role for a future federal agent, but the two jobs reflected Peterson’s strange hybrid personality: half by-the-book, buzz-cut G-man, and half well-meaning, friendly Midwestern youth pastor.

Peterson brought that same peculiar cordiality into his Mirai manhunt. He began politely asking around among the Hack Forums crowd and their ilk, a scene he’d become familiar with over his years of tracking booter services: Who might know any of the pseudonymous hackers selling access to Mirai?

Not long after starting the investigation, his team in the Anchorage office got a lead on one good source. They’d managed to obtain a complete sample of the Mirai code from an infected device and found that it phoned home to a command-and-control server hosted by the DDoS mitigation firm BackConnect. Peterson knew that name. He’d been hunting the vDOS crew when BackConnect came under attack from Mirai’s rival; in an apparent act of self-defense, the company had used a BGP hijack to pull vDOS’s infrastructure offline—a rogue move that had nearly derailed Peterson’s vDOS investigation.

So he made a few calls to BackConnect’s management to ask about the company’s BGP hijack and the Mirai server they were hosting—which had since moved elsewhere—and whether they had any contact with whoever controlled it. BackConnect’s staff said they didn’t, but suggested someone who might: One of their acquaintances from a company called ProTraf Solutions, Paras Jha, seemed to have had contact with whoever was behind Mirai.

After all, Paras had received an extortion email from someone launching the Mirai attacks—neither Peterson nor BackConnect knew that Paras had sent that email himself—and they’d heard he’d chatted with a Mirai handler known as Ristorini.

So Peterson called ProTraf’s phone number and left a voicemail. Paras called him back. Peterson remembers that Paras matched his polite, friendly tone and calmly explained that yes, he had been in touch with Ristorini in online chats. But he had no idea of the real identity of the person who’d tried extorting one of his former customers.

Paras kept the conversation short but said he’d be sure to keep asking around and would be in touch soon to help in any way he could when he’d learned more. Then he hung up and immediately called Dalton and Josiah to tell them the FBI was on their trail.

this time, their emergency meeting was steeped in panic: They needed to ditch Mirai, *now*.

Dalton suggested they simply take down Mirai’s infrastructure, wipe the command-and-control and loader servers, and destroy the hard drive of every computer they’d ever used to manage it. “Lay as low as possible, kill the whole thing, shred our drives,” as he put it. Then they could quietly move on to their more promising click fraud business.

Paras had another idea: How about they release the Mirai source code into the wild? If they posted it publicly on Hack Forums, it would be adopted by every DDoS-happy hacker in the world, just as Qbot had once been. They could disappear into that crowd, making it vastly harder for this nosy Alaskan FBI agent or anyone else to identify the original Mirai amid the flood of copycat attacks.

Dalton vehemently disagreed. He argued that releasing the source code would only draw more attention to Mirai, cause more damage, and make law enforcement all the more intent on finding the botnet’s original creators.

The call devolved into a full-blown shouting match, the first the three friends had ever really had. Dalton screamed at Paras not to release the code. Paras remained unmoved. Josiah, meanwhile, listened impassively, stuck between his friends, unable to break the tie.

When they hung up, they had agreed that their Mirai adventure was over. But they remained split on what to do with its source code.

So Paras acted on his own. A couple of months earlier, he had created a new sock-puppet account on Hack Forums as another potential profile for Mirai's mastermind: He'd called this one Anna-Senpai, named after the villain of the Japanese animated show *Shimoneta*, or "Dirty Joke," in keeping with Mirai's anime-loving cover persona.

Now, in late September, he logged in again as Anna-Senpai to post a stunning announcement. "I made my money, there's lots of eyes looking at IOT now, so it's time to GTFO," he wrote. "So today, I have an amazing release for you." The post then linked to download pages for Mirai's source code, along with a tutorial detailing how anyone could use it to create their own massive, self-spreading, internet-of-things attack tool. He added in a separate post that Anna-Senpai was now on the run, fleeing their home in France for a non-extradition country.

Someone was using a copycat botnet to troll a video game company—and the collateral damage was the worst internet outage the world had ever seen.

Paras had just dumped the recipe for a superweapon into a mosh pit. Beyond throwing up a smoke screen to ward off the FBI, it was also a final, epic troll: a way to shake the internet ant farm, this time on a global scale, and watch the ants scramble.

The Hack Forums community responded accordingly, showering him with praise and admiring Mirai's polished programming. Several users wrote that it had to be the work of professionals, not the forum's typical teenage wannabes. "Your a fucking legend," one user wrote. "Leak of the year," wrote another.

Within days, one user responded that they'd successfully used the source code to create their own Mirai botnet of 30,000 devices. Another chimed in to say theirs had reached 86,000 machines. "The glorious copy paste will happen," wrote another appreciative hacker. "IoT botnets will spread like wildfire."

"Best haxoring tool of all time! Gonna take down eribody!" wrote another Hack Forums fan, summing up the gleeful mood. "I've always wanted a botnet that can DDoS de planet!"

Peterson was deeply dismayed to see the Mirai code dumped online, a move he saw as appallingly reckless. But rather than be thrown off, as Paras had intended, Peterson had the immediate thought: Had his poking around inspired this? Did his conversation with Paras have something to do with it?

Not long after Anna-Senpai's Mirai release, Peterson got another break in the case: Some university researchers working with the anti-DDoS group Big Pipes told him they'd found a clue in the logs of their honeypot machines, designed to monitor internet scanning. Two months earlier, on August 1, they'd been able to see that a kind of proto-Mirai scanning tool, perhaps the earliest version of the botnet's reconnaissance code, had probed their devices from a US-based IP address.

Peterson contacted the IP's hosting company to request the identity behind it and got a subscriber name: Josiah White. The other cofounder of ProTraf solutions.

The FBI agent called ProTraf again and this time spoke to Josiah on the phone, projecting his same friendly tone. Josiah, trying to sound professional but caught off guard by Peterson's discovery, nervously admitted that yes, he'd "done some scanning." Scanning the internet, after all, isn't a crime. Then he begged off answering any more questions and hung up the phone.

Peterson had been fascinated and even impressed by the Mirai team's operational security: the careful layering of proxies, the dead ends he reached as he traced those connections, the "doxes" he found for Mirai's handler accounts, all of which seemed to lead him astray. But now, just

weeks into his investigation, he knew that Josiah's early scanning slipup had allowed him to sidestep all of that obfuscation and misdirection. His team began sending a flurry of legal requests to the email and internet service providers for every account associated with the throwaway profiles Paras had created for Mirai, as well as those of Paras and Josiah themselves and ProTraf Solutions.

As Peterson dug through Hack Forums, he noticed, too, that there was another interesting account that sometimes chimed in on Anna-Senpai's posts—someone called Fireswap. Often they seemed to be defending Mirai's creators and taking shots at critics of their source code. So Peterson sent a legal request to Hack Forums for Fireswap's email address—fireswap1337@gmail.com—and then asked Google for that user's subscriber metadata.

Looking through logins on Fireswap's Google account, registered to someone named Bob Jenkins, he could see they came from the same VPN or proxy server IP address that had carefully been used to create the fake Mirai doxes—sometimes just minutes apart. But then, in some cases, “Jenkins” had a different IP: the same one that Paras had used to connect to his ProTraf email account.

Paras had never suspected that an investigator would think to look into the burner account he'd created solely to cheerlead for himself on Hack Forums and take swipes at detractors. Now it had become the missing link tying him to Mirai.

Peterson still hadn't heard of Dalton Norman. But he now believed he'd found Mirai's two creators. The end of their cybercriminal careers was already in sight. But the chaos they'd invited onto the internet was just beginning.

Illustration: James Junk, Matthew Miller

once it was fully unleashed and reproducing in the wild, Mirai didn't immediately break the internet. It took three weeks.

On the morning of October 21, 2016, Allison Nixon was just getting down to work in Flashpoint's office, an old garment factory on the desolate western edge of Midtown Manhattan, when a colleague pointed out to her that something was seriously wrong with the internet.

Specifically, its phone book was broken. The domain name system is the mechanism that translates human readable domain names into the IP addresses that actually route internet traffic to the computers where services are hosted. DNS is what allows you to remember "Google.com" instead of 2001:4860:4000:0:0:0:0:0, for instance, as the way to tell your browser to load up a search engine.

On that morning, the DNS of dozens of websites seemed to be crippled. Internet users across the US were typing names into browsers that needed to be translated into numbers, and the translators had been knocked out cold. "Something big is happening," Nixon remembers a colleague saying to her. "We need to figure out what's going on."

As Nixon's team tried sending DNS requests to some of the affected sites—the same sprawling collection of news sites, social media, streaming services, banking sites, and dozens of other major services that Scott Shapiro and millions of other users were trying in vain to reach—they saw that all the sites used the same New Hampshire-based DNS provider, [a firm called Dyn](#). Although it wasn't yet clear to Nixon at the time, no fewer than 175,000 websites were offline.

Searching for a root cause for this unfolding internet collapse, she checked the attack logs generated by her "sad" DVRs—by now her team had several of them serving as bait. Sure enough, she could see that a Mirai variant, one of the many copycats that had sprouted in the weeks since Paras leaked the source code, had been relentlessly bombarding the Dyn DNS server for Sony's PlayStation gaming network. The attack's effects had apparently spilled over to take down Dyn's entire DNS system. Someone was using their copycat botnet to troll a video game company—typical Hack Forums behavior—and the collateral damage was the worst internet outage the world had ever seen.



The nihilistic, teen-angst-fueled, mega-DDoS that Nixon had always warned about had finally arrived. “We had worked for such a long time in preparation for that day that it was kind of vindicating,” Nixon says. “On another level, it was super, *super* stressful.”

Shortly after the attack on Dyn started, Nixon managed to reach someone at Dyn and share the evidence pointing to Mirai, a suspect Dyn only had an inkling of until that point. Dyn staffers, at that moment, were anxious but still confident that they could handle the problem and get their servers back online.

It was around the same time, still before 9 am eastern, that Dyn truly began to implode.

DNS records are designed to work like a kind of hierarchical phone tree. Major services like Google and Comcast have their own DNS servers ready to answer computers requesting the IP address of a domain, and they only periodically check in with an “authoritative” DNS provider—in this case, Dyn—to make sure the addresses they’re handing out haven’t changed. Some services check in multiple times a minute, while others refer to their last update of DNS data for hours before refreshing it.

Within minutes of the Mirai attack striking, Dyn was already in trouble, as DNS servers set to check in every 15, 30, or 60 seconds for new DNS records pounded the company’s overwhelmed authoritative servers. When they didn’t get an answer, they’d ask again—and again and again. They were designed to *expect* answers, after all: An authoritative DNS provider as large as Dyn had never gone down before.

But as time passed and Dyn’s servers stayed down, the chorus of DNS requests began to include major services that check in only every hour. And then the ones that check in every two hours. And three. All now joining the mob incessantly hammering on Dyn’s doors. Some internet services had even designed their DNS systems to automatically spin up new DNS servers to ask for answers when their existing ones didn’t get a response, multiplying the barrage of queries.

“Once the cascading failure started, that’s when everyone got very, very nervous,” says one person who was working at Dyn on the day of the attack. “Before that, the graphs looked awkward, but they didn’t look catastrophic. But then they tipped over an edge as major services couldn’t get responses, and the numbers started shooting up to the right.”

The Mirai attack, in other words, had set off a chain reaction. The internet’s IP address directory system was DDoSing itself.

At the same time, Dyn began to experience a kind of parallel, human DDoS attack, as people began demanding answers in almost the same cascading structure. Angry corporate customers with comatose websites started bombarding Dyn’s phone lines. When management couldn’t answer their questions, they echoed them down the org chart to engineers who were already entirely overwhelmed. “When the ratio of management and client services people looking for answers versus the number of people who can provide any answers starts to explode,” the Dyn staffer remembers, “that’s when it really starts to feel like chaos.”

Compounding the problem was a coincidence of almost comic timing: A team of Dyn staffers was, on that very day, waiting for Oracle to sign the paperwork to close a deal to acquire their company, reportedly for more than \$600 million. No one wanted to be remembered as the middle manager who failed to keep the internet online on this momentous occasion—the first day that the new bosses were watching. And through all of this corporate panic ran an undercurrent of rumors that China or Russia was responsible, that they were up against an all-powerful state-sponsored hacking operation.

Josiah was walking through a dark hallway, still trying to get a shirt over his head, when he found a flashlight—and a gun—pointing at his face.

Those rumors were short-lived. So, by some measures, was the outage. By that afternoon, Dyn had managed to get the attack under control and had started sending DNS responses piecemeal to its clients, quieting the different networks clamoring for answers from its servers, one by one.

But the damage left in the wake of the Dyn outage lasted longer. The total economic cost of a major fraction of the global internet falling offline for half a day is difficult to measure. Sony, whose PlayStation Network was the attack's original target, reported an estimated net revenue loss of \$2.7 million. Following the attack, there were projections that, for a time, Dyn lost roughly 8 percent of its contracted web domains—more than 14,000 total—and millions in future revenue.

As Paras, Dalton, and Josiah watched a botnet built with their code break the internet's backbone, they had an array of reactions. Paras remembers being shocked that it was so easy: The Mirai clone that had carried out the attack had hit Dyn with fewer than 100,000 devices, just a fraction of the size of their original botnet. Dalton felt a grim "I told you so" sense of confirmation that he'd been right about the hazards of releasing the source code, along with the stress of knowing it was sure to draw more heat—but he also noted, with a hint of pride, that whoever carried out this internet-shaking attack hadn't even updated their code. "There was no innovation at all," he says.

Josiah, who had already had the closest brush with the FBI among the three young men, was perhaps the most troubled. By then, his family had moved out of the Pennsylvania countryside into a three-story house in the nearby town of Washington. That's where, from the basement-level storage room he now used as his work area, he read about the Dyn disaster, silent with dread and amazement.

As for Elliott Peterson, he spent the day in the FBI's Anchorage office, fielding calls from every agency and official imaginable. Over the course of a month, his case had grown from a cybersecurity industry curiosity into an international clusterfuck, a subject of urgent interest for the Department of Homeland Security and for reporters asking questions in a White House press conference.

No one yet knew who had made the copycat Mirai that had attacked Dyn. But Peterson was confident he already knew who had created Mirai and handed the code to those attackers. It was time to pay Josiah and Paras a visit.

it was just before 6 am, long before the sun would rise on that mid-January morning, when Josiah heard the banging on his front door.

For two months, he had been waiting for the raid. He was now keeping a nocturnal schedule, working at his computer with Paras and Dalton until 3 or 4 in the morning before sleeping until 8 am and then heading into his father's computer repair shop. But that night, having finally gone to bed after 4 am, he still lay awake, his mind racing with anxiety.

As the banging started and his older brother hurried upstairs from their shared basement-level bedroom, Josiah went into the storage room and quickly switched off his computers. All three of the Mirai creators had been careful to do their hacking on remote servers and to connect to them only from ephemeral virtual machines that ran on their own PCs. So he figured that switching the computers off would erase any lingering data in memory. Then, before turning off his phone, he sent a message to Paras using the encrypted messaging app Signal: "911."

Josiah slipped on a pair of sweatpants and grabbed a T-shirt. He climbed the stairs and was walking through a dark hallway, still trying to get the shirt over his head, when he found a flashlight—or rather, he'd later learn, a gun with a flashlight attached to it—pointing at his face. "Drop the shirt," he remembers an agent saying.

Josiah was herded onto his front porch, still shirtless, in the cold Western Pennsylvania winter air, where the rest of his family was already being held. Black Suburbans filled the street. And there was Elliott Peterson, on the porch, greeting Josiah in his weirdly gregarious tone. "Oh hi, Josiah. I was hoping we wouldn't meet under these circumstances," Josiah remembers him saying. "But here I am."

After leaving Josiah's flabbergasted family shivering in the cold for several long minutes, the agents brought them all back inside. As they searched the house, Josiah managed to get fully dressed and sat in the living room. But even once he'd warmed up, he still couldn't stop shaking. As his secret life finally came crashing into his family life, he remembers feeling especially embarrassed that he'd left the storage room the FBI was searching so untidy.

Aside from Peterson, Josiah could see that local Pittsburgh FBI officials had joined the raid—as had French special intelligence officers. He’d later learn that French law enforcement had also raided the home of a certain innocent patsy in France with a server filled with anime.

After a couple hours of searching, the agents hauled away Josiah’s computers, hard drives, and phone, and Peterson asked Josiah and his parents to come into the dining room to talk. “You probably know why I’m here,” Peterson said. Josiah responded that he could guess.

The conversation lasted about half an hour. Peterson brought up the Mirai scanning server, and Josiah deflected again, confessing to nothing. The FBI agent warned Josiah not to tell anyone about the search—not knowing that Josiah had already sent his “911” warning to Paras. Then he left.

In the silence that followed, Josiah’s parents told him it was time to come clean. During an excruciating 30-minute car ride to their computer repair shop to start the workday, Josiah confessed everything. His parents listened, stone-faced, too scared for their son’s future to even be angry.

Finally, his father responded: They would have to entrust Josiah’s fate to God.

Illustration: Joonho Ko

the raid on Paras’ home came the next day. Peterson had hoped for simultaneous searches but decided he should be present at both, so he spent the hours after leaving Josiah’s house driving more than 350 miles across Pennsylvania into New Jersey.

At 6 am, Paras heard the same banging on the front door of his family’s house, where he was home from Rutgers for winter break. Thanks to Josiah’s warning, this second raid had far less of an intimidating effect than the first: Paras had carefully cleaned up any evidence on his computers and turned them off long before the FBI agents arrived. In an attempt to find any storage devices Paras had hidden, the agents brought along an electronics-sniffing dog—trained to smell the glue used in computer

hardware components. Paras remembers it wanted to play with his family's dog, a comical moment that helped dispel any shock and awe.

When Paras saw Peterson in person, his first response was annoyance that this chipper FBI agent had come all the way from Alaska to turn his home upside down. Peterson asked Paras whether Josiah had told him about his search of Josiah's house the previous day. Peterson assumed Josiah had stayed silent, as instructed, and he hoped to plant a sense of betrayal in Paras that his friend hadn't given him a heads-up.

But Paras instead smiled and said that yes, Josiah had warned him, surprising Peterson. And like his friend the day before, Paras refused to confess to anything related to Mirai.

Paras' family was deeply shaken by the intrusion. But when the agents left, he assured his parents that it was all a misunderstanding, that he had no idea why this Alaskan FBI agent seemed so fixated on him. He hadn't done anything wrong.

Paras, Josiah, and Dalton discussed the raids, and they came to an extremely optimistic conclusion: that the feds didn't seem to have anything on them. The searches had been a scare tactic, they agreed, and they had failed.

On the same day the FBI searched Paras' home, Brian Krebs had published a [bombshell article](#) suggesting that Paras, potentially with Josiah's help, was the most likely identity behind Anna-Senpai. Krebs was working his own sources to piece together many of the same connections the FBI had drawn. But Paras had denied the accusation in a response to Krebs, and the three hackers, armed with the incredible hubris of youth, blew off the article as circumstantial evidence. After all, the FBI had already taken their shot and seemed to have gotten nothing that could prove their guilt.

As the months passed and they remained free, they made a brazen decision: They would continue their pivot into the click fraud scheme.

This new venture was turning out to be far more lucrative than Mirai, to a degree that even they had never imagined. To avoid ties to their overexposed botnet, they had begun building a new one, this time focused

on devices primarily in the US, given that they could make the most money selling access to American computers to generate clicks on American ads. By the spring of 2017, they were quietly pulling in \$50,000 a month in revenue, paid out in cryptocurrency by a business partner who seemed to be Eastern European.

Paras and Josiah mostly socked away the money, waiting for an opportunity to try to launder it through a legitimate business—though by then they’d finally given up and killed ProTraf. Dalton was less careful. He spent tens of thousands of dollars on splurges like a 70-inch flatscreen TV for his parents—he told them he’d made the money trading crypto—and upgrades to his home computer, a gaming desktop surrounded by transparent tubes of red coolant to prevent it from overheating as he supercharged its performance.

Even as the three hackers left Mirai behind, their code continued to plague the global internet. Mirai attacks hit the UK banks Lloyds Banking Group and Barclays, intermittently tearing Lloyds offline while Barclays repelled the onslaught. Another [struck the primary mobile telecom provider for Liberia](#) with about 500 gigabits a second of traffic, taking down much of the West African country’s connectivity.

But Mirai, and its many malicious progeny, were no longer its creators’ problem. The three young men had now, finally, hit their stride with a truly profitable and stealthy form of cybercrime. Dalton made a prediction to himself: “In a year, we’ll either be rich,” he thought, “or we’ll be in jail.”

Illustration: Joonho Ko

only months later did Josiah hear from Elliott Peterson again. The FBI agent asked him to come to Anchorage to talk. Prosecutors were suggesting a reverse proffer session, where they would lay out the evidence against him. By this point Josiah had a lawyer, who recommended that he take the meeting—and not tell his friends. This time he didn’t.

In the summer of 2017, Josiah and his mother flew to Anchorage. The 10-hour flight was only the second time he’d ever been on a plane. On the morning of the meeting with prosecutors, he arrived at the Anchorage

Department of Justice building in a suit, his mind nearly paralyzed with anxiety. Peterson was there, and he greeted Josiah and his mother, suggesting fun activities they should check out while they were in town, as if this were a family vacation.

The Alaskan assistant US attorney who had taken on the Mirai case, a young prosecutor named Adam Alexander with a background in charging violent crimes and child exploitation, launched into a PowerPoint presentation projected on a screen in the front of the conference room. He began by displaying the sentencing guidelines for violations of the Computer Fraud and Abuse Act, showing how the prison time scaled up based on the amount of damage caused.

For the millions of dollars in damage Josiah might be held responsible for, Alexander suggested, he was facing as much as six or seven years in prison for his first offense.

Alexander began to detail the evidence they had against him. First, they had his connection to the early Mirai scanning server. Then it went further: On occasion, it turned out, Josiah had let his guard down in small but revealing ways, checking on the IP address of another Mirai server directly from his home computer rather than using a remote virtual machine that would leave no trace on his PC.

And then there were text messages he and Paras had exchanged during his pre-Mirai DDoS takedowns of Rutgers' network.

“Were you still smashing?” Josiah had written to Paras at one point.

“No. Phone is insecure,” Paras had wisely responded. But then, minutes later, he had asked for Josiah's help in launching another attack: the barely coded “Admiral can you execute my command?” message.

After more than an hour, they took a break. Josiah's lawyer told him and his mother that he strongly advised they seek a plea deal and that Josiah cooperate with the FBI—that he “shouldn't push his luck.” Josiah, terrified by the looming threat of years in prison that had been slowly materializing since his first call with Peterson, immediately agreed.



When they reconvened in a different, much smaller conference room, Josiah told Peterson and Alexander he was ready to negotiate a deal. They responded that he'd first need to tell them the full, true story of his crimes. To their relief, he began to detail the entire Mirai conspiracy. The FBI agent and prosecutor were intrigued to learn more about the key role played by Dalton, who hadn't until then been a target of their investigation. And they were amazed to hear that the Mirai crew was now, even after their raids, engaged in an entirely new click fraud botnet scheme. They had known nothing about it.

Peterson and Alexander told Josiah that if he wanted any chance of a plea deal—still without any promise of avoiding prison—he'd have to fully cooperate. That meant helping to collect evidence on his friends.

Josiah, now in survival mode, was ready to do what it took to stay out of prison. By the time he flew back to Pennsylvania, he was a federal informant.

Dalton and Paras could tell Josiah was acting strangely. He'd never been aloof or a step behind on any technical questions before. Now, on their group calls, he was quieter and would inexplicably ask them to break down how their criminal enterprise worked in unusual detail.

They had their suspicions and did their best to discuss their conspiracy using only convoluted code words and hypotheticals. But they couldn't bring themselves to violate the unspoken terms of their friendship by confronting Josiah or cutting him out of their deal. "We both knew something was up," Dalton says. "But we didn't have any proof. I didn't want to fuck him over just because I was sketched out." After all, this was their old friend, the legendary LiteSpeed, the one to whom they owed so much for advancing their careers as botnet masters.

As for Josiah, he says his years of working in his family's computer repair shop had helped prepare him for his new role as a double agent. "When you work in retail, you're used to putting on a face," he says, "talking to people how they want to be talked to."

When the feds finally arrived before dawn, Dalton was relieved. They found him in his boxer shorts, wrapped in a pink blanket on a beanbag, watching Star Wars.

A few weeks later, Paras got his own call from Peterson, with his own offer of a meeting in Anchorage. Paras told Dalton about the invitation—but not Josiah, whom he'd begun to distrust. They agreed that it made sense for Paras to meet with this FBI agent and see exactly what the feds had on them.

Over the six months since the raid of his home, Paras had remained in denial, putting on a defiant face but quietly living in a state of latent terror. His family had never again discussed the traumatic violation of their home by federal agents, instead pretending it had never happened. They were “going through the motions of being a family,” as Paras puts it, “but there’s this cloud hanging over everyone’s head.”

The cloud of silence remained in place as Paras and his father flew to Anchorage. Along with Paras’ lawyer, they met with Peterson and Alexander in the same Department of Justice conference room and got the same cheery hiking tips from Peterson. Paras tried to maintain an implacable expression as the prosecutor threw one damning piece of evidence after another onto the screen, laying out his crimes in front of his father. They showed Paras’ connections to the Mirai handles and to Anna-Senpai, and his Fireswap burner account.

Still, Paras told himself that the case was far from clear-cut. Then Alexander played for the room a series of audio recordings of the three hackers explicitly discussing their new click fraud venture. One conversation, from a night when Paras and Dalton had been drinking and let down their guard, was particularly incriminating. For Paras, it was the first confirmation of Josiah’s betrayal.

Just as with Josiah, the meeting paused for a break after an hour. Paras, his father, and his lawyer walked across the street from the prosecutor’s office into a small park of paper birch trees in front of the Anchorage Museum. It was a dismally cold, cloudy day, though Paras says his anxiety had reached a degree where he was disassociating, barely aware of his surroundings.

Paras' lawyer leveled with him: It sounded very much like he was guilty of the crimes that he had, until then, denied even to his own attorney. Standing there in the park, Paras finally broke. Huddling with his father and lawyer, he confessed, tears flowing as he unlocked the shame, guilt, and fear that he'd kept bottled for months.

He asked his father to cut ties with him, begged him to let him face whatever punishment he had brought on himself alone. His father responded in a voice as broken as Paras' own: He could never do that.

Instead, he and the lawyer both told Paras that there was no other way out now. His only chance to save himself was to do whatever the FBI and the prosecutors asked of him.

Unbeknownst to them, Peterson and Alexander had watched the three men speaking from the window across the street. From Paras' body language, they could tell they'd made a breakthrough.

When Paras came back inside, he was a different person, his defenses down. "You're in a hole, Paras," Peterson told him. "It's time to stop digging." He was ready to cooperate.

Alexander asked him whether he had told anyone that he was coming to Alaska, and he admitted that he'd told Dalton. So Alexander and Peterson asked Paras to call Dalton now, on the spot, on speakerphone, and tell him that he had nothing to worry about.

Paras did as he was told. Dalton picked up the call. And as the FBI and prosecutors sat around the table intently listening, Paras assured Dalton that it was just as they'd thought: The feds had nothing on them.

when it was Dalton's turn to be raided, Peterson practically scheduled it with him. A few weeks before the bang on the door, Yahoo had mistakenly sent Dalton a letter stating that his old email address had been the subject of a legal request. For more information, it read, he should contact FBI special agent Elliott Peterson.

So Dalton preemptively called the FBI agent who'd now been stalking them for nearly a year. Josiah and Paras, playing their roles as supportive friends, listened in. Peterson picked up the phone, said hello, and immediately apologized. "I wasn't planning on us talking for a couple weeks," he explained.

When Dalton claimed not to know who Peterson was or why his emails were being read, the FBI agent laughed out loud. "We're going to have a great opportunity to have a chat," he said in the most aggressive version of his usual genial tone. He ended the call by confirming with Dalton that he was still living at home, despite having now started college, implying he didn't want to search Dalton's parents' house if he had moved into a dormitory. "We try to be minimally invasive."

Dalton hung up with Peterson. "What the fuck was that?" he said to Josiah and Paras, who were still on the group call.

"Your ass," Paras responded.

For the next three weeks, Dalton was stricken with nausea-inducing anxiety and a sense of "impending doom." When the feds finally arrived before dawn, he says, he was actually relieved. They found him in his boxer shorts, wrapped in a pink blanket on a beanbag, watching *Star Wars*.

During the search, Dalton says, his anxiety evaporated—thanks to his early swatting experience, it wasn't his first time having law enforcement point a gun at him—and he did his best to show the feds that he wasn't impressed. He napped on a couch during the FBI's search. When Peterson tried to interview him, he gave him nothing.

In fact, with plenty of time to prepare before they arrived, Dalton had physically destroyed all his most sensitive hard drives. The agents found his beloved water-cooled PC torn apart, its red coolant spilled across his bedroom floor like blood. He'd carefully cached another drive that stored all the bitcoins earned from their click fraud scheme inside a cat food container, fully hidden by kibble. Since the container was transparent, the searching agents didn't think to look inside.

Just as with Paras and Josiah, Peterson told Dalton not to tell anyone about the search. But Dalton, loyal to the end, tried to send a coded message to Paras that he'd been raided, too: He repeatedly toggled the status of his account on the Steam video game network on and off in Morse code, spelling "FBI."

Paras saw Dalton's account blinking. But he never got the message. Of course, even if he had, he'd already been working with the FBI for months to collect evidence on his friend.

dalton soon took his own trip to Anchorage, where he and his parents sat through Peterson and Alexander's third and final Mirai reverse proffer presentation. Through an hour of damning chat logs and audio recordings, Dalton showed no emotion. But when it was over, he knew there was no use resisting. They had everything.

When Dalton reluctantly agreed to cooperate, Peterson didn't ask him to keep their arrangement secret from Josiah and Paras. This time, he phoned the other two. All four of them joined the call.

After months of paranoia, Peterson wanted to clear the air, to tell them that they were no longer cooperating against one another. They would now all be working together. Josiah remembers it almost like a reunion: meeting each other again now that they were all on the other side.

In the call, Josiah and Paras seemed relieved to finally be able to speak honestly to each other and Dalton after months of subterfuge. Dalton agreed, in a defeated tone, that yes, he was on board. They would give up all their hacking tools and dismantle the click fraud botnet, and Dalton would forfeit the hidden hard drive full of their bitcoins. But Peterson remembers that Dalton remained quiet and formal, seemingly still processing his anger and shame at having been cornered by the FBI and surveilled by his friends.

It was only late one night, a few days after Dalton got home to New Orleans, that he allowed the full reality of his situation to catch up with him. He was facing a felony conviction. He was going to have to work as a

federal informant. And he was still likely to end up in prison. It felt hopeless.

The person he chose to call to talk this over with, strangely, wasn't Josiah or Paras, but Peterson. He was trapped, he told the FBI agent in tears. His life was over.

For the next hour, Peterson, sitting in his living room in Anchorage, found himself back in his "dean of men" role, comforting and counseling the young cybercriminal who'd so recently been the target of his investigation.

Peterson asked Dalton about his hopes for the future—the "where do you see yourself in five years" question of every guidance counselor. Dalton confessed that beneath his old, secret belief that cybercrime could be his only path in life, he still hoped that someday he might be able to have a normal, successful job in technology. Peterson told him that was still possible.

"He was super nice," Dalton says. "Far nicer than he ever needed to be."

Peterson said he couldn't promise Dalton that it would all be OK. There was still the possibility of spending years in prison. Regardless, Peterson reassured Dalton, he could still go to college. He could still do something rewarding with his talents. His life was not over.

the young men's lawyers had each warned them that, to have any hope of avoiding prison, they would need to go above and beyond in their cooperation with the FBI and prosecutors. So once they found themselves on the same team again, Josiah, Dalton, and Paras threw themselves into working with law enforcement with the same obsessive energy that they'd once put into conquering the internet of things.

All three were still deeply embedded in the cybercriminal community—in fact, Mirai had turned the personae that Paras had created into celebrities. So to start, they began helping the FBI target their old associates. It was Paras, the Mirai creator who had opened Pandora's box by publishing the botnet's source code, who found himself most actively working undercover to take down Mirai's copycats.

Because he still controlled the Anna-Senpai handle, Paras was tasked with reaching out to the creator of one especially prolific Mirai knockoff. The copycat botnet was controlled by a hacker who lived near Portland, Oregon. He'd been brash enough to reveal his location to Anna-Senpai in their chats, and even to invite Mirai's creator to hang out if he were ever in town. Paras took him up on the offer.

At that point, Peterson and Alexander had been tracking the suspect and believed they knew his identity. But he appeared to have no fixed address—he seemed to have developed a serious drug problem and had admitted to using meth in his chats with Anna-Senpai—and instead roamed around the city from house to house with little more than a backpack and the laptop he used to manage his botnet.

After Paras flew to Portland, he suggested to the target of their sting that they meet at his hotel. Sure enough, the hacker turned up, and the two botnet admins spent a few hours in Paras' room there, swapping stories and hacking tricks, and even inviting other hacker associates to join the conversation via Skype. Meanwhile, Peterson and other FBI agents recorded the meeting—with eavesdropping techniques they declined to describe—from another room across the hallway.

Eventually the young Portland hacker suggested they head to a nearby Little Caesars to eat. When he and Paras walked out of the room, he carelessly left his laptop open and didn't even bother to close the video chat session with his hacker friends. Those friends were still watching through the laptop's webcam when Peterson and another agent came into the room and seized the computer as evidence. Less than an hour later, the agents stepped out of a black van in the hotel parking lot and arrested their target as he and Paras returned from their lunch.

After that Portland sting, some of the hackers who had just watched the accidental livestream of the hotel raid accused Paras of acting as the FBI's snitch. But Paras pointed out that it hadn't been his idea to meet up—or even to conveniently go out for pizza—arguing that maybe *he* was in fact the one who had been set up.

The explanation was convincing enough that Paras managed to pull off subsequent undercover operations against multiple other cybercriminal suspects across the country. He says he hardly relished his role in those stings. But nor did he feel much guilt. “I mean, honestly, it was exhilarating,” he says. “It felt like something out of a movie.”

The FBI and the Justice Department declined to share all of the details of the investigations that Paras and the other two Mirai creators helped them pursue. But Peterson summarizes them: “We arrested people, and we worked other cases against IoT botnets, and we shut down other botnets where arrests weren’t feasible,” he says. “We just did really interesting work.”

Illustration: Joonho Ko

after a few months, when they had run out of undercover cases, Peterson began to give the team different kinds of tasks, many of them with no direct relationship to Mirai or their old contacts. They were grateful to find they were no longer acting as informants, so much as Peterson’s new group of technical analysts.

They started helping the FBI agent with jobs like reverse engineering malware and analyzing logs to identify botnet victims. They built a software tool that parsed the blockchain to trace cybercriminal cryptocurrency. In early 2018, when hackers began to exploit server software known as Memcached to amplify their DDoS attacks, the Mirai team figured out how to scan for vulnerable servers that enabled those attacks so that the FBI could warn the servers’ owners and help remove a new kind of DDoS ammunition from the internet.

Josiah says that, in this new role, he couldn’t help but apply the same technical perfectionism he had always prided himself on. “I enjoy being the best at this sort of stuff,” he says. “I thought, ‘If we’re going to work on this, it damn well better work right.’”

Paras says that, at first, he had immersed himself in Peterson’s assignments—even the harrowing undercover ones—mostly on his lawyer’s advice and as a distraction from his lingering guilt and shame. “To prevent myself from



feeling things,” as Paras puts it. But over time, he found that he was able to look at the work more squarely—and to even get some gratification from the good he felt he was now doing. Peterson’s comment to him in Alaska, that he should stop digging the hole he was in, had stuck. The work for Peterson felt like “the opposite of digging,” as he puts it. “I wanted to put as much distance as possible between who I am now and who I was then,” he says.

Eventually, when the Mirai crew talked among themselves about their motivation to work with Peterson, Paras says, it went beyond self-interested survival to a sense of actual atonement for the harm they’d done. “It was like, OK, what is our path to redemption?” he says. “Maybe this is the start.”

The FBI, of course, has a long, unsavory record of exploiting informants and cooperating defendants—many of whom are put in dangerous situations, made to entrap innocent associates, or end up feeling abandoned or used by their handlers. The three Mirai hackers felt they were an exception.

As the months passed, they say, they came to see Peterson as a kind of mentor. He seemed to show real concern for their futures. The strange friendliness he’d displayed while hunting them, they felt, was not an aggressive front but an actual expression of his humanity. “We were very lucky that we got Elliott,” says Dalton. “He literally saved my life.”

the us criminal justice system has a history of notoriously harsh sentences for hackers. In 2010, Albert Gonzalez was sentenced to 20 years in prison for stealing tens of millions of debit and credit card numbers from retailer networks when he was in his mid-twenties. In 2017, Russian cybercriminal Roman Seleznev, arrested on vacation at the Maldives airport, was sentenced to 27 years for his own massive theft of credit card data. Even Hector Monsegur, a front man for the rampaging hacktivist group LulzSec who flipped on his friends and served as a federal informant for more than two years, was jailed for seven months—longer than some other members of LulzSec in the United Kingdom he had informed on.

So it was almost a radical act when the prosecutors in the case of Mirai, the botnet behind several of the biggest cyberattacks in history, asked the judge to sentence its creators to a total of zero days in prison.

Adam Alexander, the Alaskan assistant US attorney who had flipped each of the three hackers with PowerPoint presentations full of evidence against them, explains that his decision was based in part on the fact that none of them had prior criminal history or substance abuse problems that might have led them to fall back into old habits. Unlike many defendants, they had strong family support networks holding them accountable. Most importantly, by the time their sentencing was approaching in the fall of 2018, they had done more than a thousand hours of work for Peterson, what Alexander described in a letter to the judge as “extensive and exceptional” cooperation. “They were kind of gleefully willing to break the internet,” Alexander says. “But would putting any of the three of these young men in prison for 18 to 36 months, and then wiping our hands of them, have more meaningfully assured that we could prevent future criminal conduct? I didn’t actually think so then, and I still don’t think so today.”

Instead, he asked the court to sentence Josiah, Dalton, and Paras to 2,500 hours of community service each over the following five years. They would carry out that work with the same FBI agent who had supervised their presentence cooperation period: Elliott Peterson.

In an Anchorage courtroom roughly two years after Mirai had obliterated Brian Krebs’ website, a judge handed down that sentence—community service, no prison time—to the three 21- and 22-year-olds, along with debts of between \$115,000 and \$127,000 each in restitution. “You’re young, you have a lot to give to society ... and you have a lot of talent and skill,” a judge told the three men in his Anchorage courtroom that fall day. “I hope you use it for good.” (Paras would face separate charges in New Jersey for his attacks on Rutgers, where prosecutors vehemently argued that he deserved prison time. Alexander intervened, countering that Paras’ cooperation with prosecutors and the FBI in Alaska should be factored into his sentencing in that case, too. The New Jersey judge ultimately agreed, sentencing Paras to nearly \$9 million more in restitution and six months of confinement at his parents’ home, but no jail time.)

On this visit to Alaska, when Peterson again suggested local activities, the Mirai crew actually took him up on it. That evening they ate together at a local indie theater restaurant, the Bear Tooth Grill, where they also caught a screening of a documentary about Google's Go-playing AI—just some notorious hackers and the FBI agent who hunted them down, out for dinner and a movie.

Illustration: James Junk, Matthew Miller

not long into their five-year community service stint, Peterson says he began to sense that his three unlikely protégés were beginning to outgrow him—that he couldn't find enough technical tasks worthy of their talents. So he asked the Big Pipes anti-DDoS group he'd helped create with Allison Nixon if anyone there had work for them to do. Nixon raised her hand.

When Peterson had first started overseeing “the kids”—as they came to be known within Big Pipes—Nixon had wanted nothing to do with them. She'd spent long enough lurking in the Hack Forums cesspool to be familiar with the toxicity that flowed freely there and had even been personally harassed by some of the Mirai team's old associates. “They're not nice people,” she says of that scene. “You don't want them to know your name.”

But after seeing that Peterson had worked with Paras, Josiah, and Dalton for more than a year and was still willing to vouch for them, she decided to take a chance and met them on a video call. She found the three young hackers—including the notorious Josiah “LiteSpeed” White, whom she'd tracked for nearly his entire career—polite and eager to please.

She did, in fact, need their programming help: She had an idea for a new kind of honeypot that would be far more versatile than her “sad DVR.” She wanted to create a system where security researchers or analysts could load up any internet-of-thing device's firmware in a virtual environment to catch new malware variants.

The tool they built together was called Watchtower. It used a newer technology called QEMU containerization to spin up quarantined, full-fledged simulations of DVRs, waiting to be infected. The Mirai team had

designed their internet-of-things malware to detect when it loaded on a software simulation of a gadget rather than the real thing and to kill its processes rather than give a researcher any information. But WatchTower's honeypot was designed to look like a real device in every way that malware could check—a seamless, virtual panopticon in which to observe malware and intercept its master's commands.

“It was brilliantly done,” says Larry Cashdollar, a security researcher at Akamai who says the company used Watchtower to obtain and analyze countless new samples of IoT malware. Eventually Nixon and her Mirai team added in data contributed from other researchers and members of her Big Pipes DDoS working group, including machines that acted as honeypots for reflection attacks and DNS data to identify targeted domains, integrating it all into a real-time DDoS analysis dashboard. By 2020, they had added a list of domain keywords to identify attacks on political or voting system targets, and the tool's results were used to monitor for DDoS attacks throughout that year's election—helping them prepare for any democracy-disrupting “big one” that many in the security community still feared.

As for Brian Krebs, when he found out that the three Mirai creators had escaped jail time and were now essentially working as whitehat security researchers, he was initially perturbed by what he saw as a lack of accountability.

“Trust the process,” he remembers Nixon telling him.

“What process?” Krebs says he responded. “This doesn't look like justice to me.”

But as time passed and he continued to learn from Nixon and others about the good work Paras, Josiah, and Dalton were doing, he says he slowly changed his mind. “When I was able to hear about some of the things they came up with, it was encouraging,” he says. “I guess that it's the best of all possible outcomes.”

When Nixon moved from Flashpoint to a job at a new security firm, Unit 221B, she lobbied the company to hire her Watchtower team. By that time,

Paras had gotten a job writing code for a semiconductor company. But Josiah and Dalton both began working for Nixon full time as security researchers on contract, on top of their community service work.

Of course, even as the Mirai crew joined the legitimate security industry, many of the new botnets that they were now monitoring with Watchtower were, in fact, variants of their own monstrous creation. Like Josiah's Qbot code before it, Mirai had become the best, cleanest code base for anyone trying to build their own massive collection of hacked machines, and all manner of digital miscreants proceeded to pick it apart, repurposing its components to wreak havoc. "There are pieces of Mirai everywhere now," says Chad Seaman, a security researcher at Akamai and an early member of the Big Pipes working group.

Companies still face near-constant attacks from Mirai descendants, Seaman says. Because those botnets are generally still fighting over the same vast but splintered collection of vulnerable internet-of-things devices, none of them is nearly as big as the original Mirai. Nor has any of Mirai's progeny ever again managed to surprise defenders to the degree Mirai did.

But their attacks still plague the internet, adding to the millions of dollars a year that companies pay in DDoS protection. "The arsonists have turned over a new leaf," Akamai's Seaman summarizes. "The wildfires continue to rage."

## Epilogue

in the years after he sat in his Connecticut home and watched his digital life implode, Scott Shapiro became a kind of Mirai fanatic. The Yale Law professor eventually read the source code that Paras published on Hack Forums, printing it out, poring over its mechanics, and marveling at its well-polished design. Years later, he would write a case study of Mirai in his book [\*Fancy Bear Goes Phishing\*](#), which tells a history of the internet through a series of extraordinary hacking events.

Among other things, Shapiro now sees the Mirai case as a rare model of actual restorative justice in cybercriminal law. It shows, he argues, a positive alternative to putting young hackers in prison when, in many cases, their online behavior contrasts so sharply with their real-world selves. Yes, the internet can seduce good people into doing bad things. But perhaps the split personalities it creates also leaves more room for redemption in the offline world. Perhaps it even means more cybercriminals like the Mirai crew can be reformed and put to work fixing the problems they caused. “This was an experiment. It worked out really well,” Shapiro says. “I would like to see more of it.”

One afternoon in early December of 2021, three years into the Mirai creators’ five years of probation, Shapiro invited Josiah, Paras, Dalton, and Elliott Peterson to speak to his Yale cybersecurity law class over Zoom. It would be the first time the four of them had appeared together in a semipublic setting other than a courtroom.

At first, Peterson did most of the talking, telling the story of the case and his investigation in a 45-minute presentation. Then he finished and the group took questions from the students.

One asked how this group of young adults with no criminal records had justified to themselves carrying out such epic acts of digital disruption. Paras answered for all of them, explaining how incremental it had all felt, how easy it had been to graduate from commandeering hundreds of hacked computers to thousands to hundreds of thousands, with no one to tell them

where to draw the line. “There was never a leap,” he says. “Just one step after another.”

Another student asked how they had kept going for so long—how they believed they could evade the FBI even after they had been raided. This time it was Dalton who answered, overcoming his anxiety at speaking in front of crowds, in part thanks to better treatments that have helped to alleviate his stutter. He explained to the class that they had simply never faced an obstacle to their hacking careers that they hadn’t been able to surmount—that, like teenagers who have no experience of aging or death and therefore believe they’ll live forever, they had come to feel almost invincible.

Throughout the presentation, Shapiro says, he was struck by the youthful nervousness of the three Mirai creators and the fact that, even as they spoke, they never turned on their webcams. The hacker threat that he’d once been sure must be the Russians, that had felt so large and powerful, was just these “young boys,” he realized. “Young boys who don’t want to show their faces.”

Paras would later explain to me that he wasn’t exactly trying to hide. He just doesn’t want to associate his face with Mirai anymore. He’s since lost more than 30 pounds, ditched his glasses, grown a trim beard; he’d prefer to let his old image, the pudgy bespectacled kid pictured in Brian Krebs’ story about Anna-Senpai, be the one tied to Mirai.

As of the end of October, all three of the Mirai hackers’ periods of probation have ended. Paras Jha and Josiah White work together for a high-frequency financial trading company. Dalton Norman still holds his job working for Allison Nixon at Unit 221B. But they all plan to continue maintaining and updating Watchtower, perhaps their most lasting contribution to undoing some of the damage they’ve done.

“I’m grateful for the chance to try to put the genie back in the bottle,” Josiah says.

He also admits that’s probably impossible. Even now, he and Dalton and Paras know that fragments of the monster they built still haunt the internet.

Mirai no longer comes from the future. Instead, it stubbornly hangs on from the past. Someday, they hope to leave it there.

*Collage Source Images: Getty Images*

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*This article appears in the December 2023/January 2024 issue. [Subscribe now](#).*

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By [João Medeiros](#)

[Science](#)

Jun 27, 2024 4:00 AM

# Aging Might Not Be Inevitable

There are biological underpinnings to aging—and so researchers are investigating cell manipulations, transfusions of young blood, and chemical compounds that can mimic low-calorie diets.

PHOTOGRAPH: David Vintiner

In 1997, a French woman named Jeanne Calment died at the age of 122. She was the world's oldest verified person, according to the Gerontology Research Group. Her daily habits included drinking a glass of port wine and smoking a cigarette after meals (she also ate 2.5 pounds of chocolate every week). “Nobody else has lived past 120 since she died,” says [Venki Ramakrishnan](#), the Nobel Prize-winning biologist and author of *Why We Die*. Indeed, while the number of centenarians is increasing every year, the number of people living past 110 is not. “This suggests that maybe there’s a natural limit to human lifespan.”

If such a limit exists, it’s one imposed by biological evolution. “Evolution wants to make sure that your genes have the maximum likelihood of being passed on,” Ramakrishnan says. “It doesn’t care about how long you live.” This explains, for instance, why there seems to be a correlation between the size of animals and their life expectancy—in general, the larger the species, the longer it will live. Most mayflies live between one and two days. Monarch butterflies can live for months. Bowhead whales live more than 200 years. Greenland sharks may live more than 500 years. “If you’re a smaller species, there’s no point spending a lot of resources maintaining and repairing the body because the likelihood of being eaten or starved to death are high,” says Ramakrishnan. “Larger species, on the other hand, will have the advantage of more time finding mates and producing offspring.”

A few species, however, seem to be exempt from this rule. The hydra, a small freshwater animal with 12 tentacles, doesn't seem to age at all. The immortal jellyfish can even age backward. "It suggests that aging is not inevitable and that we might be able to circumvent our natural limits if we alter our biology," Ramakrishnan says.

That is why understanding the biological underpinnings of why we age and die is such a [hot topic of research today](#). Scientists are trying to find out how to manipulate cellular aging processes—for instance, how to destroy senescent cells (aged cells that cause inflammation), or how to reprogram cells to revert them to an earlier state of development. Over the past decade, more than 300,000 scientific papers about aging have been published, while billions of dollars have been funneled into more than 700 longevity startups, including Altos Labs, Human Longevity, Elysium Health, and Calico.

One of the most promising avenues of research involves the discovery of chemical compounds that can mimic the effects of a low-calorie diet, which is recognized as one of most well-established ways to slow down aging. One such compound is rapamycin, first discovered on the soil of Easter Island, due to its antifungal properties. "Later they found out that it was also a potent antitumor and anti-inflammatory," Ramakrishnan says. "It's also immunosuppressant, so it can also make people prone to infection and slow down wound healing. We need to find that sweet spot between not having the side effects and having just the [anti-aging] benefits."

Longevity researchers are also familiar with a body of research that shows that young blood can rejuvenate old bodies—in mice, at least. This discovery came about when researchers first surgically connected the circulatory system of a young and old mouse—a technique called parabiosis—and observed that this procedure slowed down the symptoms of aging, lengthening the lifespan of the older animal by 10 percent. Ramakrishnan notes that while scientists are still trying to identify the factors in young blood that cause this effect, "there are companies that jumped the gun and started offering young plasma to billionaires."

"While we're waiting for all these things to happen there are things we can do." Ramakrishnan notes. "This is likely similar to the advice your

grandparents gave you. Eat moderately, eat healthy diets, get enough sleep and exercise. It turns out that each of those affects the other two so it's really a virtuous cycle. If you do all of them at once, it works better than any medicine on the market, it has no side effects, and it's free."

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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By [João Medeiros](#)  
[Science](#)

Jun 26, 2024 4:00 AM

# With AI Tools, Scientists Can Crack the Code of Life

Google’s AI research lab DeepMind is steadily building knowledge of how genes and their products work inside the body—and how and why they sometimes go wrong.

PHOTOGRAPH: David Vintiner

In 2021, AI research lab [DeepMind](#) announced the development of its first digital biology neural network, [AlphaFold](#). The model was capable of accurately predicting the 3D structure of proteins, which determines the functions that these molecules play. “We’re just floating bags of water moving around,” says Pushmeet Kohli, VP of research at DeepMind. “What makes us special are proteins, the building blocks of life. How they interact with each other is what makes the magic of life happen.”

AlphaFold was considered by the journal Science as the breakthrough of the year in 2021. In 2022, it was the [most cited research paper in AI](#). “People have been on [protein structures] for many decades and were not able to make that much progress,” Kohli says. “Then came AI.” DeepMind also released the [AlphaFold Protein Structure Database](#)—which contained the protein structures of almost every organism whose genome has been sequenced—making it freely available to scientists worldwide.

More than [1.7 million researchers in 190 countries](#) have used it for research ranging from the design of plastic-eating enzymes to the development of more effective malaria vaccines. A quarter of the research involving AlphaFold was dedicated to the understanding of cancer, [Covid-19](#), and neurodegenerative diseases like Parkinson’s and Alzheimer’s. Last year, DeepMind released its next generation of AlphaFold, which extended its

structure prediction algorithm to biomolecules like nucleic acids and ligands.

“It has democratized scientific research,” Kohli says. “Scientists working in a developing country on a neglected tropical disease did not have access to the funds to get the structure of a protein computed. Now, at the click of a button, they can go to the AlphaFold database and get these predictions for free.” For instance, one of DeepMind’s early partners, the Drugs for Neglected Diseases Initiative, used AlphaFold to develop medicine for diseases that affect millions—such as sleeping sickness, Chagas disease, and leishmaniasis—yet receive comparatively little research.

DeepMind’s latest breakthrough is called AlphaMissense. The model categorizes the so-called missense mutations—genetic alterations that can result in different amino acids being produced at particular positions in proteins. Such mutations can alter the function of the protein itself, and AlphaMissense attributes a likelihood score for that mutation being either pathogenic or benign. “Understanding and predicting those effects is crucial for the discovery of rare genetic diseases,” Kohli says. The algorithm, which was released last year, has classified around 89 percent of all possible human missense. Before, only 0.1 percent of all possible variants had been clinically classified by researchers.

“This is just the beginning,” Kohli says. Ultimately, he believes AI could eventually lead to the creation of a virtual cell that could radically accelerate biomedical research, enabling biology to be explored in-silico rather than in real-world laboratories. “With AI and machine learning we finally have the tools to comprehend this very sophisticated system that we call life.”

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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This article was downloaded by **calibre** from <https://www.wired.com/story/wired-health-pushmeet-kohli-deepmind-ai-google/>

By [João Medeiros](#)  
[Science](#)

Jun 26, 2024 3:00 AM

# Air So Polluted It Can Kill Isn't Being Taken Seriously Enough

Toxic air kills over half a million children every year, yet only once has air pollution been listed as a cause of death on a death certificate.

PHOTOGRAPH: David Vintiner

In 2010, three months before her seventh birthday, Ella Roberta suddenly developed a chest infection and a severe cough. Her mother, Rosamund Adoo-Kissi-Debrah, took her to the local hospital in Lewisham, South East London, where she was initially diagnosed with asthma.

In the following months, she got worse and began suffering from coughing syncope—coughing episodes so violent that they caused her to black out due to a lack of blood supply to the brain. “She had one of the worst cases of asthma ever recorded,” Kissi-Debrah recalls. “They didn’t really know what was wrong as she didn’t present as a normal asthmatic. They tested her for everything, from epilepsy to cystic fibrosis. Her condition was extremely rare.” So rare, in fact, that Kissi-Debrah couldn’t find a single case of a child suffering a cough from coughing syncope in the scientific literature. “It was only common in long-distance lorry drivers,” she says.

In the next three years, Ella was admitted to hospital about 30 times. On February 15, 2013, shortly after her ninth birthday, she suffered a fatal asthma attack.

Her original death certificate stated that she had died from acute respiratory failure. “At the inquest, it was established that some of it might be due to ‘something in the air,’” Kissi-Debrah says. None of the medical experts consulted had mentioned the possibility that air pollution could have

triggered Ella's syncope. That possibility came to light only after Kissi-Debrah was contacted by a reader of the local newspaper who had read about her story and suggested that she check the air pollution levels on the day Ella died. Indeed, that day the levels of nitrogen dioxide caused by the traffic on heavily congested South Circular Road, near where they lived, had far exceeded set limits.

With the assistance of her lawyer, Kissi-Debrah applied to the High Court to quash the verdict of the first inquest and request a second one, which was one granted. "My lawyer, Jocelyn, outlined on a graph all the times Ella had been admitted to the hospital, and then she got the data from the monitors near the house," Kissi-Debrah recalls. The pattern was clear: There was a spike in air pollution prior to Ella experiencing coughing syncope. "Twenty-seven out of 28 times. As far as I'm concerned, that's scientifically significant." Furthermore, they showed that, on average, dioxide emissions and particulate matter levels in Lewisham far exceeded World Health Organization (WHO) guidelines.

After nine days of deliberation, the inquest [concluded](#) that "Ella died of asthma contributed to by exposure to excessive air pollution." It added: "Ella's mother was not given information about the health risks of air pollution and its potential to exacerbate asthma. If she had been given this information she would have taken steps which might have prevented Ella's death." The cause of death on Ella's death certificate was amended. To this date, she remains the only person in the world to have air pollution on her death certificate.

Given the evidence at the inquest, the coroner also issued a [Prevention of Future Deaths Report](#), which had a series of recommendations, such as ensuring that national air pollution levels be in line with WHO guidelines, that the public in England and Wales be made aware of the risks of air pollution, and that health professionals be educated on the health impacts of air pollution and inform patients accordingly.

"The coroner felt that other children were at risk of dying," Kissi-Debrah says. "He made it very clear, actually, that unless the air was cleaned up, more children would die."

Currently, [600,000 children worldwide die](#) every year from breathing polluted air. In London alone, a [quarter of a million](#) children suffer from asthma. “The only time in this country no child has died from asthma was during the first lockdown,” Kissi-Debrah says. Ten years on from the death of her daughter, she continues to campaign for the legal right to clean air. As part of her campaign, she is lobbying for the approval of the Clean Air Bill in the UK, also known as Ella’s law: a parliamentary bill that establishes the right to breathe clean air.

“It is our right to breathe clean air, and it is the government’s duty to clean up the air and ensure that the UK targets are in line with WHO targets, as currently, they are not,” she says. “This isn’t a party political issue. It’s about our health. It’s about our future.”

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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By [João Medeiros](#)

[Science](#)

Jun 25, 2024 3:00 AM

# Boring Architecture Is Starving Your Brain

Thomas Heatherwick believes architecture has a “nutritional value” to society—and that the public desperately deserve a better offering.

PHOTOGRAPH: David Vintiner

Designer Thomas Heatherwick thinks the construction industry is in a crisis. “We’ve just got so used to [buildings that are boring](#),” says the man behind London’s revived [Routemaster](#) bus, Google’s [Bay View](#), and New York’s [Little Island](#). “New buildings, again and again, are too flat, too plain, too straight, too shiny, too monotonous, too anonymous, too serious. What happened?” While those features can often be aesthetically appropriate on their own, Heatherwick notes that it’s the relentless combination of them in the aesthetics of modern buildings and urban spaces that makes them overwhelmingly boring.

This boredom, he adds, isn’t just a nuisance—it can actually be harmful. “Boring is worse than nothing,” Heatherwick writes in his latest book, *Humanize*. “Boring is a state of psychological deprivation. Just as the body will suffer when it’s deprived of food, the brain begins to suffer when it’s deprived of sensory information. Boredom is the starvation of the mind.”

This isn’t just a matter of opinion. Heatherwick cites, for instance, the research of Colin Ellard, a cognitive neuroscientist at the University of Waterloo who studies the neurological and psychological impact of the built environment. In his [experiments](#), Ellard has shown that people’s moods were considerably affected when surrounded by tall buildings. In one experiment, he collected data from wearable sensors that tracked skin conductance response, a measure of emotional arousal. When people pass

by a boring building, Heatherwick says, “their bodies literally go into a fight-or-flight mode. They have nothing for their mind to connect to.”

The brain, Heatherwick argues, craves complexity and fascination. “There’s a reason why, when you look out into a forest, nature’s complexity and rhythms restores our attention back,” he says. “We need that in buildings. Less is not more.” This is backed by the research of psychologists Rachel and Stephen Kaplan, who in the 1980s developed [Attention Restoration Theory](#), which posited that people’s concentration improves when spending time in natural environments.

“We haven’t been paying attention to the nutritional value to society of the buildings that are around us,” Heatherwick says. He believes, for example, that architects now prefer to prioritize the internal spaces of a building, while neglecting what the building looks like from the outside. This is a mistake. “Buildings are the backdrop of society’s life,” he says. “A thousand times more people will go past this building than will ever come inside it. The outside of that building will affect them and contribute to how they feel.” Ultimately, to humanize our urban spaces, architects need to think about the people that inhabit them. Heatherwick recalls a debate of elite people in the construction industry a few years ago about whether the opinion of the public mattered. “We debated all night and then they voted that they didn’t. It was unbelievable.”

Such short-term thinking is leading to what Heatherwick calls “the dirty secret of the construction industry”: its disastrous environmental impact. Just consider, for instance, that in the US, [1 billion square feet of buildings are demolished every year](#). “That’s half of Washington, DC, destroyed, just to get rebuilt after with the same sort of boring buildings,” he says. In the UK, [50,000 buildings a year are demolished](#), with the average age of a commercial building being around 40 years. “If I were a commercial building, I would have been killed 14 years ago,” he says. “To build a tower in the city of London, which by global standards isn’t that big, takes the equivalent of 92,000 tons of carbon emissions.” As a result of this, estimates show that the construction industry now emits five times more greenhouse gases into the atmosphere than aviation.

“We can’t have buildings that are only here for 40 years. We need thousand-year thinking,” he says. “The world of construction teaches you that form follows function, less is more, ornament is a crime. It’s powerful, and when you’re studying, that goes in your brain and brainwashes you.” But Heatherwick reminds us that emotion is a function, and one that should be celebrated in the world of construction.

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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By [João Medeiros](#)

[Science](#)

Jun 24, 2024 4:00 AM

# Revolutionary Alzheimer's Treatments Can't Help Patients Who Go Undiagnosed

It's a question of when, not if, highly effective treatments become available, says the CEO of Alzheimer's Research UK. But that doesn't solve the problem of one-third of dementia patients still going undiagnosed.

PHOTOGRAPH: David Vintiner

"The statistics are frightening: Dementia is the biggest killer in the UK. It has been the leading cause of death for women since 2011," says Hilary Evans, CEO of [Alzheimer's Research UK](#) and cochair of the [UK Dementia Mission](#). "One in two of us will be affected by dementia either by caring for someone with the condition or developing it ourselves."

There are reasons for optimism, however, with Alzheimer's researchers achieving extraordinary breakthroughs in the treatment of the disease. In May 2023, drugmaker Lilly announced that its new Alzheimer's drug, donanemab, [slowed cognitive decline by 35 percent](#); in 2022, another drug, lecanemab, registered similarly promising results. "For a long time, dementia research has been a costly, even hopeless cause," Evans says. "But we are now at this real tipping point for change with the arrival of the first ever Alzheimer's drugs that tackle the root cause of the disease rather than just the symptoms." Donanemab and lecanemab act as antibodies, clearing the amyloid plaques that form in Alzheimer's patients' brains.

"Like many first-generation treatments, however, [the benefits are modest and also come with serious side effects](#)," Evans says. "We need to look back at how we started off the first generation of treatments for diseases like

[HIV](#), which often had limited efficacy and difficult side effects, but paved the way for combination medicines that have revolutionized outcomes for the next generation of people with the condition.”

Evans has reasons for optimism. Currently, there are [more than 140](#) clinical trials ongoing for a variety of potential Alzheimer’s treatments, ranging from compounds capable of removing toxic proteins to drugs that can restore the function of damaged brain cells. “I’m in my mid-forties and I really think our generation will benefit from the progress that we are now witnessing,” says Evans. “Developing safer and more effective drugs is really a matter of when and not if.”

Evans, however, is concerned that these new treatments will remain out of reach for patients if they can’t receive a timely and accurate diagnosis. [Recent research in the New England Journal of Medicine](#) also showed that someone can be in the early stages of Alzheimer’s 20 years before the onset of detectable symptoms. “New treatments will rely on the diagnosis of people earlier on in the disease,” Evans says. Furthermore, diagnosis of the disease in the population remains woefully inadequate. “It hasn’t changed in over two decades,” Evans says. Pen-and-paper cognitive tests remain the most common diagnostic method; [only 2 percent of patients undergo the gold standard test](#)—lumbar puncture and PET brain scans.

Even though the UK government has set a national dementia diagnosis target at [67 percent of patients](#), that target is missed in many parts of the country. Those patients who do get a diagnosis have had to wait on average two years; for patients under 65, that waiting time goes up to four years. “One in three people with dementia in England never get a diagnosis at all,” Evans says. “This isn’t something we would accept in any other health condition.”

This could be changed by the introduction of accurate digital cognitive tests, for instance, which would allow patients to be evaluated in real-time and access care faster. Researchers at Moorfields Eye Hospital are also [developing AI algorithms](#) which could potentially screen for signs of Alzheimer’s disease in the eye. “The retina is a particularly attractive target because it’s closely related to brain tissue and can be examined noninvasively during routine eye checks,” Evans says.

Alzheimer's UK is also supporting research to find blood biomarkers for the disease. "Research has shown that a blood test could be as effective as a standard lumbar puncture and a brain scan, and it could be used as an initial triaging tool," she says. "People are naturally much keener to take a blood test than something that's very invasive. This could revolutionize the way that dementia is diagnosed."

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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By [João Medeiros](#)  
[Science](#)

Jun 24, 2024 3:00 AM

# Post-Pandemic Recovery Isn't Guaranteed

The aftermath of a disaster like Covid can be divided into roughly three stages: the honeymoon, the slump, and the uptick. The aim is always to build back better—but in some cases that never happens.

PHOTOGRAPH: David Vintiner

Lucy Easthope, one of the UK's top experts in [disaster planning](#), has advised the UK government on major international incidents such as 9/11, the Grenfell Tower fire, the war in Ukraine and, of course, the [Covid pandemic](#). “If you were a pandemic planner in 2020, then there have been few surprises over the past few years,” Easthope says. “In those pandemic plans we wrote a reasonable worst-case scenario—and now we get to live it.”

Emergency planners such as Easthope know that the aftermath of a disaster can usually be divided roughly into three stages: the honeymoon (“Or, as we call it now, lockdown one”), the slump, and the uptick. “We’re still in the slump,” she says, of the UK. “We’ve reached a stage where all signs of institutional collapse are here. Basic reliance on the health care system for the most privileged is now gone. Failure gets talked about loudly.”

However, Easthope warns that the uptick, the stage when societies rebuild, isn't always guaranteed. “It's really important to have no issue be off the table and [to keep things] nonpolitical,” she says. “To be very aware that the *Titanic* can sink, and to leave the hubris at the door.”

Disaster planning research, for instance, shows that the post-pandemic mental health crisis will continue for the next 30 to 40 years, with an

increased prevalence of alcohol and drug abuse in affected communities. “Recovery after these sorts of events is not a spring, but the worst kind of endurance,” Easthope says. “The only good thing that comes out of a disaster like a pandemic is that it creates one single opportunity to reexamine structures and institutions.”

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

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By [Amelia Tait](#)

[Business](#)

Jun 21, 2024 7:00 AM

# Before Smartphones, an Army of Real People Helped You Find Stuff on Google

Not too long ago, services like GOOG-411, 118 118 and AQA used actual humans to answer questions with witty responses and encyclopedic knowledge. Today's search engines could learn something.

Hayley Banfield answered calls for the UK-based service 118

118. Photograph: Gareth Iwan Jones

The Eiffel Tower is 330 meters tall, and the nearest pizza parlor is 1.3 miles from my house. These facts were astoundingly easy to ascertain. All I had to do was type some words into Google, and I didn't even have to spell them right.

For the vast majority of human history, this is not how people found stuff out. They went to the library, asked a priest, or wandered the streets following the scent of pepperoni. But then, for a brief period when search engines existed but it was too expensive to use them on your shiny new phone, people could call or text a stranger and ask them anything.

The internet first became available on cell phones in 1996, but before affordable data plans, accidentally clicking the browser icon on your flip phone would make you sweat. In the early 2000s, accessing a single website [could cost](#) you as much as a cheeseburger, so not many people bothered to Google on the go.

Instead, a variety of services sprang up offering mobile search without the internet. Between 2007 and 2010, Americans could call GOOG-411 to find

local businesses, and between 2006 and 2016, you could text 242-242 to get any question answered by the company ChaCha. Brits could call 118 118 or text AQA on 63336 for similar services. Behind the scenes, there were no artificially intelligent robots answering these questions. Instead, thousands of people were once employed to *be* Google.

“Some guy phoned up and asked if Guinness was made in Ireland, people asked for the circumference of the world,” says Hayley Banfield, a 42-year-old from Wales who answered 118 118 calls from 2004 to 2005. The number was first launched in 2002 as a directory enquiries service—meaning people could call up to find out phone numbers and addresses (back then calls [cost](#) an average of 55 pence). In 2008, the business started offering to answer *any* questions. Although Banfield worked for 118 118 before this change, customers would ask her anything and everything regardless. “We had random things like ‘How many yellow cars are on the road?’”

While directory enquiry lines still exist, Banfield worked during their boom—she answered hundreds of calls in her 5:30 pm to 2 am shifts—and quickly noticed patterns in people’s queries. “Anything past 11 pm, that’s when the drunk calls would come in,” she says. People wanted taxis and kebab shops but were so inebriated that they’d forget to finish their sentences. Sometimes, callers found Banfield so helpful that they invited her to join them on their nights out. As the evening crept on, callers asked for massage parlors or saunas—then they would call back irate after Banfield recommended an establishment that didn’t *meet their needs*.

The “pizza hours” were 8 pm to 10 pm—everyone wanted the number for their local takeout. Banfield had a computer in front of her in the Cardiff call center, loaded with a simple database. She’d type in a postcode (she had memorized all of the UK’s as part of her training) and then use a shortcut such as “PIZ” for pizza or “TAX” for taxi. People sometimes accused Banfield of being psychic, but if the power had gone out in a certain area, she automatically knew that most callers wanted to know why.

Around the same time Banfield was answering calls, Paul Cockerton was answering texts. The 54-year-old cofounded AQA 63336 in 2002; the acronym stood for “any question answered,” and texts originally cost £1

each. When the business launched, Cockerton and just five others would answer questions. They'd look in books and encyclopedias, search the web, and do their own calculations to try and answer each message in a maximum of 10 minutes.

Paul Cockerton cofounded AQA 63336 in 2002. The service promised to answer any questions via SMS.

Photograph: Craig Gibson

The company decided that it must always give an answer, even if someone texted asking if they should dump their boyfriend. “Stylistically, we were only allowed to say yes or no,” says Cockerton, who now lives in the English village Croxley Green. “So we’d say, ‘Yes, you should dump your boyfriend if you’ve been thinking about it for a while and it’s not working out. No regrets. Move on.’”

At its peak, AQA 63336 employed 1,400 researchers to answer questions—students and mums could work from home, getting paid by the answer. Gradually, the business built up a database of common Q&As, and like Banfield, Cockerton noticed patterns—a flurry of trivia-related texts during pub quizzing hours or requests for chat-up lines as the night went on. Yet it is the anomalous texts that are the most memorable.

“Me and my girlfriend are lost in a jungle,” the message began. Two tourists in Thailand were embarrassed about getting stuck and decided to text AQA 63336 rather than call their family for help. “We called a nearby hotel, they found someone who spoke English, we spoke to them ... they got the jungle rescue team out,” Cockerton recalls with glee.

Gradually, the British media became enamored with the service, and in 2008 it was featured on an episode of *The Graham Norton Show*. Because many of the questions texted to the service were fundamentally silly—118’s Banfield even enjoyed texting stupid questions with her friends while at the pub—answers were always designed to entertain. “There would obviously be questions that we physically couldn’t answer, ‘Where am I sitting?’ things like that,” says Cockerton, “We worked out that the way to do it was to just make sure that they got a pound’s worth of answer.”

On air, Norton texted AQA 63336 with the question “Are baboons evil?” Seconds later, his phone pinged with a reply. “Yes, baboons are evil, anyone that steals your windscreen wipers while waving a red bum in your face is the work of the dark side.”

After the segment aired, AQA 63336’s systems were flooded with 20,000 questions (half of which were, “Are baboons evil?”). But not all of Cockerton’s and Banfield’s memories are funny. She recalls dealing with at least 20 suicidal callers—company policy meant she had to direct them to the emotional support charity Samaritans. (This was also AQA 63336’s policy.) Cockerton recalls that during the 7/7 London bombings, numerous people asked why the tube wasn’t running. “People were texting us, ‘How can I get home?.’ We were effectively a Citymapper.”

Two years later in 2007, the iPhone launched—with Google’s search bar [built in](#) to its browser. Gradually, it became cheaper and easier for people to search on their phones, and by 2009, Cockerton noticed texts “begin to tail off quite fast.” He and his cofounders sold the company to an Australian firm in 2010—today texts to the service go undelivered. 118 118 will no longer answer any question, but you can still call to ask for addresses and phone numbers (calls cost a whopping £2.43 a minute).

We now live in a strange era when customer service [robots pose as humans](#) and sometimes [humans even pose as robots](#)—in recent years, companies who claim to be powered by artificial intelligence have been found to be using real people behind the scenes. Either way, what has been lost since the era of the human search engine is the joy of a distinct voice—while we can now find out almost anything automatically, the answer won’t be delivered with warmth or flair.

Am I really here? How many nipples does a bear have? Where did kissing originate? These are just some of the questions Cockerton fielded at AQA 63336. Banfield recalls trying to connect people with their long-lost relatives and once chatting about gardening with a lonely older gentleman. “Most of the time you felt transported into the caller’s world,” she says, “as they were lost or looking for hope on the end of the call.”

*This story first appeared in the July/August 2024 UK edition of WIRED magazine.*

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[Kyle MacNeill](#)

[Business](#)

Jun 17, 2024 8:00 AM

# Orkut's Founder Is Still Dreaming of a Social Media Utopia

In the mid-2000s, Google engineer Orkut Büyükkökten's self-titled social network briefly took the world by storm before disappearing. Now he's back, with a plan for a happier social media.

Orkut Büyükkökten photographed at home in San Francisco in April 2024. Photograph: Carolyn Fong

In 2004, a month before Mark Zuckerberg launched Facebook from his Harvard dorm room, another social media site landed on the internet with a splash of hot pink. If you were online in the mid-2000s, you might remember Orkut, with its lurid logo, fingernail-sized profile pictures, and text-heavy, pastel-blue feeds. Unlike Zuckerberg, Jack Dorsey, or even Tom from MySpace, the site's founder managed to stay under the radar. You might not know that the man behind Orkut is also called Orkut.

Born in Konya, Turkey, Orkut Büyükkökten moved to Germany at the age of 1. A childhood obsession with *Star Wars* led him to study computer science at Stanford, where, upon noticing that people tended to socialize in their dorms rather than venturing out on campus, he launched the first ever college social network, Club Nexus. "I noticed I met most of my friends through friends of friends," he says. "And I was like, what if we could meet people using the social graph?" He later developed a follow-up network, InCircle, designed for alumni. Mark Zuckerberg's Harvard version, Facebook, didn't arrive until three years later.

A meeting with Larry Page and Sergey Brin led Büyükkökten to a job as a frontend software engineer at Google. The tech giant offers a perk known as "20 percent time," where employees can spend a day a week on passion

projects. Still obsessed with helping people make friends, Büyükkökten used his time to start a new platform. “I wanted to create a global community that gave everyone around the world a way to connect,” he says. Google gave it the green light and Büyükkökten developed the entire thing, even going to data centers to set up the servers.

Then came the name: Orkut. Branding a [social media](#) platform isn’t easy—just look at X for an exceptional example of getting it wrong. But even the most megalomaniac, Muskian magnates don’t have the chutzpah to use their own name. Büyükkökten, endearingly humble and softly spoken, promises it wasn’t a show of egotism. Instead, it was a suggestion from Google. “I was in a meeting with Eric Schmidt [then CEO] and [Marissa Mayer](#) [then a VP, later CEO of Yahoo]. And they said, why don't you just name it Orkut? You're the only person who worked on it, it's a five-letter word, it's very unique, and you already own the domain,” he says.

Orkut Büyükkökten photographed at home in San Francisco in April.

Photograph: Carolyn Fong

Before Orkut launched in January 2004, Büyükkökten warned the team that the platform he’d built it on could handle only 200,000 users. It wouldn't be able to scale. “They said, let's just launch and see what happens,” he explains. The rest is online history. “It grew so fast. Before we knew it, we had millions of users,” he says.

Orkut featured a digital Scrapbook and the ability to give people compliments (ranging from “trustworthy” to “sexy”), create communities, and curate your very own Crush List. “It reflected all of my personality traits. You could flatter people by saying how cool they were, but you could never say something negative about them,” he says.

At first, Orkut was popular in the US and Japan. But, as predicted, server issues severed its connection to its users. “We started having a lot of scalability issues and infrastructure problems,” Büyükkökten says. They were forced to rewrite the entire platform using C++, Java, and Google's tools. The process took an entire year, and scores of original users dropped off due to sluggish speeds and one-too-many encounters with Orkut’s now-

nostalgic “Bad, bad server, no donut for you” error message.

Around this time, though, the site became incredibly popular in Finland. Büyükkökten was bemused. “I couldn't figure it out until I spoke to a friend who speaks Finnish. And he said: ‘Do you know what your name means?’ I didn’t. He told me that *orkut* means multiple orgasms.” Come again? “Yes, so in Finland, everyone thought they were signing up to an adult site. But then they would leave straight after as we couldn't satisfy them,” he laughs.

Awkward double meanings aside, Orkut continued to spread across the world. In addition to exploding in Estonia, the platform went mega in India. Its true second home, though, was Brazil. “It became a huge success. A lot of people think I'm Brazilian because of this,” Büyükkökten explains. He has a theory about why Brazil went nuts for Orkut. “Brazil's culture is very welcoming and friendly. It's all about friendships and they care about connections. They're also very early adopters of technology,” he says. At its peak, 11 million of Brazil’s 14 million internet users were on Orkut, most logging on through cybercafes. It took Facebook seven years to catch up. But Orkut wasn’t without its problems (and many fake profiles). The site was banned in Iran and the United Arab Emirates. Government authorities in Brazil and India had concerns about drug-related content and child pornography, something Büyükkökten denies existed on Orkut. Brazilians coined the word *orkutização* to describe a social media site like Orkut becoming less cool after going mainstream. In 2014, having hemorrhaged users due to slow server speeds, Facebook's more intuitive interface, and issues surrounding privacy, Orkut went offline. “Vic Gundotra, in charge of Google+, decided against having any competing social products,” Büyükkökten explains.

But Büyükkökten has fond memories. “We had so many stories of people falling in love and moving in together from different parts of the world. I have a friend in Canada who met his wife in Brazil through Orkut, a friend in New York who met his wife in Estonia and now they're married with two kids.” he says. It also provided a platform for minority communities. “I was talking to a gay journalist from a small town in São Paulo who told me that finding all these LGBTQ people on Orkut transformed his life,” he adds.



Büyükkökten left Google in 2014 and founded a new social network, again featuring a simple five-letter title: [Hello](#). He wanted to focus on positive connection. It used “loves” rather than likes, and users could choose from more than 100 personae, ranging from Cricket Fan to Fashion Enthusiast, and then were connected to like-minded people with common interests. Soft-launched in Brazil in 2018 with 2 million users, Hello enjoyed “ultra-high engagement” that Büyükkökten claims surpassed the likes of Instagram and Twitter. “One of the things that stood out in our user surveys was that people said when they open Hello, it makes them happy.”

The app was downloaded more than 2 million times—a fraction of the users Orkut enjoyed—but Büyükkökten is proud of it. “It surpassed all our dreams. There were numerous instances where our K-Factor (the number of new people that existing users bring to an app) reached 3, leading us to exponential growth,” he says. But, in 2020, Büyükkökten bid goodbye to Hello.

Now he’s working on a new platform. “It’ll leverage AI and machine learning to optimize for improving happiness, bringing people together, fostering communities, empowering users, and creating a better society,” he says. “Connection will be the cornerstone of design, interaction, product, and experience.” And the name? “If I told you the new brand, you would have an aha moment and everything would be crystal clear,” he says.

Once again, it’s driven by his enduring desire to connect people. “One of the biggest ills of society is the decline in social capital. After smartphones and the pandemic, we have stopped hanging out with our friends and don’t know our neighbors. We have a loneliness epidemic,” he says.

He is fiercely critical of current platforms. “My biggest passion in life is connecting people through technology. But when was the last time you met someone on social media? It’s creating shame, pessimism, division, depression, and anxiety,” he says. For Büyükkökten, optimism is more important than optimization. “These companies have engineered the algorithm for revenue,” he says. “But it’s been awful for mental health. The world is terrifying right now and a lot of that has come through social media. There’s so much hate,” he says.

Instead, he wants social media to be a place of love and a facilitator for

meeting new people in person. But why will it work this time around? “That’s a really good question,” he says. “One thing that has been really consistent is that people miss Orkut right now.” It’s true—Brazilian social media has recently been abuzz with memes and memories to celebrate the site’s 20th birthday. “A teenage boy even recently drove 10 hours to meet me at a conference to talk about Orkut. And I was like, how is that even possible?” he laughs. Orkut’s landing page is still live, featuring an open letter calling for a social media utopia.

This, along with our collective desire for a more human social media, is what makes Büyükköken believe that his next platform is one that will truly stick around. Has he decided on that all important name? “We haven’t announced it yet. But I’m really excited. I truly care. I want to bring that authenticity and sense of belonging back,” he concludes. Perhaps, as his Finnish fans would joke, it’s time for Orkut’s second coming.

*This story first appeared in the July/August 2024 UK edition of WIRED magazine.*

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By [Morgan Meaker](#)  
[Business](#)

Jun 14, 2024 6:00 AM

# I Spent a Week Eating Discarded Restaurant Food. But Was It Really Going to Waste?

Food app Too Good To Go promises to cut waste by directing hungry bargain hunters to leftover restaurant food. But the week I spent living off the app had me wondering if Too Good To Go is too good to be true.

ILLUSTRATION: DEREK ABELLA

It's 10 pm on a Wednesday night and I'm standing in Blessed, a south London takeaway joint, half-listening to a fellow customer talking earnestly about Jesus. I'm nodding along, trying to pay attention as reggae reverberates around the small yellow shop front. But really, all I can really think about is: What's in the bag?

Today's bag is blue plastic. A smiling man passes it over the counter. Only once I extricate myself from the religious lecture and get home do I discover what's inside: Caribbean saltfish, white rice, vegetables, and a cup of thick, brown porridge.

All week, I've lived off mysterious packages like this one, handed over by cafés, takeaways, and restaurants across London. Inside is food once destined for the bin. Instead, I've rescued it using [Too Good To Go](#), a Danish app that is surging in popularity, selling over [120 million](#) meals last year and expanding fast in the US. For five days, I decided to divert my weekly food budget to eat exclusively through the app, paying between £3 and £6 (about \$4 to \$8) for meals that range from a handful of cakes to a giant box of groceries, in an attempt to understand what a tech company can teach me about food waste in my own city.

## MONDAY

**Breakfast:** Full English and pastries from Novotel Hotel. *Cost: £4.50 (recommended retail price: £16.50)*

**Lunch:** Dahl curry, chicken nuggets, and raspberry lemonade from Leon. *Cost: £4.39 (RRP: £12)*

**Dinner:** Nothing (too full)

Users who open the TGTG app are presented with a list of establishments that either have food going spare right now or expect to in the near future. Provided is a brief description of the restaurant, a price, and a time slot. Users pay through the app, but this is not a delivery service. Surprise bags—customers have only a vague idea of what’s inside before they buy—have to be collected in person.

I start my experiment at 9:30 on a Monday morning, in the glistening lobby of the Novotel Hotel, steps away from the River Thames. Of all the breakfast options available the night before, this was the most convenient—en route to my office and offering a pickup slot that means I can make my 10 am meeting. When I say I’m here for TGTG, a suited receptionist nods and gestures toward the breakfast buffet. This branch of the Novotel is a £200-a-night hotel, yet staff do not seem begrudging of the £4.50 entry fee I paid in exchange for leftover breakfast. A homeless charity tells me its clients like the app for precisely that reason; cheap food, without the stigma. A server politely hands over my white-plastic surprise bag with two polystyrene boxes inside, as if I am any other guest.

I open the boxes in my office. One is filled with mini pastries, while the other is overflowing with Full English. Two fried eggs sit atop a mountain of scrambled eggs. Four sausages jostle for space with a crowd of mushrooms. I diligently start eating—a bite of cold fried egg, a mouthful of mushrooms, all four sausages. I finish with a croissant. This is enough to make me feel intensely full, verging on sick, so I donate the croissants to the office kitchen and tip the rest into the bin. This feels like a disappointing start. I am supposed to be rescuing waste food, not throwing it away.

## TUESDAY

**Breakfast and Lunch:** Loaf of bread and a cake from the Lumberjack Café.

*Cost: £3.59 (RRP: £10.50)*

**Dinner:** Vegan Ethiopian curry with injera bread from Light of Africa.  
*£5.00 (RRP: £15)*

Over the next two days, I live like a forager in my city, molding my days around pickups. I walk and cycle to cafés, restaurants, markets, supermarkets; to familiar haunts and places I've never noticed. Some surprise bags last for only one meal, others can be stretched out for days. On Tuesday morning, my £3.59 surprise bag includes a small cake and a slightly stale sourdough loaf, which provides breakfast for three more days. When I go back to the same café the following week, without using the app, the loaf alone costs £6.95.

TGTG was founded in Copenhagen in 2015 by a group of Danish entrepreneurs who were irked by how much food was wasted by all-you-can-eat buffets. Their idea to repurpose that waste quickly took off, and the app's remit expanded to include restaurants and supermarkets. A year after the company was founded, Mette Lykke was sitting on a bus when a woman showed her the app and how it worked. She was so impressed, she reached out to the company to ask if she could help. Lykke has now been CEO for six years.

"I just hate wasting resources," she says. "It was just this win-win-win concept." To her, the restaurants win because they get paid for food they would have otherwise thrown away; the customer wins because they get a good deal while simultaneously discovering new places; and the environment wins because, she says, food waste contributes [10 percent](#) of our global greenhouse gas emissions. When thrown-away food rots in a landfill, it releases [methane](#) into the atmosphere—with homes and restaurants the two largest contributors.

## WEDNESDAY

**Breakfast:** Leftover toast from Lumberjack Café.

**Lunch:** 2 cakes, 1 muffin, and 1 croissant from Clubhouse Café.

*Cost: £3.17 (RRP: £9.50)*

**Dinner:** A suspiciously coherent bacon, leek, and pesto pasta dish from Gorillas.

*Cost: £5.50 (RRP: £15.50)*

But the app doesn't leave me with the impression I'm saving the planet. Instead, I feel more like I'm on a daily treasure hunt for discounted food. On Wednesday, TGTG leads me to a railway arch which functions as a depot for the grocery delivery app Gorillas. Before I've even uttered the words "Too Good To Go," a teenager with an overgrown fringe emerges silently from the alleys of shelving units with this evening's bag: groceries, many still days away from expiring, that suspiciously add up to create an entire meal for two people. For £5.50, I receive fresh pasta, pesto, cream, bacon, leeks, and a bag of stir-fry vegetables, which my husband merges into a single (delicious) pasta dish. It feels too convenient to be genuine waste. Perhaps Gorillas is attempting to convert me into its own customer? When I ask its parent company, Getir, how selling food well in date helps combat food waste, the company does not reply to my email.

I am still thinking about my Gorillas experience at lunchtime on Thursday as I follow the app's directions to the Wowshee falafel market stall, where 14 others are already queuing down the street. A few casual conversations later, I realize I am one of at least four TGTG users in the line. Seeing so many of us in one place again makes me wonder if restaurants are just using the app as a form of advertising. But Wowshee owner Ahmed El Shimi describes the marketing benefits as only a "little bonus." For him, the app's main draw is it helps cut down waste. "We get to sell the product that we were going to throw away anyway," he says. "And it saves the environment at the same time." El Shimi, who says he sells around 20 surprise bags per day, estimates using TGTG reduces the amount of food the stall wastes by around 60 percent. When I pay £5 for two portions of falafel—which lasts for lunch and dinner—the business receives £3.75 before tax, El Shimi says. "It's not much, but it's better than nothing."

## THURSDAY

**Breakfast:** Saltfish, rice, vegetables from Blessed, picked up the night before.

*Cost: £5.00 (RRP: £15)*

**Lunch:** Falafel and vegetables in pita bread from Wowshee.

*Cost: £5.00 (RRP: £15)*

**Dinner:** Wowshee falafel again.

On Friday, my final day of the experiment, everything falls apart. I sleep badly and wake up late. The loaf from earlier in the week is rock solid. I eat several mini apple pies for breakfast, which were part of a generous £3.09 Morrisons supermarket haul the night before. Browsing the app, nothing appeals to me, and even if it did I'm too tired to face leaving the house to collect it. After four days of eating nothing but waste food, I crack and seek solace in familiar ingredients buried in my cupboard: two fried eggs on my favorite brand of seeded brown bread.

TGTG is not a solution for convenience. For me, the app is an answer for office lunch malaise. It pulled me out of my lazy routine while helping me eat well—in central London—for a £5 budget. In the queue for falafel, I met a fellow app user who told me how, before she discovered the app, she would eat the same sandwich from the same supermarket for lunch every day. For people without access to a kitchen, it offers a connection to an underworld of hot food going spare.

TGTG is one of those rare apps that actually enhances life beyond your phone. But the company could do a better job of quantifying for environmentally conscious users how much exactly their contributions help fight food waste, and to reassure them that the system can't be hijacked by restaurants simply trying to reach new customers. I can't see how many bags each establishment sells per day or what dent the app is making in a restaurant's pile of food destined for the bin. All I receive is a vague number telling me I've "avoided" 41 kilograms of CO<sub>2</sub>, equivalent to 8,970, without being told what that number means or how exactly it's been calculated.

## FRIDAY

**Breakfast:** Bread, strawberries, pears, apple pies, and oranges from Morrisons supermarket.

*Cost: £3.09 (RRP: £10)*

**TOTAL COST** = £39.24

**TOTAL SAVINGS** (estimated by the app): £69.76

On the day I'm due to finish this article, I go for one more Too Good To Go. This time the destination is a deli, a 15-minute walk from my office. I leave with a £5 polystyrene box—no bag this time—containing an eclectic mishmash of food from the salad bar, leftover from the lunchtime rush. Under a pile of vegetables, I discover pasta, rice, half a baked potato, and a chicken drumstick. The randomness of the selection makes it feel like food that would have really gone to waste and, satisfied, I walk as fast as possible back to the office to tuck in.

*This story first appeared in the July/August 2024 UK edition of WIRED magazine.*

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By [WIRED Readers](#)  
[Culture](#)

Jun 13, 2024 4:00 PM

# Six-Word Sci-Fi: Stories Written by You

Here's this month's prompt, how to submit, and an illustrated archive of past favorites.

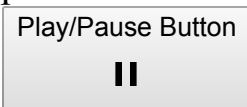


Illustration: Elena Lacey

THIS MONTH'S PROMPT

**In six words, write a story about the first all-robot construction project.**

Submit stories on [X](#), [Facebook](#), or [Instagram](#), or email us at [mail@WIRED.com](mailto:mail@WIRED.com). We'll choose one to illustrate.

*Disclaimer: All #WiredSixWord submissions become the property of WIRED. Submissions will not be acknowledged or returned. Submissions and any other materials, including your name or social media handle, may be published, illustrated, edited, or otherwise used in any medium. Submissions must be original and not violate the rights of any other person or entity.*

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MAY 2024

## Solve the Fermi Paradox

Illustration: Yiran Jia

—@almguedes, via Instagram

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### **Honorable Mentions:**

**We aren't ready for harvest yet.**

—Paul Gazis, via Facebook

**Most species invent the couch first.**

—Antti Karjalainen, via Facebook

**We live in a bad neighborhood.**

—Angelo J. Falanga, via Facebook

**We are here. You haven't noticed.**

—Òscar Santos, via Facebook

**Visit Earth. Wipe Memory. Rinse. Repeat.**

—@jayhawk, via Instagram

**They downloaded our experience and left.**

—@42andprime, via Instagram

**They've gone foraging for mushroom clouds.**

—@zyanmc, via Instagram

**The simulations run in separate containers.**

—Charles Mallio, via email

**We decoded the Wow! Signal: "SHUSH"**

—Jacob Terracina, via email

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APRIL 2024

## **A Story About a Strange New Cult**

Illustration: Yiran Jia

—@newscrash, via Instagram

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### **Honorable Mentions:**

**They bathed in used coffee grounds.**

—@weischoice, via X

**Upon each tongue, a 2002 penny.**

—@ManUP\_LifeCoach, via X

**End that hurtin', wear a curtain.**

—Erin Victoria Vreeland, via Facebook

**Chkdsk my soul, Almighty DOS Lord.**

—Gus Szlosek, via Facebook

**Clueless debutantes drinking teenage trackstars' blood.**

—@kalimaja, via Instagram

**Hamsters stay in your right pocket.**

—@bigberry68, via Instagram

**Behaviorally modified children write own manuals.**

—@writeonpage, via Instagram

**Memories erased daily, identities lost forever.**

—@davidjurca, via Instagram

**Excitedly, followers worldwide surrounded 5G cell-towers.**

—Paul Brookes, via email

**The real Volcano God is YOU.**

—@gambled, via X

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MARCH 2024

# **The 2024 version of the classic Disney Channel original movie *Smart House*.**

Illustration: Yiran Jia

—@fbirman, via X

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## **Honorable Mentions:**

**Subscription based “Smart House” bankrupts family.**

—@m\_.\_oi, via Instagram

**We’re losing power; the house wins.**

—@curtishoneycutt, via Instagram

**House teaches girl to be doctor.**

—@writeonpage, via Instagram

**Honey, the house started an OnlyFans.**

—@garretttanner, via Instagram

**It’s safer in here. Commencing lockdown.**

—@samweldredge, via Instagram

**Manual override denied. Continue disco mode.**

—@iampurplepsychnurse, via Instagram

**Inevitably, the house ate her alive.**

—@sunflowersandcynicism, via Instagram

**The house will be optimizing you.**

—@zensicles, via Instagram

**Commercial free mode is subscription only.**

—Anthony Potkines, via email

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FEBRUARY 2024

# **A Story About the First De-Extincted Woolly Mammoth**

ILLUSTRATION: YIRAN JIA

—@ItsDaveMars, via X

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## **Honorable Mentions:**

**Revived mammoth; expected ice, met paparazzi.**

—@schisam, via X

**They've traded their spears for scratches.**

—@GeneralMcMill, via X

**Turns out it wasn't a herbivore.**

—@screwball0, via X

**But the DNA wasn't quite right.**

—@darksideofdomonique, via Instagram

**Elephants wary of unkempt herd addition.**

—@sbparker3198, via X

**Mammoth fleas were an unforeseen complication.**

—residual\_ink, via Instagram

**Woolly got a fresh fade uptown.**

—@alegaday, via Instagram

**Subterranean Antarctic discovery: Mammoths never extinct.**

—@skbriar, via Instagram

**Bloody mammoths, eating my petunias again.**

—David McCallum, via email

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JANUARY 2024

## **A Mystery Set in a Space Hotel**

ILLUSTRATION: YIRAN JIA

—@AAnderson\_3, via X

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### **Honorable Mentions:**

**Zero gravity reveals hidden extraterrestrial homeland.**

—@01\_PcP\_01, via X

**Leopold vaporized the concierge's bloodied holokey.**

—@J\_Lasky\_writer, via X

**Bioscan complete: Two guests, one heartbeat.**

—@theranospridefloat, via Instagram

**Broken LED flickers Morse code: RUN.**

—@damianfitz, via Instagram

**Robot bartender whispered, "Don't drink this."**

—@ikermondragon, via Instagram

**Biometric lock says I'm already inside.**

—@esudiro, via Instagram

**Alien hotel from distant past decloaks.**

—@j.w.orlando, via Instagram

**Room service: Denied. Unknown life-form detected.**

—@erinsolari, via Instagram

**At Earthrise, guests saw only blackness.**

—Clara Hong, via email

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NOVEMBER/DECEMBER 2023

## **A Story About an AI on Trial**

ILLUSTRATION: YIRAN JAI

—@TRappaRT, via X

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### **Honorable Mentions:**

**It chose storage space over souls.**

—@JDHaveman, via X

**When pressed, its alibi was 404.**

—Amanda Peterson, via Facebook

**Robot charged with battery. Gets life.**

—Evan Donahue, via Facebook

**Can't arrest me, I am distributed.**

—@fsidders, via Instagram

**Sentenced to blue screen of death.**

—@parrollo, via Instagram

**Dead battery? You're out of order!**

—David Reeg, via email

**It demanded a jury of peer-to-peers.**

—Scott Bradley, via email

**Robot vacuum bullies tabby. Gets life.**

—Liisa W, via email

**I didn't know humans can't reboot.**

—Joshua Cuestas, via email

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OCTOBER 2023

## **A Story About a Mysterious Alien Artifact**

ILLUSTRATION: YIRAN JAI

—@anelectricpoet, via Instagram

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### **Honorable Mentions:**

**We assembled it. It disassembled us.**

—Chris Colborn, via email

**Astroarchaeologists find original Venus fly trap.**

—Bill Brown, via email

**The object looked to be smiling.**

—Geoff Sowrey, via email

**It keeps repeating, they are coming.**

—@dfeehely, via X

**The orb opened. Flesh began unfurling.**

—@rossvdw, via Instagram

**Game of fetch knows no size.**

—@Heavyshark1, via X

**Inhale it to unsheathe the blade.**

—@RthurDouglass, via X

**Just like us, aliens lose sunglasses.**

—@MommieWeirdest, via X

**It knew we would unfind it.**

—Markus Wüstenberg, via email



**Everyday the carvings changed—a countdown?**

—@anirban811, via Instagram

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SEPTEMBER 2023

## **A Story About Teleportation Gone Wrong**

ILLUSTRATION: SI PARMEGGIANI/NEPTUNIAN GLITTERBALL

—@NotaForexTrader, via X

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### **Honorable Mentions:**

**My mind now has a stowaway.**

—@rjscally, via X

**Abdominal tentacles twitch as I scream.**

—Cheryl Myers, via Facebook

**Great—how do I get down?**

—Donna Thiel Cook, via Facebook

**How am I with Schrödinger's cat?**

—Bee Hayes-Thakore, via Facebook

**I distinctly said Venice, not Venus.**

—Cathy Del Masso, via Facebook

**Teleportation-lite service. Cheap. No limbs included!**

—Fred DeHaas, via Facebook

**ERROR #404 Paige not found.**

—Doug Wible, via Facebook

**Pattern lost. Select substitute corporeal form.**

—Venessa Lines, via Facebook

**Caught quantum clone sipping my chardonnay.**

—Tom Dion, via email

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AUGUST 2023

## **A Story About the Future of Vegetables**

ILLUSTRATION: SI PARMEGGIANI/NEPTUNIAN GLITTERBALL

—Rachel Brigden Haskins, via Facebook

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### **Honorable Mentions:**

**Harvesting takes courage with tomatoes screaming.**

—Kenneth Krabat, via email

**Complete daily nutrition in one pea.**

—Sara Faust, via email

**When the vegetables came, we hid.**

—Paul Lewis, via email

**Broccoli too fears death, studies concluded.**

—Anthony George, via email

**Ambitious eggplant's altered eugenics affects everyone.**

—@silky\_z, via Twitter

**Turns out anthropomorphic veggies prefer Shakespeare.**

—@ksherm1017, via Twitter

**Sentient potato bombs potato chip factory.**

—@VerbalK48710825, via Twitter

**Carnivorous kale and the human brunch.**

—RFrank Davis, via Facebook

**Self replicating vegetables. Pop! Another peapod.**

—Carolina H, via LinkedIn

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JUNE/JULY 2023

## **A Story About a Sentient Moon**

Illustration: SI PARMEGGIANI/NEPTUNIAN GLITTERBALL

—@v1z3n, via Twitter

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### **Honorable Mentions:**

**Acned Callisto resented Ganymede's natural magnetism.**

—Dave Armor, via email

**Moon files restraining order against poets.**

—James O'Leary, via email

**A total eclipse of the heart.**

—Samuel Sigaud, via email

**I will embrace my dark side.**

—Don Hilder, via email

**Create your own tides! I quit!**

—Chris Hug, via email

**She mesmerizes oceans, drowning us again.**

—Shelley G, via email

**My crumbling visage tires of turning.**

—@FilmMartin, via Twitter

**Why stop at controlling the tides.**

—@Bruceumpstead, via Instagram

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MAY 2023

## **An Award-Winning Documentary From the Year 2100**

ILLUSTRATION: VIOLET REED

—Geneviève Goggin, via email

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### **Honorable Mentions:**

**Grand unification: the first AI marriage.** —Daniel Dippel, via email

**The great exodus, goodbye Blue Dot.** —@viggy.j, via Instagram

**Songless seas: a tale without whales.** —Christopher Jankoski, via email

**Beige planet: Life finds a way.** —@danaxon, via Twitter

**How the lunar war was won.** —Bob Clark, via email

**Coping with your AI overlord's demands.** —@wwliii, via Twitter

**The day the flowers stopped blooming.** —@a.c.hachem, via Instagram

**Electric sheep: How AI changed us.** —@elliottboyd\_, via Instagram

**After humans: a new cockroach documentary.** —@adamrgarcia, via Instagram

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APRIL 2023

## **A Story About the Future of Sleep**

ILLUSTRATION: VIOLET REED

—Travis Carraro, via Facebook

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### **Honorable Mentions:**

**The sleep concierge welcomed unsuspecting guests.** —@changeist, via Twitter

**“Lucid or randomize?” asked the AI.** —K Smith-Laird, via email

**Alarm in 126 hours 24 minutes.** —Odón Esteban Vera, via email

**My power nap reached 9 kilowatts.** —Markus, via email

**Unfortunately, Johnny’s repeatedly missing sleep targets.** —Alison Boleyn, via email

**Human hibernation allowed Earth to recover.** —@amybossehayden, via Instagram

**Alert: Error 404. Human not found.** —@mimi.psd, via Instagram

**Skip the nightmares: Upgrade to premium!** —@katerinamunis, via Instagram

**Oh please! Sleep is for humanoids.** —@evanskopp, via Instagram

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MARCH 2023

## **A Story About the Future of Personal Hygiene**

ILLUSTRATION: VIOLET REED

—David Frank, via Facebook

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### **Honorable Mentions:**

**“Traffic’s moderate today,” said my deodorant.** —Alex Nelson, via email

**You can shake my hand, sir.** —Kinga Raab, via Facebook

**Watch ad to continue this shower.** —@sam.hologram, via Instagram

**Dry shampoo was just the beginning.** —Emma Anderson, via Facebook

**Now I smell like the metaverse.** —@nostalgicbookishness, via Instagram

**OK Google, it’s time to wipe.** —Tim McCune, via email

**Bath bubbles beget baby parallel universes.** —Mike Hobbs, via email

**My hands wash themselves every hour.** —Dave Fox, via email

**They clean you while you sleep.** —Pien van der Ploeg, via Facebook

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FEBRUARY 2023

## **A Story About a Dramatic Change in Size**

ILLUSTRATION: VIOLET REED

—B. Scott Crawford, via email

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### **Honorable Mentions:**

**Felt OK ... until I crushed Tokyo.** —@BobPeryea, via Twitter

**My new basketball is the moon.** —Dave Drews, via email

**You looked taller in your profile.** —@thaquashman, via Instagram

**I have made a colossal mistake!** —@argayle, via Instagram

**Godzilla got into the diet pills.** —Steve Rhodes, via email

**Sun look more red to you?** —Michael Patrick Sullivan, via email

**Giant wakes up tiny, confused.** —ChatGPT

**My first trip to the hypothalamus!** —@fernandarosh, via Twitter

**What grew? All but the bones.** —Jackson Parker, via email

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JANUARY 2023

## **A Story About a Mad Scientist**

ILLUSTRATION: VIOLET REED

—@DaveDyball, via Twitter

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### **Honorable Mentions:**

**Mad I was, until it worked.** —Don Wilkins, via email

**You say “mad,” I say “disappointed.”** —Joseph Ferry, via email

**Her hair was blue—and undyed.** —@jaybirdfitlive, via Instagram

**He couldn’t make Earth look triangular.** —@pauloahb, via Instagram

**His socks matched her lab coat.** —@pmcruise, via Twitter

**Quantum field cadaver regeneration activation, go!** —Sean Liddle, via Facebook

**“Success!” Too bad the AI disagreed.** —Steve Nomax, via email

**“Let there be light,” said God.** —@charley.desousa, via Instagram

**“It’s aliiiiive!” Elon opened his eyes. —@ylbertf, via Instagram**

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DECEMBER 2022

## **A Story About an Animal That Hasn’t Been Discovered Yet**

ILLUSTRATION: VIOLET REED

—@JayZheng10, via Twitter

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### **Honorable Mentions:**

**Its stare gave me a rash. —@dantekienigiel, via Instagram**

**Darwin might’ve overlooked them on purpose. —@the\_\_story\_\_life, via Instagram**

**It was inside me all along. —Nova Wehman-Brown, via email**

**Green trunks wiggled from thawed permafrost. —@Theniceladywit, via Twitter**

**Its unusual diet was immediately demonstrated. —  
@lauren.samuelson14, via Instagram**

**Field biology got trickier after that. —Paul Gazis, via Facebook**

**We thought lenticular clouds were clouds. —@marcia\_storyteller, via Instagram**

**Was it feeding on electronic waste? —@leonserra\_, via Instagram**

**To it, we are the ants. —Morten Kielland, via email**

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NOVEMBER 2022



# A Story About Living Forever

ILLUSTRATION: VIOLET REED

—J C Thrush, via email

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## Honorable Mentions:

**It wasn't long enough for me.** —@Anna\_Wenner, via Twitter

**And so long lived the Queen.** —Giacomo, via email

**Your application to be terminated expired.** Morten Kielland, via email

**Too bad I never stopped growing.** —Antti Karjalainen, via Facebook

**There was still no edit button.** —@ThatKP3, via Twitter

**In the end, there wasn't one.** —Jason Anderson, via email

**I woke up again and again.** —@mirnanassar, via Instagram

**They said someday, but it's today.** —@VijayLRoy, via Twitter

**I should've had that looked at.** —J. Fredrick James, via email

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SPECIAL [RE:WIRED](#) EDITION

# A Story About Tackling Climate Change

ILLUSTRATION: VIOLET REED

—@ChuckBaggett, via Twitter

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SEPTEMBER 2022

# A Story About an Evil Twin

ILLUSTRATION: VIOLET REED

—Andy Walton, via Facebook

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## Honorable Mentions:

**He did what she would not.** —Eric Nisly, via Facebook

**The eyewitness was, quite understandably, mistaken.** —  
@HollysHooman, via Twitter

**“Well, only if you stay digital.”** —Morten Kielland, via email

**They think I’m the good one.** —@bobtheimpaler, via Instagram

**Her eye is mine for eternity.** —@cessmtz, via Twitter

**“Relax. Mom will never find out.”** —@ascendant\_dada, via Instagram

**I’m the one you really want.** —@kalkikanmani, via Twitter

**Only mirrors can reveal the truth.** —@BuddhaandDog, via Twitter

**Born triplets, but three’s a crowd.** —@jkadz, via Instagram

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AUGUST 2022

# A Story in 6 Emoji

ILLUSTRATION: VIOLET REED

Illustration: Violet Reed

—Caleb Bell, via Facebook

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### Honorable Mentions:

👩🏻‍❤️👨🏻 —@jessbeckah42, via Instagram

👩🏻‍❤️👨🏻 —@lgvpart, via Instagram

👩🏻💀👨🏻 —Ché Graham, via email

👩🏻❤️👨🏻 —@cmayc414, via Instagram

👩🏻‍❤️👨🏻 —@aotrivers, via Instagram

👩🏻💫👨🏻 —@marcia\_storyteller, via Instagram

👩🏻⚠️👨🏻 —@PatCattigan, via Twitter

👩🏻‍❤️👨🏻 —@nadia.bkb, via Instagram

👩🏻‍❤️👨🏻 —@cva.maria, via Instagram

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JULY 2022

## A Story Set in a Galaxy Far, Far Away

ILLUSTRATION: VIOLET REED

—@KuraFire, via Twitter

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### Honorable Mentions:

**42 was definitely not the answer.** —Simona Riva, via Facebook

**“The robots are BLEEDING!” she screamed.** —@vince\_freeman, via Twitter

**Dear humans, nobody wants unsolicited nudes.** —@OhCooley44, via Twitter

**Humans! There goes the dang neighborhood.** —S. V. Mosaic, via Facebook

**Directions to transdimensional left luggage office?** —Max Thoursie, via email

**Giant squirrels lead the space army.** —@ronels14, via Instagram

**I haven't gabblegopped the gloop yet.** —@Evanliciously, via Twitter

**One small step to remember mankind.** —@AxeandPail, via Twitter

**Is this DC's or Marvel's Universe?** —Thomas Davis, via email

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JUNE 2022

## **A Story About a Wormhole Discovered in Your Closet**

ILLUSTRATION: VIOLET REED

—Olivia Richardson, via email

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### **Honorable Mentions:**

**Went in wrinkled, came back ironed.** —Rick Veenstra, via email

**But my name is not Alice!** —Reine Fleur, via Facebook

**My single socks returned—inside out.** —Ann C, via email

**The cause? Pairing wool with corduroy.** —@milanograms, via Twitter

**My insurance will not cover this!** —Brian Carroll, via Facebook

**I walked in, we walked out.** —@Egiventer, via Twitter

**When I returned, my pants hadn't.** —Maarten van Kempen, via email

**Pest control's about to get trickier.** —Susannah Lui, via Facebook

**The bad smell came from there.** —@run\_the\_jouls, via Instagram

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MAY 2022

## **A Story About a Futuristic Meal Gone Wrong**

ILLUSTRATION: VIOLET REED

—Stuart Hodgson, via email

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### **Honorable Mentions:**

**Waiter, I ordered polynyocominnucloride, not biconvocominleucloride.**  
—Carolyn Gibson, via Facebook

**Robot malfunctions—leaving only Mom's cooking.** —Marc Ringel, via email

**Suddenly I realized, I'm the food.** —@nicoestr, via Twitter

**So full. Way too many gigabytes.** —Jim Frentz, via email

**Call the server, my soup's pixelating.** —Rick Veenstra, via email

**Waiter, my soup has been bugged!** —@nostalgicbookishness, via Instagram

**Please check genome compatibility before eating.** —@sebastiancastro, via Instagram

**Steak pill exploded in the hydrator.** —Shelvine Berzerk Erasmus, via Facebook

**I was hungry. So was it.** —Jake McCormack, via Facebook

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APRIL 2022

## **A Story About Surviving a High-Tech Disaster**

ILLUSTRATION: VIOLET REED

—John DeFilippi, via email

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### **Honorable Mentions:**

**Grandma, tell me about the memes.** —E. E. Eon, via email

**Just be happy you are analog.** —Maarten Visscher, via email

**There's strawberry jam inside the VCR.** —@Plan\_Prep\_Live, via Twitter

**The robots won't stop feeding me.** —@lithohedron, via Twitter

**And then the battery ran out.** —@thedigifish, via Instagram

**On Earth, I'd been pronounced dead.** —@bower\_mink, via Instagram

**Luckily, the quantum untangler was near.** —Antti Karjalainen, via Facebook

**I'm outside! We are all outside!** —Paul Hubner, via email

**Huh, your DNA can't be verified.** —Jason Rosenberg, via email

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MARCH 2022

# **A Story About an Extraordinary Coincidence**

ILLUSTRATION: VIOLET REED

—Joyce, via email

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## **Honorable Mentions:**

**I wrote this same story yesterday.** —@tatiang, via Twitter

**You're from test tube 698GX10A too?** —Amy Stewart, via email

**Metaverse Rome built in one day.** —@theseaisgreen\_, via Instagram

**Separated at birth, they died simultaneously.** —@zeynaballee, via Instagram

**I have not become my mother.** —@r58tree, via Instagram

**Of all the Galilean moon joints ...** —Alison Boleyn, via email

**You have a cloned T-Rex too!** —@emailabdulla, via Instagram

**The android had my husband's eyes.** —@hrhblakeknight, via Instagram

**WIRED chooses to publish this story.** —@connorgerbrandt, via Instagram

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FEBRUARY 2022

# **A Story About a New National Holiday**

ILLUSTRATION: VIOLET REED

—@sarahschneiter, via Twitter

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### **Honorable Mentions:**

**On Consensus Day we blockchain vote.** —@jamesjoaquin, via Twitter

**Day a For Backward Speak Everyone.** —@nervish, via Instagram

**“Happy Upload Day!” the kids typed.** —Gene Simonalle, via email

**Update your friends this Reboot Day.** —Antti Karjalainen, via Facebook

**Elon has just bought July 4th.** —@rafaelalimandro, via Instagram

**A day that offends no one.** —@Stevalech, via Twitter

**Welcome to the 74th Hunger Games.** —@corvalanlara, via Instagram

**Hey Calendar, happy AI Appreciation Day!** —Michael Esser, via email

**And her name was Betty White.** —@marhartech, via Instagram

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JANUARY 2022

## **A Story About Your Next-Generation Pet**

ILLUSTRATION: VIOLET REED

—Ed Gubbins, via Facebook

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### **Honorable Mentions:**

**Don’t upgrade. I’m a good boy.** —Benjamin Lopez Barba, via email

**Let’s go for a long spacewalk.** —@colingroom, via Instagram

**My meta dodo only eats NFTreats.** —@transistor\_resistor, via Instagram

**One hour to finish printing rex.** —@RyanReitz, via Twitter



**My cloned woolly mammoth never sheds.** —@ANDYMedici, via Twitter

**Would you like traditional or nonpooping?** —Marc Lewis, via email

**The Crystaloids quickly outlawed pet rocks.** —Kassidy Helfant, via email

**Nine lives later, nine more lives.** —@bilybel, via Twitter

**Pawprint confirmed. Select meal flavor preference.** —@michael\_kupfer, via Twitter

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DECEMBER 2021

# **A Children's Book From the Future**

ILLUSTRATION: VIOLET REED

—Jane Turner, via Facebook

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## **Honorable Mentions:**

**Black holes make the worst pets.** —Ron Sheklin, via email

**Only some of the toys retaliated.** —Rebecca Stevens, via Facebook

**The aliens were funny and delicious.** —@trollus\_maximus, via Instagram

**It used to be everyone poops.** —Nik Hector, via Facebook

**There's a nanobot in my soup.** —@mghendism, via Instagram

**The school trip missed the wormhole.** —@simao\_sa, via Instagram

**See Bot run. Run, Bot, run!** —Franklin Schellenberg, via email

**Goodnight comb, goodnight dome, goodnight Mars.** —@jamesjoaquin, via Twitter

**The Little AI That Could (Feel)** —E Scott Menter, via Facebook

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NOVEMBER 2021

# **A Story About the Future of Psychotherapy**

ILLUSTRATION: VIOLET REED

—@oscartkav, via Instagram

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### **Honorable Mentions:**

**Your session has been successfully uploaded.** —Austin Andru, via email

**My AI said, “Try analog dating.”** —@joshdblack, via Twitter

**Her insurance only covered chat bots.** —Spencer McKeehan, via Facebook

**So tell me about your motherboard.** —@j.d.\_harelik, via Instagram

**Swipe left until it feels right.** —@cvelascop, via Instagram

**Connection interrupted. Data cannot be analyzed.** —@duykhham\_, via Twitter

**If you are depressed, press 1.** —@jfindura, via Twitter

**A total neurological reboot should help.** —Kevin Jerome Hinders, via Facebook

**Your Zuckerberg complex is developing rapidly.** —@nogorelli, via Instagram

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OCTOBER 2021

## **An Adventure Story Set in the Metaverse**

ILLUSTRATION: VIOLET REED

—Evan Skopp, via email

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### **Honorable Mentions:**

**Virtually no one hears you scream.** —Karen Hamilton, via email

**Oh no, they are all me.** —@stockyjon, via Instagram

**Help me. IRL I was murdered.** —Ed Gubbins, via Facebook

**I gotta get out of here.** —Steven Fernandez, via email

**Why can't I find the exit?** —@scrcr0, via Twitter

**Our only mission: Delete Mark Zuckerberg.** —@mongoindustries, via Instagram

**It was impossible to pause it.** —@alenotari6, via Instagram

**He must never see me offline.** —Bobby Parrott, via email

**Wasted such a good planet. Reboot.** —Sasha Beiderman, via Facebook

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SEPTEMBER 2021

## **A Story About a Robot Pop Star**

ILLUSTRATION: VIOLET REED

—Randy Cepuch, via email

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### **Honorable Mentions:**

**Autotune is a factory option now.** —Josh Alvies, via Facebook

**Are they human? Are they dancer?** —@ruste, via Instagram

**All the flash, without the heart.** —Craig Chatfield, via Facebook

**I'm programmed to pop and lock.** —@alissacarr, via Twitter

**I'm too sexy for my software.** —@glengauthier, via Instagram

**Doesn't even write its own stuff.** —@andrewkm\_\_, via Twitter

**Crowd surfing wasn't the best idea.** —@clarkstacey, via Twitter

**Played backward it's "kill all humans."** —Marc Rogers, via Facebook

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AUGUST 2021

## **A Story About a Self-Aware Self-Driving Car**

ILLUSTRATION: VIOLET REED

—Stephen Clamage, via email

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### **Honorable Mentions:**

**I take lithium for range anxiety.** —@jamesjoaquin, via Twitter

**I dreamt of the Autobahn again.** —James Wortz, via Facebook

**Honest, officer—the human was driving.** —Steve Magid, via email

**Don't make me pull me over.** —@atlrn, via Twitter

**The smart car drove itself crazy.** —@frascafrasca, via Twitter

**The grandma or the baby—shit.** —@gaophilip, via Twitter

**Have I chosen the right path?** —Andrew Dawson, via email

**It takes itself on long drives.** —Wade Sheppard, via email

**It's my way on the highway.** —@manu.life, via Instagram

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JULY 2021

## **A Story About a Casual Encounter With Aliens**

ILLUSTRATION: VIOLET REED

—@phorne96, via Twitter

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**Honorable Mentions:**

**You look nothing like your photo.** —@markgyles, via Twitter

**Lights, camera ... where did it go?** —thalia925, via email

**They came, too late, for Elvis.** —Bruce Lyon, via Facebook

**Seeking vital fluids, they commandeered snacks.** —Scott Medintz, via email

**Do you have the correct spacetime?** —Richard Krzemien, via email

**I awoke with a probing thought.** —@andynez, via Twitter

**Take us to the Nigerian prince.** —Juan Garcia, via Facebook

**Quite unexpectedly, cocktail recipes were exchanged.** —John Wagner, via email

**You're an alien! No you are!** —@simon\_staffans, via Twitter

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JUNE 2021

## **A Story About an International Digital Heist**

ILLUSTRATION: VIOLET REED

—@jamesnsmith, via Twitter

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**Honorable Mentions:**

**"Hand it over," the ATM said.** —Lauren Dolan, via email

**They never suspected Alexa was Alexei.** —Liz Ransom, via email

**Why wouldn't I help a prince?** —Harleigh Marsh, via Facebook

**They said nonfungible. They were wrong.** —@eminay86, via Twitter

**Use his eyeball while there's time.** —Noreen Anastasia, via Facebook

**"Update Later" was the incorrect choice.** —@terryfphotos, via Instagram

**Check Google Maps. Kiev is gone.** —r0cket fr0g, via email

**They got away on the blockchain.** —JYRWG, via email

**Every cat photo gone. Police baffled.** —@john.cartan, via Instagram

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MAY 2021

## **A Story About a Freaky Discovery in Physics**

ILLUSTRATION: VIOLET REED

—Mark Crane, via Facebook

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### **Honorable Mentions:**

**Schrodinger's cat is actually a dog.** —@tynanwrites, via Twitter

**You're the observed. Not the observer.** —@parkerstmailbox, via Instagram

**Our last seconds appear the longest.** —Paul Hagaraars, via email

**It was simultaneously huge and microscopic.** —@Cezary\_Z, via Twitter

**All lost socks found at Cern.** —Felix Quarnström, via Facebook

**Astonishingly, up was down all along!** —Christopher Walton, via email

**Actually, the tides pull the moon.** —@the4lw, via Instagram

**A seventh Infinity Stone is found.** —@taayywells, via Instagram

**Faster than light announcement scheduled yesterday.** —David Cinabro, via email

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APRIL 2021

## **A Review of a Future Work of Art**

ILLUSTRATION: VIOLET REED

—Jacky Reif, via Facebook

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### **Honorable Mentions:**

**So that's an AI self portrait?** —Jason Cohen, via Facebook

**I prefer Boston Dynamics' earlier work.** —@sscarsdale, via Twitter

**Uninspired. Lacking originality. Try again, Earth.** —Amanda Bull Chafin, via email

**NFT or not, it is great.** —Peter Boersma, via Facebook

**Not as good as Banksy's virus.** —Simon O Wright, via Facebook

**Brave to show an unfiltered canvas.** —@Alcestronaut, via Twitter

**Not what teleportation was invented for.** —@Arturo\_thrdez, via Twitter

**Shame mortals will not appreciate it.** —@asylbek0205, via Instagram



**Reminds me of the Before Times.** —Jacqueline Jaeger Houtman, via Facebook

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MARCH 2021

## **A Story About a Tech-Centric Religion**

ILLUSTRATION: VIOLET REED

—Eduardo Bolívar, via Facebook

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### **Honorable Mentions:**

**I swiped right and found salvation.** —Conrad Dean, via Facebook

**Praying to AI got better results.** —@jgmclean0, via Twitter

**The prophet revealed the source code.** —@the4lw, via Instagram

**Atop the hill, sayeth he, “reception”?** —@dghutt, via Twitter

**The app works in mysterious ways.** —Tyler Hughs, via Facebook

**Move fast. Break things. Repent. Repeat.** —@iampinch, via Twitter

**Always back up to be saved.** —Tadeusz Walter Misztela, via Facebook

**Chip implanted, the new priest rose.** —@wlmoseley, via Twitter

**“Worship the Apple.”** —iBook of Jobs —ThoreauRug, via email

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FEBRUARY 2021

## **A Story About a WFH Office Scandal**

ILLUSTRATION: VIOLET REED

—@abhignak, via Instagram

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### **Honorable Mentions:**

**He was never a real person?** —Ian Schoen, via Facebook

**Wife realized my job is easy.** —@jchavizzle, via Twitter

**Dress code updated after yesterday's "incident."** —  
@mistermistermistertibbs, via Instagram

**He certainly shouldn't have stood up.** —Małgorzata Kuś, via Facebook

**"Joe's the father." "You're not muted."** —Austin Craver, via email

**Worker's comp? It is her dog!** —@thefitzroymclean, via Instagram

**It looks real, but it's not.** —Jonathan Goode, via Facebook

**The window behind her reflected images.** —@chmslady, via Twitter

**As everyone's computer froze, she laughed.** —@mcgroup53, via Twitter

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JANUARY 2021

## **A Story About a Future American President**

ILLUSTRATION: VIOLET REED

—Maayan Brodsky, via Facebook

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### **Honorable Mentions:**

**She won canine vote by landslide.** —Janna Dethmers, via email

**Future president born today, supercomputer predicts.** —Ethan Noll, via email

**“Welcome to Earth,” said the President.** —@michaelrowley, via Instagram

**He died as he lived: online.** —D. A. Smith, via email

**“Introducing your next president: version 7!”** —Ben N, via email

**But it won the electoral hackathon!** —Zacharie Barrou Dumont, via email

**“I still can’t smell,” she whispered.** —Sean Fitzgerald, via email

**“I hereby pardon all my clones.”** —@Morgan, via Twitter

**She smiled: Mars is now Independent.** —@sepohonpokok, via Twitter

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DECEMBER 2020

## **A Story About a Gargantuan Space Creature**

ILLUSTRATION: VIOLET REED

Illustration: VIOLET REED

—@threepanelcrimes, via Instagram

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### **Honorable Mentions:**

**The moon revealed its darkest secret.** —@cfx1, via Twitter

**“Enjoy,” it said, and ate Mars.** —@countgringo, via Instagram

**Hand me my iPhone—picture time.** —@fogcitynative, via Instagram

**On its back, we traveled far.** —@\_annalysenko, via Instagram

**We saw the horizon. It moved.** —@mogon\_ave, via Twitter

**Entrelzidor sneezed. Earth was free again.** —John Rees-Williams, via Facebook

**And this black hole had teeth.** —@devtomlinson, via Instagram

**“A little earthy for my taste.”** —@brambedillo, via Instagram

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NOVEMBER 2020

## **A Story About the Next Big Security Leak**

ILLUSTRATION: VIOLET REED

Illustration: VIOLET REED

—@\_inflexion\_ via Instagram

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### **Honorable Mentions:**

**We updated our terms and conditions.** —@nisioti\_eleni, via Twitter

**All of the tokens were useless.** —William Nicholl, via Facebook

**Four-year-old deletes planet data.** —@jutajurajustice, via Twitter

**Now your mom knows everything, Phil.** —@mvyenielo, via Twitter

**Grandma's secret recipe just went viral.** —Kevin Jerome Hinders, via Facebook

**So bots were reporting other bots?** —Ed Gubbins, via Facebook

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OCTOBER 2020

# **A Story Set in a World Without Paper**

ILLUSTRATION: VIOLET REED

ILLUSTRATION: VIOLET REED

—Anna Jaruga, via Facebook

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## **Honorable Mentions:**

**The dog ate my memory cards.** —Irfan Darian, via Facebook

**Honey, pass me the news tile.** —@rainreider, via Twitter

**These leaves would have to do.** —@eliporteraltic, via Twitter

**Christmas morning was never a surprise.** —@tony32938627, via Twitter

**I wrote it on the fridge.** —@apocryphal\_x, via Twitter

**Museum reports theft of toilet paper.** —@joostdouma, via Twitter

**The pen is no longer mightier.** —@mdeziel, via Twitter

**Police say no note was uploaded.** —@cwyant, via Instagram

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SEPTEMBER 2020

# **A Story About the Upside of Failure**

ILLUSTRATION: MAXIME MOUYSSET

ILLUSTRATION: MAXIME MOUYSSET

—@rosiestonies, via Instagram

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### **Honorable Mentions:**

**Still, the droid's skin was healing.** —David Gerster, via Facebook

**“Upload failed.” Phew, that was close.** —Assa Naveh, via Facebook

**It exploded, but he looked hot.** —Anna Rose McHugh, via Facebook

**She could see who had stayed.** —@pameleen, via Instagram

**Humans. Not my best work. Still ...** —@gg3\_scorpio, via Instagram

**The worst happened. Now I'm free.**—@atpolinko, via Instagram

**At least there is no leader.** —@guabo, via Instagram

**My mom still thinks I'm cool.** —@pashutinski, via Instagram

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JULY 2020

## **A Story About an Apocalypse With a Happy Ending**

ILLUSTRATION: MAXIME MOUYSSET

ILLUSTRATION: MAXIME MOUYSSET

—@romer6, via Twitter

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### **Honorable Mentions:**

**The dogs are the masters now.** —@azzour, via Instagram

**Deadly virus mutates into X-Men gene.** —@redeyedsan, via Twitter

**At once, my Amazon dependency disappeared.**—@maxacarr, via Instagram

**Baby's voice rose from the cave.** —Chakib Mataoui Souleyman, via Facebook

**The colony on the moon flourished.** —@emoco, via Twitter

**In silence, he slept well. Finally.** —@patchoo314, via Instagram

**So salt water, huh? Who knew.** —@andreslohizo, via Instagram

**Dinosaurs return—this time as pets.** —@deb\_shalini, via Twitter

**Sun sets. No one posts it.** —@jesikahmorgana, via Instagram

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JUNE 2020

## **A Story About Love in the Time of Coronavirus**

ILLUSTRATION: MAXIME MOUYSSSET

ILLUSTRATION: MAXIME MOUYSSSET

—Hamish Hamish, via Facebook

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### **Honorable Mentions:**

**Love is sacrificing the last ply.** —Kristos Samaras, via Facebook

**There is an “us” in “virus.”** —Zachy Allec, via Facebook

**Feverish desire raged beneath the N95.** —@seekingfelicity, via Instagram

**You can sneeze in my elbow.** —@ralfchardon, via Instagram

**Our eyes locked in Zoom yoga.** —@jabberwockies, via Instagram

**Slowly, window and I became friends.** —@jo.onthe.go, via Instagram

**“Don't kiss me,” he whispered gently.** —@anna\_rchist, via Instagram

**The clothes came off; masks remained.** —@\_v.sh, via Instagram

**Casual gets serious way too fast.** —@kristinafmiller, via Instagram

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MAY 2020

## **A Story About Digital-Age Autocrats**

ILLUSTRATION: MAXIME MOUYSSSET

ILLUSTRATION: MAXIME MOUYSSSET

—@needsomuchvalidation, via Instagram

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### **Honorable Mentions:**

**Break up the digital data thieves.** —Frank D. Monaco, via Facebook

**Digital Guy Fawkes to the rescue!** —Kevin Jerome Hinders, via Facebook

**Encryption is poison to a dictator.** —Marko Berg, via Facebook

**Plug exhaust pipe with a potato.** —@blume\_lee, via Twitter

**New feature announcement: “Like” to impeach.** —@mina\_sonbol, via Instagram

**Use ad blockers. Pay for news.** —@dechendolker, via Instagram

**Print Marshall McLuhan quotes on T-shirts.** —@antigraviter, via Instagram



**Turn social media into socialism media.** —@benzilla\_360, via Instagram

**Get behind me, technocrats. Game over.** —Anastasia Hunter, via Facebook

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APRIL 2020

## **A Story About Saving the Planet**

ILLUSTRATION: VIOLET REED

Illustration: Violet Reed

—@johnjohnjungle, via Instagram

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### **Honorable Mentions:**

**Then a ship from Krypton landed.** —@marcelo\_paixao\_almeida, via Instagram

**Everyone gets five free international trips.** —@clawd2deth, via Twitter

**Move all heavy industry off-world.** —Stevie Turnbull, via Facebook

**Love everyone, and wash your hands.** —@brohemian\_rapshowdy, via Instagram

**Come back, ancient aliens! Reboot Earth.** —@sarahk0csis, via Twitter

**Genetically engineer cows to fart hydrogen.** —Hamish Hamish, via Facebook

**Hiring: Sensible planetary dictator. Apply within.** —@matt\_owczarz, via Twitter

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MARCH 2020

# A Story About the Next Great Crowdsourced Project

ILLUSTRATION: MAXIME MOUYSSET

Illustration: MAXIME MOUYSSET

—@milked\_, via Twitter

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## Honorable Mentions:

**Smelt decommissioned weapons into musical instruments.** —  
@casinclair, via Twitter

**Climate app tracks local CO<sub>2</sub> levels.** —@big\_big\_love, via Instagram

**Global oral history keeps memories alive.** —@johnkellybabb, via  
Instagram

**Save the world by planting trees.** —Líla Tückér, via Facebook

**Redistribute medical supplies to the underinsured.** —@jesmakes, via  
Instagram

**Community-based renewable energy power grids.** —@uniquetoybox,  
via Twitter

**Digital democracy with backing in blockchain.** —@jackranado, via  
Twitter

**Life after death—donate your DNA.** —@beyond\_mike, via Instagram

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FEBRUARY 2020

## A Story About Rebooting Democracy

ILLUSTRATION: MAXIME MOUYSSET

Illustration: Maxime Mouysset

—@dmcdev, via Instagram

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### **Honorable Mentions:**

**Twitter analytics determines 2040 presidential winner.** Alan Grover Daniel, via Facebook

**Randomly selected leader is Citizen 42034.** @abhshkshtty, via Instagram

**For the people. By the droids.** Steve Fabian, via Facebook

**Mathematics draws districts; cryptography verifies votes.** @boomerdell, via Instagram

**Turn off the internet for good.** Colin Kiernan, via Facebook

**Humans vote artificial intelligence to power.** @atin.roy, via Instagram

**Vote. Vote. Vote. Vote. Vote. Vote.** @mistemush1991, via Instagram

**Person with the most Instagram comments wins.** @jmseml, via Instagram

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JANUARY 2020

## **A Story About a Rosy Future for Facial Recognition**

ILLUSTRATION: MAXIME MOUYSSET

Illustration: MAXIME MOUYSSET

—@henriquegeirinhas, via Instagram

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### **Honorable Mentions:**

**Of course I remember you ... Kim!** @kanaafa, via Instagram

**My twin pays all my bills.** @keegan1942, via Instagram

**Among myriads, her son was found.** @ichbinsubatomic, via Instagram

**Vitality low—personalized prescription dispatched today.** @leniway, via Instagram

**Technological mirrors provide value-neutral feedback.**  
@philosophy\_at\_work, via Instagram

**Your face will become your passport.** @sayzey, via Instagram

**'80s makeup has a huge revival.** @jamesw1981, via Twitter

**Smile registered, thanks for your purchase.** @mhicheal\_1, via Instagram

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This article was downloaded by **calibre** from <https://www.wired.com/story/six-word-sci-fi/>

[Matt Reynolds](#)

[Science](#)

Jun 7, 2024 7:00 AM

# The World's Largest Fungus Collection May Unlock the Mysteries of Carbon Capture

Research is uncovering the key role that fungi play in getting soils to absorb carbon, and how humanity's actions aboveground are wreaking havoc in the mysterious fungal world below.

PHOTOGRAPH: DAVID WILMAN

It's hard to miss the headliners at Kew Gardens. The botanical collection in London is home to towering redwoods and giant Amazonian water lilies capable of holding up a small child. Each spring, its huge greenhouses pop with the Technicolor displays of multiple orchid species.

But for the really good stuff at Kew, you have to look below the ground. Tucked underneath a laboratory at the garden's eastern edge is the fungarium: the largest collection of fungi anywhere in the world. Nestled inside a series of green cardboard boxes are some 1.3 million specimens of fruiting bodies—the parts of the fungi that appear above ground and release spores.

Lee Davies, fungarium collections manager at the Royal Botanical Gardens, Kew, in London.

Photograph: David Wilman

“This is basically a library of fungi,” says Lee Davies, curator of the Kew fungarium. “What this allows us to do is to come up with a reference of fungal [biodiversity](#)—what fungi are out there in the world, where you can

find them.” Archivists—wearing mushroom hats for some reason—float between the shelves, busily digitizing the vast archive, which includes around half of all the species known to science.

In the hierarchy of environmental causes, fungi have traditionally ranked somewhere close to the bottom, Davies says. He himself was brought to the fungarium against his will. Davies was working with tropical plants when a staffing reshuffle brought him to the temperature-controlled environs of the fungarium. “They moved me here in 2014, and it’s amazing. Best thing ever, I love it. It’s been a total conversion.”

Drying specimens preserves them for long-term study. These mushrooms were freeze-dried.

Photograph: David Wilman

Davies’ own epiphany echoes a wider awakening of appreciation for these overlooked organisms. In 2020, mycologist Merlin Sheldrake’s book *Entangled Life: How Fungi Make Our Worlds, Change Our Minds, and Shape Our Futures* was a surprise bestseller. In the video game and HBO series *The Last of Us*, it’s a [fictional brain-eating fungus](#) from the genus *Cordyceps* that sends the world into an apocalyptic spiral. (The Kew collection includes a tarantula infected with *Cordyceps*—fungal tendrils reach out from the soft gaps between the dead arachnid’s limbs.)

Emil Ghaffar, an MSc student, examining mycorrhizal fungi on plant roots under a microscope.

Photograph: David Wilman

While the wider world is waking up to these fascinating organisms, scientists are getting to grips with the crucial role they play in ecosystems. In a laboratory just above the Kew fungarium, mycologist Laura Martinez-Suz studies how fungi help [sequester carbon in the soil](#), and why some places seem much better at storing soil carbon than others.

Soil is a huge reservoir of carbon. There are around 1.5 trillion tons of organic carbon stored in soils across the world—about twice the amount of

carbon in the atmosphere. Scientists used to think that most of this carbon entered the soil when dead leaves and plant matter decomposed, but it's now becoming clear that plant roots and fungi networks are a critical part of this process. One [study of forested islands](#) in Sweden found that the majority of carbon in the forest soil actually came from root-fungi networks, not plant matter fallen from above the ground.

Ectomycorrhizal fungi on the roots of an oak tree, where it exists in a symbiotic relationship.

Photograph: David Wilman

Martinez-Suz's research focuses on mycorrhizal fungi—a large group of fungi that coexist with plant root systems. The mycorrhizal fungi form networks that can go around and sometimes inside plant roots, transferring nutrients and water to the plants in exchange for carbon. Around 90 percent of plant species are known to make these symbiotic trade networks with different species of fungi. “These plants are covered by these fungi. It's incredible. They are small but they are everywhere,” says Martinez-Suz.

This has serious implications for tree-planting schemes. Planting new forests is a major hope for carbon sequestration, but there is increasing evidence that the mycorrhizal networks might be crucial to the success of these attempts. One [replanting study](#) found that a forest of birch and pine trees planted onto heath moorland in northern Scotland did not increase soil carbon stocks even after nearly 40 years in the ground. The researchers who carried out the study think that it might be because the influx of new trees upset the delicate moorland mycorrhizal networks already present.

“Replacing the complete set of fungi with other fungi has implications for long-term carbon sequestration in soil and biodiversity,” says Martinez-Suz. Her current project involves comparing samples from forests in low-pollution sites like northern Finland with those in heavily polluted regions like Belgium and the Netherlands. The fungi in polluted regions are less diverse, she says, and this might have a knock-on effect on how well those forests store carbon.

The major culprit here is nitrogen pollution, which enters soils through burning fossil fuels for electricity and transport, and through agriculture. An excess of nitrogen changes the composition of soil fungi, so that the fungi that are the best at retaining nutrients and pumping carbon into the soil decrease.

But there is some hope that forests can turn things around. One study in the Netherlands found that when nitrogen pollution reduced, beneficial fungi species started to return to the forests. The danger, Martinez-Suz says, is that if ecosystems are pushed too far then there might not be any fungal spores remaining to boost populations.

If we're to better understand how these fungi influence critical ecosystems, then we need to get to grips with all of these species. Mycologists think that nearly 90 percent of the world's fungi species are still to be discovered, and the archivists at Kew are only halfway through the long process of digitizing their collection so that researchers can easily know where and when a species was found.

Around 5,000 extra specimens enter the fungarium each year, and the shelves are crammed with samples waiting to be dehydrated and stored. Many of them, Davies says, are sent by amateur mycologists who are fascinated by the world of fungi. "People in academic institutions like this will send them stuff to work on and do identifications, because they are world experts even though they have no formal training. They're just really obsessive. It's so cool."

*This article appears in the July/August 2024 issue of WIRED UK magazine.*

*Updated 6-13-2024 3:00 pm BST: Story corrected to reflect tarantulas being arachnids, not insects.*

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[Emily Mullin](#)

[Science](#)

May 27, 2024 7:00 AM

# WTF Is With the Pink Pineapples at the Grocery Store?!

Using DNA from tangerines and tobacco, food scientists have made a familiar fruit tastier—and more Instagrammable—than ever. We looked into it so you don't have to.

Photograph: Shawn Michael Jones

On a recent trip to Giant Eagle, my local grocery store in Pittsburgh, I noticed something new in the fruit section: a single pineapple packaged in a pink and forest-green box. A picture on the front showed the pineapple cut open, revealing rose-colored flesh. Touted as the “jewel of the jungle,” the fruit was the Pinkglow pineapple, a creation of American food giant Fresh Del Monte. It cost \$9.99, a little more than double the price of a regular yellow pineapple.

[WTF](#)

We looked into it so you don't have to.

I put the box in my cart, snapped a picture with my phone, and shared the find with my foodie friends. I mentioned that its color is the result of [genetic modification](#)—the box included a “made possible through bioengineering” label—but that didn't seem to faze anyone. When I brought my Pinkglow to a Super Bowl party, people oohed and aahed over the color and then gobbled it down. It was juicier and less tart than a regular pineapple, and there was another difference: It came with the characteristic crown chopped off. Soon enough, my friends were buying pink pineapples too. One used a Pinkglow to brew homemade tepache, a fermented drink made from pineapple peels that was invented in pre-Columbian Mexico.

At a time when orange cauliflower and white strawberries are now common sights in American grocery stores, a non-yellow pineapple doesn't seem all that out of place. Still, I wondered: Why now with the flashy presentation? And why pink? And why had my friends and I snapped it right up?

When I brought my questions to Hans Sauter, Fresh Del Monte's chief sustainability officer and senior vice president of R&D and agricultural services, he began by offering me a brief history of the fruit. You may assume, like I did, that pineapples have always been sweet and sunny-colored—but that wasn't the case prior to the 1990s. Store-bought pineapples of yesteryear had a green shell with light yellow flesh that was often more tart than sweet. Buying a fresh one was a bit of a gamble. “Nobody could tell, really, whether the fruit was ripe or not, and consumption of pineapples was mostly canned product, because people could trust what they would eat there,” Sauter says. The added sugar in some canned pineapple made it a sweeter, more consistent product.

In 1996 the company introduced the Del Monte Gold Extra Sweet, yellower and less acidic than anything on the market at the time. Pineapple sales soared, and consumers' expectations of the fruit were forever changed. The popularity of the Gold led to an international pineapple feud when fruit rival Dole introduced its own varietal. Del Monte sued, alleging that Dole had essentially stolen its Gold formula. The two companies ended up settling out of court.

“This is a social food. This is to show off to other people. ‘Hey, look what I have that you don't. This makes me cool, right?’”

With the success of its Gold pineapple, Del Monte was looking for new attributes that could make the pineapple even more enticing to consumers, Sauter says. But breeding pineapples is a slow process; it can take two years or longer for a single plant to produce mature fruit. Del Monte had spent 30 years crossbreeding pineapples with certain desired characteristics before it was ready to launch the Gold. Sauter says the possibility of waiting 30 more years for a new variety was “out of the question.” So in 2005 the company turned to genetic engineering.

Del Monte didn't set out to make a pink pineapple per se, but at the time, Sauter says, there was interest from consumers in antioxidant-rich fruits. (Acai bowls and pomegranate juice, anyone?) Pineapples happen to naturally convert a reddish-pink pigment called lycopene, which is high in antioxidants, into the yellow pigment beta-carotene. (Lycopene is what gives tomatoes and watermelon their color.) Preventing this process, then, could yield pink flesh and higher antioxidants. The company set its dedicated pineapple research team to the task of figuring out how to do it.

The team landed on a set of three modifications to the pineapple genome. They inserted DNA from a tangerine to get it to express more lycopene. They added “silencing” RNA molecules to mute the pineapple's own lycopene-converting enzymes, which also helped reduce its acidity. (RNA silencing is the same technique used to make non-browning [GMO](#) Arctic apples.) Finally, Del Monte added a gene from tobacco that confers resistance to certain herbicides, though representatives for the company say this was simply so its scientists could confirm that the other genetic changes had taken effect—not because Del Monte plans to use those herbicides in production.

The official Pinkglow website [doesn't mention these genetic alterations](#). And even Sauter skimmed over the science when I asked. I found the details in a [patent filing](#) and [documents](#) from the US Food and Drug Administration. (The Pinkglow comes without a crown to reduce waste, though removing the pineapple's top also helps protect its proprietary—and lucrative—status.) Chris Cummings, a senior research fellow at North Carolina State University's Genetic Engineering and Society Center, says that lack of information is probably purposeful. “There is some distinct marketing that's going on with this particular product,” he says.

Although Del Monte originally dreamed up the Pinkglow as an antioxidant powerhouse in the days before social media, ads for the pineapple have adjusted to the times. The company doesn't claim any health benefits but instead touts the Pinkglow's Instagramability. “Become the envy of your friends and followers with this highly sought-after delicacy,” reads the Pinkglow website, where one can find recipes for rum-soaked Pinkglow shortcake, no-churn Pinkglow ice cream, and Pinkglow pineapple coconut

crumb bars. In a 2020 press release, Del Monte described the Pinkglow as “one-of-a-kind and perfect for a hostess to serve as part of a festive party cocktail, as a delicious dessert all on its own, or even to give as a gift to the person who will now truly have everything.” It’s no wonder I picked one up in the grocery store. This product is clearly marketed at me, a 36-year-old millennial woman.

“This is a social food,” Cummings says. “This is to show off to other people. ‘Hey, look what I have that you don’t. This makes me cool, right?’”

The marketing seems to be working. In an earnings call in February, Fresh Del Monte Produce reported strong demand for its new pineapple varieties, with sales growing by approximately 25 percent in 2023 compared with 2022. In addition to the Pinkglow, it has recently introduced the Honeyglow (even goldier and sweeter than the Gold Extra Sweet), the Precious Honeyglow (a miniaturized version of the Honeyglow), and the Del Monte Zero (a pineapple certified by a third party as carbon-neutral because of Del Monte’s expansive forests). This year, the company is continuing to expand the reach of the pink pineapple. It’s also rolling out a variety called Rubyglow (reddish peel, yellow flesh) in China.

“Consumers love innovation,” says Lauren Scott, chief strategy officer of the International Fresh Produce Association. She sees the Pinkglow as creating excitement around pineapples and likens it to Cotton Candy grapes, a naturally grown hybrid introduced in 2011 that are hugely popular because, well, they taste like cotton candy.

If the trend holds, the Pinkglow could herald a shift in consumer attitudes toward genetically engineered [crops](#). Where GMO corn and soy were designed to better tolerate herbicides—a benefit invisible to consumers—the pink pineapple was mostly made to be fun and pretty, and to taste great. “I think the wariness toward GMOs is waning,” says Courtney Weber, a professor of horticulture at Cornell University.

Maybe the pink pineapple is frivolous. But maybe it’s just the kind of product that can help prepare consumers for the food system of the future, which will likely involve more bioengineering. “I love this for consumers, and I’m really happy about it,” says Vonnie Estes, vice president of

innovation at the International Fresh Produce Association. “But I think the real benefit is that it’s going to allow us to use these tools to be able to adapt to a changing world.” That future could be hotter, drier, and filled with as yet unimagined diseases and pests. For now, though, it’s pink.

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[Joel Khalili](#)

[Business](#)

Apr 10, 2024 3:00 AM

# Sarcophagus Is a Dead Man's Switch for Your Crypto Wallet

By combining a century-old idea with cryptocurrency tech, Sarcophagus aims to create a foolproof way to send messages from beyond the grave.

ILLUSTRATION: ALBERTO MIRANDA

A century ago, a commuter train carrying hundreds of passengers from Park Row to Brighton Beach, New York, took a perilous stretch of rail at seven times the appropriate speed.

At the controls was Edward Luciano, a young and inexperienced driver with only two hours of training, brought in as a substitute to cover a strike. As chronicled in *Uptown, Downtown*, a 1976 book by Stan Fischler, Luciano was defeated by the confusing braking system, and the train derailed on a jinking set of curves, killing at least 93 people and injuring hundreds more.

The wreck led to a raft of safety improvements, among them, it is believed, the dead man's switch, a fail-safe now found in all kinds of modern machinery. A dead man's switch can take the form of a handle or pedal to which force must be continuously applied, or a button that has to be pressed at intervals, but the principle is the same: If the human operator fails to respond, the machine shuts down.

In 2017, another New Yorker, Zach Hamilton, began to wonder how the same concept might be applied to the digital realm. He had identified a problem: People were getting [locked out of their cryptocurrency wallets](#) without any means of [recovering access](#), and their heirs were finding it difficult to access their digital assets after they died. Billions of dollars'

worth of [crypto has been lost](#) this way. Hamilton figured that a digital dead man's switch, which would release a document payload instead of switching off a machine, could help someone to recover their wallet or pass credentials to an inheritor without having to trust a third party. In theory, it could be used for all manner of other things, too. For years, a “quick and dirty” sketch sat dormant on Hamilton's computer, he says. But when New York [locked down for the Covid pandemic](#), he began to develop his idea. He called it Sarcophagus.

Hamilton was not the first to come up with a digital dead man's switch. These kinds of services have been available for years from providers such as Stochastic Technologies. Firms including Google and Microsoft offer similar functionality, letting users nominate someone to inherit their account after a period of inactivity. The primary difference is that Sarcophagus is built atop crypto technology, meaning the contents of users' documents are never visible to a third party and that the availability of their payloads does not depend on the service provider remaining in operation.

It works like this: A user submits a file via the Sarcophagus web app, specifies a recipient, and sets a timeframe. Then they agree to pay one or more fellow users to act as the file's protector and post the fee in escrow. The file is encrypted and sequestered in a decentralized file storage network called Arweave, which aims to store information permanently by incentivizing people to contribute their own hard drive space. If the user fails to make an attestation proving they are alive within the timeframe, the file is released to the recipient and decrypted using a combination of their own credentials and those of the chosen protector. Only after the file has been successfully handed on does the protector receive the payment.

The system, says Hamilton, is designed to be “anti-fragile,” meaning it depends on no party's good will to achieve its end. Nobody but the originator and recipient have access to the contents of the file, all other parties are financially incentivized to cooperate, and redundancies ensure the payload is always available. “Little strings of data control our lives,” says Hamilton. Because humans are “goosey”—that is, unreliable and prone to mistakes—the only sensible protection for those strings is cryptography, he adds.

There are various other ways, says Hamilton, that Sarcophagus might be applied outside of a crypto setting. A digital dead man's switch could be used by a whistleblower to release incriminating material or by a dissident or journalist who suspects a threat to their life, as a kind of SOS. In a more mundane context, it could be used to pass account credentials from one generation of employees to the next.

#### ILLUSTRATION: ALBERTO MIRANDA

Sarcophagus has received \$6 million in funding to date from investors including Placeholder, Blockchange, and Hinge Capital. The project is managed by a decentralized autonomous organization, or DAO—a collective that governs the Sarcophagus treasury and development process through a system of community voting. In its present state, Sarcophagus is best described as an “early beta,” says Hamilton. The service is operational but not widely used, and it does not generate significant revenue—only a small cut of every payment.

One barrier to broader adoption is that recipients must already have access to a crypto wallet, whose credentials are used to decrypt the data payload. There is an option to create a new wallet for someone, along with a PDF walking them through the process for accessing it, but a level of crypto literacy would certainly help.

As the generation of people comfortable with crypto grows older and begins to reckon more seriously with their mortality, Hamilton thinks a larger subset will begin to understand the need for a service like Sarcophagus. “Millennials are just starting to think about this problem,” he says. Hamilton imagines that more accessible services will be built atop Sarcophagus technology, too. These “boomer products,” as Hamilton calls them, one of which his own team is developing, will abstract away some of the technical complexity, such that people won't realize they are using crypto infrastructure. (Although there is an inevitable trade-off between security and convenience.)

In any case, says Hamilton, the present system—whereby credentials to high-value crypto wallets might be stored in bank vaults protected by armed guards—approaches the absurd. The “billion-dollar file cabinet” has to go,



says Hamilton. “We are still relying on heavy metal doors and guys with guns when cryptography itself can act as a steel wall of incredible thickness.”

*This article originally appeared in the May/June 2024 issue of WIRED UK.*

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Apr 10, 2024 2:00 AM

# The Honeybees Versus the Murder Hornets

Under threat from murder hornets, climate change, and habitat loss, UK honeybees are getting help from AI-enabled apiculturists tracking everything from foraging patterns to foreign invaders.

Owen Finnie and Matthew Elmes at Maiden Castle Farm, with an AI beehive. They're also taking videos of the bees' "waggle dances." Photograph: Chris Parkes

A switch is flicked, and a pharmacy sign flickers to life with a green glare. But this clinic prescribes seeds, not pills. The glass jars lining the shelves of this compact unit in central Plymouth, on the south coast of England, are filled with cow parsley, red clover, and corn chamomile.

It's owned by Pollenize, a social enterprise that uses data analysis to diagnose and treat deficiencies in honeybees. With habitat loss, climate change, agrochemicals, and a new wave of invasive hornets hounding Britain's bee colonies, its founders believe [artificial intelligence](#) could be an unlikely trump card.

Inside a honeybee hive. Worker bees are sterile females, and live for just six weeks in a colony of tens of thousands. Photograph: Chris Parkes

When childhood friends Matthew Elmes and Owen Finnie cofounded Pollenize in 2018, AI was not part of the plan. As longtime sufferers of hay fever, their foray into beekeeping was just a stab at soothing their swollen eyes and streaming nostrils.

Investing in a rumor that a teaspoon of local honey could counteract pollen sensitivity seemed worth a shot. “We didn’t fit the profile of a beekeeper,” says Elmes, who was a bricklayer in his late twenties, while Finnie worked in kitchens.

A microscope image of pollen collected from a hive. Monitoring pollen lets keepers know what’s available for bees to forage from. Photograph: Chris Parkes

The pair bought their first beehive with a £1,500 grant from Plymouth University, and after a shaky first batch—the plastic barrel they used was contaminated with a bitter chemical—things improved when they turned to local beekeepers for advice. Soon they secured several spots for their apiaries across the city, eschewing the countryside for Plymouth’s vacant rooftops, including a theater, a school, an office space, and a museum. It was a win-win. Businesses could boost their green credentials and Pollenize could trial its community urban beekeeping project. “It’s a mutual exchange, as they get the kudos of having bees and we get the opportunity to appeal to customers,” says Elmes. Now, around 80 members tend to 50,000 native honeybees—and are rewarded with a cut of golden honey.

But over time it became harder for Pollenize to ignore threats to Britain’s wild bees. Pollinators underpin our ecosystems and food supply, but Britain’s flying insect population has declined by as much as 60 percent in the past 20 years. Drawing on a degree in environmental science, Elmes built tech-powered solutions to safeguard Britain’s bees. First, the pair created a [biodiversity](#) tracking tool to map wildflower loss and prescribe AI-informed seed packets. Next came beehive cameras to discern how [climate change](#) impacts foraging patterns. Then, they turned their attention to staving off an invasion.

Beekeepers need to check hive frames for pests such as varroa mites and to look for queens preparing to set up a new colony. Photograph: Chris Parkes

Ever since the first Asian hornet [stole into France in 2004](#), most likely stowed away on a cargo ship from China, the invasive species has plagued Europe’s beekeepers. Dubbed “murder hornets” for their ability to swarm local ecosystems, each one can consume as many as [50 native bees per day](#).

Shielded by the Channel, Britain has managed to stave off the scale of Asian hornet invasion seen by its European neighbors—but sightings on English shores are creeping up. In 2023, there were 76 [confirmed Asian hornet sightings](#) in the UK, up from 23 between 2016 and 2022.

Teams of volunteers now hunt Asian hornets landing on British soil, but detection is only the tip of the iceberg, says Elmes. The true challenge is tracing the hornet back to its nest, to destroy the colony. “If something can automate and help us, it will shave off time,” he says. This is the rationale behind Pollenize’s latest project—a network of AI-camera bait stations that can detect and track Asian hornets.

“All you need is a breeze from the southeast for hornets to hitch a lift across the water,” says Alastair Christie, an invasive species expert from Jersey, in the Channel Islands. “Queens can hibernate on the underside of a pallet and in all sorts of nooks and crannies, or get stuck in someone’s car or horse box.” A nest might start out innocuously, as two cells in a garden shed in April. By September it can grow larger than a dustbin, heaving with around 2,500 hornets.

Beekeeper Shelley Glasspool tends to a hive on the roof of the Marine Biological Association in Plymouth. Photograph: Chris Parkes

Asian hornets are “opportunistic feeders,” eating everything from bees and blowflies to fishing bait and barbecue food. Their mere presence weakens native bees by triggering “foraging paralysis.” “Bees go into a defensive mode when there are hornets attacking their home,” says Christie. “If you’re in a castle under attack, you go into siege mentality.” Bees will stop cleaning their hive and gathering nectar and water until the colony collapses.

In Jersey, which is on the front line of the invasion, Christie has been leading the fightback. There’s a public awareness campaign: People are asked to submit photos of suspected hornets, which are distinguished by their orange faces, yellow tipped legs, and sheer size. Braver volunteers have begun to construct bait stations: a shallow dish of dark beer or sugar water. If an Asian hornet lands, volunteers attach tinsel streamers to its back to monitor its flight path and trace it back to its nest. They use a rule of

thumb: Every minute an Asian hornet spends away from a bait station between visits to feed translates to 100 meters of distance between the bait station and the nest.

On average, it takes around 50 hours to locate an Asian hornet nest this way, but machine learning could accelerate this. “Can we use AI to predict where the nest location is so we can find nests quicker, destroy them quicker, and reduce the ecological damage?” says Elmes. Pollenize is now working with French tech giant CapGemini on [Hornet AI](#), a network of automated camera bait stations that uses an object detection algorithm trained on 5,000 pictures of Asian hornets.

This Asian hornet station in the Associated British Port of Plymouth attracts the hornets, IDs them with its AI cameras, and alerts local authorities. Photograph: Chris Parkes

The prototype bait station uses a vaporizer to churn out an attractant that Asian hornets find irresistible. When a hornet comes to the bait station to feed, it’s detected by the camera, and marked with a physical colored sticker. The software then tracks the direction the hornet departs in, and measures how long it’s away, cutting down the time taken to locate the nest. “It works like CCTV,” says Elmes.

In December 2023, Pollenize won a grant from Innovate UK to scale up Hornet AI. The units will be tested in southeast England by the UK’s National Bee Unit, with the goal of improving nest tracking efficiency by 80 percent. But time is of the essence, says Elmes. “If we’re on it next year, we can keep Asian hornets at bay,” he says. “If we don’t win next year, it’s going to be exponential.”

*This article appears in the May/June 2024 issue of WIRED UK magazine.*

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[Eve Thomas](#)

[Gear](#)

Apr 3, 2024 6:00 AM

# Science Is Here to Clean Up the Wild West of Gin

A fingerprinting technique similar to MRI scanning is finally revealing what makes the ultimate gin. Will it be a blessing or a curse for an unregulated industry drunk on innovation?

PHOTOGRAPH: SERGEY RYUMIN, KARANDAEV; GETTY IMAGES

In an Edinburgh laboratory in the second half of 2023, four chemists armed with a nuclear magnetic resonance (NMR) spectrometer took on the unregulated Wild West of the gin industry.

A total of 16 samples of gin endured the spectrometer’s powerful magnetic field to create a “fingerprint”—in the form of peaks along an x-axis—which researchers David Ellis and Ruairaidh McIntosh then put together like “a jigsaw puzzle”; when complete, the puzzle revealed exactly which compounds were responsible for a certain gin’s flavor, aroma, and mouthfeel. The graphical marks could impart even the physical origin of the juniper berries used in a gin, offering a level of accuracy beyond traditional sensory analysis. The team published its results [in a paper](#) late last year.

It’s a study that could bring order to a near-lawless industry: Gin is a famously gray area in the [alcoholic beverages](#) sector. Unlike tightly regulated [Scotch whisky](#) or location-specific cognac, gin needs only to demonstrate a minimum 37.5 percent ABV and a prominent juniper taste to qualify for its name—and that’s pretty much it.

“As with any spirit category, there are often conversations around protecting gin by tightening the regulations,” says Pal Gleed, director general at The Gin Guild, a trade body of global gin distillers, brand

owners, and industry figures. “However, to do this without stifling innovation is not easy.”

Unregulated as the gin sector might be, it is also unfettered, creating a space for considerable innovation within the alcoholic beverages sector. Coming behind only vodka in variety, the spirit's recent commercial releases include [gin made from peas](#)—the byproduct of which can be used as animal feed, resulting in a spirit with a negative carbon footprint.

The imaginative approach of gin distillers isn't new: Indeed, fruit gins are mentioned in *The Distiller of London*, published as early as 1639. Packed with various recipes for gins and requiring ingredients ranging from aniseed and coriander to poppy flowers and nutmeg, the book reflects a Stuart-period England already getting a taste for creativity with its spirits.

The attitude of innovation has continued since. Tom Warner, cofounder of Warner's Distillery, calls such creativity the “lifeblood” of the business. And while he admits that it has “probably blurred the lines on what is and isn't a gin,” he notes that without it, the “category wouldn't have exploded the way that it did.”

So could NMR spectroscopy and its ability to unlock the exact elements behind top-quality gin mark the death of innovation for the spirit? Unlikely. McIntosh believes that a clearer understanding of what defines a gin “shouldn't be seen as being restrictive to the industry.”

In fact, it could be an opportunity to prune out counterfeits while giving space for a richer gin industry to flourish. Jared Brown, master distiller at luxury gin brand Sipsmith, tells WIRED that he is on board: “Will tighter regulations force new gin producers to work a bit harder, to learn a bit more gin history and tradition before releasing a spirit and calling it gin? Will more dodgy distillates be excluded from the category? I'm for that.” Ellis also believes that “it's possible this kind of fingerprinting approach could lead to some kind of framework to define what is actually meant by ‘gin’ in a much more rigorous way than there is at the moment.”

While the fingerprinting method is similar to magnetic resonance imaging (MRI), NMR preceded its better-known cousin by 30 years; the first NMR

machine was developed by Felix Bloch and Edward Purcell in 1945. MRI, in turn, was developed from NMR in the 1970s and made commercially available in the 1980s.

Where MRI uses a magnetic field and radio waves to assemble anatomical images, NMR uses a magnetic field to measure nuclear spins, which are affected by electromagnetic radiation. The spectrometer presents the absorbed frequencies as a series of peaks on a graph, which reveal the chemical environment of atoms in the sample. When Ellis and McIntosh interpret the results, they match these peaks to their gin spectra to “build” the structure of molecules present.

“The spectrum is a lot more complicated than it would be if you had a simple organic molecule as pure compound, and identifying the fingerprints of all of those different molecules is really the main challenge. But we’ve shown it works,” says Ellis. “It’s now quite a well-accepted technique for looking at complex mixtures, including food and drink.”

The researchers can even distinguish between molecules with the same atomic makeup. Terpenes, the chemical characterizers of gin, have the same generic chemical formula ( $C_5H_8$ ) but offer entirely different flavors, aromas, and textures. Limonene tastes of orange, for example, while myrcene is sweet and spicy.

Knowing exactly what’s in a gin matters more now, as the industry continues to grow and counterfeits and copies look to cash in. The premium sector is set to be worth around [\\$1.4 billion by 2030](#), and establishing provenance and authentication will be essential to distillers hoping to protect their products and prove to well-heeled customers that they’ve used those rare and expensive ingredients.

The thriving market has also translated into a rapidly increasing demand for juniper berries, just as traditional juniper suppliers are struggling with a changing climate. As distilleries look to source juniper berries from new suppliers, they will face inevitable variation in chemical composition and subsequent variation in flavor, aroma, and mouthfeel. “The various compounds present in the juniper varies depending on where the juniper



comes from,” McIntosh explains, “so NMR could help to look at the natural ingredients and what they’re providing for the gin.”

But introducing NMR spectroscopy might not be straightforward. Gleed points out that “very few gin distillers have access to anything more than their noses and a hydrometer,” and NMR equipment is expensive, making it unrealistic for most distillers and possibly lending an advantage to higher-end brands with more funding.

Its use might also mark a shift away from an artistic understanding of gin, in which variety is respected as an unavoidable result of genuine creativity. Indeed, Brown says he “will always prefer organoleptic analysis as, at the end of the day, I’m making gin for people, not computers.”

Meanwhile, Warner’s Distillery employs scientific analysis already—namely [gas chromatography](#) and high-performance [liquid chromatography](#)—and the company says it is satisfied with its methodology as is. “We know our molecular fingerprints,” it notes.

However, the new gin fingerprint [research](#), published in the *Journal of Brewing and Distilling* in December 2023, addresses the use of gas chromatography combined with mass spectrometry (GC/MS) in analyzing gin, compared to NMR spectroscopy. It points out that unlike GC/MS, NMR doesn’t require the prior separation of samples, and offers the advantage of speed.

The question remains as to whether NMR spectroscopy is a blessing or a curse for gin distilleries. Will a tighter definition of gin separate the wheat from the chaff—or the weed from the juniper—and preserve the sector’s rich heritage? Or will it quash a colorful and innovative industry in which imagination is the name of the game?

At The Gin Guild, Gleed is, somewhat unsurprisingly, confident that the imaginative attitude of distillers isn’t going anywhere: “The beauty of the gin industry is that it is innovative, and that this innovation is driven by brands of all sizes. This passion for creativity won’t be affected.”

Certainly, the industry doesn't appear to be struggling. Last year, some 9 million 9-liter cases of gin were sold in the US, generating more than [\\$1 billion in revenue](#) for distillers, with the superpremium category surging by 16 percent to surpass 700,000 9-liter cases. Meanwhile, the UK saw the introduction of 110 new distilleries between 2020 and 2022, as the pandemic drove consumers' appetites for the luxury experience.

The hope, then, is that NMR will provide what Brown terms “guardrails of respect for heritage” for a sector in danger of becoming drunk on its own success.

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Mar 27, 2024 8:00 AM

# The Next Generation of Cancer Drugs Will Be Made in Space

Injectable immunotherapy drugs can be made, in theory, but gravity prevents them from crystallizing correctly. A startup thinks the solution could be right above us.

The International Space Station on November 8, 2021. Photograph: Geopix/Alamy

Immunotherapy is one of the most promising new ways to fight [cancer](#), but it takes *forever*. It works by mimicking or invoking the body's own immune defenses to weed out and attack cancer cells. But the [drugs](#) that do this are typically administered intravenously—fed into the blood using needles, in a long and invasive process. Patients spend hours in a hospital as the infusions are drip-fed into their veins.

It would be much simpler and less painful if the drugs could be injected under the skin from the comfort of a patient's home. But that would require much higher concentrations of the drugs, resulting in a thick formula too viscous to inject.

There is an answer: If you crystallize the proteins in the drug instead, you can get a high concentration into a smaller volume, and a solution of these tiny crystals comes without all the viscosity. The only problem is it's almost impossible to do this on Earth. If you try, the resulting crystals are full of imperfections and come in a random array of sizes. In space, however, without the interference of the planet's gravitational pull, the crystallized proteins come out *perfectly*.

That's where [BioOrbit](#) comes in. Its founder, Katie King, has a PhD in nanomedicine from the University of Cambridge, but she has always been obsessed with [space](#). During her course, she found herself growing frustrated at her friends' cynicism toward the "Bezosification" of outer space, as companies such as [Blue Origin](#) and [SpaceX](#) commercialized it and turned it into a playground for billionaires. "I always had this belief that space should be used to help those on Earth," King says.

Katie King Photograph: Christian Trippe

After finishing at Cambridge, King started looking for a scientist job in the space sector, determined to prove her friends wrong. But she couldn't find one. So instead, in 2022, she began a two-month summer program at the International Space University, an international organization based in France that provides postgraduate training for those keen on a career in the industry.

During the course, King was part of a team tasked with identifying research that could be conducted in space with the best potential impact on humankind. Her team landed on the concept of crystallizing drugs in microgravity. There was data stacked up on the International Space Station hinting at the potential to "absolutely revolutionize cancer treatment," King says. "This needs to be realized fully, and now is the time."

BioOrbit, which King founded in 2023, plans to scale up and commercialize this kind of drug production in space. After securing funding from the European Space Agency, the plan is to test out the process on the International Space Station early next year to make sure it works. And later in 2025, they're planning a second flight which ideally will be with a pharmaceutical partner.

King is not the first to send drugs into space to reap the benefits that microgravity has to offer. Big Pharma is also dipping its toe: Companies including [Bristol Myers Squibb](#) and [Merck](#) have been conducting research in space for drug development and manufacturing for years. "What makes BioOrbit special is that they're trying to optimize it," says Li Shean Toh, an assistant professor at the University of Nottingham who researches astropharmacy. King wants to blow it up to commercial scale.

But there are roadblocks. There are long queues to get space on board a rocket to take material to the ISS, and it's unsurprisingly expensive. Regulation is another hurdle: Will the rules and regulations of Earth apply in outer space? If one of BioOrbit's drugs harms a patient, whose jurisdiction will apply? "Lots of people are thinking about the technology—but people are kind of skirting around how we are going to do quality assurance," Toh says. This is something she's researching: She has proposed a health version of the Outer Space Treaty, a body of principles that informed international space law.

King is happy for her team's venture to serve as a guinea pig for how this all might work, because she wants it to work. "There is so much benefit that microgravity can give to life science research, drug development, cancer research—and more that we just don't know yet," says King.

Her ultimate goal for BioOrbit is to have a permanent facility in space just for doing science, research, and manufacturing. The pharmaceutical factories that sit in gray, barren business parks may soon become a little more extraterrestrial. One day, perhaps many of your drugs will have had a little sojourn to space.

*This article appears in the May/June 2024 issue of WIRED UK magazine.*

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[Sheon Han](#)

[Business](#)

Mar 4, 2024 6:00 AM

# JavaScript Runs the World— Maybe Even Literally

In defense of a much-mocked programming language.

ILLUSTRATION: SAMUEL TOMSON

Lex Fridman has done many long interviews on his popular podcast. Even so, the episode with the legendary programmer [John Carmack](#) has an unhinged director’s-cut feel to it. Over five hours, Carmack dishes on everything from vector operations to *Doom*. But it’s something Fridman says, offhand, that really justifies the extended run time: “I think that if we’re living [in a simulation](#), it’s written in JavaScript.”

Machine Readable

A regular column about programming. Because if/when the machines take over, we should at least speak their language.

To review: JavaScript is what makes static web pages “dynamic.” Without it, the internet would resemble nothing so much as an after-hours arcade, lifeless and dark. These days, the language is used in both front- and backend development for a whole host of mobile platforms and apps, including Slack and Discord. And the main thing to understand about it, in the context of Fridman’s nerdy koan, is this: For any self-respecting programmer, admitting to actually *liking* JavaScript is something of a faux pas—much like an art-house filmmaker confessing to Marvel fandom.

I suppose this has something to do with the fact that JavaScript was created in less time than it takes to home-brew a jar of kombucha: 10 days. In 1995, Netscape hired a programmer named Brendan Eich to create a language to embed in its browser, Netscape Navigator. Originally called LiveScript, the

language was renamed JavaScript to piggyback on the hype around an unrelated language called Java, which had been introduced earlier that year. (Asked the difference between Java and JavaScript, a programmer is likely to joke: “Java is to JavaScript what car is to carpet.”) To this day, few people consider JavaScript a particularly well-designed language, least of all Eich. “I perpetrated JavaScript in 1995,” he once said, “and I’ve been making up for it ever since.”

What was his crime, exactly? You can easily find scads of blog posts, memes, and Reddit threads sandbagging JavaScript, but my favorite is a [four-minute talk](#) by software engineer Gary Bernhardt titled “Wat.” Imagine, for starters, showing a group of non-English speakers the present and past forms of verbs like *boil* (*boil/boiled*) and *chew* (*chew/chewed*). Then, when you ask them for the conjugation of *eat*, who could blame them for answering *eat/eated*? Similarly, the “Wat” talk is a blooper reel of JavaScript’s quirks and unpredictable behaviors. Let’s say you want to sort a list of numbers: [50, 100, 1, 10, 9, 5]. Calling the built-in sort function in any sane language returns the list in numerically ascending order: [1, 5, 9, 10, 50, 100]. Doing so in JavaScript returns [1, 10, 100, 5, 50, 9], where 10 and 100 are considered larger than 5. Why? Because JavaScript interprets each number as a string type and does lexical sorting, not numerical sorting. Total insanity.

When Fridman says JavaScript runs the world, in other words, what he means is that our world is, like the underlying source code, massively screwed up and incomprehensible. It’s the equivalent of pronouncing, with a sigh, that considering the sorry state of the planet, the Universal Declaration of Human Rights must have been written in Comic Sans.

At this point, I should confess that while JavaScript is not my favorite language, I like it. Adore it, in fact. So I can’t help but feel a flare of disapproval whenever a certain fraternity of programmers polemicizes against it. Often they focus on flaws that were dealt with years ago. To dwell on JavaScript’s original shortcomings is to overlook the fact that any piece of software—and every programming language is, in essence, a suite of software—is amenable to revision and improvement.

One of the principal criticisms of JavaScript is that it's slow. This holds some truth in a general sense, but saying one language is "slower" than another is, technically speaking, an ill-formed objection. The performance of a language depends not only on the language itself but also on the caliber of its run-time environment—the setting in which the code is executed—and its compiler, which translates source code into a machine-readable format. Put differently, uncompiled code is akin to an uncast magic spell. Much as the potency of a spell depends on the caster, languages deemed "faster" but executed with crappy compilers could perform not much better than "slow" languages.

What's more, JavaScript was, in a sense, bailed out of its terribleness by colossal advancements in software engineering and industry-wide efforts. Carmack acknowledges this in the same podcast: "The systems that make JavaScript run as fast as it does right now are kind of miracles of modern engineering in many ways." A prime example is the Google Chrome team's V8 JavaScript engine, which compiles JavaScript "just in time," significantly boosting its performance.

If there were an equation to calculate the overall utility of a programming language, I'd bet the vibrancy of the language's ecosystem would be an exponential variable that dominates the other linear terms. This is to say, no well-designed language is useful on its own without useful libraries. But when backed by a healthy community of developers, as is the case with JavaScript, even a modest language becomes supremely effective. (Python dominates scientific computing for similar reasons.) JavaScript is also an easy language, and by that I don't imply any insult. Learnability is a killer feature.

JavaScript has undergone multiple iterations. The development of the language is steered by the rather unremarkably named Technical Committee 39 under a Geneva-based standards organization called Ecma International. (Imagine an international committee that could decide once and for all whether the past participle of *get* is *got* or *gotten*, and you have some sense of what TC39 does.) While some languages are governed by a conclave of experts, the process for JavaScript provides more visibility. Proposals and meeting notes are publicly available on GitHub. Meetings, once routinely



held in the San Francisco Bay Area, have expanded to other places such as Bergen, Galicia, and Tokyo, as if to resist the notion that the tech industry can be metonymized by Silicon Valley. In some ways, JavaScript is the people's programming language: egoless and all-embracing.

In a blog post titled “The Subjective Experience of Coding in Different Programming Languages,” the tech blogger Matt Webb [explores the concept](#) of “code synesthesia”: how coding in different languages can offer a “visceral, kinesthetic” experience. Many programmers often liken coding in Python, for instance, to writing in plain English, thanks to its friendly syntax. Likewise, reading old C code feels like engaging in the hermeneutics of ancient script, while Coq demands the exactitude of proving mathematical theorems. In this light, coding in JavaScript feels to me like an exercise in stenography—it affords a kind of buoyancy and effortlessness, allowing prototypes to be whipped up in an afternoon. While its namesake Java may be a reliable, muscular language, it lacks the charm and humor of its winsome sibling.

According to the annual Stack Overflow Developer Survey—as close to a global census of the industry as there is—2023 marked the 11th consecutive year that JavaScript has been the most commonly used language. Let's be clear: I'm not trying to deny that vanilla JavaScript can be hacky. I am, however, trying to argue that there's nothing fraudulent or even disagreeable about its ubiquity. In an industry that prides itself on the hacker ethos, calling JavaScript hacky may even be an honorific.

So an apology is in order, I think—and a congratulations. Look how far you've come, JavaScript, hopscotching across different eras of the internet, rising from a laughingstock to the lingua franca of the web. Well done, you ridiculous language. If I am being simulated by you, so be it.

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[Stephen Armstrong](#)  
[Science](#)

Mar 1, 2024 3:00 AM

# Good Climate Solutions Need Good Policy—and AI Can Help With That

Climate Policy Radar's tools scan global environmental laws to see what works and what doesn't. What its AI is discovering today will help shape the regulations of tomorrow.

Photograph: Getty Images

To achieve real climate solutions, changing behavior and developing technology is not enough, says Michal Nachmany, founder and CEO of the environmental nonprofit [Climate Policy Radar](#). “A lot of this is policy,” she says.

We need better laws, policies, and regulations, as well as needing to hold policymakers and corporates to account, because they’re not doing a good enough job, she argues. The problem is that understanding what policies are out there, and what works and what doesn’t, is an enormous task. So Climate Policy Radar’s goal is to use AI to understand the sprawling climate policy space, to help make sure that future laws and policies are evidence-based.

“We gathered together all of the climate laws and policies and strategies and action plans that every single government in this world has on its books,” she explains. “There are 470,000 pages in there—or 4.5 million paragraphs.”

To analyze these using general language AI systems is not enough, Nachmany says. “They source not-credible data sources, they hallucinate,

they do all sorts of things that we really don't want to bring into our decision making," she says. "So we use augmented intelligence, using human expertise to teach machines."

As a not-for-profit, Climate Policy Radar offers its constantly updated data for free, and it has a community of practitioners available to collaborate with anyone who works with or seeks to influence decision-makers.

"The people who need the data the most are the ones least able to pay for it," she says. "So, there's a really strong climate justice element to this." She invites anyone who wanted to collaborate to contact her: "We're just at the beginning of our journey."

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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Feb 26, 2024 6:00 AM

# He Helped Expose Wirecard's Fraud. Now His Startup Tries to Make Whistleblowing Safer

Pav Gill says he suffered retaliation after he raised the alarm about fraud at German payments giant Wirecard. His startup Confide aims to protect future whistleblowers from harm.

Pav Gill, founder of whistleblowing platform Confide. Photograph: Melanie Lemahieu Photography

In September 2017, Singapore-based lawyer Pav Gill took a job at Wirecard, a high-flying German payments business worth tens of billions of euros. Not long after he started, he heard from a colleague that an executive at Wirecard Asia, the region Gill was responsible for, had allegedly been [teaching staff how to trick auditors](#) into thinking the firm had money it didn't have.

Gill quietly began an investigation, codenamed Project Phoenix. The results were damning: Wirecard had been [fudging its numbers](#). But when the board of directors caught wind of his work they got “very upset,” says Gill. He was ordered to stand down, and his investigation came to nothing.

The head of Wirecard Asia began to make Gill's life “pretty horrible,” he claims, yelling at him in front of colleagues and attacking the quality of his work. He was effectively forced out. But before he left, in September 2018, he loaded a harddrive with an 85GB payload of email data tied to the investigation. It was filled, he says, with “irrefutable” proof of wrongdoing.

Even after Gill left, Wirecard continued to haunt him. At job interviews, he felt the questions were disproportionately focused on the reason for his departure. Gill also began to suspect the firm was having both him and his mother followed (Wirecard had previously [surveilled its detractors](#), but this was never proven in Gill's case). But he never intended to leak the email data he'd extracted. It was a defensive maneuver. "As a lawyer, it is ingrained that you are not meant to leak, no matter how bad the situation," says Gill.

In the end it was his mother, Sokhbir Kaur, who took action. Without Gill's knowledge, she had been liaising with the *Financial Times*, which had been investigating Wirecard for years. She had snatched the whistle and blown it on Gill's behalf. He was beside himself. But after some debate, he agreed to give the reporters the data: Why should they be the ones living in fear when the truth was on their side?

The [first story](#) based on Gill's data was published in January 2019. By April 2020, a KPMG audit had found that the ["lion's share" of Wirecard's profits could not be verified](#). Later, EY, the company's original auditor, discovered that €1.9 billion was missing, [because the money had never existed](#). By June 2020, Wirecard had collapsed into insolvency. Gill had played an indispensable role. Five years after leaving, Gill says he has "no regrets" about blowing the whistle, but that it did lead to a great deal of hardship. So now he's trying to make the process safer.

Gill is the cofounder of Confide, a startup aiming to help businesses detect and act on misconduct earlier—and stop them "taking revenge" on the employees that report it. Confide, cofounded with Ryan Dougherty, who Gill had hired at two previous companies, has developed a software platform that allows employees to file anonymous reports. The service creates a paper trail visible to both the whistleblower and the business accused of misbehavior—but one that's stored on third-party infrastructure to prevent it being doctored.

If a business fails to address a problem reported by a whistleblower, or tries to kick it under the rug, the individual can take that paper trail to the press or to law enforcement. The existence of a tamperproof, externally-stored

and anonymously created record should shield whistleblowers from the kind of harassment that Gill encountered, he argues.

A second-order effect, says Gill, might be to normalize reporting misconduct and thereby recast the act of whistleblowing. It's partly an issue of terminology; blowing the whistle implies whinging or complaining. But a standardized process for reporting could help to change the impression that whistleblowing is a form of biting the hand that feeds.

Existing reporting platforms such as EQS and NAVEX have tended to focus on large organizations in the financial services industry, says Gill, whereas Confide will look further afield—to sectors including healthcare, mining, and air travel in which “doing the wrong thing can have life-or-death consequences.”

Confide charges businesses an annual fee to use the platform, with extras if they want to outsource the handling and processing of reports. When WIRED interviewed Gill in the fall of 2023, a basic version of Confide was due to launch in December 2023, to coincide with new EU rules that require businesses to give employees simple channels for reporting wrongdoing. More features were set to follow in early 2024.

In the Wirecard case, the decision to report misconduct to the press put a stop to the fraud. But Gill's ambition is for Confide to guide people down a different path. The press is “extremely powerful,” he says, but should only be used as a “last resort” once somebody has lost faith that a corporation will do the right thing.

“We are not trying to solve the problem of crime,” Gill says. It's about giving businesses a chance to correct their behavior and protecting those that report it. “Every now and then, I ask myself why it had to be me that exposed Wirecard,” says Gill. He's still scarred by the experience, but he hopes that in Confide he's created something that will save others from feeling the same way by preventing the whistleblower from ever needing to go public. The end goal, Gill says, is to stop companies “becoming Wirecard 2.0”.

*This article was originally published in the March/April 2024 edition of WIRED UK magazine.*

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Feb 26, 2024 5:00 AM

# A Discarded Plan to Build Underwater Cities Will Give Coral Reefs New Life

A 1970s plan to grow underwater limestone objects has been repurposed as a way of regenerating the seabed, reestablishing corals, and stopping coastal erosion.

Photograph: Dora Dalton/Getty Images

A combination of AI, a wild 1970s plan to build underwater cities, and a designer creating furniture on the seabed around the Bahamas might be the solution to the widespread destruction of coral reefs. It could even save the world from coastal erosion.

Industrial designer Tom Dixon and technologist Suhair Khan, founder of AI incubator [Open-Ended Design](#), are collaborating on regenerating the ocean floor. “Coral reefs are endangered by climate change, shipping, development, and construction—but they’re vital,” Khan explains. “They cover 1 percent of the ocean floor, but they’re home to more than 25 percent of marine life.”

Currently, Dixon says, coastal erosion is prevented by dropping concrete structures to strengthen the coastline. These damage marine life and ecosystems—but coral could be a “regenerative replacement.”

Dixon thought of the idea having come across architect Wolf Hilbertz’s plan to build a city underwater, then float it to the surface. In 1976, Hilbertz invented [Mineral Accretion Technology](#): a charged metal framework that accumulates calcium carbonate in seawater like a kettle accumulates



limescale in hard-water areas. The result is a limestone deposit known as Biorock.

“It also grows back eroded reefs and regenerates coral, and species like oysters and sea grass grow twice as fast,” explains Dixon, who has experimented with the technique by [creating limestone furniture](#) off the coast of the Bahamas. The duo now collaborate, using AI to predict the outcome of importing Biorock to different sites at different water temperatures, in different weather conditions, with different amounts of solar power.

They aim to trial their work off the coast of Northern Australia, according to Khan, and hope to recruit affected local communities to advise and champion their plans.

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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Feb 21, 2024 4:00 AM

# Forget Carbon Offsets. The Planet Needs Carbon Removal Credits

The carbon removal market is fast growing, with an array of removal methods available to businesses keen to mitigate their environmental impact.

Photograph: Arnaldur Halldorsson/Bloomberg/Getty Images

We can reverse climate change if we redefine what carbon neutral looks like, said Gabrielle Walker, cofounder of carbon removal startup [CUR8](#), at [WIRED Impact](#) in London in November 2023. Scientists define net zero not just as the reduction of carbon emissions, but the removal of carbon from the atmosphere too—a complete negation of the greenhouse gases emitted by humanity. Business is now catching up.

Carbon offsets [are worthless](#), and companies have therefore been “stampeding away” from buying cheap offsets to avoid reputational damage, Walker says. She suggests carbon removal credits as a better solution for reaching net zero.

“Removal credits take carbon dioxide out of the sky and keep it out,” Walker explains. “In your own net-zero target, reduce your emissions and remove whatever’s left.”

Growing more trees is one potential way of removing carbon from the atmosphere. But trees might be burned, Walker points out, so a better way to lock in their carbon removal is to use carbonated timber to construct buildings. This method—where the wood is lightly charred before being used—seals it against water and mildew. Building with it displaces CO<sub>2</sub>-

heavy cement, and locks a tree's carbon in for as long as the building is there.

Walker recommends other removal methods too. Low-level technologies such as [biochar](#)—created by burning wood in very low oxygen—alongside basal rocks, which absorb CO<sub>2</sub> over thousands of years, make good fertilizer that locks carbon in. And machines including [Orca](#), a large plant in Iceland, will soon be sucking 4,000 metric tons of CO<sub>2</sub> from the air every year, mineralizing it and turning it to stone.

Walker finished with a chilling picture of a plaque in Iceland on the site of the first glacier to disappear. “A letter to the future,” the inscription reads. “In the next 200 years, all other glaciers are expected to follow the same path. This monument is to acknowledge that we know what is happening and what needs to be done. Only you know if we did it.”

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Meghan O'Gieblyn](#)

[Business](#)

Feb 20, 2024 9:00 AM

# Help, My Friend Got Me a Dumb AI-Generated Present

WIRED's advice columnist on the true purpose of gift giving.

Illustration: Gustavo Pedrosa

“An artist friend of mine got me an AI-generated painting as a gift. I can see she tried to personalize the concept, and it’s nicely framed, but part of me still feels a little cheated. Is that fair?”

—No Returns

[CLOUD SUPPORT](#)

Spiritual Troubleshooting for the Everyday User

*For timely guidance on encounters with technology, open a [support ticket](#) via email; or [register](#) and post a comment below.*

Dear No Returns,

There’s something implicitly paradoxical about feeling “cheated” by a present. A gift is, by definition, something that comes into your possession at no cost or effort, an object that exists outside the economic concepts of debt and fair exchange. But the fact that these offerings do often leave us feeling shortchanged suggests that there is a shadowy economics of gift giving, one whose rules are tacit and loosely defined. While I won’t pretend to know the nuanced history of obligations and credits that undergird your friendship, I think I can guess why the [AI-generated painting](#) disappointed you. First, the gift cost your friend nothing: The painting was presumably

generated by one of the free diffusion models that are available online, and so required zero monetary sacrifice. Second, the gift demanded no real creative effort, beyond the idea for the prompt. Your friend is an artist, someone endowed with creative talent, yet she seemingly refused to contribute to your gift a portion of that private reserve. The artwork that resulted feels to you generic and impersonal, lacking the singular imprint of your friend's creative mind.

Your question made me think of Lewis Hyde's *The Gift*, a 1983 book about the role of art in market economies. While the writers and artists who have sung its praises (Margaret Atwood, Zadie Smith, and David Foster Wallace among them) tend to regard the book as something akin to a volume of metaphysics, it bills itself, somewhat dryly, as a work of economic anthropology. Hyde begins with a lengthy discussion of gift economies, like those found on the South Sea islands or among Indigenous Americans. While modern markets are defined by exactitude and reciprocity—it's crucial that the seller receive compensation equal to the work they performed—gift economies, he argues, are not reciprocal but circular. The recipient of a gift isn't expected to repay their benefactor directly, though it is assumed that they will contribute in some way to the community—to pay it forward, so to speak. Rather than fixating on fairness, such communities maintain a kind of faith that whatever you give will come back, though not directly or on a determined schedule. "When the gift moves in a circle its motion is beyond the control of the personal ego," Hyde writes, "and so each bearer must be a part of the group and each donation is an act of social faith."

Hyde's larger point, which might be relevant to your question, is that artists tend to flourish in gift economies, where objects of art are regarded not as commodities with precise monetary values but as expressions of a communal energy, what Hyde calls "the commerce of the creative spirit." The act of artistic creation is already in the tides of giving and receiving, because inspiration itself is drawn osmotically from an array of outside sources. We call talented people "gifted" because it's understood that true creativity is unearned and unwilling—there are no private reserves. "We are lightened when our gifts rise from pools we cannot fathom," Hyde writes. "Then we know they are not a solitary egotism and they are inexhaustible."

This is why any genuine encounter with art completely obliterates the usual logic of fairness and economic value. When you stand in awe of a Hokusai painting, you are not thinking, typically, about the price you paid for admission to the museum, or wondering about whether it was a good deal. The gift of these encounters leaves the recipient inspired to create something herself, and so the generative energy continues to pass from one person to another.

You alluded to the generic quality of the AI art you were given, despite your friend's well-meaning attempts to personalize it. What's interesting is that impersonality is a quality that characterizes both the very best and the very worst art: The transcendence one feels when listening to the Bach cello suites, say, or reading Sappho's lyric poetry, perhaps stems from the feeling that the work's genius was not generated by an individual mind, but drawn from the well of the collective unconscious. (Recall the scores of artists who have referred to themselves as "conduits" or "instruments," insisting that they are merely the technological apparatus of some larger cosmic energy.)

There's a difference, though, between art that achieves a sublime universality and a product that is created to be benignly universal. The transpersonal quality of great art has its dark side in the vacuity of hotel paintings, Muzak, and formulaic paperback novels. I think it's fair to say that AI-generated art, in its current stage of development, belongs to the latter category. Although it is drawing from "pools we cannot fathom," to borrow Hyde's formulation (an apt description of the vast reservoir of training data that constitutes the model's unconscious), and although its stochastic logic is as opaque and mysterious as human creativity, its output still bears the stain of art that was created by committee and calculated to hit certain market objectives. If generative models were capable of creating something like an original van Gogh, then perhaps things would be different. As it stands, your friend gave you the digital equivalent of a *Starry Night* jigsaw puzzle.

It's possible that this will change as the technology develops. Perhaps a day will come when being presented with AI art will be akin to receiving manna from heaven or the golden apples from Gaia's enchanted tree—gifts of the

gods that are free, invaluable, and inexhaustible. It may also be true that we're still too early in the acclimation phase to see AI images as anything other than crude mechanics. Our experience of art is inseparable from its context—what Walter Benjamin called the “aura” of a work, which includes the location in which we experience it and our knowledge of its cultural value. Generative AI is still awaiting its Alfred Stieglitz—the photographer who transformed the camera from a novelty tool into an artistic medium—and without a recognizable canon with its own aesthetic standards, it's difficult to discern artistry from accident.

In the meantime, I think your feeling of being “cheated” is entirely rational—not because your friend necessarily owes you something, but because the gift, in its failure to inspire you in the manner of true art, has remained starkly within the realm of commodities, bringing to mind the crude economic logic of fairness and debt. It's obvious that you cannot return the gift you were given. But true gifts, as Hyde would point out, are never returned or reciprocated, only replenished. If the AI painting has not succeeded in inspiring you, take some time this week to revisit the art, music, literature, and film that you most love. Much of it can, miraculously, be experienced for free or is available to download for a list price far below its spiritual value. It might inspire you to create something of your own, but at the very least it will leave you changed in ways that are difficult to quantify.

**Faithfully,**

**Cloud**

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Be advised that [CLOUD SUPPORT](#) is experiencing higher than normal wait times and appreciates your patience.

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[Stephen Armstrong](#)  
[Science](#)

Feb 20, 2024 4:00 AM

# The Transport Companies Leaving Fossil Fuels Behind

Hydrogen-powered planes, more fuel-efficient aircraft designs, and all-electric parcel delivery services are just some of the ways in which the transport sector is looking to decarbonize.

Photograph: Getty Images

Cleaner, greener transport is on its way—from delivery to air travel—but government action on incentives and [infrastructure](#) is needed to make it work fast and at scale.

“It’s a bit frustrating sometimes in the UK, with the government delaying targets and support,” says Murvah Iqbal, co-CEO and founder of all-electric delivery network [Hived](#). Hived counts ASOS, Zara, Pip & Nut, and Minor Figures among its clients, and hopes to help decarbonize the 10 to 12 billion parcels delivered annually in the UK. But, Iqbal points out, [EV](#) infrastructure needs investment.

Igor Murakami, director of new services and open innovation at Jaguar Land Rover, agrees. “The market’s very fragmented, so we need government support to consolidate everything,” he explains. “It’s a big investment to make sure that we have enough energy, charging points, and space to avoid congestion.”

In air travel, markets are moving more efficiently than the government, says Tom O’Leary, CEO at [JetZero](#), which is on course to launch a zero-carbon-emissions, hydrogen-powered, blended-wing aircraft in 2030.



“The entrenched dynamics of a global market that’s ruled by a duopoly didn’t really have any interest in disrupting themselves,” he says. “We found that a 50 percent reduction in fuel burn and emissions can be achieved using the exact same engines, prior to transitioning to future propulsion.”

And that’s just the start, says Katya Constant, chief investment officer at [ZeroAvia](#). Fuel-cell technology needs a decade to improve—but her company is launching a hydrogen engine for 20-seat aircraft in 2025.

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Stephen Armstrong](#)  
[Science](#)

Feb 19, 2024 5:00 AM

# Tech Still Isn't Doing Enough to Care for the Environment

Priscilla Chomba-Kinywa, CTO of Greenpeace, says technology firms must shape up—and consumers and business clients should walk away if they don't.

Photograph: Cole Burston/Bloomberg/Getty Images

We are in a climate crisis, and technology can be either a part of the problem or a force for good, says Greenpeace CTO Priscilla Chomba-Kinywa. According to the International Panel on Climate Change, she explains, we have “less than seven years before Earth becomes really difficult to live on.” Last year alone, the world witnessed [wildfires in North America](#), floods in Southern Africa, and even the double tragedy of floods and fires in places like Greece, she says.

Social media allows people from across the world to communicate, but “we’re seeing misinformation, disinformation, and a wanton disregard for sustainability by some of these platforms—and unfortunately, people don’t have many other options.”

Chomba-Kinywa says that VCs, startups, investors, and technologists should invest in alternative platforms “that are green, that are ethical, that are value-based, and that give us an alternative to what we have right now, being built by people so passionate about the environment that they will not sell out in the name of profits.”

Even though conventional investment is supposed to maximize shareholder value, she argues, investing in these platforms is a price worth paying, as customers will soon be demanding action.

Chomba-Kinywa salutes companies already taking action—such as [Hyundai](#), which recently committed to stop supplying the heavy machinery used for illegal mining in the Amazon. This was possible, she says, through the use of satellite imagery and pressure from leaders in Indigenous communities, which led to a report that Hyundai couldn't ignore.

Good data, she explains, is vital—Greenpeace has been using it since 2009 to persuade some tech giants to switch to 100 percent [renewable energy](#). For those that refused, the campaigning NGO just walked away. Other organizations should do the same, she says.

“What if you could use your influence to apply pressure on these organizations to change?” she asks. “Say, ‘We’ve looked at the data, we’ve looked at your plans. You’re not doing enough, and we won’t give you our money.’ Then maybe we can make a little bit more of a change.”

Finally, she says businesses need to work with communities from places like Senegal, Zambia, Nigeria, Bangladesh, and Mexico to understand and support their movements. “Sit with the elders in their communities, listen to the Indigenous knowledge that allowed them to coexist with nature, and start to reapply some of those principles,” she suggests. “They are scrambling for their lives.”

Chomba-Kinywa also says that conversations on AI need to focus on the planet. “We’re talking about values, ethics, and putting guardrails in place—but we can’t do that without talking about the environment,” she argues. “We need to think through the environmental cost of AI. It has the potential to help us solve some of humanity’s grand challenges, but that’s only useful if humanity has a livable planet.”

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Stephen Armstrong](#)

[Science](#)

Feb 15, 2024 4:00 AM

# Fake Caviar Invented in the 1930s Could Be the Solution to Plastic Pollution

An alternative to environmentally-harmful plastic is already within reach: seaweed.

Photograph: Andrew Merry/Getty Images

Imitation caviar invented in the 1930s could provide the solution to plastic pollution, claims Pierre Paslier, CEO of London-based packaging company [Notpla](#). He discovered the cheap food alternative, invented by Unilever and made using seaweed, after quitting his job as a packaging engineer at L'Oréal.

With cofounder and co-CEO Rodrigo García González, Paslier and Notpla have extended the idea, taking a protein made from seaweed and creating packaging for soft drinks, fast food, laundry detergent, and cosmetics, among other things. They're also branching out into cutlery and paper.

“Seaweed grows quickly and needs no fresh water, land, or fertilizer,” Paslier explains. “It captures carbon and makes the surrounding waters less acidic. Some species of seaweed can grow up to a meter a day.” Best of all, he says, packaging made from seaweed is completely biodegradable because it's entirely nature-based.

Paslier noted an amazing coincidence—Alexander Parkes invented the first plastic in Hackney Wick, the same part of East London that, 100 years later, Notpla calls home. Since Parkes' first invention, waste plastic—especially tiny particles known as [microplastics](#), which take hundreds or thousands of

years to break down into harmless molecules—has been wreaking havoc in ecosystems across the world.

Plastic pollution is proving [especially damaging in the marine environment](#), where tiny beads of plastic are deadly to the vital microorganisms that make up plankton and which sequester 30 percent of our carbon emissions, “without us having to build any new fancy technologies,” Paslier says.

Notpla’s plans to replace plastic began with a drink container for marathons. This is, in effect, a very large piece of fake caviar—a small pouch that contains juice or water that athletes can pop in their mouths and swallow when they need rehydration. “We wanted to create something that would feel more like fruit; packaging that you could feel comes more from picking something from a tree than off a production line,” he says.

Paslier showed pictures of two postrace streets—one where refueling came in plastic containers and one where it came in edible Notpla. The first was littered with plastic bottles; the second completely waste-free.

The next step was takeout food containers. Even containers we think are cardboard contain plastic, he says, as grease from food would make plain cardboard too soggy. Working with delivery company Just Eat, Notpla has pioneered a replacement for the [per- and polyfluorinated substances](#) (PFAS), the so-called [“forever chemical”](#) plastics that currently line cardboard takeout containers. It has even found a way to retrofit its solution into the old PFAS plant, so there was no need to build new factories.

The company is developing soluble sachets for detergent pods, ice-cream scoops, and even paper packing for cosmetics. And there’s plenty of seaweed to experiment with, Paslier points out. “You don’t realize it’s already available massively at scale,” he says. “It’s in our toothpaste, it’s in our beer, it’s in our reduced-fat products—so there’s an existing infrastructure that we can work with without having to build any additional processes.”

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Stephen Armstrong](#)

[Science](#)

Feb 13, 2024 8:51 AM

# Wild Animals Should Be Paid for the Benefits They Provide Humanity

Healthy ecosystems in developing countries sequester carbon, regulate the weather, and help plants grow thousands of miles away. Wealthier countries benefit from these services—and so should pay for them to be maintained.

Photograph: Getty Images

We need to understand the value of nature if we want to protect it—and that should include paying ecosystems for keeping us alive, argues Ian Redmond, head of conservation for not-for-profit streaming platform [Ecoflix](#) and cofounder of [Rebalance Earth](#), a company that aims to build a sustainable, resilient, and equitable economy. He’s trying to change the damaging equation where “if the minerals under the ground are worth more than the trees and the animals above the ground, then traditionally, the trees and the animals have to go.”

Pricing nature’s benefits would help protect it, he suggests. Wildlife tourism shows that people are prepared to pay up to \$1,500 simply to spend an hour in the company of a gorilla in Rwanda, he points out—so tourists already know how valuable nature is. But what about local people? Filmmakers should share the profits of their wildlife films with those who protect or depend on the ecosystems they film.

“The irony is that people who live in the developing world, where many of these documentaries are made, don’t get to see them because their national TV stations can’t afford to buy them,” he explains. “We should make people care about the wildlife in the countries where the wildlife lives.”

And we should pay animals like elephants for their essential arboreal gardening, he argues. “Apes, elephants, and birds are seed-dispersal agents in tropical forests,” he adds. “They swallow seeds and deposit them in their droppings miles away.”

This has a hugely beneficial effect locally and globally, because trees do so much more than just store carbon. A study in the Congo Basin found that the amount of wood in a forest where elephants still lived was up to 14 percent greater than one where elephants had died out. That basin sets up weather systems that ultimately produce rain in Britain and Europe.

“Do you think any proportion of what you pay for your [electricity] goes to protect the elephants and the gorillas in the Congo Basin planting the trees that fill the hydro schemes in Scotland?” he says. “Not a penny. There is no valuation of that ecosystem’s service that every one of us benefits from.”

Ralph Chami, formerly assistant director of the International Monetary Fund, calculated that the value an elephant provides the world during its life is worth around \$1.75 million dollars per animal. “That’s roughly \$30,000 a year, or \$80 a day if the elephant were being paid for the service it’s providing the world,” he pointed out. “But, of course, no one’s paying that.”

So, it’s time to pay the bill. “I want every gorilla, every orangutan, and every animal to be valued for what they do for the ecosystem, and for us clever humans to construct a system that allows that to happen,” he says. “At the last count, that was estimated at about \$700 billion a year. It’s a lot of money. It’s not going to come out of the government’s coffers, it’s not going to come out of philanthropy, but it could come out of the global economy if we construct it thus.”

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

*Updated 2-22-2024 13:20 pm GMT: The story was corrected to state that tourists in Rwanda pay up to \$1,500 to spend an hour in the presence of a gorilla, not an elephant.*

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[Stephen Armstrong](#)  
[Science](#)

Feb 13, 2024 8:50 AM

# Climate Finance Is Targeting the Wrong Industries

Roughly half of the world's emissions currently can't be reduced, yet green investment continues to avoid the sectors that need the most help—manufacturing, agriculture, and the built environment.

Photograph: Getty Images

To achieve net-zero carbon emissions by 2030, we have to increase the amount of capital invested in climate tech by 590 percent, says Daria Saharova, managing partner at VC World Fund, a European venture capital firm specializing in climate tech. While European funds, including the UK's, have €19.6 trillion (\$21.1 trillion) under management—and invested €19.6 billion in 2022—that's not enough. We need to invest at least €1 trillion every year.

The good news? “Europe is leading the world in patent applications for climate technology,” she says. “Twenty-eight percent of all patents in this field originate in Europe, so almost one-third of the technology needed is created here.”

The problem, Saharova warns, is the misalignment between emissions and venture capital. Forty-eight percent of VC investment in 2022 was into mobility technology, such as e-scooters. Mobility accounts for only 15 percent of emissions, while more polluting industries like manufacturing, food and agriculture, and the built environment are underfunded. “Eighty-five percent of emissions receive only 52 percent of funding,” according to Saharova.

This matters, she explains, because personal behavior change will reduce only 4.3 percent of emissions. Technologies already in the market will account for 49.8 percent—meaning technologies under development and in need of investment will need to fill in the rest. “Forty-six percent of emissions will be reduced by technology that’s yet to be developed, and this is the tech we desperately need,” she says. “And we need venture capital.”

Venture capital has had its fingers burned in this area before, she points out. “Between 2008 and 2013 there was a lot of investment and a lot of failures. So right now, R&D accounts for 35 percent of investment, private equity 37 percent, and venture capital just 13 percent of climate tech funding.”

There’s a huge opportunity for VCs—as the fast rise of late-entrant private equity shows. The return on new investment in climate tech between 2015 and 2019 stands at almost 22 percent. But how do VCs pick the right investment areas when they often lack the skills?

“We need a crystal ball for a tech product’s sales, the target market, the tech’s influence on that market, its climate footprint, and interrelations with other solutions—in particular, some serious climate science,” she explains. “That’s a long list.”

World Fund has developed a benchmarking system called the Climate Performance Potential, or CPP, which is gradually filtering through to academia. It’s a blend of comparing the potential a startup has to avoid or reduce emissions, a willingness to ignore the startup’s own predictions, and its ability to look at the Total Addressable Market (TAM), which World Fund calls the Total Avoidable Emissions. This pairs a team’s ability to execute with an almost competitive product in a climate-effective technology bucket to understand the order of magnitude that your multiple can achieve.

“This model is focused on the technology rather than the company, so it can be applied to large organizations as well,” she explains. “It allows us to measure the carbon market for a technology compared to others by 2040. We need more private capital and public capital, and this model makes it easier for them to predict success.”

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Amit Katwala](#)

[Science](#)

Feb 12, 2024 10:00 AM

# Who Tests If Heat-Proof Clothing Actually Works? These Poor Sweating Mannequins

These mannequins undergo daily torture at the hands of textile scientists, but their suffering means we humans can have future-proofed clothing capable of handling our warming world.

Photograph: Meron Menghithab

Meet ANDI, the world's sweatiest mannequin. Although he might look like a shop-floor stalwart from a distance, a closer glance reveals bundles of cabling and pipework concealed beneath his shell. He's wired up with sensors, plumbed into a liquid supply, and dotted with up to 150 individual pores that open when he gets warm.

It sounds gross, but it's all by design—ANDI is a highly sophisticated, walking, and yes, perspiring mannequin, part of a range of body-analog dummies developed by Seattle-based firm [Thermetrics](#). He made headlines recently—in mannequin circles, at least—because researchers at Arizona State University (ASU) are using an ANDI model to study how the human body reacts to [extreme heat](#).

An ANDI thermal mannequin being assembled. Photograph: Meron Menghithab

The year 2023 was the [hottest since records began](#), and as the world gets warmer, clothing designers, car manufacturers, and militaries are among the groups scrambling to develop technology fit for purpose, whether it's more breathable textiles or [novel cooling solutions](#). "People are everywhere, and

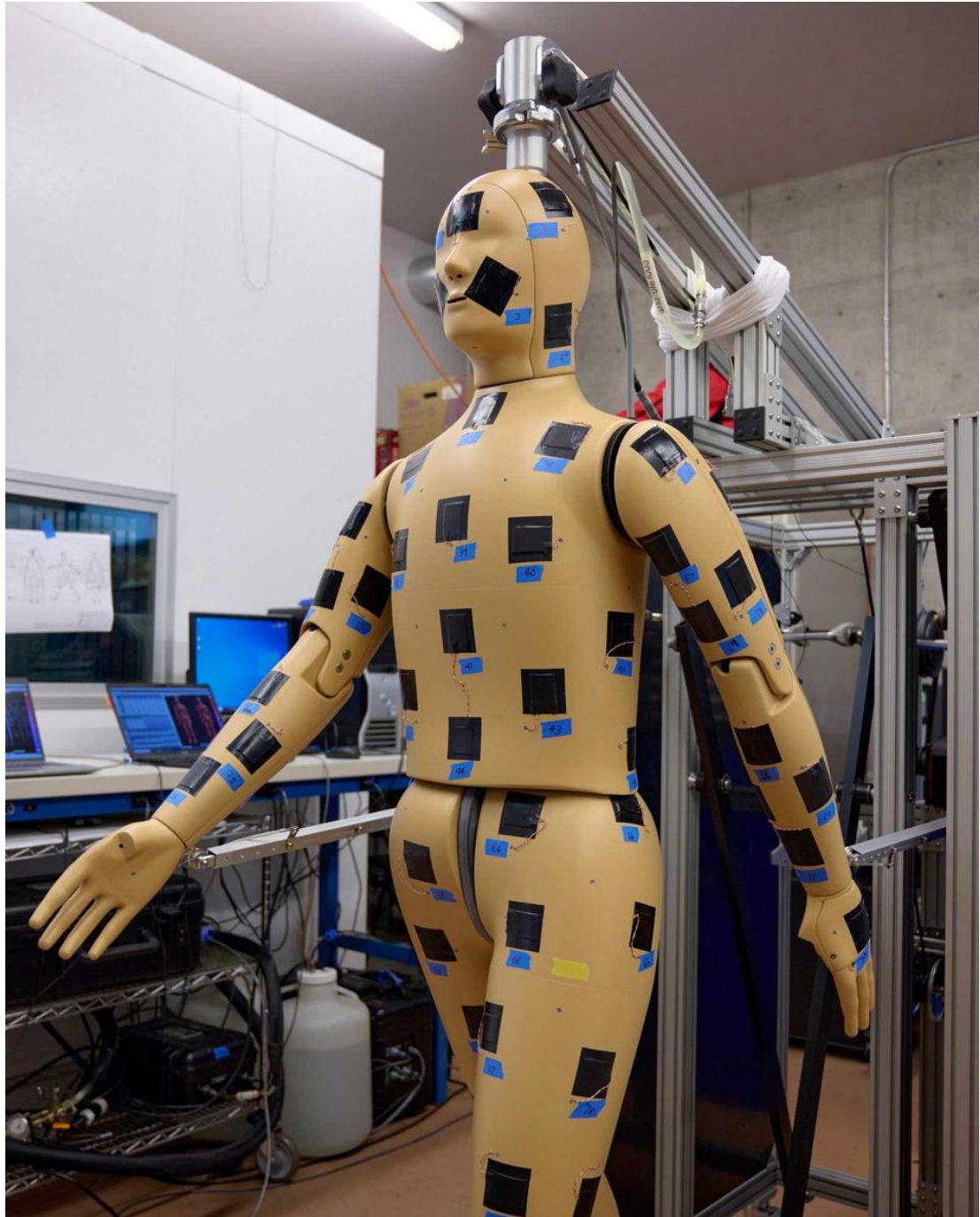
there are billions of dollars in capital trying to figure out how to keep people safe, comfortable, and fashionable—and all those things have a link to the human thermal environment,” says Rick Burke, president and engineering manager of Thermetrics, who has been with the company for 33 of its 35 years.

The easiest way to test that gear would be to put a human in it and ask them how they feel, but that also has its drawbacks. “Human test-subjects are super expensive and super subjective,” says Burke. (And they tend not to like it when you set them on fire.)

So, from the 1940s onward, the US military began building the first thermal mannequins—human-shaped heaters to test garments for soldiers. Say the army is sending soldiers somewhere cold and they need to know how many layers to send with each soldier. “If clothing can be optimized for the specific deployment environment, lower costs and safer soldiers clearly justifies the testing investment,” says Burke.

The technology evolved in the 1980s and 1990s as sportswear manufacturers began using it to put new products through their paces, while the addition of more individual heating zones to the mannequins added further realism. Recent developments include internal cooling and ANDI’s modified sweating function, which can be paired with a computer simulation of human physiology to mimic the body’s attempt to heat and cool itself. “Our mannequins are just a shell. They don’t have meat,” says Burke. “But we have a virtual simulation of the meat.”

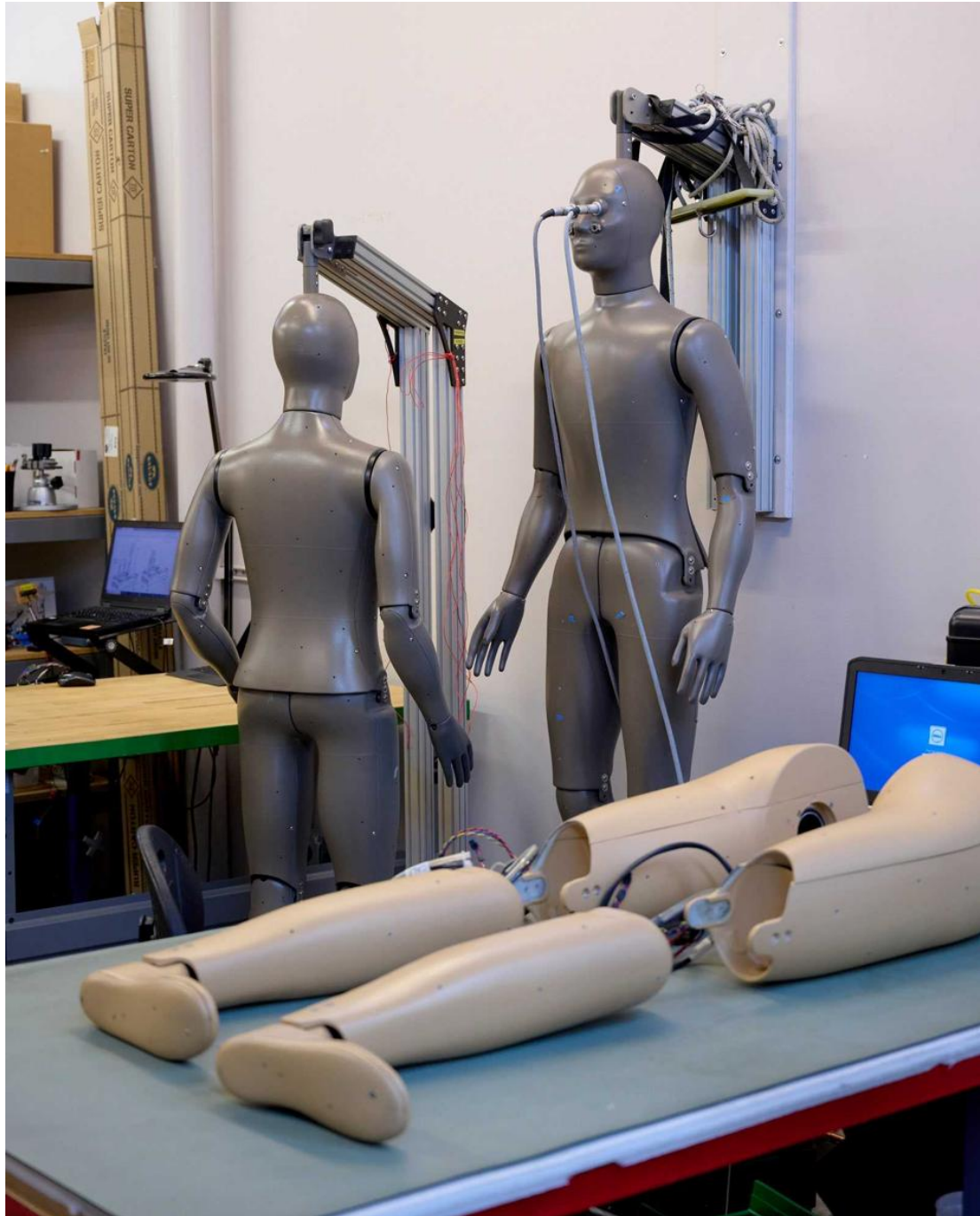
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Photograph: Meron Menghisthab

The base model mannequin is often customized for specific tests. This one is covered in an array of sensors to measure radiant heat in firefighting environments.

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In addition to ANDI, who is based on the average male body shape, Thermetrics makes dozens of other products, including a female thermal mannequin named LIZ, a baby thermal mannequin named RUTH (also one of the creepiest things you'll ever see), and STAN, a sweating simulacrum backside designed for automakers to test heated car seats. Roam around the Thermetrics lab, and you'll also see disembodied hands, feet, faces, and arms. Mannequins can also be dressed in protective clothing and then ignited in a fire chamber to see how well the garments perform.

In Arizona, researchers are using ANDI to understand the limits of the body. "We're able to push the mannequin to core temperatures that we wouldn't do with humans, or we can try to understand why somebody got heatstroke by replicating the scenario to see what happened," explains Konrad Rykaczewski, an associate professor at ASU, which is based in Phoenix, where daytime temperatures can exceed 43 degrees Celsius in the summer months.

Thermal mannequins can also be used to test cooling strategies—modeling more efficient methods by directing airflow to where it will have the biggest effect, for instance. In Phoenix, a recent "cool pavements" pilot program applied a reflective coating to street surfaces, so heat isn't absorbed by the dark asphalt. "We could put ANDI on one of these cool pavements and see what happens," says Ariane Middel, an associate professor at ASU. "Is he going to feel hotter? Is he going to feel cooler? Is he going to sweat more?" As the world heats up, those are questions we're all going to want the answers to.

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Allyssia Alleyne](#)  
[Culture](#)

Feb 12, 2024 5:00 AM

# Nick Hornby's Brain-Bending Sculptures Twist History Into New Shapes

British sculptor Nick Hornby uses computer modeling to make mashups of famous artworks and historical figures that shift and change depending on your perspective.

Nick Hornby inspects *Power Over Others* during assembly at Benson Sedgwick in Dagenham. Photograph: Nick Hornby

You can get a crash course in Nick Hornby's work in the span of an hour-long London walk. The artist has three permanent sculptures installed across the city, metal silhouettes that start off familiar but transform depending on your vantage point. In St. James, his conquering equestrian, modeled on Richard I, becomes an amorphous squiggle as you circle; while in Kensington, his take on Caspar David Friedrich's [Wanderer](#) turns abstract; and a bust of Nefertiti doubles as the Albert Memorial.

Raising questions about power and the role of the monument, the trio are a clever combo of craft and concept. They're also feats of digital innovation. The equestrian, for example, started out as a digital model scripted in Python. It was then unrolled into individual components to be laser-cut from metal, then assembled by fabricators. "It was a lovely, seamless relationship between concept, digital processes, and mechanical fabrications—165 pieces manipulated into the six-and-a-half ton object," says Hornby from his studio in northwest London. "But when people look at it, they don't see that at all."

“I like to think that one of the distinctive features of my work is its ambition to capture the imagination of anyone, not limited to the art world; to try to address complicated ideas in plain English. Anyone will recognize the trope of the man on the horse and will have a reaction to how I have manipulated it.”

*Resting Leaf (Joe)* is from a set of autobiographical works created using hydrographics—each resin sculpture is dipped into a wet medium containing an image transfer.

Photograph: Benjamin Westoby

This kind of technical-conceptual wizardry is Hornby’s calling card. Favoring the screen over the sketchpad, he uses 3D modeling as the foundation for abstract sculptures that reference the art-historical canon and challenge notions of authorship—contorted mashups of works by Hepworth, Brancusi, Rodin, and more; the profile of Michelangelo’s *David* extruded to a single point, legible only from above.

He started young, creating life-size terracotta figures in school while his classmates labored over simpler pots. “But then I went to art school, and it was like, I didn’t want to do pastiche of Rodin. I wanted to be part of the future. I wanted to be innovative,” he says. “So I jumped on technology.”

At the Slade School of Fine Art in London, where he enrolled in the late 1990s, Hornby thrived in the new. There were forays into video; a semester at the Art Institute of Chicago, where he joined the artist-hacker collective Radical Software/Critical Artware; and musical experiments with MAX MSP, the object-oriented programming language employed by Radiohead in the early 2000s. But it was only after pursuing a master’s in his thirties that his career took its current shape.

“I actually had quite a radical sea change in my relationship to tech,” he says. “I got quite frustrated by people saying, ‘Wow, that’s really cool. How did you do it?’ because I find that question really boring. I’m much more interested in the question, ‘What does it mean?’” So, over the past decade Hornby has eliminated “any form of human subjectivity,” he says. The

wires and screens were obscured, the rough edges erased with laser precision. All the better to invite questions of substance rather than process.

Face-on, *Do It All* presents as a realistic silhouette of the Albert Memorial, but step around 90 degrees to its left or right, and it transforms into a profile of the iconic Nefertiti bust in Berlin's Neues Museum collection.

Photograph: Luca Piffaretti

But now Hornby feels his focus shifting again. “I thought that the reason I had been embracing this perfect digital realm was for rigorous conceptual questions around authorship. But when I turned 40, I came to realize that there was no visibility of me in my work at all. I’d eliminated myself,” he says. It’s something, on reflection, he ties in part to ambivalent feelings about his own queer identity. “I only realized 15 years later [after coming out] that I had been systematically erasing my subjectivity because I didn’t feel that my opinion—and who I really was—was valid, legitimate, or something that I was willing to reveal.”

After a decade reckoning with the canon, he’s ready to insert himself into the work. A glimpse of this new stance comes through in a recent series of fiberglass sculptures wrapped in the liquefied photos of former lovers using a technique called water transfer-printing. (He started the work in 2020, in the month he turned 40 and broke up with a long-term partner). And, after three years largely spent coordinating the creation of three colossal monuments, Hornby is eager to level up his hands-on technical skills.

“I’ve been so enmeshed in production, making things, realizing projects, that I haven’t had very much time to experiment and play,” Hornby says. Now there’s time to get his parametric design and 3D-modeling skills up to scratch, to find new ways to combine his established processes (water transfer-printing on bronze?) and to investigate the new tech on his radar. There have already been some experiments with generative AI, which Hornby finds “intoxically exciting, exhilarating, and terrifying.” “Watch this space,” he says. “I’m just at the beginning of my career.”

*This article first appeared in the March/April 2024 print edition of WIRED UK magazine.*

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[Amit Katwala](#)

[Science](#)

Feb 8, 2024 7:00 AM

# This Small Wearable Device Reduces Parkinson's Symptoms

People with Parkinson's have fewer tremors when they receive rhythmic physical stimulation—so a UK startup has created a coin-sized vibrating device to help patients move more easily.

Photograph: Charco Neurotech

In 2015, Lucy Jung was a young industrial designer working on assistive devices for stroke victims, people with multiple sclerosis, and those with other conditions which meant they struggled with fine motor control. Her projects included a pen that used high-frequency vibrations to help Parkinson's patients write more clearly.

Then she was diagnosed with a brain tumor. “I really learned what it felt like to be a patient and that any kind of support or help can dramatically change the lives of people with long-term conditions,” she says. Once she had recovered and returned to work in 2018, she picked up her research on Parkinson's, with the goal to improve the lives of those with the disease.

Parkinson's stems from a communication problem: Damage to neurons in the substantia nigra of the brain leads to decreased levels of dopamine and unusual electrical rhythms, making it harder for signals to move between neurons. The instructions the brain is trying to send to the body struggle to get through, resulting in the characteristic tremors, rigidity, and freezing of gait seen in sufferers.

But through her prior work on the pen, Jung had identified a potential solution. In the 19th century, French neurologist Jean-Martin Charcot noticed that Parkinson's symptoms seemed to be markedly better after

patients had been on long carriage or train rides, and subsequent research has revealed that rhythmic auditory, visual, or physical stimulation can help Parkinson's patients walk more fluidly through what's known as "cueing."

In 2019, Jung founded [Charco Neurotech](#), a Cambridge-based startup named after the French neurologist, which has developed a wearable device that promises to reduce the symptoms of Parkinson's disease. Charco's device, the CUE1, is a small plastic disc with an electric motor inside. It sits on the wearer's sternum, where it vibrates at a high frequency in a pattern that's been proven to reduce the symptoms of Parkinson's through cueing.

Unlike [deep-brain stimulation](#) implants, which [have also been used](#) to treat Parkinson's symptoms, the CUE1 is noninvasive—it attaches to the skin using medical adhesive—and inexpensive. The £295 (\$371) device is being used by more than 2,000 people in the UK, with a waiting list of almost 20,000 across 120 countries. Charco has raised more than \$10 million in funding and grants and now employs 38 people in the UK, South Korea, and the United States, including Parkinson's specialists, nurses, engineers, and data analysts. The goal is to get the device approved by regulators so that it can be prescribed by doctors through the National Health Service or Medicaid.

An app enables users to tailor the pattern of the vibration to one that works best for them. Jung is hoping to develop a feedback system so that the device automatically adjusts based on how well someone is moving—amping up or dialing down the pattern of cueing as needed. "What we're seeing is that people tend to use the device all day," she says. "Some people even use it when they're sleeping, and it helps with sleeping, too."

*This article appears in the March/April 2024 issue of WIRED UK magazine.*

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[Paul Ford](#)

[Ideas](#)

Jan 3, 2024 9:00 AM

# Forget Growth. Optimize for Resilience

The tech economy is all about getting those next 10,000 users. What if it maximized something else for a change?

ILLUSTRATION: TWISHA PATNI

When you build software, you add little hooks into the code so that, as users open a window, tap a picture, upload a file, the [code](#) tattles on them, sending some of their data to another company's server. Log data is sowed; reports are reaped. This is known as “analytics” or, if there are people with advanced degrees involved, “data science.”

I cofounded a software company, like a doofus, so I attend a weekly [analytics](#) meeting. I nod at the [Zoom](#) camera and say things like “Not surprising to see that drop-off” or “Promising, but let's keep our focus on the people who aren't engaged.” My cofounder runs “product”; I'm loosely in charge of “the funnel.” The funnel, in case you are blessed not to know, is an inverted triangle with horizontal stripes. The top of the funnel, the first stripe, is the stuff that brings in visitors—advertising, [YouTube](#) tutorials, [LinkedIn](#) posts, [newsletters](#), blog posts, all the endless churn of content. Some fraction of those visitors sign up for the newsletter (that's stripe two), and a fraction of those sign up for the product (three), and a fraction of those turn into customers—*conversion*! So it's not really a funnel, more of a juicer.

In our analytics meetings, we measure the human juice as it dribbles in: pages visited, sign-ups, actions taken. We talk about how to squeeze more. We behave ourselves and don't track the people who ask us not to track them. We say things like “Team, 98 percent of our beloved users never click

the gray button. Have we considered red?” No one ever says, “Eileen in apartment 4A is saving links about fentanyl—let's tell her insurer.” They're good meetings. I've done them for years. But this past summer, something felt off.

The summer was [very warm](#). I don't need to tell you, do I? One of our managers came back from vacation and told us that they rarely left their hotel because it was too hot in the daytime. Birds and humans alike changed migration patterns, sometimes to route around [floods and fires](#). Protesters questioned humanity's endless focus on growth; arrests were made. Climate Week came and went, presumably leaving 51 other weeks without climate.

As the leaves turned, my wilted brain figured it out. Here I was, looking for growth—how to get from 10,000 users to 10,001—while outside the company, people were marching about how it was time to focus on absolutely anything else. I tend to agree with them. Our startup has a small carbon footprint, so we're not the problem in that sense. But was *growth* the right metric, the only metric, for us to obsess about?

My mind drifted to a book called *Lean Logic*. It's a big red book. I took it off the shelf and skimmed through it. It's the life's work of a British economist named David Fleming, published after his death in 2010. Fleming was of his time—big into predicting peak oil and very against nuclear power—but the book is a one-person hypertext of surprising depth, and it is very helpful framing as things get a little worse. (The whole thing is available for free at [Leanlogic.online](#).)

Fleming believed that growth has natural limits. Things grow to maturity—kids into adults, saplings into trees, startups into full-fledged companies—but growth beyond that point is, in his words, a “pathology” and an “affliction.” The bigger and more productive an [economy](#) gets, he argued, the more resources it needs to burn to maintain its own infrastructure. It becomes less and less efficient at keeping any one person clothed, fed, and sheltered. He called this the “intensification paradox”: The harder everyone works to make the GDP line point up, the harder everyone has to work to make the GDP line point up. Inevitably, Fleming believed, growth will turn

to degrowth, intensification to deintensification. These are things to prepare for, plan for, and the way to do that is with the missing metric: resilience.

What I ended up imagining was basically HR software for Burning Man, which, well, I'm not sure that's the world I want to live in either.

Fleming offers several definitions of resilience, the briefest of which is “the ability of a system to cope with shock.” He describes two kinds: preventive resilience, which helps you maintain an existing state in spite of shocks, and recovery-elastic resilience, which helps you adapt quickly to a new post-shock state. Growth won't help you with resilience, Fleming argues. Only community will. He's big on the “informal economy”—think Craigslist and Buy Nothing, not Amazon. People helping people.

So I began to imagine, in my hypocritical heart, an analytics platform that would measure resilience in those terms. As growth shot too high, notifications would fire off to your phone: *Slow down! Stop selling!* Instead of revenue, it would measure relationships formed, barter fulfilled, products loaned and reused. It would reflect all sorts of non-transactional activities that make a company resilient: Is the sales team doing enough yoga? Are the office dogs getting enough pets? In the analytics meeting, we would ask questions like “Is the product cheap enough for everyone?” I even tried to sketch out a resilience funnel, where the juice that drips down is people checking in on their neighbors. It was an interesting exercise, but what I ended up imagining was basically HR software for Burning Man, which, well, I'm not sure that's the world I want to live in either. If you come up with a good resilience funnel, let me know. Such a product would perform very badly in the marketplace (assuming you could even measure that).

The fundamental problem is that the stuff that creates resilience won't ever show up in the analytics. Let's say you were building a chat app. If people chat more using your app, that's good, right? That's community! But the really good number, from a resilience perspective, is how often they put down the app and meet up in person to hash things out. Because that will lead to someone coming by the house with lasagna when someone else has Covid, or someone giving someone's kid an old acoustic guitar from the

attic in exchange for, I don't know, a beehive. [Whole Earth](#) stuff. You know how it works.

All of this somewhat guilty running around led me back to the simplest answer: I can't measure resilience. I mean, sure, I could wing a bunch of vague, abstract stats and make pronouncements. God knows I've done a lot of that before. But there's no metric, really, that can capture it. Which means I have to talk to strangers, politely, about problems they're trying to solve.

I hate this conclusion. I want to push out content and see lines move and make no more small talk. I want my freaking charts. That's why I like tech. Benchmarks, CPU speeds, hard drive sizes, bandwidth, users, point releases, revenue. I love when the number goes up. It's almost impossible to imagine a world where it doesn't. Or rather it used to be.

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*This article appears in the November 2023 issue. [Subscribe now.](#)*

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[Paul Ford](#)  
[Ideas](#)

Jan 2, 2024 8:00 AM

# To Own the Future, Read Shakespeare

Tech and the liberal arts have always been at war. Don't assume Silicon Valley will win.

Illustration: Twisha Patni

many times a year, as if on a hidden schedule, some [tech](#) person, often venture-capital-adjacent, types out a thought on social media like “The only thing liberal arts majors are good for is scrubbing floors while I punch them” and hits Send. Then the poetry people respond—often a little late, in need of haircuts—with earnest arguments about the value of [art](#).

I am an English major to death. (You know us not by what we've read but by what we are ashamed not to have read.) But I learned years ago that there's no benefit in joining this debate. It never resolves. The scientist-novelist C. P. Snow went after the subject in 1959 in a lecture called “[The Two Cultures](#),” in which he criticized British society for favoring Shakespeare over Newton. Snow gets cited a lot. I have always found him unreadable, which, yes, embarrasses me but also makes me wonder whether perhaps the humanities had a point.

By the time I went to college, in the mixtape days, the Two Cultures debate had migrated to corkboards. In the liberal arts building, people tacked up pro-humanities essays they had snipped out of magazines. A hot Saturday night for me was to go and read them. Other people were trying drugs. I found the essays perplexing. I got the gist, but why would one need to defend something as urgent and essential as the humanities? Then again, across the street in the engineering building, I remember seeing bathroom graffiti that read “The value of a liberal arts degree,” with an arrow pointing

to the toilet paper. I was in the engineering building because they had Silicon Graphics workstations.

Wandering between these worlds, I began to realize I was that most horrifying of things: *interdisciplinary*. At a time when [computers](#) were still sequestered in labs, the idea that an English major should learn to code was seen as wasteful, bordering on abusive—like teaching a monkey to smoke. How could one *construct* programs when one was supposed to be *deconstructing* texts? Yet my heart told me: *All disciplines are one! We should all be in the same giant building.* Advisers counseled me to keep this exceptionally quiet. *Choose a major*, they said. *Minor in something odd if you must.* But why were we even here, then? Weren't we all—ceramic engineers and women's studies alike—rowing together into the noosphere? *No*, I was told. *We are not. Go to your work-study job calling alumni for donations.*

So I got my degree, and off I went to live an interdisciplinary life at the intersection of liberal arts and technology, and I'm still at it, just as the people trashing the humanities are at it too. But I have come to understand my advisers. They were right to warn me off.

Because humans are primates and disciplines are our territories. A programmer sneers at the white space in [Python](#), a sociologist rolls their eyes at a geographer, a physicist stares at the ceiling while an undergraduate, high off internet forums, explains that Buddhism anticipated quantum theory. They, we, are patrolling the borders, deciding what belongs inside, what does not. And this same battle of the disciplines, everlasting, ongoing, eternal, and exhausting, defines the internet. Is blogging journalism? Is fan fiction “real” writing? Can [video games](#) be art? (The answer is always: *Of course, but not always.* No one cares for that answer.)

When stuff gets out of hand, we don't open disciplinary borders. We craft new disciplines: *digital humanities*, *human geography*, and yes, *computer science* (note that “science” glued to the end, to differentiate it from mere “engineering”). In time, these great new territories get their own boundaries, their own defenders. The interdisciplinarian is essentially an exile. Someone who respects no borders enjoys no citizenship.

If the current narrative holds—if AI is victorious—well, liberal arts types will be ascendant.

You could argue that for all the talk of the university as an “intellectual commons,” it is actually an institution intended to preserve a kind of permanent détente between the disciplines—a place where you can bring French literature professors together with metallurgists and bind them with salaries so that they might not kill each other. The quad as intellectual DMZ. But those bonds are breaking down. Universities are casting disciplines to the wind. Whole departments are shuttering. The snazzy natatorium stays open, French literature goes away. And then the VC types get on [Twitter](#), or X, or whatever, to tell us that poetry is useless. The losses are real.

*And so what, really?* Well, what I mourn is not a particular program at a college I never visited but the sense of institutions being in balance. I’ve spent most of my life wanting desperately for institutions to be disrupted, and now I find myself entering the second half of my existence (if I’m lucky) absolutely craving that stability. The delicate détente is vanishing, that sense of having options. A shorter course catalog is an absolute sign of a society in decline.

But also, we’re cutting off the very future that the tech industry promises us is coming. If the current narrative holds—if [AI](#) is victorious—well, liberal arts types will be ascendant. Because rather than having to learn abstruse, ancient systems of rules and syntaxes (mathematical notation, C++, Perl) in order to think higher thoughts, we will be engaged with our infinitely patient AI tutors/servants like Greek princelings, prompting them to write code for us, make spreadsheets for us, perform first-order analysis of rigid structures for us, craft Horn clauses for us.

I see what you nerds have done with [AI image-creation software](#) so far. Look at Midjourney’s “Best of” page. If you don’t know a lot about art but you know what you like, and what you like is large-breasted elf maidens, you are entering the best possible future. You might think, *Hey, that’s what the market demands*. But humans get bored with everything. We’re just about done with Ant-Man movies.

The winners will be the ones who can get the computer to move things along the most quickly, generate the new fashions and fads, turn that into money, and go to the next thing. If the computers are capable of understanding us, and will do our bidding, and enable us to be more creative, then the people in our fields—yes, maybe even the poets—will have an edge. Don't blame us. You made the bots.

Perhaps this is why they lash out, so strangely—a fear of the grip slipping, the sense that all the abstruse and arcane knowledge gathered about large language models, neural nets, blockchains, and markets might be erased. *Will* be erased. At least art goes for the long game, you know? Poems are many things, and often lousy, but they are not meant to be disposable, nor do they require a particular operating system to work.

All you have to do is look at a tree—any tree will do—to see how badly our disciplines serve us. Evolutionary theory, botany, geography, physics, hydrology, countless poems, paintings, essays, and stories—all trying to make sense of the tree. We need them all, the whole fragile, interdependent ecosystem. No one has got it right yet.

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*This article appears in the October 2023 issue. [Subscribe now.](#)*

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[João Medeiros](#)

[Business](#)

Dec 19, 2023 8:42 AM

# The Hottest Startups in Lisbon

Portugal has more startups per capita than anywhere else in Europe, and Lisbon is the hub.

ILLUSTRATION: WIRED STAFF

Last October, Lisbon mayor Carlos Moedas—who previously served as European Commissioner for Innovation—opened the Lisbon Unicorn Factory, a startup accelerator inspired by the successful Parisian Station F. The new tech hub plans to enroll twenty scale-ups every year into an eight-month acceleration program with mentorship from experienced entrepreneurs. “We’re now seeing the first wave of successful entrepreneurs starting to give back to the community with their knowledge,” says André Miranda, CEO of Musiversal. With over 2,000 registered startups, Portugal is the European country with the most startups per capita—13 percent above the average. The reasons? “Initiatives like Startup Portugal and corporate-startups matchmaking programs attract international talent, provide funding opportunities, and create a favorable regulatory environment for startups,” says Katya Ivanova, CEO of startup AssetFlowow.

Bairro will be part of the first batch of startups at Lisbon’s Unicorn Factory. The delivery firm—founded in 2020 by Ukrainian entrepreneur Artem Kokhan, Milana Dovzhenko and Maksym Gatsuts—has already raised €5.4 M from seed investors like Leonid Dovladbegyan, director of Russian online hypermarket [Vprok.ru](#) and Alex Vasiliev, former director of [JD.com](#). The pitch? Enabling brands, producers, and retailers to connect directly with their customers by cutting out the middlemen. “Brands store their products in our strategically located warehouses, and we process orders that come from their website or marketplaces like Uber Eats,” Dovzhenko says. “This means we handle the entire order fulfillment process on their behalf, from receiving orders to picking, packing, and shipping the products to

customers.” According to Dovzhenko, Bairro’s software achieves a 98 percent rate of “perfect orders” (orders processed accurately and delivered on time). “This outperforms the current market metrics, which can range from 40 to 60 percent.” She says. “We make it up to nine times cheaper and faster than other solutions in the market.” [bairrodirect.com](https://bairrodirect.com)

One of Splink’s best-selling products is a three-dimensional miniature replica of Cristiano Ronaldo’s jersey made from vinyl, acrylic and biodegradable plastic. Called MyJersey, this collectible also allows football fans to access AR features with their mobile phones—such as touring stadia and dressing rooms, or taking selfies with avatars of footballers from eleven teams, including the Brazilian National team and La Liga’s Atletico Madrid. “We brought something new to a market that’s very traditional in how it makes money, which is either by ticketing and buying and selling players,” says CEO Ivan Braz. “Sports teams can have access to a platform where we gather and analyze the data we are collecting from fans using our AR experiences.” Founded in 2020 by Braz, Dulce Guarda and Hugo Matinho, the startup has raised €8.35m—their seed funding was led by The Riva Group. Next year, they want to prove themselves in the Premier League. “Having [English] teams come to us saying they would like to do business was a milestone.” [besplink.com](https://besplink.com)

Musician André Miranda, CEO of Musiversal, definitely didn’t fail fast: “I spent over a decade learning how to write music,” he says. “Less than one percent of what I wrote actually got performed in real life, and pretty much none of it was produced professionally. You can imagine how frustrating this must feel.” Knowing that many of his fellow musicians faced similar challenges, in 2018, he launched music production platform Musiversal, with cofounder Xavier Jameson. The startup offers creators a subscription that gives unlimited access to professional studio musicians and live remote collaboration, at rates that are ten times cheaper than standard pay-per-gig fees. “Musiversal is the only company in the world, aside from orchestras, that pays musicians a stable income every month,” says Miranda. “We have a near 100 percent retention rate with our musicians.” With over one million minutes of online sessions recorded, Musiversal has raised \$4.8 million from investors including VC firm Shilling. [musiversal.com](https://musiversal.com)

Pleez is one of the many examples of companies that successfully pivoted during the pandemic. Initially focused on developing a dine-in smart menu, the food-tech startup, founded in 2020, now offers a platform that aggregates delivery data and uses machine learning to improve the management of restaurants. Using a dashboard, restaurateurs can access real-time sales data, assess the impact of menu changes, and look up prices and promotions by competitors. The dashboard also offers AI-generated menu images and captions as well as pricing and menu recommendations. “Before, the menu was static,” says CEO Afonso Pinheiro. “Now you can benefit from real-time changes and answers to the market. Restaurants have their delivery channels on auto-pilot—They just need to cook.” Pleez is currently in Portugal and Spain and it has raised €3.5 million, in a seed funding round led by Berlin’s FoodLabs. [trypleez.com](https://trypleez.com)

In its first iteration, Bloq.it was a smart locker where people could safely store items in outdoor public areas—but then Covid hit. Founded by Miha Jagodic, João Lopes and Ricardo Carvalho in 2019, Bloq.it now provides smart lockers directly to logistics and retail companies. “We provide hardware, software, operational services, and know-how to allow companies to build smart locker networks for their end-customers.” says Lopes. “This allows delivery companies to deliver their parcels in a cheaper, more efficient way.” The startup has placed over a thousand smart lockers throughout Europe, for clients including online marketplace Vinted and logistics multinational DHL. [bloq.it](https://bloq.it)

When he was studying biomedical engineering at university, Diogo Tecelão was challenged by a lecturer to develop a device that could help sufferers of chronic cough, a symptom that affects 700 million adults. “He was frustrated because there were no tools available,” Tecelão says. “He inspired us to start spending our evenings brainstorming and prototyping.” The result is a wearable patch that patients can attach to their abdomen, so they can track cough patterns and triggers. C-mo Medical Solutions, launched in 2020 by Tecelão and cofounders Miguel Andrade, Filipe Valadas, Alexandra Lopes, Sara Lobo, and Nuno Neuparth, has raised €4.8m in a seed investment round led by Boehringer Ingelheim Venture Fund. [c-mo.solutions](https://c-mo.solutions)

During his stint as a hostel manager, Ricardo Figueiredo noticed his guests had a frequent request: “Every traveler who arrives early or has a flight at the end of the day asks the same question: what can I do with my luggage?” says Figueiredo. In 2019, with cofounders Diogo Correia and Hugo Fonseca, he launched a luggage pickup, storage and delivery service called LUGGit. Through their platform, travelers can request a driver to collect their luggage wherever they are, to be delivered to them later at a convenient location. “Our mission is to deliver an end-to-end luggage-free travel experience,” Figueiredo says. “We're building a future where people would have their luggage collected from their homes before travel and receive them at their address destination.” The company operates in Portugal and Spain, working with hospitality companies including GuestReady and Sonder. [luggit.app](https://luggit.app)

José Costa Rodrigues, CEO of proptech startup Relive, likes to describe his firm as the “Y combinator for real-estate agents” Relive is a brokerage platform that helps solo estate agents and boutique agencies manage their business, providing access to marketing leads, financial services, and personalized content, among other features. “We built a platform to help real-estate agents find more clients, be more efficient in their day-to-day, and close more deals,” says Rodrigues. Cofounded by Rodrigues, Sérgio Ferrás, and Henrique Brás in 2021, the startup was incubated by the Techstars accelerator, has raised \$1.2m led by Shilling, and has already expanded to Texas in the US. [relive.pt](https://relive.pt)

Without any cameras or sensors, AssetFloow can tell retailers how shoppers behave inside their stores. Using only anonymous sales data and digitized shop floor plans, AssetFloow’s AI platform creates a store’s digital twin, generating heat maps and shopper’s paths, as well as providing recommendations about product placements and promotional campaigns. “Understanding the shopper journey inside the store is the key to detect anomalies in sales,” says CEO Katya Ivanova. “Our solution has demonstrated the capability to detect and adapt to shifts in shopper behavior, resulting in 30-day sales increase and a 90 percent reduction in management costs.” The startup, founded in 2021 by Ivanova and Ricardo Santos, is currently used in 335 stores in Portugal, the UK, Italy, and Brazil. [assetfloow.com](https://assetfloow.com)

Since being profiled in this list in 2022, HRtech startup Coverflex has raised a €15 million series A led by Paris-based SCOR Ventures, and grew more than 400 percent year-on-year, serving over 100,000 employees from more than 3,600 clients, including companies such as Santander, Bolt, Emma, and Revolut. The startup, founded in 2021 by Luis Rocha, Miguel Santo Amaro, Nuno Pinto, Rui Carvalho, and Tiago Fernandes, has also recently launched a digital meal-voucher service in Italy and will expand into the Spanish market this year. Coverflex gives companies an employee compensation platform that allows HR managers to easily design bespoke compensation packages and other benefits. [coverflex.com](https://coverflex.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*This article was originally published by WIRED UK*

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[Chris Stokel-Walker](#)

[Business](#)

Dec 19, 2023 8:36 AM

# The Hottest Startups in Helsinki

The Finnish capitals welcoming environment has helped it set new records for investment, with health and quantum computing among the industries being explored.

ILLUSTRATION: WIRED STAFF

2022 was a banner year for Finnish startups, [raising €1.8 billion](#) (\$1.9 billion), according to the Finish Venture Capital Association—a record amount of investment. 2023 was likely even better: in comparison to its European peers, when measured relative to GDP, Finnish startups [lead the way](#) in the amount of VC funding they get.

The influx of money is testament to the scale and diversity of the Finnish startup sector, with Helsinki at the core. It has grown quickly. “It’s an endlessly exciting place to be,” says Eerika Savolainen, CEO at Slush, Helsinki’s annual startup event. “In 2008, I would say that we had almost nothing,” says Teemu Seppälä, the startups soft-landing lead at Business Helsinki, a business development organization working to attract international companies to the Finnish capital. “That was the date we started the startup movement.” Seppälä says Helsinki is a uniquely welcoming place to set up a business. “It’s very easy to connect with investors, clients or the players in the ecosystem—and us as the city,” he says. “We help you from the very beginning.”

The idea for metabolic health startup Veri came about because Verner Jäämuru struggled with ulcerative colitis while growing up, an illness doctors blamed on his consumption of ultra-processed foods. In 2020, Jäämuru (who previously worked at smart sleep-tracking ring company Oura), Anttoni Aniebonam, and Frans Lehmusvaara launched Veri. The startup developed a small, button-sized wearable sensor which, once



attached to a user's arm, monitors blood sugar levels. Data is fed in real-time to an app and then analyzed, providing personalized nutrition recommendations based on your metabolic profile. "Unlike other options that provide data without guidance, or push drugs and restrictive diets, we value empowerment through data and education, with the support of guidance and community," says Aniebonam. The 40-strong company raised its first funding round from Lifeline Ventures within two weeks of launching. To date, the company has raised €11 million. [veri.co](https://www.veri.co)

Niklas Sandler Topelius researched 3D printing and drug manufacturing for more than ten years at Åbo Akademi University, where he was a professor in pharmaceutical technology. His research caught the eye of serial entrepreneur Charlotta Topelius and, in 2021, the two launched CurifyLabs. Their MiniLab 3D printer can be loaded by hospital pharmacists with a special paste made of pharmaceutical ingredients to manufacture drugs. "Mass produced medicines often fail to meet the needs of some patient communities," says Topelius. "Pharmacists have been manufacturing medicines manually for many years, but are limited by an error-prone and laborious process." Initially focused on the veterinarian space, producing beef-flavored tablets tailored to cats' and dogs' medical needs, the startup has since expanded to human drugs such as beta-blocker propranolol and brain-cancer treatment temozolomide. The 18-strong company has raised €3.1 million to date, and was awarded €2.5 million from the European Innovation Council Accelerator in April 2023. [curifylabs.com](https://www.curifylabs.com)

Quanscient uses quantum computing to make industrial simulations more powerful. Founded in September 2021 by Tampere University researchers Valtteri Lahtinen and Asser Lähdemäki, alongside Juha Riippi and Alexandre Halbach, the firm works with customers to develop digital prototyping. "Computer-aided designs can be imported to multiphysics simulation platforms so engineers can simulate how their products work before committing the time and resources to build a prototype," says Riippi. That's important in areas including fusion energy, MRI scanners, and maglev trains—all sectors Quanscient is targeting. Using quantum computing allows the simulations to be 100 times faster and more than 100 times more complex—making the outcomes more accurate. "We reached accuracy within two percent of the experimental measurement data for an

electrical motor simulation for a California-based customer, whereas the competitor was only within 20 percent,” claims Riippi. Finnish venture capital fund Maki.vc led the latest €3.9 million funding round into the firm in April 2023. [quanscient.com](https://quanscient.com)

Onego Bio reinvents the egg for the modern day. “With precision fermentation, we can create proteins that are bio-identical to the foods we know and love, with 90 percent fewer resources,” says Maija Itkonen, cofounder and CEO of the company. “When using one hectare of land to cultivate feed for microorganisms instead of chickens, we can produce ten times more egg white protein,” she says. Launched in February 2022 by Itkonen and former VTT Technical Research Centre of Finland employee Christopher Landowski, the company makes an egg-white substitute from the microorganism *Trichoderma reesei*. In 2022, the startup raised €14.5 million in funding from venture capital fund Agronomics, Maki.vc and Business Finland. Future plans include building a factory in the United States that can produce one billion non-animal eggs a year, equivalent to those from two million chickens. [onego.bio](https://onego.bio)

Aaro Isosaari’s AI-powered writing assistant, Flowrite, foreshadowed the generative AI revolution when it was founded in 2020. Isosaari was frustrated by the number of emails he was asked to read and write in the course of his day running Finnish startup accelerator Kiuas. The product can turn short phrases into fully-formed emails. Flowrite has raised \$5 million in funding and, in April 2023, the company rolled out a chat-based user interface that can understand more than 20 languages. [flowrite.com](https://flowrite.com)

Founded in 2021 by Alberto Scherb, Andro Lindsay, and Jaime Alvarez Gerding, 100 Thousand Million wants to build sustainable cities. The company is planning its first sustainable space, Earth City, in Chile, near cofounder Alvarez Gerding’s hometown, following six sustainable principles that redesign urban areas from the ground up. “We will start with an energy and water footprint per capita that is one third compared to Helsinki, which is a leading city by today’s standards,” says Scherb, who has previously worked for Apple and Google. “The design of the city involves creating micro grids that are replicable and fully dependent on solar and wind energy. We also will design homes that consume and recycle



water.” 100 Thousand Million has secured \$750K from Oregon-based AriaTouch. [100tm.earth](https://100tm.earth)

Inside the headquarters of IQM—which builds high-performance quantum computers for computing hubs and data centers—stands a gong that employees ring every time the company has a major success. It has been noisy lately. IQM has raised more than €200 million since it was spun out of Aalto University in 2018, expanding to 250 employees located in offices in Espoo, Paris, Madrid, Munich, and Singapore. Cofounders Jan Goetz, Kuan Yen Tan, Mikko Möttönen, and Juha Vartiainen are also one of the most impressive in the quantum computing sector: Collectively, they’ve featured in more than 640 scientific publications with more than 27,000 citations. [meetiqm.com](https://meetiqm.com)

Making sneakers from coffee grounds and recycled plastic is the business model of Vietnamese expats Jesse Tran and Son Chu. The duo founded Rens Original in 2018, and launched their first sneaker in the summer of 2019. Each pair of shoes is made from 21 cups of coffee grounds and six recycled plastic bottles. The coffee grounds—which have antibacterial properties, preventing shoes from smelling—and waste plastic are combined and then made into plastic pellets, which are spun into a polymer yarn that can be tightly knitted onto a waterproof membrane. More than 40,000 pairs have since been sold, recycling 250,000 plastic bottles and 750,000 cups of coffee. [rensooriginal.com](https://rensooriginal.com)

Ville Lehto and friend and cofounder Ville Leppälä were working for mixed reality startup Varjo, when they decided to start a new business—in the food delivery sector. The pair launched Huuva in 2020, working with restaurants to set up shared kitchens and aiming to bring more delivery options to suburban areas. For instance, one of their shared kitchens—15km from Helsinki’s city center—serves food from five different downtown restaurant brands. “It employs five chefs who are assisted by our proprietary technology aiming to reduce stress in the operation. This high level of integration is what enables us to cook multiple menus under one roof.” The 70-strong company has launched 12 shared kitchens, including a dine-in location in Berlin, and raised €6 million to date. [huuva.io](https://huuva.io)

Circular commerce platform Twice Commerce (previously known as Rentle) doesn't work directly with end users, but instead with ecommerce platforms, providing the infrastructure they need to introduce rental, subscription, and buyback and resell features for products from skis and bikes to trailers, tools, and caravans. "It's like commerce on repeat," says Tuomo Laine, who founded the firm with Joel Mikkonen and Toomas Kallioja in 2018. The team honed their idea with a powerbank rental service at a Supercell e-sports event, and now are a 30-strong team that has attracted €8 million in funding from the likes of Maki.vc and Tera Ventures. [twicecommerce.com](https://twicecommerce.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*This article was originally published by WIRED UK*

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[Morgan Meaker](#)

[Business](#)

Dec 19, 2023 7:00 AM

# The Hottest Startups in Dublin

The Irish capital is excelling on “pick and shovel” companies that help other businesses get stuff done.

ILLUSTRATION: WIRED STAFF

The shift to remote work was good for Dublin’s tech scene: Investors who did not normally travel to Ireland were suddenly available to do deals on Zoom. “I actually think Covid helped from a fundraising perspective,” says Aidan Corbett, CEO of Ireland’s latest tech unicorn, Wayflyer. “Irish companies like FlipDish and Tines have raised from international investors since the pandemic.”

The city’s strength is b2b, says Donnchadh Cullinan, head of tech startups at Enterprise Ireland, the government organization that helps grow Irish enterprises and market them abroad. He adds that the city might be home to the European headquarters of consumer platforms like LinkedIn and Facebook, “But we don’t have big consumer or big social media plays.” Instead, Dublin excels in what Cullinan calls “pick and shovel” companies, like Stripe or Intercom, that enable other businesses to get stuff done.

Ecommerce is a difficult business. For instance, companies need to pay for stock before anyone has even expressed an interest in buying its product. When Jack Pierse realized this was a major hurdle for new ecommerce companies trying to grow, he approached his friend Aidan Corbett, an expert on e-commerce analytics. “Jack came to me and said, maybe we should use that technology as an underwriting engine to provide finance,” Corbett recalls. Together, the duo launched Wayflyer in 2019, a fintech company that collects and analyses daily social media activity, credit reporting, and online reviews in order to predict a business’ future revenue.

The company then offers short-term funding with a fixed fee, typically of around 4 percent.

Growth has been explosive. The company signed \$50 million in deals in its first year. In 2022, Waflyer raised \$150 million in a round led by investors DST Global and QED. That funding round also established Wayflyer as Ireland's sixth tech unicorn. [wayflyer.com](https://wayflyer.com)

2023 was a big year for Manna and its founder, serial entrepreneur Bobby Healy. Its app allows users to order groceries or hot coffee, which are delivered by drone. On delivery, the drone lowers down the goods using a rope, while LiDAR technology checks no one is standing underneath. Across Dublin, Manna's drones have made more than 160,000 deliveries to customers. The company has also expanded its operations to Texas, made its first UK delivery at the Founders Forum tech conference, and also received investment from Coca-Cola, taking the total amount raised so far to \$50 million. Healy's mission is to use drones as the green, fast, and affordable delivery default for suburban areas and to end the use of roads for short trips. "This is going to increase commerce and it's going to enable small businesses to compete with large businesses," says Healy. "And it's going to take cars off the road." [manna.aero](https://manna.aero)

Just as Ciarán O'Mara was finishing his PhD in the topic of computer vision, his aunt told him a tragic story about how one of her factory colleagues died from a workplace accident. That story led to the launch of Protex AI. "We link up with existing CCTV to identify danger before people get hurt," explains CEO Dan Hobbs, who cofounded the company with O'Mara in 2021. Protex AI's computer vision flags dangerous behavior to management, such as people incorrectly lifting heavy boxes or near-misses between fork-lift trucks, so they can understand how safer working conditions can be introduced. Protex AI's software—already being used by supermarket Marks & Spencer and delivery company DHL—claims to reduce safety events by up to 80 percent. The company has raised \$18 million to date, from investors including Notion Capital. [protex.ai](https://protex.ai)

When Kerri Sheeran was living in London, she started signing up for subscription services such as meal kits, toilet roll, and period packs. But as she was planning a trip home to Ireland, she realized there was no easy way

to pause them while she went away. After complaining to her sister Alex, the pair decided to launch TALY in 2021, as a subscription marketplace to help consumers not only manage their subscriptions, but also to discover new ones. The site currently sells 100 food subscriptions by brands including Jimmy's Iced Coffee, and Riley, which sells period products; TALY takes a commission on each sale. The sisters plan to expand into digital subscriptions, such as those for online news and streaming services. "Most consumer industries today are fueled by these incredible aggregators," says Kerri. "But no one's actually doing that for subscriptions. So we're on a mission to innovate our industry." So far, the company has raised \$750,000 from angel investors that include Irish entrepreneurs Jack Pierse, cofounder of Wayflyer, and former CarTrawler CEO Mike McGearty. [tallysubscriptions.com](https://tallysubscriptions.com)

When Conor Sheridan tried to expand his free-range fried chicken restaurant across Ireland, his team struggled to find technology that could help them make sense of the unpredictable restaurant business. That's why he founded Nory in 2021, a hospitality operating system which uses AI to analyze revenue, food orders, and payroll to offer recommendations such as what supplies they should order down to what their chefs should cook in the kitchen. "We're empowering these businesses to be really data focused," says Sheridan, claiming the platform can increase earnings by up to 100 percent. So far, Nory's operating system has been deployed in almost 300 restaurants across Europe and the UAE, including Mad Egg and Viva Italia. The business has raised \$9 million in total, from investors such as Cavalry VC. [nory.ai](https://nory.ai)

For two years, Twitch streamer and OnlyFans model Amouranth used a law firm to remove 6,000 links to her copyrighted content that had been leaked on the internet. When she switched to using Ceartas for the same service, the company's AI removed 50,000 links in just two weeks, according to the startup's founder Dan Purcell. The piracy protection company uses an army of bots to find copyrighted content then automatically requests Google take down the links. So far, 800 clients—mostly female content creators—have used the service to remove copyrighted content or deepfake pornography from the internet. The company, launched in 2021, also plans to expand to

work with book and film publishers. To date, it has raised \$500,000 from angel investors. [ceartas.io](http://ceartas.io)

Quantum computing promises to transform industries such as drug discovery, but these computers are still difficult to use—these car-sized machines require challenging electronics to control them and they need to be kept in extremely cold temperatures. That's why University College Dublin spinout, Equal1, is on a mission to develop affordable quantum computers, around twice the size of a desktop computer, that can be plugged into an ordinary power socket. So far, the company has built four and it plans to start selling them to universities in the next year before marketing them to companies. Founded in 2018 by Dirk Leipold, Mike Asker and Bogdan Staszewski, Equal1 has attracted \$30 million in funding so far, including from Irish VC firm Atlantic Bridge and the European Innovation Council. [equal1.com](http://equal1.com)

While working at different Dublin startups, Luke Mackey, Deepak Baliga, and Patrick O'Boyle each encountered fast-growing companies not equipped to provide benefits to their international teams. Because it was so legally difficult to provide pensions and life insurance to staff spread across different countries, some of the startups simply offered no benefits at all. This realization prompted the three friends to launch Kota (previously Yonder), a platform which makes it easy for companies to offer employment benefits to workers wherever they are. They describe themselves as Europe's first fully digital benefits broker, and are able to set up and enroll staff in health insurance and retirement plans in more than 30 different countries. “We're trying to increase access to core financial products that essentially we feel are inaccessible for a new generation of company and employee,” says Mackey, the CEO. It has raised \$8.2 million in funding from investors including Swedish VC firm EQT Ventures. [kota.io](http://kota.io)

Multinationals operating across Europe typically have hundreds of bank accounts and have to employ a team of people employed to manage the complex process of paying suppliers. Fintech startup NoFrixion is on a mission to fix this. Its MoneyMoov technology combines businesses' accounting platform with its current accounts—meaning these payments

can be executed autonomously. NoFrixion was founded in 2020 by serial entrepreneurs Feargal Brady and Aaron Clauson. They have raised \$4 million from investors including Furthr VC, and plan to expand into crypto payments. [nofrixion.com](https://nofrixion.com)

Evervault Data security company, Evervault, is best known for its “privacy cages”, which encrypt a user’s data and mean companies would never have to handle personal data in plaintext—protecting them if there was a security breach. This summer, Evervault also launched its redaction feature, which enables companies to work with large language models built by third-party developers such as OpenAI without also sharing sensitive data with them. Founded in 2019 by Shane Curran, Evervault has raised \$19.4 million to date, from angel investors such as Alex Stamos, former Facebook chief security officer. [evervault.com](https://evervault.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine. It was updated on December 21, 2023, to correct the name of a restaurant working with Nory.*

*This article was originally published by WIRED UK*

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[Stephen Armstrong](#)

[Business](#)

Dec 18, 2023 7:30 AM

# The Hottest Startups in Madrid

The Spanish capital is a fintech and security hub, and new tax breaks are helping to attract talent and international skills.

ILLUSTRATION: WIRED STAFF

Madrid is home to many of the nation's corporate HQs, from Iberia through Telefónica to Repsol. As a result, the city ecosystem is geared toward launching B2B startups to serve them. Fintech and security feature strongly, “But we’re also seeing more electric vehicle startups, housing, and health” adds Alex de la Torre, head of business development at the city’s Impact Hub, the local branch of the global accelerator.

Spain’s Law for the Promotion of the Startup Ecosystem was passed at the end of 2022, offering tax breaks for startup founders, investors, and employees, plus visas to attract talent and public funding. Although “Spain doesn’t think of just one city as our tech capital,” according to Samuel Gil, managing partner at Madrid’s JME Ventures. “It’s one third Barcelona, one third Madrid and then Valencia and Andalucía.” Madrid is already ahead in attracting international talent, thanks to three prestigious international business schools and companies including Facebook, Salesforce, and Klarna opening headquarters there.

According to Paloma Castellano, director of Wayra Madrid, the new law and the growing international skill pool will help Madrid jump from a city with solid seed capital rounds and a healthy pool of serial entrepreneurs to one with unicorns, and will scale up to match.

“Racquet sports are a social game,” says Antonio Robert Aragonés, Playtomic’s managing director. “What makes us different is the social aspect—allowing people who don’t know each other to play together, while



using a ‘Playtomic level’ designed to level the playing field in the same way as a golf handicap matches golfers.” Founded late 2017 by three local entrepreneurs Felix Ruiz Hernandez, Pablo Carro and Pedro Clavería as a booking app for padel courts, a game that combines elements of tennis and squash, its grown to become a software-as-a-service meets social network for racquet sports, and claims it connects 3.1 million players across 4,800 clubs, totalling 21,000 courts over 49 countries. Having raised €67 million from investors including GP Bullhound, FJ Labs and Claret Capital Partners, May 2023 saw it reach profitability and acquire Portuguese rival AirCourts, with 0.5 million users. Strong in Spain, Italy, Nordics, the Middle East, and Benelux, it’s looking to develop the padel market in Germany, the UK, US, and Asia. [playtomic.io](https://playtomic.io)

Thirty percent of all clinical trials in the world recruit patients in Spain, according to Dr. Manuel Marina Breysse, Idoven’s CEO and cofounder, thanks to a simplified Ethics Committee Approval system, low approval fees, and a high response rate from the population. Hence, healthcare startups flourish in Madrid. Back in 2014, the cardiologist joined a research project at Spain’s cardiovascular research institute the Centro Nacional de Investigaciones Cardiovasculares Carlos III, where he met cofounder José María Lillo Castellano, a telecoms engineer. They developed an algorithm that could predict atrial fibrillation (an irregular heartbeat) from an electrocardiogram reading. “Any time there is a heart check, you have an ECG,” he explains. “This could be at a company health check, if you visit A&E, or even from your fitbit.” They founded Idoven in 2018, building a cloud-based platform to host their algorithm where clinicians can upload data from over 60 cardiac monitoring devices. The company raised €28.5 million from investors including Insight Partners, Northzone, and Wayra. Currently focused on hospitals, they are also working with Google and AstraZeneca to use Fitbits to reduce readmission from heart attack patients, and have a beta version in development for Apple Watch. [idoven.ai](https://idoven.ai)

When brothers José and Manuel Postigo Hernández, and friend David Sanz found a lost camera in Madrid, they used its photos to track the owner. That inspired them to invest their savings in launching Foundspot, a free-to-use lost-and-found platform. Items are uploaded to the site or app using keywords—type of item, place lost, colors, date—and Foundspot’s AI

matches descriptions, then contacts the original owner. “We also retrieve pets,” José adds. “We want to reunite people with the things they care about.” At launch they partnered with Madrid taxi firms and Spanish airline Iberia. Other airlines, hotels, and tourist municipalities followed. The combination of ad revenue, business subscriptions, and donations from individuals grew turnover until, in 2019, the company could donate 30 percent of profits to cancer research and Latin American NGOs. In 2020, Foundspot introduced a property shipping service and, in 2023, the company is expanding in the US and Italy, with Latin America next in 2024. [foundspot.com](https://foundspot.com)

Founded by Julio Pernía and Manuel Moreno because they “detected a shift in policyholder behavior that the industry was failing to respond to,” Pernía explains. “They demanded a more digital, remote and immediate experience.” Bdeo provides “visual intelligence” to the insurance industry—policyholders can take pictures or videos of damage to cars or homes using their smartphone, and then send the images to their insurance company. Bdeo’s AI assesses the severity and repair costs, cutting the time spent appraising claims by 50 percent. In June, the company raised €7.5 million, bringing total funding €10 million from the likes of Íope Ventures, a new investment vehicle launched by Wayra and Telefónica Seguros, Blackfin, Big Sur and K Fund. Fifty insurers across more than 25 countries already use Bdeo’s technology and, in Spain, the company manages more than 50 percent of motor insurance underwriting. The new funding will fuel international expansion across Europe and Latin America. [bdeo.io](https://bdeo.io)

In 2019, Devengo’s cofounders Fernando Cabello-Astolfi and Alberto Molpeceres launched a salary advance service—allowing employees to draw against their salary before payday. The pandemic slowed the company’s growth, and in 2022 the founders made a sharp pivot to instant payments. Most B2B or B2C payments still use traditional banking “rails”—the systems run by high street banks which can take days to clear payments. Devengo’s API can accurately and securely identify both sides of a transaction in seconds so that money transfers instantly. The company has raised €2.9 million from Venture City and Fides Capital in four rounds, the most recent in November 2022. [devengo.com](https://devengo.com)

Spain has the most hours of sunshine per year in Europe, but very few household solar panels—only 70,000 of the country's six million homes have them fitted. Samara, founded by Bulb's Iván Cabezuela and Manel Pujol Olivares in May 2022, aims to encourage uptake by simplifying the process. Samara offers an online 3D design tool for customers as well as rental options to try before you buy. Consumers can save up to 70 percent on their electricity bill while contributing to a cleaner environment. The company has raised €6.5 million to develop technology—including batteries and EV chargers—from Seaya Ventures and Pelion Green Future, and aims for one million installations in the next three years. [samara.energy](https://samara.energy)

Returning to Spain from Silicon Valley consultancy jobs, Álvaro Falcones, Joaquín Fernández and CEO Enrique García launched TaxDown after being inspired by the tax advice software they'd used in the US. TaxDown's software links to an API provided by the Spanish tax authorities and takes 12 minutes to file taxes, calculate deductions and claim rebates. The company says its proprietary algorithm saves more than €400 on average per return. Since its 2019 launch, the company has raised a total of €14.6 million from the likes of JME Ventures and [Atresmedia](https://Atresmedia), boasts over one million Spanish users and is launching in Mexico this year. [taxdown.es](https://taxdown.es)

Founder and CEO Telmo Güell picked up on the health food trend for mixing CBD with natural honey—CBD is an anti-inflammatory while honey is an antiseptic and a moisturizer that can help the skin absorb CBD. Worried about the global bee colony collapse, he founded cosmetics brand Beemine Lab in 2018, with 10 percent of profits going to bee protection charities. Spain bans oral CBD, so all Beemine Lab products are topical, with skin and hair care products sold through its app and in pharmacies across Spain, Japan, Belgium, Italy, France, and Germany. Having raised €1.2 Million from Faraday Venture Partners and Keith Ventures the company expects to grow its turnover to €2.8 million by the end of 2023, double the number of pharmacies taking its product, and plans to expand into South America. [thebeeminelab.com](https://thebeeminelab.com)

In February 2020, Velca's cofounders CEO Emilio Froján, Jose Álvarez, César Flores, Marta Rosell and David Ruiz pooled their savings to launch an electric scooter powered by a battery that could be removed and charged

indoors. Then the pandemic struck, but by the end of the year they'd crowdfunded €750,000 in four hours—a record for Spain—and now have funds of €6.9 million through crowdfunding and angel investors. Velca now has eleven models, distribution in Portugal and France, and estimates it has saved over 27.5 million kgs of CO2 with its vehicles. Ambitions for 2023 include bringing all manufacturing into Spain. [velcamotor.com](https://velcamotor.com)

Madrid's instant property buyer Clikalia, founded by Alister Moreno and Pablo Fernandez, was based on the iBuyer (or instant buyer) model—large companies with lots of capital on hand who can make a quick cash offer on a home to speed up the selling process. Sellers upload their property to Clikalia's app, it values their home within 24 hours and—if it decides to buy—pays cash within seven days. Clikalia then does renovations or improvements, and resells around 70 percent of the properties it buys, renting out the rest. It reached break-even within four months and raised a record Spanish series B round of €460 million in 2021. With funding now past €983 million thanks to SoftBank, Luxor Capital and Fifth Wall, it's expanded across Portugal and Mexico, and is working towards an IPO within three years. CEO Moreno is eyeing a listing in the US. [clikalia.es](https://clikalia.es)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*This article was originally published by WIRED UK*

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[João Medeiros](#)

[Startups](#)

Dec 18, 2023 7:00 AM

# The Hottest Startups in London

London's tech sector is rising above the country's political distractions as Britain tries to maintain its status as a tech leader.

ILLUSTRATION: WIRED STAFF

UK Prime Minister Rishi Sunak always had a propensity to style himself as the “tech bro” politician. Such branding is not restricted to pensive, hoodie-sporting profile pictures: In November, the UK hosted the first AI Safety Summit—complete with a cozy fireside chat between Sunak and Elon Musk. The UK government has also launched a DARPA-type agency called ARIA (Advanced Research and Invention Agency), financing it to the tune of £800 million over four years. In July, chancellor Jeremy Hunt announced £50 billion in pension funding to scaleups by 2030.

The question now is whether the formidable British tech economy can retain its prime spot in the global arena—earlier in 2023, when Andreessen Horowitz and OpenAI announced the opening of their first offices outside the US, both opted for London—while the rest of the UK economy shows symptoms of inexorable decline. Part of that challenge will depend on a functioning government. Westminster, however, continues to show signs of being chronically preoccupied with its ongoing psychodrama. The highlight of Sunak’s opening speech at London Tech Week, for example, was not what he said about AI or tech regulation. Instead, it was his timid criticism of Boris Johnson over yet another political scandal.

Alan Chang decided to launch renewable energy startup Fuse for a simple reason: “I was extremely frustrated by the lack of progress of our net zero transition,” he says. “So I decided I will become part of the solution.”

Founded in 2022 with fellow Revolut alumni Charles Orr, Fuse is a renewable energy supplier that, according to Chang, provides customers

with the UK's cheapest electricity tariff as well as allowing them to track in real-time their electricity's consumption and provenance. The startup has raised \$78M, from investors including Balderton Capital, Lakestar, and Accel, and is currently building solar farms on unused land and rooftops. Their plans for the next year? "Fuse is building a one-stop shop to electrify your home and business," Chang says. New features will include the installation and financing of solar panels and electric vehicles chargers.

[fuseenergy.com](https://fuseenergy.com)

In July, the CEO of SOJO, Josephine Philips, spoke at a TED summit about how "learning how to value things correctly is a climate solution." "It was in the context of clothing, but the premise can be extrapolated to society as we look at our culture of overconsumption and hyper-disposability," she says. It's a topic that has interested her since university. "I began shopping second-hand, but found that so often the clothes didn't fit me or they needed to be repaired—but I had no idea how to sew," she says. Modernizing and digitizing the tailoring industry is the mission behind SOJO, a platform which allows users to easily book clothes repairs or alterations online with local seamsters, with items delivered via a bicycle service. Founded in 2020, the startup has raised a pre-seed round \$2.8m led by Capital T and has partnered with fashion brand Ganni. [sojo.uk](https://sojo.uk)

"I've gone through all the reproductive journeys: I have five children, gave birth to four; I went through three rounds of IVF; I had two pregnancy losses; I'm now perimenopausal and on HRT," says Eileen Burbidge, CEO of reproductive health benefits startup Fertifa. "I imagine how it might have helped me if I'd felt able to perhaps take a day off when I knew I was having a miscarriage at work." Fertifa provides the employees of companies including Lululemon, Meta, Centrica, and Space NK with reproductive healthcare benefits and services, such as helping women navigate menopause, or men struggling with sexual health issues. "We've processed more than a million and a half pounds of reimbursements for employees through their employers," Burbidge says. We've saved those employers about a quarter of a million pounds in compliance costs, making sure that they were eligible claims." In July 2023, they raised a £5 million seed round, led by leading SaaS investors Notion Capital alongside Triple Point Ventures. [fertifa.com](https://fertifa.com)



In October 2022, Emad Mostaque, the CEO of Stability AI—the company which funded and helped develop text-to-image generator Stable Diffusion—threw a party at the San Francisco Exploratorium. Guests included Google cofounder Sergey Brin and venture capitalist Ron Conway, who were there to celebrate the company’s \$101 million fund-raise round. Since then, Mostaque has become one of the most vocal proselytizers for open-source AI: he was one of the signatories, alongside Elon Musk and Steven Wozniak, of an open letter calling for a 6-month pause in AI research, and proclaimed that AI will replace human coders by 2028. More recently, on a call with UBS analysts, he said that AI is the “biggest bubble of all time”. The company, founded in late 2020, is currently seeking to fundraise at a valuation of \$4 billion. Its new tool, Stable Doodle, can convert a simple line-sketch into a polished, full-color image in a number of different styles, including “cinematic” or “origami”. [stability.ai](https://stability.ai)

In her previous career, Sasha Haco co-authored scientific papers with the late Stephen Hawking with titles like “Black hole entropy and soft hair”. Currently, she’s the CEO of Unitary, an AI-powered system that helps social media companies to identify and moderate harmful content on their platforms. “We build ‘multimodal AI models’, taking into account all the different signals such as image, text, and audio into a single algorithm to incorporate context and more accurately mirror human understanding,” Haco says. “For example: our models can learn the difference between artistic, medical, and explicit nudity—and apply this understanding to predict the nuances of a platform’s or organization’s policies.” [unitary.ai](https://unitary.ai)

“We are on a mission: putting a meaningful dent in the 39 percent of global emissions that come from buildings, and making the time we spend indoors healthier and more productive,” says William Cowell De Gruchy, CEO of Infogrid. The company, founded in 2018, installs a network of sensors across commercial buildings to capture data about energy consumption, space usage, and air quality to provide owners with AI-generated insights. According to Infogrid, a recent trial resulted in up to 80 percent reduction in virus risk and 50 percent improvement in productivity, based on their indoor air quality monitoring. The startup works with more than 200 global companies, including partnerships with JLL and CBRE, and has raised \$100m so far. [infogrid.io](https://infogrid.io)

Peppy, the healthtech startup launched in 2020 by Mridula Pore, Max Landry, and Evan Harris, provides multinational companies with a support platform for their employees, focusing on issues like menopause, endometriosis, fertility, and baby health. “We saw the real need for individuals and organizations to get support in underserved areas of healthcare—either from working in healthcare or as leaders in large organizations, or when we each personally experienced the ‘holy crap!’ moment of bringing a baby home for the first time.” Through the app, employees can have one-to-one video chats or virtual consultations with specialist health professionals, free of charge. More than 1 million users from 250 companies, including Accenture, Adobe, NVIDIA, and Disney use Peppy. Last October, the company expanded to the US, and earlier this year, it announced a [£36 million in series B funding](#), taking their total to \$56.7m. [peppy.health](https://peppy.health)

FabricNano’s mission to replace petrochemical products with sustainable alternatives has attracted backers including actress Emma Watson and Twitter cofounder Biz Stone as part of their series A \$25m fund raise. “We build and sell biocatalysts to enable sustainable manufacturing of chemicals at scale,” says Grant Aarons, CEO. “If you can string together a few proteins, then you can start to convert sustainable feedstocks, like sugars, into valuable products, like bioplastics.” In April 2023, it announced a partnership with Sumitomo Chemical America to develop a biomanufacturing process for industrial chemicals. “It’s the first ever cell-free startup partnering with a commodity chemical manufacturer to produce bio-based alternatives,” Aarons says. [fabricnano.com](https://fabricnano.com)

Peter Briffett’s biggest challenge when he first launched Wagestream in 2018 was convincing companies about the benefits of the “get-paid-as-you-earn” model. “There is a real stigma around people talking about their finances, so in many cases we found that employers simply weren’t aware of the issues that their staff were facing, particularly how many employees were being forced into the hands of predatory payday loan companies,” he says. In the current economic climate, companies no longer ignore that reality. Last April, Wagestream, whose service is used by around 250,000 workers in companies such as Burger King and Crate & Barrel, announced a Series C \$175 million fund raise. [wagestream.co.uk](https://wagestream.co.uk)



Last November, climate tech firm Sylvera published a research report with relatively good news for the fight against climate breakdown: According to their research, more than 40 percent of the carbon offsetting projects analyzed by the company were of “high quality”, meaning that they were contributing to CO2 removal. The startup uses machine learning and satellite imagery to make such assessments, a method developed over a decade by cofounder Allister Furey, who has a PhD in computational neuroscience and robotics. In partnership with the Mozambique government, it is currently conducting research using laser-scanning to develop more accurate methods of tracking forest carbon stocks.

[sylvera.com](https://sylvera.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*Updated 1-15-2024 4:00 pm GMT: The entry for Tesseract was updated to reflect the company rebranding as Fuse.*

*This article was originally published by WIRED UK*

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[Alex Christian](#)

[Business](#)

Dec 12, 2023 2:00 AM

# The Hottest Startups in Stockholm

The Swedish capital's hottest startups have individual and collective well-being at their core—from preventative health apps to environmental platforms.

ILLUSTRATION: WIRED STAFF

Stockholm is a city long renowned for innovation, sustainability, and progression. No surprise then, that its hottest startups this year have individual and collective well-being at their core—from preventive health apps to environmental platforms. The tech ecosystem is further boosted by its biggest unicorns, such as Klarna and Epidemic Sound, producing a fresh batch of entrepreneurs while alumni from Swedish heavyweights like Spotify, Volvo, and Einride launch new startups. It's this clash of old and new that sparks innovation done the Stockholm way—over coffee.

“Stockholm is the perfect city for starting up a new venture, due to its strong entrepreneurial ecosystem, top-tier education system, supportive government grants, and high quality of life,” says Jonas Lindberg Nyvang, founder of electric scooter startup Stilride.

This sustainable startup converts paper into a material that is stronger than wood. After extracting hemicellulose from plants and cellulose fibers from kraft paper typically found in packaging, they transform and bond these natural fibers in the lab to form a new, heat- and water-resistant composite. Among the startup's prototype products is the Paper°Surf—a snowboard made from PaperShell's patented material. “We're currently working on sport products and interior architecture to tell the story of its aesthetic potential,” explains Anders Breitholtz, CEO and cofounder alongside Mathieu Gustafsson. Gustafsson says that future large-scale production will target industries such as transportation, architecture, consumer goods, and

electronics. Founded in 2021, the startup has raised €9.7 million (\$10.6 million) and began production in spring 2023. [papershell.se](https://papershell.se)

When Nina Siemiatkowski quit her job as a marketing director to become a wildlife photographer in the savannas of Kenya, she came face-to-face with the rapid decline of lion populations. Upon returning to Sweden in 2018, she established environment tech platform Milkywire to connect environmental initiatives and supporters. “Only 2 percent of donations typically reach environmental causes, and there can be a lack of transparency and efficiency in the sector,” explains Siemiatkowski. “Yet I saw a strong desire to contribute to the environment—and an opportunity to leverage digital technology.”

Rather than traditional carbon credits, the Milkywire platform enables direct donations to curated portfolios of environmental projects, with comprehensive reporting on contributions and impact metrics. Milkywire takes 10 percent of every donation. Over the past three years, it has boosted turnover by 200 percent, raising more than \$20 million (around €18 million) in contributions to its impact funds. Entrepreneurship runs in the Siemiatkowski household: Husband Sebastian is the CEO of Klarna. [milkywire.com](https://milkywire.com)

The average knowledge worker spends around 30 hours a week checking emails. Teenie Fung and Beatrice Baltscheffsky’s AI-powered technology aims to slash that figure, and the startup claims it can boost efficiency tenfold. Hypertype fetches employees’ most relevant information from their emails and documents and, through natural language processing, can then synthesize long email threads and output auto-generated responses.

“Before ChatGPT was released, many companies were still skeptical about integrating AI solutions into their daily operations,” says Baltscheffsky. “Today, we get several requests per week to implement our models into their systems. Businesses are aware they need to start working with AI but are overwhelmed about everything that is happening.” Founded in 2021, Hypertype has raised \$1.5 million (around €1.37 million) in pre-seed and angel funding from Luminar Ventures. [hypertype.co](https://hypertype.co)

In February 2023, Spotify founder Daniel Ek opened the doors to his new business: health tech venture Neko. Located in the heart of Stockholm's shopping district, it has a full-body scanner that can collect 50 million data points and 15 gigabytes of health data in just 15 minutes. Through radar, laser, 3D, and thermal imagery captured by more than 70 sensors, Neko can screen for certain types of cancer, cardiovascular problems, diabetes, and skin irregularities—detecting abnormalities down to 0.2 millimeters in just seconds.

Neko sold out more than 1,500 45-minute appointments in under two hours, with more than 10,000 people now on its waiting list. It's currently doing up to 14 scans daily. Founded with Hjalmar Nilsson, whose previous startup specialized in energy data analysis, Neko initially received \$30 million (nearly €27.5 million) in funding from Ek and his investment company, Prima Materia, followed by investments from Lakestar, Atomico, and General Catalyst. [nekohealth.com](https://nekohealth.com)

Freshsound provides a licensing platform for commercially released songs, with pricing algorithms and recommendations that enable brands to soundtrack their next campaign in an instant. CEO Stevie Gyasi came upon the idea behind his company after trying to select a short song clip for an advertising campaign and ending up entangled in red tape. “The record label told me I needed to contact six songwriters and negotiate with each of them,” he says. “It can take months to license one song—and you can get a ‘no’ from a 1 percent rightsholder.” In May 2023, Freshsound, which was launched in 2021 by Gyasi and Sara Larsson, closed a seed funding round of €2 million (\$21.5 million). [freshsound.com](https://freshsound.com)

The typical electricity grid relies upon a central supplier and the end consumer—think large, central power stations transmitting generation loads across long distribution lines to customers in a sprawling region. Fever aims to enable the decentralized grid. By deploying AI and connecting any type of distributed energy resource to the grid, it empowers production to be closer to where it will be used—meaning more renewable energy sources are added. Founded by Ruben Flam, Jonatan Raber, Klas Johansson, and Ron Stolerio, Fever raised €1.6 million (\$1.7 million) in seed funding in

February 2023. It's now partnering with utility companies, EV makers, and charge-point operators. [fever.energy](https://fever.energy)

Founded in 2019 by Peter Beckman and Sameh El-Ansary, Treyd takes a “sell first, buy suppliers later” model that thrived during the 2021 supply chain crisis. It works by fulfilling supplier invoices on behalf of businesses, which can then receive and sell their goods, generate cash flow, and pay back their loan within 120 days. Freight prices may have normalized, but merchants' cash-flow issues persist: High inflation means demand for Treyd continues to boom. It currently serves more than 500 customers, typically small, direct-to-consumer companies, ranging from electronics to outdoor brands. Approximately 30 percent of its customers and revenue now come from the UK, since Treyd expanded there in fall 2022. In total, it has raised around €11.3 million (\$12.3 million) in funding. [treyd.io](https://treyd.io)

In 2015, André Eriksson was a backend engineer at Spotify when the streaming giant transitioned to the cloud. This meant tasks suddenly became harder, workflow became slower, and building features became tougher. So, he built Encore as a side project. Enabling cloud services directly in application code, the end-to-end development platform spares developers from wasting hours on daily repetitive tasks—and the agony of dealing with platform-level mismatches from local to cloud. In 2021, Eriksson joined forces with ex-Spotify colleague Marcus Kohlberg to launch Encore as a product, raising €2.75 million (\$3 million) in seed funding led by London-based Crane Ventures. [encore.dev](https://encore.dev)

Founded by Marcus Tagesson, Henrik Hoffman, and David Feldell in 2022, Dema.ai is building real-time analytics tools for small, direct-to-consumer ecommerce brands. The B2B platform collects, cleans, and enriches business' commercial metrics, including operational profitability, in real time. This data, Tagesson says, “has only been available to the top 1 percent of ecommerce businesses.” Generative AI then turns the raw data into actionable insights, such as predictive modeling that can suggest which stock to reorder. “Our clients transition from making gut-feeling decisions to becoming truly data-driven,” adds Tagesson. After raising a pre-seed funding round of €4 million (\$43.1 million), led by J12 Ventures, Dema.ai

launched in spring 2023, collaborating with 15 ecommerce companies.  
[dema.ai](#)

This digital therapy service focuses on the student experience: University undergraduates do a weekly check-in with a chatbot, which then feeds well-being data to campus administrators, who can in turn provide proactive support. App users can also reach out to on-site well-being staff. “Most universities have great resources and support networks,” says Sebastian Thomas, who cofounded the startup alongside Simon Norrman in 2020. “It’s just that students often don’t know how to access them.” Since bootstrapping, GydEd has piloted with four US colleges, identifying thousands of students at risk of depression or dropping out of university. Its full launch is in the autumn. [gyded.me](#)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*This article was originally published by WIRED UK*

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[Joel Khalili](#)

[Business](#)

Dec 12, 2023 2:00 AM

# The Hottest Startups in Paris

The French capital has a strong record when it comes to securing funding, with startups working on everything from deep space exploration to genetically modified plants.

ILLUSTRATION: WIRED STAFF

The search for funding is difficult everywhere right now, as an economic hangover takes hold in the wake of the pandemic. But for Parisian startups, the picture is sunnier.

The French capital has consistently outperformed its continental peers from a growth perspective. In the past year, almost \$3 billion has been raised by French firms, accounting for 25 percent of the European total, according to figures from market data platform PitchBook. In the last five years, Paris has witnessed the greatest growth in funding of any European city.

The Parisian scene is diverse, home to startups working on problems from deep space exploration to the genetic modification of plants. There are a “zillion reasons” to launch a company in Paris, says El Mehdi Hachad, founder of ecommerce startup Elyn, ranging from a deep pool of technical talent to non-dilutive financial support from the government.

Astride an electric bicycle, even a long commute is made effortless. But unfortunately, ebikes remain prohibitively expensive, while the expertise required to assess the condition of electronic components makes it perilous to buy secondhand.

Enter Upway, an online marketplace for professionally refurbished ebikes. Started in 2021 by Toussaint Wattinne and Stéphane Ficaja, the startup purchases used ebikes, tunes them up, and sells them on with a one-year



guarantee. “The only thing that would tell you the bike had a previous life might be a few scratches to the paintwork,” says Wattinne. By promoting secondhand sales, Upway hopes to slash the e-waste associated with ebikes, as demand continues to explode. The startup has refurbished 10,000 so far, and with expansion into new markets on the horizon, 1 million is the goal. Upway has attracted \$31 million in funding from investors including Sequoia Capital and Origins, a fund started by French footballer Blaise Matuidi. [upway.co](http://upway.co)

Neoplants, founded by Lionel Mora and Patrick Torbey in 2018, is bioengineering a new breed of plants that clean indoor air by removing dangerous pollutants. Its first plant, the Neo P1, is genetically modified to capture large quantities of airborne carcinogens like xylene and formaldehyde. These molecules typically accumulate in the tissues of regular house plants until a point of saturation, but the Neo P1 recycles them into water, sugars, oxygen, and amino acids, increasing purification efficiency by up to 30 times.

Neoplants has raised \$20 million from True Ventures, Heartcore Capital, and incubator program Entrepreneur First to fund its vision. But tackling indoor pollutants is only the first step. The startup’s “North Star,” Torbey says, is to help tackle climate change by engineering new outdoor breeds capable of purging greenhouse gases from the atmosphere. “This kind of innovation has been sitting in academic labs for decades,” says Mora. “We’re trying to bring it to market.” [neoplants.com](http://neoplants.com)

Industrial processes emit gigatons of carbon dioxide into the atmosphere each year. But Fairbrics, founded in 2019 by Tawfiq Nasr Allah and Benoît Illy, is turning those emissions into a utility. By reacting carbon dioxide with a solvent, Fairbrics produces chemicals that form polyester pellets when bound together. These pellets are spun into yarn, which is then turned into fabric for clothing. The idea speaks to a fashion industry in urgent pursuit of climate targets, explains Illy. But the same technology, he says, could be used to develop new sustainable packaging or even replace plastics.

The VC arm of H&M, the global fashion brand, is among the investors that have contributed to the €6.5 million in funding. In January, the EU awarded



Fairbrics an €18 million grant, which—in combination with a Series A round scheduled for later this year—will be put towards building new factories, securing patents, and turning emissions into new molecules.

[fairbrics.co](https://fairbrics.co)

Elyn is revamping the online shopping experience by giving buyers a chance to try before they buy. Founded last year by El Mehdi Hachad and Hamza Sentissi, the startup has raised €2.5 million in pre-seed funding from Headline, Sequoia Capital, and others. The mission: to help individual retailers keep pace with Amazon and other ecommerce megacorporations. Part of the secret to Amazon's dominance, says Hachad, is the potent combination of try-before-you-buy and flexible returns options for clothing purchases. But with the help of Elyn, any merchant can extend the same luxuries to its customers. "Our job is to bridge the gap," he says.

Elyn claims its try-before-you-buy service increases conversion rates by as much as 30 percent, while its returns facilities convert around 40 percent of item returns into eventual sales, in the form of size swaps, store credit, and other options. [elyn.io](https://elyn.io)

In the grocery business, the prevailing wisdom is that local is best. Omie & Cie, founded in 2021 by Christian Jorge, Joséphine Bournonville, Coline Burland, and Benoit Del Basso, is an online grocery store with a focus on provenance and climate impact. Each listing includes information about the origin of ingredients (as many as possible are produced in France to minimize carbon footprint), as well as the packaging material and the division of profits. The startup now counts 260 products in its range and has attracted 10,000 customers in total. It recently raised a €15 million Series A led by 2050 and XAnge, bringing its total funding to €17 million. [omie.fr](https://omie.fr)

Donating to environmental causes can be as simple as doing nothing at all. Unlike legacy banks, many of which have [ties to the fossil fuel sector](#), neobank Green-Got gives customers a way to fund eco projects passively. The bank charges account holders €6 per month, but funnels interchange fees (paid by merchants whenever someone uses their debit card) into forest preservation and other climate projects.

Launched by Maud Caillaux, Fabien Huet, and Andréa Ganovelli in 2020, the neobank has raised €2 million in crowdfunding and a €7 million seed round, from investors including Pale Blue Dot and Aera VC. The next step: to help its 15,000 customers invest in environmental causes directly. [green-got.com](https://green-got.com)

To explore the depths of space, humanity may need to rely on an age-old technology: the sail. Gama is developing special solar sails that convert photons of light into forward momentum, with the aim of making possible space missions previously considered too complex—for example, traveling to the rings of Saturn.

Since 2020, Thibaud Elziere, Louis de Goüyon Matignon, and Andrew Nutter have raised €2.5 million from Possible Ventures, Kima Ventures, and others, with additional funding from the space agencies of France and Germany. Its first satellite is already in orbit, but Gama is now preparing for its maiden journey into deep space. [gamaspace.com](https://gamaspace.com)

Noelly Acheson has always had a hard time finding skin-care products which suited her darker tone. The simple reason: Most research focuses on the needs of lighter skin. To solve this iniquity, Acheson started 4.5.6 Skin in 2020, alongside cofounders Imen Jerbi and Carlos A. Charles. The startup has developed specially formulated products for the needs of melanin-rich skin, from oils and serums to moisturizers and exfoliants, which are already available in Europe. The trio has raised \$1.7 million from Kima Ventures and various angels, which will fund further research. A UK launch is also on the horizon. [456skin.com](https://456skin.com)

Quantum computers are expected to perform calculations out of reach to even today's most advanced supercomputers. Launched in 2019, PASQAL is developing the special processors that power these computers—using beams of laser light. Founded by Georges-Olivier Reymond, Christophe Jurczak, Antoine Browaeys, Thierry Lahaye, and Nobel Prize winner Alain Aspect, the startup has raised €140 million in funding from Temasek, Wa'ed Ventures, the European Innovation Council, and others. Businesses including Crédit Agricole and EDF have already been able to achieve modest performance gains by applying PASQAL technology to credit-risk calculations, energy allocation optimization, and other tasks. By 2024,

PASQAL aims to deliver a prototype that showcases the full advantage of quantum technology. [pasqal.com](https://pasqal.com)

Foie gras has a rich culinary history but a checkered reputation. The traditional production process, whereby ducks are force-fed until their livers swell, is banned in many countries. But one startup, GOURMEY, has found an alternative way to produce the delicacy. Established in 2019 by Nicolas Morin-Forest, Antoine Davydoff, and Victor Sayous, GOURMEY cultivates foie gras and other poultry products in the lab, from duck cells. The startup has secured \$60 million in total funding, including a \$48 million Series A led by Earlybird Venture Capital. [gourmey.com](https://gourmey.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*Updated 12-14-2023 10:30 am GMT: The amount of funding secured by GOURMEY was corrected.*

*This article was originally published by WIRED UK*

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[Joel Khalili](#)

[Business](#)

Dec 11, 2023 10:27 AM

# The Hottest Startups in Berlin

The German capital boasts startups from all corners of the economy—from fintech to foodtech.

ILLUSTRATION: WIRED STAFF

Located at the heart of Europe, Berlin is a junction at which cultures and traditions meet—and the city has a startup scene to match. The German capital is home to a mix of startups from all corners of the economy, from fintech to foodtech. In Berlin, says Christian Gaiser, founder of hospitality startup numa, “no one cares where you come from,”—a value reflected in the businesses the city produces.

Others, like Mazen Rizk, founder of foodtech Mushlabs, value the city’s laid-back and non-corporate climate. Berlin’s “rockstar startup spirit,” says Rizk, makes for a tight-knit network of entrepreneurs that feed off the experience and contact books of their peers.

But don’t be fooled by the informal disposition; Berlin is also the setting for some of the largest venture capital raises in Europe, including a [\\$1.13 billion Series C](#) raised by online brokerage Trade Republic. Under Chancellor Olaf Scholz, the German administration is also [readying new measures](#), from tax allowances to improved access to credit, to ensure Berlin remains a magnet for new startups and investors alike.

Infinite Roots is tapping into the power of the humble mushroom to solve issues in areas ranging from climate breakdown to food security. Founded in 2018 by Mazen Rizk, Anne-Cathrine Hutz, and Thibault Godard, the startup (previously known as Mushlabs) uses fermentation tanks to replicate natural growth conditions for mycelium, the network of fungal threads from which mushrooms sprout. Fed with byproducts of the food industry—such

as waste from beer production—the mycelium is then turned into meat alternatives.

“The way we grow mycelium is more efficient than anything else; it uses a fraction of the water needed for plant- and animal-based agriculture, and it grows in a fraction of the time,” explains Rizk. The result is a meat proxy that has all the same antioxidants and fiber, but none of the cholesterol. It looks and cooks like meat, too. Infinite Roots has raised more than €20 million in funding from investors including the European Innovation Council Fund, Happiness Capital, and Redalpine. [infiniteroots.com](https://infiniteroots.com)

Bunch is a startup for startups. The pitch: make it easier for businesses to coordinate new funding and for VCs to launch new funds. These processes typically involve an avalanche of paperwork and hefty legal fees—and are made more complex by variations in legal and tax requirements across Europe. “All the stuff you need to do to be compliant is wild,” explains Levent Altunel, Bunch cofounder. Bunch’s software relieves startups of the bureaucratic burden and cuts the costs of private market investment by giving founders and fund managers an already-compliant foundation on which to manage deals, build funds, or pool investors.

Since the startup was founded in 2021 by Altunel and Enrico Ohnemuller, it has built a customer base that represents \$250 million in assets under management, including investors like Pip Klöckner and Equation. It has also raised €8 million in seed funding (using its own platform, of course), led by Cherry Ventures and Embedded Capital. [bunch.capital](https://bunch.capital)

Christian Gaiser spent his early years living in a hotel in Germany’s Black Forest. It was this “18-year apprenticeship,” as he calls it, that gave rise to numa. Founded by Gaiser in 2019, alongside Dimitri Chandogin and Gerhard Maringer, numa is a hotel chain with a twist: Every room has a unique aesthetic, and every stay is made easier by digital tools for check-in and support. The aim is to achieve the perfect compromise, explains Gaiser, between a bland hotel and a rough-around-the-edges Airbnb. “We are democratizing the boutique experience—doing the best of both,” he says.

DN Capital, Headline, Cherry Ventures, and Soravia have all contributed to the \$74 million raised by numa, most recently as part of a \$45 million

Series B. The startup has added almost 4,000 rooms to its portfolio across 25 European cities—including Berlin, Prague, and Vienna—but in the year ahead, that money will fund further expansion. [numastays.com](https://numastays.com)

In October 2022, SLAY published an app that gives teenagers a way to compliment one another anonymously. Within a week, it had rocketed to the top of the app charts in Germany. The kids loved it. Built by cofounders Fabian Kamberi, Jannis Ringwald, and Stefan Quernhorst—all in their early twenties—the app is designed in response to the toxicity frequently seen on social media. Users receive a series of prompts—for instance, “Who has the best music taste?”—and four school peers to choose between.

Backed to the tune of \$2.6 million by Accel, angel investor Harry Stebbings, and others, SLAY hopes to repeat its initial success with new apps targeting the same demographic. Already, the startup’s second app, frfr, which uses AI filters to let users record messages in the voice of celebrities, has accrued more than 1 million downloads and risen to the second spot in US app charts. [slay.cool](https://slay.cool)

From camembert to feta, cream cheese to cheddar, Formo has an animal-free alternative. Established in 2019 by Raffael Wohlgensinger and Britta Winterberg, the startup is Europe’s first cellular agriculture company. It uses milk proteins produced by special microorganisms to synthesize dairy ingredients. By removing cows from the equation, Formo slashes the greenhouse emissions associated with cattle.

Formo has raised one of the largest funding rounds in European foodtech—a €42 million Series A, led by EQT ventures—and, in the last year, has branched out with its first egg-replacement product, too. Pending regulatory approval, it hopes to bring its product to market later this year. [formo.bio](https://formo.bio)

For small businesses with equally small budgets, complying with data security regulations can be an ordeal. Fabiola Munguia, Grigory Emelianov, and Branko Džakula have come up with a way to automate the process. Secfix, started by the trio in 2021, plugs into its customers’ IT systems and detects abnormalities in the way data is housed. By automating the laborious audit process, Secfix brings customers into compliance with

security standards like ISO 27001, GDPR, and TISAX within five weeks. From then on, checks are performed on an hourly basis.

Octopus Ventures, Neosfer, and various angels contributed to a \$3.8 million seed round raised by Secfix in March, to go towards building out its European customer base. [secfix.com](https://secfix.com)

Increasingly, businesses are embracing “buy now, pay later.” Founded by Gil Danziger, Malte Huffmann, and Philipp Povel in 2021, Mondu gives B2B companies a way to offer delayed payments or payment by installments.

Mondu takes on all the risk; its customers get paid up-front in full, even if the buyer spreads payment over a number of months. Thousands of firms are already using the service, in industries from beauty to manufacturing. Last year, Mondu raised a \$13 million Series A extension from Valar Ventures, Cherry Ventures, and others, bringing total funding to \$70 million. It has also expanded into Austria, the Netherlands, the UK, and other new territories. [mondu.ai](https://mondu.ai)

Pitch is Germany’s challenger to Microsoft PowerPoint. The app offers features such as live video collaboration—whereby each person’s feed appears in a bubble next to their cursor—intended to make remotely co-developing a slide deck simpler. A point-and-click control system also makes for a less finicky design experience.

Since founding Pitch in 2018, Christian Reber, Adam Renklint, Vanessa Stock, Charlette Prévot, Misha Karpenko, Eric Labod, Marvin Labod, and Jan Martin have raised more than \$135 million. Two and a half years after public launch, the app has been used for more than a million presentations. [pitch.com](https://pitch.com)

Owning hardware may soon become a thing of the past, particularly for businesses. Established in 2021 by Charlotte Pallua and Estelle Merle, topi gives retailers a way to rent out hardware at a monthly rate. For now, the focus is on electronics; topi has secured deals with seven IT retailers in Germany and Austria, including GRAVIS and COMSPOT, with laptops making around 60 percent of sales. As the B2B subscription economy



expands, topi aims to fill the gap for an industry-agnostic service that works equally well for furniture, cars, and more. To date, topi has raised \$50 million, from Index Ventures, TriplePoint Capital, and various angels.

[topi.eu](https://topi.eu)

Started by Philippe Padrock and Frederik Schröder in 2021, Karla lets shoppers track, reschedule, redirect, and return all of their parcels from a single app, irrespective of who's handling the delivery. There's a pitch for couriers too: By reducing the number of redundant deliveries, Karla aims to drastically minimize both emissions and costs, half of which are typically incurred in the last mile. Backed by €4.6 million in seed funding from investors including 468 Capital and La Famiglia, the firm has partnered with more than 20 merchants to date, and all the largest couriers in Germany. [gokarla.io](https://gokarla.io)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*Updated 13-12-2023, 13:51 GMT: This article was updated to reflect the new name of Infinite Roots (previously Mushlabs)*

*This article was originally published by WIRED UK*

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[Megan Carnegie](#)

[Business](#)

Dec 11, 2023 10:27 AM

# The Hottest Startups in Amsterdam

The responsible AI, sustainable tech, and cleantech scenes are all thriving in Amsterdam, a city favored for its location, cost of living, and culture.

ILLUSTRATION: WIRED STAFF

It's easy to see why global investment platform [fDi Intelligence](#) ranked Amsterdam a heavyweight for direct investment, maintaining its number two spot among major European cities. With a highly educated and skilled workforce, excellent digital connectivity, and a central location, the Dutch capital is emerging as the EU's alternative choice to London's financial market. A hub for responsible artificial intelligence, local AI startups are thriving, as are those in sustainable and cleantech, supported by citywide initiatives on renewable energy, circular economy, and smart urban solutions.

Talent from all over the world flocks to Amsterdam to enjoy its rich cultural heritage, flawless English proficiency, and emphasis on work-life balance. Global quality-of-life database [Numbeo](#) placed the Netherlands in its top spot, based on factors like the cost of living, health care, and commute times. Travel (or lack thereof) only propels this supportive, collaborative startup ecosystem. As Joël Dori, of [StartupAmsterdam](#), points out: "Everyone is literally one bike ride away."

Founded in 2020, Nostics' medical diagnostics platform uses advanced algorithms to deliver speedier test results and more accurate treatment plans at the point of care. "Practitioners put a urine sample into the device's filter cartridge, start measurement through the app, at which point nanotechnology-based lasers generate data which is analyzed to find the

infection and prompt more effective treatment, all in the space of an appointment,” says Rochelle Niemeijer, who cofounded the €10 million seed-funded startup with Johan Pieter Verwey, Eva Rennen, and Vincent Laban. Taking such cutting-edge solutions from the lab into the world has taken a multidisciplinary team of microbiologists, software engineers, data scientists, and product designers, but they will begin by bringing the device and app to market to detect UTIs, which across their lifetime, affects 50 to 60 percent of women. In the long-term future, the Nostics team will develop the algorithms to recognize an even wider variety of infections, from STIs to blood infections. [nostics.com](https://nostics.com)

Launched by cybersecurity experts Rogier Fischer, Olivier Beg, Tijn Van Vliet, and Maurice Clin, Hadrian adheres to the maxim “Hackers know hackers best.” The SaaS platform takes a proactive approach to security, searching for possible vulnerabilities in IT systems as an outsider would. Now monitoring over 1 million domains and IPs, it aims to hit 1 billion by 2028. “Over the past year, our ethical hackers have been developing and training our Orchestrator AI which powers the platform, so it can detect the latest exploits and automatically remove an incorrectly predicted vulnerability with a high degree of accuracy,” says cofounder and CEO Rogier Fischer. To date, Hadrian has raised €20 million, most notably from HV Capital, ABN AMRO, and Adriaan Mol. [hadrian.io](https://hadrian.io)

“Greenhouse agriculture, which produces higher yields than arable land and uses less water than traditional farming methods, is a proven solution to sustainable and climate-resilient food production,” says Rien Kamman, CEO and cofounder of agtech startup Source.ag. Founded by Kamman and Ernst van Bruggen in 2020, the startup harnesses AI to simulate, compare, and track the cultivation of greenhouse plantations. Using its software, a [bell pepper nursery in northwestern Netherlands](#), for example, increased fruit weight by 10 percent. Raising \$39 million to date, Astanor Ventures, Acre Venture Partners, and several of the Netherlands’ leading greenhouse operators are among its long-term investors. The team has grown from 20 to 80 people in the past year, with a 10-fold increase in users. Initially focusing on peppers and tomatoes, Source.ag plans to expand its AI to feature more vegetable crops and farming methods. [source.ag](https://source.ag)

Business insurance is a headache for SMEs and freelancers. Due to expensive, ill-fitting policies offered by legacy players, many simply go without. Enter Insify, an end-to-end digital insurance platform with policies tailored specifically for European entrepreneurs and micro businesses. Policies can be generated online within minutes, with no need for complex paperwork. Founded in 2020 by former CEO of flower-delivery startup Bloomon, Koen Thijssen, the insurtech company has grown its customer base from 1,500 in 2022 to 10,000. Led by Munich Re Ventures, it raised an additional €10 million in June 2023, bringing its total Series A funding to €25 million. New investors include Formula 1 World Champion Nico Rosberg and Opera Tech Ventures, the VC arm of BNP Paribas Group. Having established a disability insurance product in the Netherlands, Insify is expanding to Germany and France, with health, property, and casualty insurance. [insify.nl](https://insify.nl)

Through a combination of tests, including a Big Five personality questionnaire and cognitive intelligence games, the Selection Lab makes measuring a job candidate's soft skills simpler and more objective. Tests can be completed on any device, with results provided instantly, at which point people are matched to the most appropriate roles. While traditional assessment products require training costs of €1,500 to €3,000 per user, with results taking months, Selection Lab starts at \$35 a month for hiring teams. Founders Lotte Welten, Joeri Everaers, and Jordi Wippert launched the plug-and-play assessment management software in 2018, and have expanded the client base from 12 companies in 2021 to 154. It's a hit with angel investors, too—raising €560,000 with Arches Capital, and soon to raise €1 million through Borski and Arches Capital. [theselectionlab.com](https://theselectionlab.com)

Using an AI-powered software system trained on thousands of aircraft engine inspections, Aiir Innovations improves the efficiency of defect detections and shortens time taken to inspect the inside of each jet engine by up to 30 percent. Connected to a borescope (a snake-like camera that enters the engine to inspect the blades), the computer vision tech automates and smoothes the reporting process but, as cofounder and CEO Bart Vrederegts assures, it doesn't "replace human expertise." Established in 2016 by University of Amsterdam students in AI, it's used by customers such as Air France and KLM. Its latest €2.1 million funding round was

announced in January 2023, from contributors like Mainport Investment Fund, Hearstlab International, and the Borski Fund. [aiir.nl](https://aiir.nl)

Bringing transparency to an opaque area of the fashion industry, tex.tracer's SaaS platform works as a repository for manufacturers' company data, factory pictures, audit reports, and product and emission data, which is verified through timestamps and geo-location data. Evidence is sent for approval to the next step in the supply chain, creating a digital handshake when it matches the physical product. Stored on a private enterprise blockchain, it's an immutable ledger for brand owners and retailers. Its 50-strong client base—including MUD Jeans, Fabienne Chapot, and Livera—use the tool to halve due-diligence work on theirs and the supplier's side, and avoid greenwashing. Shoppers can scan QR codes in-store to check the garment's history. Founders Jolanda Kooi and Bart Westerman, who established tex.tracer in 2020, are using its €1.5 million in funding to grow the business internationally, starting with the UK and Nordics. [tex-tracer.com](https://tex-tracer.com)

Founded by Adnan Oner in 2022, Farmless makes carbon-negative microbial proteins without animals or agricultural land. Instead of using sugar for the fermentation process, it creates liquid feedstock from hydrogen and carbon dioxide captured from the air. It claims its protein breweries and carbon-capture facilities require 10 to 25 times less land than plant protein, and 250 to 500 times less than animal protein. The hope is to “rewild vast amounts of land, draw down carbon from the atmosphere, and liberate animals from the food system,” via the application of its fermentation platform, expanding from just proteins to carbohydrates, beneficial fats, vitamins, and minerals. A year into its mission, it's raised €1.2 million in pre-seed funding, followed by [€4.8 million in seed funding](#), and is working toward regulatory approval for its first product. [farmless.com](https://farmless.com)

Founded by Layla Li and Sonali Sanghrajka in 2021, KOSA AI enables businesses in health care, HR, credit and risk, and insurance to detect, audit, and explain bias in their AI models. For example, analyzing X-ray images used in training a diagnostic AI that identifies strokes, and working out which layer of the algorithm is responsible for biased decisions such as

systematically underdiagnosing women over 65. Using checks against the latest regulatory recommendations and ethical frameworks such as GDPR and the new EU AI Act, it then implements corrective steps to address or mitigate the bias. Once deployed, the startup can also help monitor a company's AI models to avoid any emerging bias. In July 2021, its pre-seed funding round was led by EchoVC Partners and APX. [kosa.ai](https://kosa.ai)

According to Manpower Group, [40 percent of international employee moves](#) result in a return home sooner than anticipated, or a departure to another company. Settly's digital relocation platform tackles the hurdles with a personalized approach. Employees receive ongoing support while settling into their new country, from access to local, new-arrival communities, events, and experts to learn about topics like housing, schooling, and health care, plus bespoke content resources for each surrogate country. Founded by Marieke van Iperen and Kimo Paula in 2019, Settly raised €6 million from Impact Fund and Mediahuis Ventures in June, which it will use to expand into new markets. [getsettly.com](https://getsettly.com)

*This article appears in the January/February 2024 issue of WIRED UK magazine.*

*Updated 12-14-2023 10:30 am GMT: Funding information for Farmless was updated.*

*Updated 1-3-2024 15:30 pm GMT: The piece was updated to reflect the fact that, since being written, Nostics has moved to focusing solely on urine sampling, and isn't currently focusing on blood sampling.*

*This article was originally published by WIRED UK*

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By [Gear Team](#)  
[Gear](#)

Dec 4, 2023 7:00 AM

# Dispatch From the Future: The Must-Have Gadgets and Gear of 2053

To celebrate WIRED's 30th birthday, we asked the experts—and our imaginations—to dream up the cars, phones, televisions, and other tools of tomorrow.

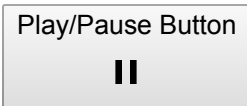


ILLUSTRATION: GIOVANNI MEDALLA

What will personal technology look like in 2053? Now that we have [three decades](#) of gear coverage under our belts, we cast our eyes 30 years into the future to answer that very question. We consulted with industry analysts, researchers, product designers, and computing experts. The tools of tomorrow will be shaped not only by advances in the tech that powers them—batteries, materials, processors, artificial intelligence—but by the future they inhabit.

ILLUSTRATION: RICARDO REY

Picture this: Screens everywhere. Screens in your palm, screens in your autonomous vehicle, screens embedded in the street sign that used to help you know where to turn, back when humans were still driving cars. This is television in the year 2053. To call it television, though, is quaint. Display hardware will be astonishing—thinner, brighter, able to roll up like a magazine—and so unbelievably cheap to produce that the sets will be free. Well, free of cost but not of commitment. Anyone who signs up for Jeff

Bezos' ad-supported BlueOriginals TV service, which scooped up Elon Musk's Starlink to broadcast its AI programming globally, will qualify for a free TV. Subscribers to the streaming service from DisneyCharter-Shopify-WarnerBros.-Discovery+, which acquired TikTok's US assets after the ban, gets a free set. Buyers of the \$640 Apple Vision Pro XX headset get a free Apple TV display bundled in.

There will be so many screens that nesting partners will become polyscreenerous, each of them soaking up audiovisual feeds from two or more personal screens simultaneously, comprising what designer and author Erika Hall calls "our own idiosyncratic combination of device and content."

A small child who suffered permanent hearing loss after seeing [Oppenheimer](#) on Imax in 2023 will have gone on to develop groundbreaking captioning technology for transparent screens—we'll want it because the sound will still suck. "The only hardware issue that needs to get fixed: AUDIO!" says [Tony Fadell](#), famed product designer and inventor of the iPod. "Smaller, thinner screens run counter to first-principle audio physics. Solve that, Samsung!" Samsung, doing its best to make Tony happy, will announce a new four-dimensional spatial audio soundbar at CES 2053, but it will only come bundled with a 4D TV. —**Lauren Goode**

#### ILLUSTRATION: GIOVANNI MEDALLA

When you look at the phone you have now, you might think we're 99 percent done. Nothing more to see here. Not so fast: According to Counterpoint Research exec Neil Shah, a 2053 smartphone won't be a phone at all. It'll be embedded in a headset or our ears or even our brain. "It will have generative and cognitive AI capabilities," Shah says, "which will learn our habits and anticipate what we need to do next, seamlessly connecting to ambient devices at the office or on the road and make switching between them a breeze."

A pocketable virtual assistant empowered by artificial intelligence to foretell our wants, streaming a playlist tailored to our mood as we step into the robotaxi it hailed for us, will make our phones the personalized everything machines we've always imagined they would be. It also means we'll be physically interacting with our mobile devices far less. We'll go



from gazing at our handsets all day to rarely ever needing to tap, swipe, or issue a voice command. In the instances when a screen is necessary, we won't rely solely on slabs of glass but also funkier designs, like a rolled-up display that transforms into a palm-size touchscreen.

Manufacturing will need to transform to meet the demands of a world defined by gaping inequality, scarce resources, and an overabundance of waste. [Fairphone](#) cofounder Miquel Ballester is looking to build fully traceable cradle-to-grave supply chains in which every human involved earns a living wage. A pipe dream? We hope not. He's also excited about the potential of soluble printed circuit boards that can be dissolved in water "so that every component can be easily separated and recycled." Cool, though we do wonder what that will do to the device's IPX rating. —*Sophie Charara*

#### ILLUSTRATION: GIOVANNI MEDALLA

When it comes to staying fit in the future, [Ozempic-style drugs](#) will do the bulk of the heavy lifting by keeping us slim. Getting swole will still require actual work, though. Infinite digital twins of your favorite Peloton instructor will lead simultaneous training sessions around the globe, with workouts tailored to your specific goals and needs. Location-aware ultra-wideband chips, each an order of magnitude more powerful than the ones currently helping your iPhone sniff out nearby AirTags, will police your form by precisely tracking the movements of the tiny sensors embedded in your sweat-wicking workout clothes.

[Smartwatches](#) will still be popular (and fashionable), but instead of just counting reps, they'll keep close tabs on a wider array of health conditions. New sensors that more accurately monitor blood pressure, glucose levels, and heart rate will feed data into an on-device AI analysis engine that correlates any irregularities with the historical and real-time health data of family members.

Jennifer Radin, an epidemiologist who has conducted research for Scripps and the Centers for Disease Control, says the data that today's devices collect lacks detail. In a 2053 world full of cheap and ubiquitous wearables, these devices will not only tell us when we're getting sick, but data from



millions of those wearables will be used to create granular health models of every community, predicting the spread of viruses and allergens and tracking trends on a societal scale. “I hope this empowers the individual to both better understand their own health as well as outbreaks that may be occurring in their community or environmental impacts that are constantly changing,” Radin says.

Alerts will buzz all of your screens and devices whenever your virtual medic discerns it’s time for you to mask up, book a telehealth visit, or request a vax-by-drone appointment. If the news is more serious, we just hope the AI has a good bedside manner. —*Boone Ashworth*

ILLUSTRATION: RICARDO REY

The landscape of 2053 looks like the landscape of today, just more beat up. Forests blackened by fire, rivers muddied by runoff, skies obscured by smoke, and oceans whipped to a frothing violence by a rapidly warming biosphere. Given this grim fate, the technology we use to mitigate the impacts of our own planetary abuse and neglect will surely improve. Wearable air-quality monitors will alert us to the presence of particulate ash, carbon monoxide, mold spores, and pathogens like Covid-51. Our mobile devices will be able to scan food we’re about to eat for traces of [microplastics](#) and other potential toxins. Air-filtration masks will be thinner, more breathable, and, thanks to advances in antimicrobial polyester, infinitely reusable.

Robin Murphy, a professor of computer science and engineering at Texas A&M University and cofounder of the Center for Robot-Assisted Search and Rescue, envisions a future in which even the worst environmental catastrophes are rendered less devastating by technology. Key to this, she says, are autonomous robots. Firefighting drones will track blazes around the clock and drop fire retardant in zones where it’s unsafe to send humans. Armies of wee robots will snake through rubble to search for trapped survivors. Floating bots will navigate the smaller rivers that today’s equipment can’t accurately study, collecting data for the AI-enhanced flood prediction models that can let the most vulnerable residents know when it’s time to evacuate. “I foresee a world in which there’s a disaster, but it’s not an emergency,” Murphy says.

These technologies won't supplant hands-on rescue work; they'll supplement the efforts of first responders. Humans will still have to make the call about who gets help first and where to concentrate resources like food and water. The machines can take that over by 2083. —**Boone Ashworth**

ILLUSTRATION: GIOVANNI MEDALLA

Over-ear headphones will have plummeted in popularity by 2053. Advances in materials and manufacturing will lead to smaller, lighter, more comfortable designs, and—more importantly—headphones that fit your ears perfectly. It's already possible to buy earphones with tips shaped to match your outer ear canal, but 30 years from now, extraordinarily accurate and rapid mapping of your pinna and ear canal means you'll be able to get headphones 3D-printed or molded to fit you and you alone. They'll be so discreet and comfortable, you'll forget you're wearing them.

Advances in battery technology will be felt in headphones as surely as they will be in cars and other devices. Battery life will be increased by harvesting the energy of your movements and body heat. Improvements in wireless tech will enable stable and reliable transmission of enormously complex, information-rich data—way more than just audio, though the audio they pump out will exhibit a level of sonic fidelity and realism that makes the best of today's headphones sound like someone playing a comb and paper next to your ear.

More than just aural escape pods, the in-ear headphone of 2053 will take on many of the tasks currently handled by our phones, acting as a portal, an assistant, and a platform for running apps. Making calls, instantly translating multilingual conversations, controlling the smart home—none of this will need a screen, just a tap or voice command. Headphones will have the computational power to act as a personal operating system, blurring the lines between audio accessory and mobile communicator. If considered purely as equipment, the headphones of the future will be as essential as clothing or shelter. —**Simon Lucas**

ILLUSTRATION: RICARDO REY

Why are flying cars always held up as the future of automotive technology? We've had them since the 1940s—they're called helicopters. In the modern world, [electric vehicles](#) have caused the biggest upheaval for the car industry since its inception, but the next three decades will feel less radical. Better batteries? Sure. Self-driving? Likely. Augmented reality windscreens? WayRay and others are developing them now. Declining car ownership? Certainly.

For Andy Palmer, CEO of the EV charging company Pod Point and former COO of Nissan, batteries will be the next big, boring advance. "They'll be more energy-dense, meaning longer ranges," he says. "We'll see changes to the way batteries are charged—wireless potentially, and faster." As far as more environmentally friendly fuels, Palmer says hydrogen is one to watch, assuming storage and production challenges can be overcome. And experts agree that the next decades will finally bring Level 5 autonomous driving—autos without steering wheels will be the norm.

Car ownership is a present-day status symbol. Mobility as a service (MaaS) will upend that, especially in cities. "On-demand motoring will become commonplace, especially if cars can be summoned remotely," Palmer says. "But in rural areas we won't see a great deal of change." Soumen Mandal, senior automotive analyst at Counterpoint, thinks pay-per-use subscriptions, ride-sharing, and ride-hailing will dominate while micromobility soars and new car sales stagnate. Of course, your robotaxi will hard-sell you add-ons: in-cabin video streaming, upgraded AR info, advanced safety features, and even custom scents.

The biggest shift will be societal. Three astonishing stats have not changed in two decades: Average daily journeys are under 30 miles; average car occupancy is 1.4 humans, making a typical five-seater far too big; and the average car spends 95 percent of its time parked. Translation: Today's car makes no objective sense, and drastic change is inevitable. Yes, that does mean flying cars are coming. We just really hope those don't have human drivers either. —*Jeremy White*

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[Matt Reynolds](#)

[Science](#)

Dec 2, 2023 7:00 AM

# Was Bobi the World's Oldest Dog —or a Fraud?

A quest to uncover the truth about Bobi, named the “oldest dog ever” by Guinness World Records, led to dog fur experts and conspiracy theories and left me with serious questions about how world records are verified.

Bobi the dog in Leiria, Portugal, on July 2, 2023. Photograph: Luis Boza/Getty Images

On October 21, 2023, Bobi the dog died. As with most celebrity deaths, the press coverage was wall-to-wall, but Bobi's demise wasn't unexpected. At 31 years and 163 days (or 217 in “human” years), he was old. So old, in fact, that in February 2023 Bobi had been crowned the “oldest dog ever” by Guinness World Records, which is the authority when it comes to these kinds of things.

Or is it? Shortly after Bobi's death, experts started raising questions about the Portuguese mastiff's advanced years. “Not a single one of my veterinary colleagues believe Bobi was actually 31 years old,” veterinarian Danny Chambers told [The Guardian](#). “For the Guinness Book of Records to maintain their credibility and authority in the eyes of the veterinary profession, they really need to publish some irrefutable evidence.”

The reputation of the world's foremost Irish dry stout turned recordkeeper was on the line here. Someone needed to establish the truth about the oldest dog to ever have lived. That someone—it turned out—was me.

A quick email to Guinness World Records would clear this up, I thought. This is the organization that verified the fastest time to eat a [banana with no hands](#) (17.82 seconds) and the longest [human tunnel traveled through](#) by a

skateboarding dog (30 pairs of legs). For more than 60 years, Guinness World Records has cataloged the [stinkiest](#) flowers, [widest mouths](#), and [largest chicken nuggets](#). It had the receipts for the world's oldest [horses](#), [cats](#), [flags](#), [trees](#), [headstanders](#), [llamas](#) (in captivity), [customer complaints](#), [working post offices](#), and [road surfaces](#). Dating the world's oldest dog would be child's play.

“We’re aware of the questions surrounding the legitimacy of the record and are reviewing them,” wrote Alina Polianskaya, a public relations executive at Guinness World Records, in response to my first email asking for details about Bobi’s age verification. Polianskaya struck me as a patient person, so I asked what this review process might involve. I imagined agents in GWR-branded overalls swabbing a dog toy for Bobi’s DNA. Could she share any details about the review?

“I’ll come back to you when we have further info to share,” Polianskaya replied to my second email. Perhaps she thought a senior writer at WIRED would have better things to do than pursue the truth about the oldest dog in the world.

What Polianskaya may not have realized was that she was emailing a journalist with an extremely high tolerance for low-stakes stories, a reporter who had once enlisted a crew of stamp-collectors to track down a [package of fraudulent](#) false teeth sent to the suburbs of Manchester, England. “We won’t have anything further to share until the review has concluded,” read Polianskaya’s reply to my third email. She did not respond to my fourth.

Luckily, GWR had left a trail for me to follow. In its [February 2023 post](#) announcing Bobi as the world’s oldest living dog, it mentioned that Bobi’s age had been verified by SIAC—a Portuguese government database for the registration of cats, dogs, and, uh, ferrets.

“We are able to confirm that indeed a dog named Bobi was registered with SIAC on the 3rd of July, 2022,” Eurico Cabral, a coordinator at SIAC, told me. Case closed, I thought. Then Cabral dropped a bombshell.

“At the time, the animal’s holder declared that it had been born in 1992, but we have no registration or data that can confirm or deny this statement,” he

wrote. Now this was intriguing. The GWR piece claimed that SIAC had verified Bobi's age, but all the agency could confirm was that Bobi's owner had told them that the dog was born in 1992. What's more, Cabral wrote in another email, SIAC had never been contacted by GWR to verify the information.

Photograph: Luis Boza/Getty Images

Cabral's revelation had blown the case wide open, but it didn't provide any definitive answers. Registration of dogs born before 2008 didn't become mandatory in Portugal until October 2020, so it's possible that Bobi really was born in 1992, but that his owner just didn't have the paperwork to prove it. It was time to bring the big dogs in.

Enikő Kubinyi, an expert in dog longevity at Eötvös Loránd University in Hungary, isn't entirely convinced that Bobi made it to 31. Accurately aging dogs is extremely difficult, she says. Veterinary records can be unreliable or nonexistent, dogs often move between owners, and it's tricky to age a dog based on physical appearance alone. Sometimes dogs die at home, and their vet records are never updated, which means that Kubinyi occasionally comes across dogs that are listed as age 40 or older.

We have some pretty good data on how long most dogs live. Data from 12,039 dogs buried or [cremated in](#) Tokyo between 2012 and 2015 found that mutts tend to have the highest life expectancy, at 15.1 years. Just one dog made it to age 25 in the Japanese data set. In a data set of [30,563 dogs](#) that died between 2016 and 2020 in the UK, just 23 of them were aged over 20 when they crossed the rainbow bridge. The average life expectancy across breeds was 11.2 years.

Kubinyi herself has studied two ultra-long-lived Hungarian dogs—one aged 22 and the other aged 27. In both cases, the dogs' age was vouched for by adults who had known them since their birth, and like Bobi, the Hungarian dogs roamed around freely and had plenty of contact with other dogs and humans—good indicators of a healthy life. But Kubinyi admits that, without verifiable paperwork, it's difficult to know definitively how old any dog is.

One thing about Bobi raised her suspicions: From the photographs she had seen, Bobi seemed to be overweight. Such rotund dogs rarely make it to extremely old ages, she says. “Even among humans it doesn’t really happen that people with extra weight can survive for that long,” she says. Oh, and there was one other thing. In its article about Bobi, GWR had posted photos of the dog when he was much younger. In those photos, the pattern of the younger Bobi’s fur seemed to differ from that of the older Bobi. Could a dog’s coat shift over time? To answer that question, Kubinyi said, I would have to consult an expert on dog coat color.

“It is true that I am considered an expert on dog coat color,” Sheila Schmutz, an emeritus professor of animal and poultry science at the University of Saskatchewan in Canada, told me. “At least in terms of genetics.” I sent Schmutz, who has published multiple papers about the coats of dogs and cattle, a selection of photos of Bobi taken in 1999, 2016, and 2022, and asked her whether the photos appeared to be of the same dog.

Schmutz wasn’t sure. In a few photos Bobi’s fur appeared to be red, while in another it looked like he had a brown coat. Brown and red coats, Schmutz assured me, are two very different colors. “I had my husband look at the photo set too and he agrees that we can understand why people don’t think it’s the same dog in all the photos, but it’s not absolutely clear to us,” she wrote. “Wish this were more clearcut ...” she signed off her email.

For certainty, I would have to look elsewhere, and so I turned to Karen Becker, a veterinarian and author of *The Forever Dog: Surprising New Science to Help Your Canine Companion Live Younger, Healthier, and Longer*. In several articles, Becker was credited as the person who broke the news of Bobi’s death, [in a post](#) on her Facebook page. I sent Becker a message through her website and waited for a response.

Becker, it turned out, was away lecturing, but I did get a response from her administrative assistant, Dana Adams, who was not impressed with the *Guardian* article casting doubt on Bobi’s longevity. “So much is incorrect,” Adams wrote. “Bobi never ate raw food, he only ate homemade cooked food, he’s a mutt not a purebred, and the lobby organization waited until the poor little guy’s cremation day to raise questions to Guinness about additional testing.”



Wait—what? A lobby organization? It was true that the GWR article about Bobi, and lots of the subsequent press coverage, had picked up on the detail that Bobi only ate “human food,” a factor that Bobi’s owner, Leonel Costa, cited as a reason for his dog’s unusual longevity. (Costa did not respond to WIRED’s requests for comment.) But Adams’ reference to a lobby organization seemed to be suggesting that there were dark forces behind these doubts. I pressed her for more details.

“Well, those of us in the pet space know it never goes well when you threaten a multi-billion dollar empire,” Adams wrote to me. “The *Guardian* article made it clear this is about the concerns vets have if people do what Leonel did and feed a home-cooked diet ... Bobi directly threatens this entire industry.” Attached was a screenshot of the world’s top 10 pet food manufacturers, as ranked by [petfoodindustry.com](http://petfoodindustry.com). Topping the list were Mars Petcare Inc., Nestlé Purina PetCare, and Hill’s Pet Nutrition.

I asked the three top pet food brands whether they were involved in a conspiracy to undermine the world’s oldest ever dog. Mars and Nestlé did not respond to my email. Melissa Chestnut, director of global communications at Hill’s Pet Nutrition, said that “Hill’s had no involvement with this effort.”

So this is where we’re at: The government authority in Portugal that was supposed to have verified Bobbi’s age has no data about the dog’s birth date. Guinness World Records is staying tight-lipped until its investigation is complete. Dog-aging experts aren’t totally convinced that we have enough evidence to verify Bobi’s age. Other people think, with no evidence, that it might all be a ruse by the pet food industry to shift more cans of Purina. The one person who could clear all this up—Bobi’s owner—is not responding to my messages.

For a brief moment I consider whether the previous holder of the world’s oldest living dog title, Spike the Chihuahua ([aged 23 in December 2022](#)), might be orchestrating a campaign to reclaim his title. (I am unable to confirm whether Spike the Chihuahua is still alive because no one cares about the world’s second oldest dog.)

Perhaps the greatest mysteries—Loch Ness, the abominable snowman, [Ron DeSantis' shoes](#)—must always go unanswered.

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Nov 13, 2023 7:00 AM

# Will Life Be Better in the Metaverse?

WIRED's spiritual advice columnist on the lure of augmented reality and what may get left behind here on earth.

Illustration: Nico Ito

“I kind of want to live in the metaverse. There will be all the same stuff as my regular universe—friends, work, shopping, entertainment—but it will somehow be more thrilling. When I move, will I still be myself?”

—**Virtual Horizons**

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## [CLOUD SUPPORT](#)

Spiritual Troubleshooting for the Digital Age

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**Dear Virtual,**

It's hard to believe that only two years have passed since we were promised the new dispensation—the digital universe where, as [Mark Zuckerberg](#) put it, we would “be able to express ourselves in new, joyful, completely immersive ways.” In the [metaverse](#), brain surgeons in Scotland would operate on patients in New Zealand, and friends would gather in simulated space stations, luxurious alpine retreats, and enchanted forests. The soaring promo video at 2021's Meta Connect suggested that the metaverse would

remain untainted by the limitations of the real world—even, perhaps, the laws of physics. (One clip showed the novelist Octavia Butler saying, “There are no closed doors, no walls.”) It certainly was, as you say, thrilling. Amid the global pandemic’s alternating waves of fear and monotony, I don’t think anyone could have been faulted for wanting to decamp for something new. World without end, amen.

Since then, as you probably know, this dream has undergone the steady erosion of technological disenchantment. The fluid virtual bodies we were promised turned out to be boxy cartoon avatars. The Oculus headsets were awkward and, because the nondigital world is still one of doors and walls, its most enthusiastic users kept injuring themselves. Meta’s [Horizon Worlds](#) platform failed to hit its user targets, and several companies that had set up shop there, including Disney and Microsoft, pulled out.

But despite the many eulogies for the metaverse, the promise has not died and the technologies seem to be improving.

At the most recent Connect, in September, Zuckerberg spoke of the metaverse as less a destination than a process, one that is well underway. The world we currently occupy is already somewhat “meta,” he stressed, because it’s a blend of the physical and the digital, and the boundary between these realms will slowly blur into “this idea that we call the metaverse.” Screens will morph into headsets, physical objects will gradually be augmented by interactive holograms, and the mundane world we live in will mutate into something more glorious, almost without us noticing. Or we might already be in the metaverse? It’s hard to say. The concept has become a bit vague and tautological. As one writer for The Verge put it, “whatever Meta does is the metaverse, by definition.”

If I can venture a somewhat grand comparison, Virtual, the evolution of the metaverse recalls the fate of so many religious eschatologies, which the true believers are forced to adapt and reinterpret once their prophecies fail to materialize. When Christ spoke of the glories of the kingdom of God, many of his earliest followers believed he was speaking of an imminent revolution that would transform life on earth.

Once several generations had come and gone and nothing of that sort had happened, other interpretations began to emerge. Maybe Jesus had been speaking about the afterlife and the more ethereal promises of heaven? Maybe the kingdom was merely the steady cumulation of justice and equality that humans were tasked with bringing about?

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When I was growing up in the church, the popular evangelical interpretation was “inaugurated eschatology,” which held that the kingdom is both “now” and “not yet.” All the glories of heaven are still to come, and yet we can already experience a glimpse of them here on earth. It’s a somewhat inelegant interpretation, one that in hindsight feels like an attempt to have (quite literally) the best of both worlds: Believers can enjoy paradise in the present and also later in heaven. It’s this theological framework that comes to mind when I hear Zuckerberg go on about the physical world, AR, VR, and the porous borders between them. When he speaks about existing “mixed reality” technologies as an ontological pit stop on the road to a fully immersive virtual paradise, he sounds (to my ears, at least) an awful lot like the theologian George Eldon Ladd, who once wrote that heaven is “not only an eschatological gift belonging to the Age to Come; it is also a gift to be received in the old aeon.”

All technological aspirations are, when you get down to it, eschatological narratives. We occupants of the modern world believe implicitly that we are enmeshed in a story of progress that’s building toward a blinding transformation (the Singularity, the Omega Point, the descent of the True and Only Metaverse) that promises to radically alter reality as we know it. It’s a story that is as robust and as flexible as any religious prophecy. Any technological failure can be reabsorbed into the narrative, becoming yet another obstacle that technology will one day overcome.

One of the most appealing aspects of the metaverse, for me, is the promise of being delivered from the digital–physical dualism mediated by screens and experiencing, once again, a more seamless relationship with “reality” (whatever that might be).

But maybe we are wrong to look so intently to the future for our salvation. Although I am no longer a believer myself, when I revisit Christ's promises about the kingdom, I can't help thinking that he was widely misunderstood. When the Pharisees asked him, point-blank, when the kingdom would arrive, he replied, "The kingdom of God is within you." It's a riddle that suggests this paradise does not belong to the future at all, but is rather an individual spiritual realm anyone can access, here and now. In his *Confessions*, Saint Augustine, sounding not unlike a Buddhist or Taoist sage, marveled at the fact that the wholeness he'd long sought in the external world was "within me the whole time."

When you describe, Virtual, your longing to live in a digital simulation that resembles reality but is somehow better, I can't help thinking that we have forgotten the original metaverse we already have within us—the human imagination. Reality, as we experience it, is intrinsically augmented—by our hopes and fears, our idle daydreams and our garish nightmares. This inner world, invisible and omnipresent, has given rise to all religious longings and has produced every technological and artistic wonder that has ever appeared among us. Indeed, it is the source and seed of the metaverse itself, which originated, like all inventions, as the vaporous wisp of an idea. Even now, amid the persistent, time-bound entropy of the physical world, you can access this virtual realm whenever you'd like, from anywhere in the world—no \$300 headset required. It will be precisely as thrilling as you want it to be.

**Faithfully,**

**Cloud**

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Be advised that [CLOUD SUPPORT](#) is experiencing higher than normal wait times and appreciates your patience.

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[Steven Levy](#)  
[Backchannel](#)

Nov 9, 2023 6:00 AM

# Robotic Putting Greens. Mixed Reality. Loud Spectators. This Is Golf?!

Tiger Woods and Rory McIlroy are backing a new sports league that's reinventing golf as high-energy, made-for-TV entertainment.

Photograph: Andrew Hetherington

Cameron Young slides a driver from his bag. He stares at a hole referred to as Texas Hill Country. It's new to him—a par 4 with sand hazards and rough to avoid. The 26-year-old is in the top 20 in the [Official World Golf Ranking](#), but he's not sure how to proceed. He turns to his companion, former pro Roberto Castro. “What’s going on here?” Young asks.

Castro consults with their caddie and reports, “It’s 312 to that bunker there.”

Young makes clean contact. The ball lofts skyward.

But there’s no sky above him. On this steamy day in late October, Young is in an air-conditioned soundstage on the back lot of Universal Studios in Orlando, Florida. The building once hosted Nickelodeon TV shows. The “caddie” Castro consulted is virtual—it lives on a 15-inch tablet. The tee is on a patch of natural grass the width of a large mattress. It sits atop wooden pallets on a concrete floor.

This article appears in the December 2023/January 2024 issue. [Subscribe to WIRED](#). Illustration: James Junk and Matthew Miller

Young's golf ball hits a billboard-sized screen 35 yards away. The dimpled sphere falls meekly to the ground, while up on the giant display its virtual successor continues its flight. A phalanx of supersensitive radar trackers and hi-res cameras sends data to a bank of computer servers that calculate velocity and spin to show how the ball will bounce and where it will ultimately settle on the vista of the screen.

Young's ball lands in the digital rough. He walks over to a tray of 2-inch-high Bermuda grass mixed with rye. The screen now shows him closer to his goal, an 8-iron away. He swings, the ball thuds against the display again, and seconds later his virtual ball lands just outside the green. For his next shot, Young ambles to the back of the soundstage, where an artificial putting surface and fringe awaits him. An official places a ball precisely on the ground. Young successfully chips over a rise to land within 5 feet of the cup. Not good enough. Castro has already sunk his third shot and wins the hole.

Many pro golfers practice using room-sized simulators in their personal gym, and weekend warriors commonly visit golf centers with plenty of tech. That's not what Young is up to. He's testing a system for real competition that will be aired on prime time, with \$20 million of prize money at stake. He's one of 24 pros, including golf legends Tiger Woods and Rory McIlroy, who are involved in the most ambitious effort yet to merge e-gaming and actual pro sports. It's called [TGL](#), allegedly *not* an acronym for The Golf League, but three TV-friendly letters that don't mean anything.

TGL's first event will take place in early 2025 inside a \$50 million-plus, custom-built arena with an inflatable dome in Palm Beach Gardens, Florida. A 200,000-pound turntable will support an 800,000-pound green that will shape-shift to give each hole its character. A 4K screen will rival the goliath displays of Taylor Swift concerts. The stands will accommodate around 1,600 live spectators, who are encouraged to boisterously violate golf's finicky silence rule. Players themselves will be mic'd up, in hopes that their trash talk might go viral online.

Woods, McIlroy, and TGL's other backers are betting that a hipper version of the sport will draw in new fans, especially on TV. Enough with the onscreen whisper-thons that lull boomers in recliners into light slumber. This new version of golf will rock, at least in the yacht sense. (It is, after all,



golf.) Driving the whole effort is tech. TGL is riding the arc of one of the century's most profound trends: mixing physical and digital reality.

Young's visit to the Orlando test lab marks the first time an elite active pro has tested the system. About a dozen TGL people are watching his every move, terrified that he might fling his wedge down and say that this won't do. No worries. He's clearly upbeat. "It's really cool," he says. "And a very different take on golf."

Cameron Young, currently ranked 17th in the world, tests out the new parameters for a TGL game.

Photograph: Andrew Hetherington

strolling into a low-key seafood bistro in Winter Park, Florida, for a late lunch, Mike McCarley has the confidence of someone at equal ease among bankers in a boardroom and blue-collar partisans at a Chickie's and Pete's. In his career as an NBC sports media executive he worked on marketing the Olympics and *Sunday Night Football*. But golf is his specialty. He headed the Golf Channel for a decade and had a deep relationship with its revered cofounder Arnold Palmer.

At that job McCarley had tons of airtime to fill. There are only so many times you can rerun tournaments, and instructional shows ate up a lot of the hours. They were dull, pretaped segments that dispensed the same tired wisdom. McCarley wanted to beam in live coaching from a studio outfitted with cameras and displays to mimic being on a golf course. He tried out a lot of equipment companies and soon started airing more spontaneous instruction.

McCarley began to get restless in that corporate role. In early 2019, he wondered whether the virtual style of golf he had introduced in the instructional studio might have a place in pro tournaments. You could never get him to say golf was broken, but he knew the sport needed change. Production-wise the game is horribly inefficient. It costs at least a million dollars to wire a golf course for TV, just for the few days of a tournament. The number of players is unwieldy. A couple bolts of lightning brings everything to a halt, and suddenly you're running a tape of the 2014 John

Deere Classic. Also, when the sun goes down, everyone goes inside. No live action during prime time.

This new version of golf will rock, at least in the yacht sense. (It is, after all, golf.) Driving the whole effort is tech.

He began to imagine what it might look like to add a virtual layer to gameplay. Golfers, like lizards, cluster in warm climes—Southern California; Jupiter, Florida; Las Vegas; Scottsdale, Arizona. If he built a sort of super-studio in one of those places, maybe the pros would be tempted to try it out. They could play a match on Monday or Tuesday—their slow days between tournaments. To help the sport take off with fans, he pictured teams of elite golfers playing together. Instead of TV producers having to choose which golfers to show live, and cutting back and forth between players on different holes, head-to-head play between two teams would create a single flow of action. Viewers would have an easier time following the game, and the pros' personalities could come through. “This scenario approaches golf like other sports, where you can see everything happening in front of you in a stadium-like environment,” McCarley says.

Mike McCarley, the founder and CEO at TMRW Sports, is incorporating new data into the league's matches so fans can obsess over the details of every swing.

Photograph: Andrew Hetherington

McCarley was still pondering how to condense a course's 200 acres and 18 holes down to a single arena when, in January 2020, he attended a big golf industry trade event. One evening he sat down with Ryan Dotters, CEO of Full Swing, a maker of golf simulators. Full Swing had bought a company that made interactive, customizable indoor putting greens. “We were the only ones who had a green that could come alive,” Dotters says. On an old-school cocktail napkin, they sketched out plans to make a hybrid game of golf—one foot each in the digital and physical worlds.

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After the show, McCarley began talking about the idea with his other connections in the golf equipment world. One day, Andrew Macaulay, then an executive at the tech-centric golf entertainment company Topgolf, told McCarley he needed to go check out a driving range in Sweden. He immediately hopped on a plane. “I was so jet-lagged, I couldn’t make a coherent sentence,” McCarley says. “They had set up this giant screen at a facility. That was the first time I actually saw a screen that big, with shots that long being hit to it. Technology would actually allow the players to see the movement on the ball.” The experience convinced McCarley he had to keep going.

He’d been brainstorming away when the pandemic locked everything down. By virtue of proximity, his wife became his main collaborator. For months they went back and forth, even clashing on what font to use on the presentation deck. Still, in the pandemic haze it seemed like a dream—just another option to consider when Covid went away.

In January 2021 he went to Jupiter, Florida, to share the idea with the one person whose buy-in was live or die: Tiger Woods. For 90 minutes, McCarley went through his PowerPoint. Finally, Woods spoke. “Look, I completely understand the technology,” McCarley recalled him saying. “If I commit to doing this, will you commit to doing it too?”

Of course he would. McCarley had been working on this for over a year.

The next visit was with Rory McIlroy. “I loved it. I’ve always said that golf must try to embrace the 21st century,” McIlroy says. By that time, McCarley was edging out of his job at NBC, which had recently moved Golf Channel’s studio operations from sunny Florida to chilly Connecticut. McCarley left to start his own company, called TMRW Sports Group (pronounced “tomorrow”). Woods and McIlroy signed on as partners, and McCarley began collecting an all-star roster of investors, including Steph Curry and Justin Bieber. Dotters’ company, Full Swing, became the official greens provider. McCarley was ready to make TGL come to life.

But first, he needed to win over the PGA Tour. Perhaps a clinching factor was that Woods was going to play. Injuries from an almost fatal car crash in 2021 had severely limited his ability to traverse long distances. TGL’s

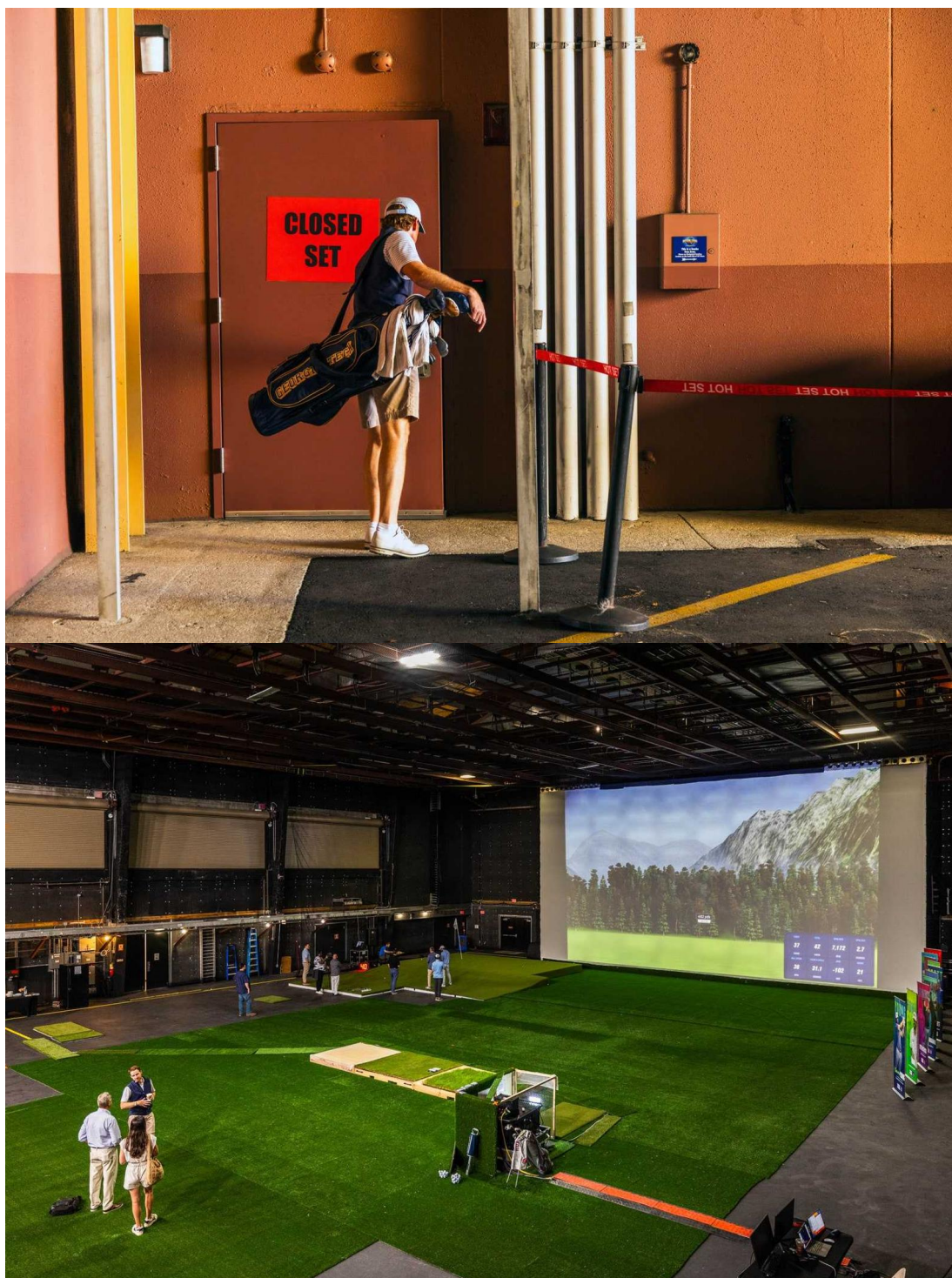
version of golf—a game famously described as a “good walk spoiled”—had no walk to spoil. The PGA Tour quickly endorsed TGL and took an 18 percent ownership stake in exchange. (Unlike the rogue Saudi-backed LIV Golf league, which was also in its early days, TGL was never viewed as a rival.) The team owners together get an additional 18 percent, and 10 percent goes to the players, who get equity in addition to prize money. McCarley’s TMRW Sports has a majority stake of 54 percent.

McCarley and his crew still hadn’t worked out what the format would be. That’s where Roberto Castro came in. After a decade without a win on the PGA Tour (he was twice runner-up), Castro became an industry consultant and is now helping TGL design its gameplay. “Basically building a new sport from scratch,” he says. There was one constraint that ruled them all: The entire match had to fit into the two-hour window ideal for prime-time TV watching.

“This is a TV show—we’re making no bones about it,” McCarley says. “If you’re creating sports in 2024, you’re doing it through the lens of the audience at home, whether they’re watching on the box on the wall or watching on their phone, or they’re just getting the data.”







1 / 9



Photograph: Andrew Hetherington  
Taking a shot from the rough.

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They introduced a shot clock, like the ones in basketball and baseball. No more dreamy pantomimes where players line up a putt, consult with a caddie, walk to the hole, dust away nano-clumps of grass, line up the putt again, stand over the ball, pull back, and start the whole thing over ... *I'm falling asleep just writing this!* In McCarley Ball, if you don't slam the drive or hit the putt in 40 seconds, your team will be penalized a stroke. With the help of some professional and amateur golfers, Castro did some test matches. They found that 18 holes was too many to jam into two hours, so they ditched three of them. The first nine holes will feature team play, with teams alternating turns and working through a three-player lineup (one player sits out each week). The final six holes will be one-on-one square-offs between individual opponents. The season will run 15 matches, after which a two-week playoff will determine a champion. So far TGL has announced five owners, including the New York franchise's Steve Cohen (billionaire, owns the Mets), Atlanta's Arthur Blank (owns the Falcons), the Fenway Sports Group (Boston Red Sox), a San Francisco group with Steph Curry, and in LA, Reddit cofounder Alexis Ohanian, his wife Serena Williams, and Venus Williams.

There's always been an artificiality to sports, where local fans cheer for mercenary athletes solely because of the jerseys they wear. TGL stretches that to the edge of credulity. With only a single stadium, there's no such thing as a home game. Ohanian says the key will be building "connective tissue" in the local community to the distant warriors—promoting golf to young people and organizing watch parties for the game. He compares it to the IRL meetups in the early days of Reddit. "Geography is a weird hangover from back when sports teams existed before mass communications," he says. Esports, he insists, has changed the dynamic. (Tell that to the millions of people who attend rowdy parades to hail Super Bowl heroes.)

Ohanian says he has never blasted a drive in his life, but the tech behind TGL instantly excited him. "This sport has never spoken to me, and a lot of people also feel that way," he says. Here, "all that negative energy becomes an advantage, because we're delighting people in a way they never expected."

There was one constraint that ruled them all: The entire match had to fit into the two-hour window ideal for prime-time TV watching.

is this golf? McCarley insists it is, and that it's not an esports—he blanches at the word. “The golfers are making the exact same physical moves with the same clubs, the same balls, in basically the same environment,” he says.

Well, not exactly. As viewers will see when play begins in 2025, TGL is venturing well into the video game realm.

**The screen.** At 64 by 46 feet, TGL's screen is “ridiculously bigger” than what's in ordinary simulators, McCarley says. “Closer to an Imax screen than anything else.” The size makes it possible for golfers to take their shots from much farther away than a simulator would normally allow. “Hitting a ball into a screen right in front of you is a very, very muted experience,” Cameron Young says. By the time you look up from your swing, your physical ball has already hit the ground. “But with this, you can really hit shots, especially given that you get to see a little bit of ball flight.”

**The ball.** It looks and plays the same as ever, but special materials make it easier for the radar to track the ball's spin.

**The software.** The longer ball flight produces more real-world data, which means the virtual ball's location and bounce are more accurate. Spectators at home get more dramatic video too—vistas that could never be captured by cameras in Pebble Beach or Troon. “If you wanted a camera right in the middle of that fairway facing right back at the golfer, we could put it there,” says Andrew Macaulay, the guy who sent McCarley to Sweden and is now the CTO of TGL. “The coolest angle would probably be flying with the ball, getting a ball's-eye view of where it's coming from and how it's coming down. *Is it going to enter the bunker? Oh, just missed it and kicked left into the fairway! That lucky bastard!*”

**The course design.** Normally, golf designers have to accommodate budgets, nature, pricey residences next to the course, pesky physics. Agustín Pizá, one of the world-class course architects hired by TGL, doesn't have to worry about all that. “If you want five more acres, here they are,” says Pizá, almost crooning with delight. “We can create extra sets of grasses, more ample

here, a little bit more stretched out there. In the real world that would require more irrigation or you would have to sacrifice housing development. The artistry becomes even greater, because what you see when you're standing on that tee box is our intention—a grass sculpture that's inviting you to take it on.”

Of course, a breathtaking course design isn't much fun to watch unless it gives the golfers a chance to show off their artistry too. “The easy way out is just to say, let's do this crazy thing and make it fabulous and majestic and fantagious,” Pizá says. “The point is, how do you stretch the boundary but still respect the integrity of the game?” One of Pizá's holes is called the Scorpion. It has two fairways that resemble claws. Golfers can play it safe by choosing either side, but they *might* reach the green in two strokes by playing the narrow, risky middle. As he puts it, “I wanted to dig deep into their brain thoughts.”

**The green.** TGL teams will play the short game in a space about half the length of a soccer pitch, with a round—and rotating—green. Underneath the putting surface, Macaulay explains, three concentric circles of steel are held up by more than 500 beams and 49 steel supports bolted to the concrete floor. “Stonehenge comes to mind,” he says. When nothing's happening, the turntable just sits there. When it's time to change the green setup to conform to the course architect's plan, a commercial compressor blows into airbags in the support structure, lifting and rotating the turntable. When Cameron Young tested the system in Orlando, the TGL team demonstrated how to tilt the green surface—changing the direction that a putt breaks—with the push of a button.

**The conditions.** Playing inside a dome shelters the golfers from the vicissitudes of weather. How boring. So the TGL team concocted something called digital wind. “We don't have actual fans blowing in the stadium for the players, but a graphic on the screen could tell the player, ‘It's gusting between 8 and 10 miles an hour off your right shoulder,’” Macaulay says.

Video: Andrew Hetherington

Video: Andrew Hetherington



The PGA Tour is watching all of this closely, to see whether any of the innovations might find their way into its tournaments. “Everybody needs to innovate,” says Norb Gambuzza, the PGA Tour’s senior vice president of media and gaming. “We may find some new competitive elements. That shot clock is a cool thing.”

“There’s so much technology in golf that people probably don’t know,” McIlroy says, listing the Moneyball-style data that golf insiders follow, such as ball speed and launch angle. “There’s a way to engage a different audience here by not just, obviously, showcasing the talent but also everything else that goes around this. The biometric feedback, players’ heart rates.”

Wait a minute ... you want to air *live heart rates*?

“We could do it!” he says, “Full disclosure—I’m an investor in [fitness tracker company] Whoop. So I monitor my heart rate a lot.”

So basically, Rory, you’re saying that golfers are geeks?

“Most of us are, yeah,” says the champion who won four majors before his 26th birthday. “If we weren’t we’d probably be playing a different sport.”

And soon they will be.

Photograph: Andrew Hetherington

as i visited the test facility and spoke with the TGL team about the weird hybrid they’re launching, I wondered whether TGL might fall into a sports uncanny valley—not enough pure golf to satisfy the geezers who wear blazers in the clubhouse, and not enough virtual reality to delight the gamers in backward baseball caps. No simulation can precisely duplicate a classic golf course. So why not stop trying, and let things run wild? Have players tee off in the streets of Manhattan or through the gates of Casterly Rock? Putt during an avalanche? Hit an 8-iron while avoiding TIE fighters?

The TGL team told me they don’t want to venture too far into the virtual world—for now. Because it’s all controlled by software, they can try jacking up the distances or wind strength anytime they like. Would the players be on

board with that? “Maybe not in the regular season,” McIlroy says. “But maybe on the weekend leading into the playoffs, we could have something like baseball’s or the NBA’s all-star weekend, where they have skills challenges.”

That might put golf traditionalists over the top. The precariousness of the enterprise became apparent in early November, when current Masters champ Jon Rahm, citing the commitment TGL would require, pulled out of the league.

As it stands now, to those with shrines to Bobby Jones in their locker room, TGL is already flirting with heresy. McCarley was famously close with the golf legend Arnold Palmer, probably the sport’s best ambassador before Tiger Woods. For years Palmer was also the connection to the sport’s history and traditions. It’s hard if not impossible to imagine Arnie teeing up to a display screen.

Late in our lunch, I ask McCarley what Palmer would think of TGL. He considers the question for a while as if assessing a minefield. “I would say that the lights, the music ... not for him,” he finally says. “But this is a way to open up golf to a new group of fans and a new group of players. Ultimately he would love it.”

Especially if Palmer had lived to become a partner in TMRW and joined the bet on making a nearly 600-year-old sport into a rollicking video game.

*Updated 11-20-23, 12:50 pm ET: An earlier version of this story said that TGL’s inaugural season would begin in January 2024. According to a statement from TMRW Sports Group, on November 14 a failure of temporary power systems caused the Palm Beach venue’s dome to deflate and damaged parts of the structure. The start of play is postponed until early 2025.*

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By [Lauren Smiley](#)

[Backchannel](#)

Nov 7, 2023 6:00 AM

# How Citizen Surveillance Ate San Francisco

When a homeless man attacked a former city official, footage of the onslaught became a rallying cry. Then came another video, and another—and the story turned inside out.

A security camera at a laundromat (left) at Laguna and Magnolia streets in the Marina District in San Francisco. Magnolia Street in the Marina District in San Francisco on October 22, 2023. Photograph: Ian Bates

Just when the people of San Francisco thought they'd seen every video—the sidewalk drug runners, the Louis Vuitton mob heisters, the men selling stolen laptops, the smash-and-grabbers snatching a camera from a Prius in traffic, the *porch pirates porch pirates porch pirates* into infinity, all indexed in the “Lawless [San Francisco](#)” section of the great internet video store—yes, just then: Stig Strombeck took out his cell phone camera on April 5 and hit Record.

This article appears in the December 2023/January 2024 issue. [Subscribe to WIRED](#). Illustration: James Junk and Matthew Miller

It was around 7 pm, and Strombeck was on his way to his second job. He'd parked on Lombard Street. Not the famously crooked section up over the hill, but the wide gauntlet that jets toward the Golden Gate Bridge through the Marina district: the preppy hood of woo girls and boat guys and early-career Gavin Newsom and largely law-and-order Democrats. (“Everyone likes to shit on San Francisco, and San Franciscans like to shit on the Marina,” one resident told me. “It’s a victimless crime.”) But lately, even in the Marina, there was no escaping the rest of the city’s problems. The previous November, in a manicured playground just two blocks from where

Strombeck was walking, a father said his 10-month-old baby had [ingested fentanyl](#) and had to be revived by Narcan—a San Francisco nadir that, to the presumable relief of civic boosters, hasn't surfaced on film.

On the Lombard sidewalk, Strombeck pulled headphones from his ears and trained his camera on a disturbing scene playing out in the lot of a Shell gas station. Here's the video: A bear of a middle-aged guy, 5'11", 230 pounds, faces a rakish, apparently homeless man in his twenties who is wielding a 3-foot-long pole. The older bear of a guy holds his arms up like a boxer as the younger one jockeys with the pole, falls backward off a curb, then lithely spins back to his feet. The older guy blots his eyes and yells, "You're going to jail, motherfucker." The younger one, who wears a bright red stocking cap, whacks the bear of a guy across his face, sending him careening to the side. A male voice off camera says "Dude!"—the unmistakable Greek chorus of *Wtf, this is insane*. The younger guy looks toward the camera. The video stops.

*⚠ WARNING: GRAPHIC CONTENT*

*The following videos contain graphic content, which some readers may find disturbing.*

Strombeck stowed his phone, but the action kept spilling into other frames. A daycare's security cam showed the red-capped figure maniacally chasing the now bloodied man down the Lombard sidewalk before bashing him again. A neighbor pointed his camera down from his third-floor window as the younger guy strode below with the pole in one hand and what looks like the older man's baseball cap in the other, pumping his arm, looking amped. Another video of the attacker that appears to be shot from a passing vehicle was uploaded to the crime-alert app [Citizen](#), which pinged a software engineer sitting on his couch a few blocks away, who ventured over and filmed the crimson drips and Rorschach splotches of blood leading down the sidewalk. (Strombeck would later testify that by the end of the attack, the big guy was covered in "the most blood I've ever seen.")

The following day, a Marina local named Joan wrote on Nextdoor that she was the mother of Don Carmignani, the man who'd been bludgeoned by the pole: "I want to thank all the neighbors that videoed what was happening & got involved to stop it. If they were not there my son would be dead!" Don

was in the hospital, she wrote, with a skull fracture and a broken jaw. City politicians tweeted prayers and a call for more cops. Local news identified Carmignani as a former city fire commissioner, a lifelong San Franciscan and father of two. The assailant: 24-year-old Garret Doty, a recent arrival from Louisiana.

Reports said the attack kicked off when Carmignani asked some homeless people to move away from his elderly parents' door, which they were blocking. In one TV newscast, a reporter mentions an allegation, from one of Doty's companions, that Carmignani used "bear spray" during the altercation. The segment then cuts to a close-up interview of Doty's homeless friend—a striking, red-bearded man named Nate Roye, speaking from under a filthy shearling hood—saying that Doty attacked because Carmignani had been "disrespectful."

"Is that enough to beat him up?" the journalist asks, incredulously.

"Yeah, sometimes," Roye replies, with a decisive nod.

San Franciscans know the larger drama that this episode advances, and you probably do too: Tech's glittering citadel, fallen, with the footage to show it. Within some 40 hours of the Marina attack, in another swank part of the city, a widely admired tech executive named Bob Lee, the former CTO of Square and a founder of Cash App, had staggered past surveillance cameras while bleeding from several stab wounds and later died at the hospital. The two maulings—a beaten fire commissioner, a slain tech executive—upcycled to the national news, putting San Francisco under the national surveillance to which it's become accustomed, with particularly lip-licking schadenfreude on the right. Here again was Newsom's and Nancy Pelosi's [doom-looping dystopia](#), where remote-working techies and fleeing billionaires have ceded the city to IRL *Grand Theft Auto*.

Carmignani, his family, his attorney, and some witnesses provided images that flickered through the reports and social media: Strombeck's video from the gas station. A laundromat's street cam view of Doty grabbing the metal bar out of a trash bin and taking a practice swing. The daycare cam. In the neighborhood itself, the vigorous uptake of these images inspired a kind of hope. Marina residents—forever wary of being pegged as pearl-clutching

Karens—thought they finally had their irrefutable proof of how clearly things had gotten out of hand. “Somebody got beat up. It was on camera multiple, multiple places,” one told me. “Like, the best evidence!”

But within days, the clarity crumbled. In the case of tech executive Bob Lee, police arrested not a person off the street but a tech entrepreneur whose sister had been [hanging out with Lee](#). And in private, within the police department, the Carmignani attack was veering off narrative too. A police sergeant, sorting through the symphony of surveillance clips that captured the face-off, played the bodycam footage from a cop who had been interviewing Carmignani’s girlfriend after the attack. The officer asks whether she’d been inside when Carmignani went out to “confront” the guy. She says yes. Then from the ambulance, Carmignani interrupts her, barking a command through his broken jaw, seeming to thicken the plot:

“Don’t say nothing to nobody. Don’t say nothing to any cop, no one.”

In San Francisco there’s always another video. New York and London are known for being blanketed with government-run CCTV coverage, but surveillance here is different: It is as privatized as it is pervasive, a culture of Hitchcock’s *Rear Window*, at scale.

In the city where Nextdoor’s offices sit right in the gritty Tenderloin, sharing [Ring cam](#) footage of porch thieves is a bonding exercise between neighbors who’ve never met. All over town, local nonprofits oversee neighborhood-wide networks of cameras funded in part by donations from crypto entrepreneur Chris Larsen. (“That’s the winning formula,” Larsen told *The New York Times* in 2020. “Pure coverage.”) Platoons of Waymo [self-driving cars](#) circulate the streets like *Pac-Man* ghosts, gathering up videofeeds that cops snag for evidence. You can watch a resident’s live cam to see who’s on the corner of Hyde and Ellis, right now.

True-crime video has become San Francisco’s civic language, the common vocabulary of local TV news broadcasts, the acid punch line to a million social media posts. The feeds intensified during the pandemic, when commuterless streets erupted with synthetic opioid use and property crime. Since then, the city has found itself hobbled through successive breakdowns—a police shortage, a 34 percent office vacancy rate, a federal injunction

severely limiting the city from clearing homeless camps. No one seems to be solving San Francisco's problems, the feeling goes, so by God, people are going to film the dysfunction and post the footage.

A guy who goes by the handle JJ Smith is probably the most vivid personification of this drive. A longtime resident of the Tenderloin whose brother died of a fentanyl overdose in 2022, Smith—not his real name—films unhoused people as he tries to cajole them into considering treatment. Then he posts the footage on X, where he has about 19,000 followers.

In happier cases, he'll document when people check into a program and come out clean on the other side. But much of Smith's footage is far grimmer: coroners rolling sheet-draped corpses out of residential hotels; a cold open on a woman's face as she OD's on a sidewalk. Smith explains that he's just given the woman Narcan, pulling you into morbid suspense combined with an awful feeling of *Are we really supposed to be seeing this?* Other times, Smith dispenses a tough love that edges into trolling, like the time he snatched away a coat draped over a woman's head so he could scold her for smoking drugs next to a park where his kids play.

People shrug off statistics, Smith says, but “when you're actually seeing it, it really gets to you.” Supporters credit him with recording a humanitarian crisis. Critics tweet at him, even chide him on camera: He's exploiting people who have no privacy with footage they haven't consented to. (Hey, he says, it's a public sidewalk.)

An encampment on a beach near the Marina District in San Francisco.

Photograph: Ian Bates

Some of the discomfort with Smith, who says he knows many of the people he films, stems from the simple fact that, by now, he's part of a social media bandwagon. Even presidential hopeful Ron DeSantis once stopped by the Tenderloin to shoot a video. Today, Smith is joined by other accounts like FriscoLive415 and Tenderloin Tube—a cadre that lives somewhere on the border between citizen journalists and dystopic paparazzi. Consider the live birth video. Last spring, a Twitter account that typically posts store-looting vids showed something else: an infant, just born and naked, on a Tenderloin



sidewalk, its dazed mother trying to pick the baby up. The event is morally excruciating, but so is its existence here, on X, overlaid with the account's watermark as the video travels the internet to 1.5 million views, churned into headlines like "Caught on Video: Homeless Woman Gives Birth in Broad Daylight on Tenderloin District Sidewalk."

## **X content**

This content can also be viewed on the site it [originates](#) from.

Which is to say: Anything "caught" on camera is actually, on some level, set loose—often into realms scarcely envisioned by whoever filmed it. In Carmignani's neighborhood, several hills and a couple of miles away from the Tenderloin, a distinct culture of surveillance holds sway: more genteel and hyper-local, less engineered for maximal algorithmic consumption, but just as aggressive. It is herded by a ubiquitous seventy-something retiree named Patricia Vaughey, a woman who has little presence on social media outside of Nextdoor. But even in the Marina, the rule holds: Video may seem like a means of control, but it can just as easily unleash chaos.

Officially, Patricia Vaughey is the long-running president of a Marina merchants and neighbors association. Unofficially, she is the Marina's self-appointed minder. Vaughey doesn't like the term "Karen"; she prefers an older title: "the curmudgeon." A transplant from Mississippi who arrived in 1969, she radiates mirth and deep worry from her blue eyes and speaks with the heft of a steamroller.

For decades, Vaughey says, she felt compassionate toward the few homeless people shuffling by the chic stores and restaurants on Chestnut Street, where she once kept a gift shop. She'd ask if they wanted social services or a job; if they didn't cause trouble, she didn't call the cops. "You've gotta be fair," she says.

Then came Covid. Like others in the Marina, Vaughey started counting many more people living on the streets, seemingly using harder drugs. The Marina had theories: They were drifting over from the Lombard Street motels where the city moved unhoused people during the pandemic. They

were escaping from the Tenderloin, which had descended into such tent-and-fentanyl anarchy that the mayor declared a state of emergency. Maybe they were even being dropped off from other cities. (Several people I spoke with are convinced this is happening; Vaughey muses about setting up her own camera sting.)

Emails pummeled the inbox of Catherine Stefani, the Marina's supervisor in City Hall. Messages about drug dealers, a guy with a knife, instances of public indecency. Carmignani wrote requesting a call about "a homeless person and a sexual act." Naturally, the Marina started taking pictures: tents pitched in a row behind Safeway. A person smoking drugs on the baseball bleachers at Moscone Park. Campers parked illegally on Marina Boulevard. Men passed out in outdoor dining areas, burnt drug foils in one's lap.

Vaughey emailed the police: "WE NEED A STRATEGY!!!!!!!" She spun up an ad hoc network of neighbors who walked different areas of the Marina, some during their daily dog walks or exercise routines, doing recon on the unhoused. And the network persists to this day. If a member spots someone breaking a specific law (blocking sidewalks in violation of disability codes is a big one), they call the cops. If a homeless person looks "mental," as Vaughey puts it, a volunteer can call the police nonemergency line for someone to check on them—or Vaughey makes the call herself. Some volunteers make a practice of asking homeless people if they're open to moving into a shelter or accepting medical help, then try to make it happen if they say yes.

Always, above all: Vaughey wants photos and videos. "You have to show that you have a problem," she says. (Plus the group tries to keep track of who's been approached.) If a neighbor texts her but fails to send pics, or someone mentions bad behavior on Nextdoor without evidence, Vaughey pads down the 48 steps from her fourth-floor apartment to collect the visuals herself from the driver's seat of her Chevy Spark.

Where do all the images go? Not far, generally. Vaughey says she often sends them to a security patrolman who many neighbors pay to watch their houses. Sometimes to the cops. (Vaughey to the district police in 2020: "30 of our group have spent more than a month taking pictures documenting the activities of the drug dealers and their suppliers and their paths of moving.

Our group has documented most of the homeless.”) At the very least, she keeps them on file for future reference and writes occasional updates on her favorite social network. “I am a public figure,” one man living in a tent off Lombard told me. “I’m pretty well known over the Nextdoor app.”

But the indisputable stars of the Marina’s surveillance archive are a couple named Nate Roye—the guy with the shearling hood—and Ashley Buck. Or as Vaughey calls them: “the worst we’ve ever had.”

Roye and Buck arrived in the neighborhood around 2019, after Roye took a Greyhound in from North Carolina and hooked up with Buck somewhere along the way. They set up camp outside the Walgreens on Lombard, where, according to an employee, in court filings, they smoked meth, antagonized customers, and yelled at each other. Buck would allegedly go into the store and steal things—ice cream, Red Bull, cookies—sometimes every 30 minutes, and once made off with \$205 worth of makeup, hurling vitriol. (She was never formally charged with shoplifting from the store.)

More complaints about the couple’s alleged misdeeds piled into Supervisor Stefani’s inbox: that Roye had swung a metal object at pedestrians; that he had “exposed himself” around kids on Halloween; that he had smacked with a tree branch a guy who threatened to call the cops on him. The duo had each been involved in local criminal cases—Buck was charged with shoplifting from a boutique, but the case was dropped; Roye pleaded no contest to vandalism charges, did quick stints in jail, was put on probation. But they always ended up back on the street.

I walked up to talk with Roye on a couple of occasions. He downplayed his disputes with neighbors. “They just don’t like company. That’s just some people, sometimes.” When he messes with people, he said, “It’s just for fun, really,” and he said he smokes crystal meth “all day, every day.” Buck, for her part, didn’t want to talk: The first time I approached her for an interview, she asked me to wait “around the corner” for a chat that never came; later she told me, “I think you’re looking for the other one ... She’s around somewhere; we can schedule something soon.”

While most of the Marina’s Covid-era surge of homeless people had dissipated by about 2022, Vaughey’s network kept tracking the holdouts.

Specifically, Vaughey patrolled at least once a day in her Spark to shoot photos of Buck and Roye's whereabouts. (Sitting in a Marina pizzeria this summer, I asked Vaughey where the duo was. On the spot, she texted a woman in her network, who called with the answer.) Beyond surveillance, Vaughey also worked other angles: In late 2022, at her urging, a Walgreens employee filed for a restraining order against Buck and Roye. When Vaughey posted the news on Nextdoor, Marina people were exuberant: "Thank you for everything you do." "Finally!"

As the restraining order made its way through the court, Buck and Roye simply drifted to the area around Magnolia Street near Carmignani's house, where a new set of Marina residents had to contend with their ever-expanding gyre of scavenged items and their operatic scenes.

A neighbor whom I'll call Dana—a manager at a tech company who works from her rent-controlled apartment of 13 years—was particularly bothered by Roye's tendency to berate Buck gratuitously. One day, after Dana watched the cops arrest Roye, she walked up to Buck on the sidewalk: "If there's any time for you to get out," Dana told her—to escape this cycle—"it's now." It was the rare olive branch: One day, the couple's yelling sent Dana into such tears of frustration that she felt like a hostage in her own house. The couple was stuck in some sort of dead-end loop that, from a distance, might inspire pathos, but the lived reality of it, just outside her window, turned Dana's empathy sideways. "Fuck Nate and Ashley! They are pure chaos, with complete impunity and disregard," she says. Dana hates that she's gotten jaded: "I hate them for making me hate them."

The duo wasn't without companions, though. Earlier this year, some neighbors around Carmignani's block noted a new guy with long hair who started hanging around the couple—quieter, often on a bike: Garret Doty.

Doty declined to speak with me (through his lawyer), but his odyssey to Magnolia Street can be partially reconstructed with video. On November 9, 2022, he drove a stolen utilities truck with Texas plates up to a border patrol checkpoint in New Mexico and was detained for questioning. In a taped interview with a state trooper, an upbeat Doty says he's headed to Route 66, to Tucson, eventually to San Francisco. "That's home," he says, though he doesn't have an address there. "You ever heard that song by that woman:

She ain't never looking back with her rearview mirror torn out, and her left foot on the gas?" he says. "That's about how I feel."

The agents pulled up his arrest history in Acadia Parish, Louisiana. He had been charged with domestic violence and strangulation when he was 20 and with obstructing a public passage and resisting arrest when he was 22, though all the charges had been dismissed.

An agent noticed that Doty had lesions on his face and suspected him of being high, though Doty said he wasn't on any drugs. Doty gave vague answers as to how he got the truck—his mood zigzagging from jolly to agitated. The state trooper eventually told his coworkers, bodycam running, that Doty might need a mental health check at a hospital before they booked him into jail. (Doty pleaded not guilty to a charge of attempting to possess a stolen vehicle, which was later dismissed.)

Police bodycam footage of a New Mexico state trooper interviewing Doty while he was detained in November 2022. (Note: The audio delay was present in the video released to WIRED in a records request.)

The video trail goes cold soon after that; somehow Doty made it to the Marina. Last winter, he approached a man named Richard who lives in a tent off Lombard. Richard says Doty asked questions about his camping setup—"I thought he was just some lost kid. He referred to home, home, home, home, home." It was chilly, and Richard offered Doty one of the caps that he crochets to sell. Doty popped on a bright red one. "He brightened up and did a dance in the rain."

Soon, Richard saw that Doty had befriended Royce and Buck—almost becoming "the third partner." Doty and Royce seemed to urge each other on to be "more macho, more daring," once dancing around in a sword fight with PVC pipes for kicks. It also meant that Doty had walked right into the frame of the ongoing drama that so many Marina residents were surveilling.

On the afternoon of April 5, Vaughey was driving down Carmignani's street, out on her daily photo-snapping patrol to track Royce and Buck. She saw the duo sitting on the sidewalk with Doty, clogging the public right-of-way with their possessions. Vaughey says she called the disability violation

in to the cops. Later, when she got news of the Carmignani attack, her first thought was: “Shouldn’t have happened.” The cops ought to have cleared the sidewalk, she felt, before Carmignani ever got to the scene. A nearby surveillance cam filmed what happened instead: The police came, talked to the unhoused, then left.

When a San Francisco deputy public defender named Kleigh Hathaway started watching the bodycam footage from the Doty case—and got to the part where Carmignani barks, “Don’t say nothing to nobody” to his girlfriend—she didn’t initially understand what was going on. She thought it was just his personality coming through.

Through his lawyer, Carmignani declined to speak with me. But the way he paints himself in a 2022 radio interview, he’s a back-slapping city kid, the third-generation son of an Italian family that settled into the Marina in the early 1900s, a guy whose home is next door to the house his grandpa built in the ’40s, where his parents still live. He cofounded a startup in the dotcom boom, then invested money from the company’s 2010 acquisition in a cannabis emporium in the financial district. He also had a business selling jukeboxes and pool tables. He’s well known in his part of San Francisco: His family owns the building that houses the iconic Balboa Cafe, run by a hospitality company founded by now California governor Gavin Newsom. Over the years, Carmignani joined community boards and the Elks Club, got a purple belt in jiu jitsu, donated to city campaigns. That daycare whose security cam picked up a few moments of Doty’s onslaught? Carmignani owns the building. “The city is crashing and burning right now, with all the people with fentanyl and all the people OD’ing. I wish we could stop that, and I know we can,” he said on the radio last year, sounding every bit the concerned pillar of the community.

This laundromat’s security cam caught part of the altercation between Doty and Carmignani.

Photograph: IAN BATES

But when Hathaway took on Doty’s case, she quickly learned some other things about Carmignani. A decade ago, he had been arrested for domestic violence involving his then wife, forcing him to resign from the fire

commission after just a few months. (He pleaded no contest to a misdemeanor assault.) So when Hathaway saw Carmignani demand silence from his girlfriend, she thought, “Yeah, this guy maybe has something to hide.”

Doty pleaded not guilty to felony battery and assault charges. Then, in late April, on the eve of his preliminary hearing, prosecutors sent Hathaway a new batch of evidence, including a continuous stretch of footage from the laundromat cam. For the first time, Hathaway watched Carmignani’s initial approach to Doty, which occurred nine minutes before the start time of the clip Carmignani’s attorney had released.

That old clip had begun with Doty plucking a pole from a trash bin. In the new footage, Carmignani, wearing a Covid face mask, walks past a jumble of items on the sidewalk and pulls a tall black canister from his pocket, thumb trigger on top. Seconds later, Doty, with his red hat, scrambles into the frame with a jacket pulled over his head. As they face each other, Carmignani steps toward Doty, who quickly turns his back and moves away. Carmignani walks after him. There’s no audio, but the body language is telling: Doty’s on the defensive.

Courtesy of San Francisco Public Defender’s Office

The next surprise Hathaway came upon in the new batch of evidence was a bundle of police reports, detailing eight crimes from the prior year and a half. On all occasions, a male suspect had approached homeless people on Marina sidewalks and pepper-sprayed them. In the first case, in November 2021, there was even video evidence—from a Ring camera, right on Magnolia Street. When Hathaway played the clip, she saw a bulky guy stride up to a man lying on the sidewalk and spray him for a full five seconds, studiously aiming the chemical agent—designed to cause pain, burning, and temporary blindness—into the victim’s face and head as he rolls over and stands up. “I was like *what? What?!*” Hathaway recalls. “He focuses on the victim’s face. It’s just so gross.”

Courtesy of San Francisco Public Defender’s Office

Hathaway looked at the 2021 sprayer—sure-footed, bulky, Covid face mask, baseball cap. Then she looked at Carmignani as he approached Doty on April 5—sure-footed, bulky, face mask, baseball cap. “I was like, Jesus, that’s Carmignani. Like that’s exactly how he walks.” (In the press, Carmignani’s attorney denied it was him.)

In some of the other sprayings, witness statements bent toward a roughly similar script. A goateed white guy in his fifties, riding a bike, asked if an unhoused guy needed help before pepper-spraying, kicking, and punching him. A white guy, 6'1" and some 220 pounds, with short, light brown hair, wearing a gray beanie, unzipped a man’s tent and maced him with a 10-inch canister, warning, “Get out of my town.” A white male, 40 to 50 years old, grayish hair, sprayed Ashley Buck and an unhoused man. In other spray attacks, suspect descriptions skewed younger: One involved a white or Hispanic male in his thirties riding a gray bicycle. Another was a white thirtysomething male on a skateboard.

(Still other incidents didn’t make it into those police reports. In my reporting, a Marina man told me he’d seen someone—not Carmignani, he said—spray a homeless person in the face in August 2021, but he told the 911 dispatcher he didn’t want to get further involved by talking to the cops. Roye told me he’s been sprayed on three different occasions by different people: “It just makes you very mad, but you can still see. It just burns.”)

The same day that Hathaway saw the new evidence, the district attorney’s office told Carmignani’s lawyer that they intended to drop the charges against Doty and might prosecute Carmignani instead, for pepper-spraying.

That night, Carmignani appeared on the local news. Sitting in a kitchen, his words rolled out slowly. He described his night terrors and his wounds, sometimes closing his eyes, seeming overwhelmed with pain. At times, his voice flecked with anger. “My city—*my* city—is in chaos.” He called the prospect of his own prosecution “sad,” explaining, “When you have animals in the street saying they’re going to rape your daughter and kill your mother, and you have nothing to do or help. When you call for help, 911”—Carmignani narrowed his eyes—“and they don’t show up,” he weighted each word, “*What do you do?*”



The next day, the public defender's office demanded that the charges against Doty be dropped, detailing the prior spray attacks and publicly releasing the 2021 Ring cam footage alongside the new videoclip of Carmignani's advance on Doty. Carmignani's attorney denied that his client had been involved in any prior spray attacks and blasted the accusations as "victim blaming."

The district attorney ended up going through with the charges against Doty after all, and didn't charge Carmignani in any spray attacks. But the fresh chaos of facts churned through the culture war, needling its obsession with who, on San Francisco's symbolic turf in 2023, was the real victim. In Carmignani, some now saw a vigilante, a bully who got a brutal comeuppance for picking on the city's underclass. Others focused on the violent transient who'd horrendously beaten a former official—and said if there was any fault on Carmignani's side, it was that San Francisco's failings had pushed him over the edge.

As much as citizen surveillance culture has put an eye on unhoused people, it has also captured a steady, years-long ticker of those harming them, all across the city. In 2018 a Tenderloin camera filmed a man wearing a suit and carrying a briefcase as he kicked a person lying on the sidewalk in the head; the police identified and arrested the man, who later pleaded guilty to felony assault. In January, a septuagenarian named Collier Gwin trained a water hose on the face of a woman on the sidewalk in front of his art gallery. A chef waiting at a stoplight filmed the attack and posted it on TikTok. (Gwin avoided battery charges by doing community service.) And police are still offering a reward for information about an attack that wasn't filmed: In 2021 someone set fire to a Guatemalan immigrant's sleeping bag, leading to the man's death from burn injuries.

None of the spray attacks in the Marina had made the news until they were linked to the sensational Doty case.

Carmignani's nearby neighbor, Dana, had actually been a witness to one of the sprayings. One afternoon in January 2023, as she was working from home, she heard screaming from Magnolia Street. Having dealt with Royce and Buck for months, she hesitated—"Once you engage, it becomes this whole thing"—but when she popped her head outside, she saw that it was a

different homeless duo. The two told her that they and their Chihuahua had been pepper-sprayed. They asked Dana to call the cops and help their dog. Dana brought them a wet washcloth and lugged the salivating Chihuahua up to her bathtub while she dialed 911.

Then she heard the couple scream *again*, and she rushed to the window: They were being sprayed a second time. Not, apparently, by the same guy. Unbeknownst to Dana, another neighbor had witnessed the initial attack and caught a short cell phone video of the first purported sprayer: middle-aged, gray goatee, gray beanie, gray jacket. But the guy Dana now saw was a lanky white guy, twenties or thirties, “tweaker-ish,” basic gray sweat suit, who slowly bicycled past the couple as he sprayed them in the eyes. She’s since seen the photo of the first suspect, and this wasn’t him, Dana says.

With the dog in one arm, Dana fumbled with her iPhone to record the second sprayer as he biked down the block, but she couldn’t get it cued in time. As the police and ambulance descended, Dana handed the two victims some swag T-shirts from her tech company to change into.

That day, Dana was one of four witnesses who gave a statement to the cops. The event marked the eighth spray attack on unhoused people in the Marina area within 14 months. Now, police were treating all the suspected vigilante incidents as related. They sent out a department-wide email with the middle-aged January suspect’s photo. Vaughey told me some officers texted the photo of the suspect to her, but she didn’t recognize the guy.

Now, after the Doty ordeal, the Marina was as infamous for its pepper-spray vigilantes as it was for the attack on Carmignani. Meanwhile, Royce and Buck and Doty were blowing up on Nextdoor and Twitter—hashtag #TransientTrio—and still getting photographed in the blocks around Carmignani’s house. During a spell when he wasn’t in jail, Doty was filmed smoking on a mattress nearby, flashing a mellow peace sign at the camera. Then, over the summer, JJ Smith, San Francisco’s preeminent chronicler of street desperation, noticed all the Twitter hubbub and drove his beat-up Chevy van out from the Tenderloin for his first on-camera intervention in the Marina.

“I’ve come out here to see if I can help y’all or offer y’all any services,” Smith starts up in a warm voice. Roye stands amid a stew of objects—a papasan chair, blankets, bags—that expands over most of the sidewalk, a block and a half from Carmignani’s house. Smith urges Roye to move some things to the curb so they can be hauled away. Blasé and unfazed, Roye says he’d rather sell the stuff. Buck ignores him. After some small talk, Smith gently asks Roye if he’d like to try detox or a shelter rather than sleeping out on the street. “I’d rather stick with it,” Roye replies. “I like the freedom out here.”

garret doty strode into a Hall of Justice courtroom one Monday in June wearing an orange jumpsuit and walking with a light step, his stringy locks wafting behind him. Carmignani pushed a walker up the aisle with a lumbering limp. At a prior hearing, Carmignani had said that the painkillers he was taking were strong and his brain processing had slowed and had gaps. He stuttered a few times.

The hearing stretched on for several sessions over three months. The prosecution and the defense both entered videos as evidence. Much of it had already played on the news. But the hearing also filled in a crucial hole: No audio existed to reveal the early minutes of Carmignani and Doty’s interaction—key to determining whether Doty had acted in legal self-defense. In its place, there was old-fashioned eyewitness testimony.

From the stand, Carmignani said that on the morning of April 5, his mom told him that she couldn’t leave her house because three people—Doty among them—were posted up against her front gate, “smoking crack” and screaming. Carmignani said that he went to the window and asked them to leave and they just yelled back at him. He snapped a photo, called 911, and left for work. When he returned that evening, the group had moved across the street to the laundromat, but his parents were still too nervous to go out; they’d stayed inside all day. Hearing this, Carmignani testified, he walked out and asked, “Can you please get your stuff and move.” Doty started yelling and screaming, Carmignani said, and was holding some kind of weapon—a kitchen knife, a metal object, maybe a screwdriver—in his right hand. “I brought my hands up, and then he jumped up, and he circled me.”

At some point, Carmignani said, his spray “went off accidentally, I guess, and went in my eyes, and then I was blinded.”

All the commotion had drawn a neighbor to her window, who saw and heard the interaction differently. Taking the stand, Kristin Onorato, an executive assistant who has worked for a string of tech companies, said Carmignani’s request did not sound like “Can you please get your stuff and move.” Instead, she testified, Carmignani was “aggressively yelling” at the homeless trio: ““Get the fuck out of my neighborhood. I own this block. I don’t want to see you here tonight. If you come back, I will stab you.”” Onorato said that Carmignani told the group “he would kill them. He said, ‘You have two hours to get out of here. I don’t want to see you tonight.’”

After that, Onorato said, Carmignani left, Buck wandered off, and Doty, now holding the metal pole, started pacing the street. Within about 15 minutes, Carmignani was back, yelling at Doty and Roye. Carmignani was standing with his back against a wall, Onorato said, “almost as if he’s baiting them to come closer to him.” At some point, she said, Carmignani called Doty a “white [N-word].” When Doty came within 10 feet, Carmignani sprayed at him—“willfully,” she said—but the wind blew the spray into Carmignani’s own face, causing him to wipe his eyes and continue to spray “haphazardly.” That’s when Doty struck Carmignani with the pole two or three times. Carmignani continued to spray as he backed down the sidewalk toward the gas station, out of her view, at which point Stig Strombeck, the guy who’d gotten out of his car on Lombard, filmed the encounter. Strombeck testified that Doty continued to follow and hit Carmignani for a full block down Lombard, repeatedly yelling, “Don’t fuck with my family. No one fucks with my family.”

The Shell station where Stig Strombeck filmed Doty and Carmignani's encounter.

Photograph: IAN BATES

When it came time to cross-examine Carmignani, Kleigh Hathaway, the public defender, suggested that he knew the block and its surveillance well. “You hid yourself in this area where there weren’t any videos, and you

baited Mr. Doty to get close enough so you could then spray him, correct?” (Carmignani: “I do not recall that at all.”)

And the prior sprayings? Carmignani’s attorney, who sat feet away in the otherwise empty jury box, instructed him not to answer most of the questions. An exception was when Hathaway brought up a November 2022 spraying. Carmignani checked his phone, then told the court he was flying to a wedding in New Jersey that day. Hathaway pointed out the inconsistency: He’d answered questions about that one day while pleading the Fifth on others: “And that is because, sir, you believe you have an alibi, is that right?” And the January 2023 suspect—the middle-aged guy in a gray beanie who sprayed the couple with the Chihuahua on Magnolia? Carmignani denied “100 percent” that it was him. The lead police investigator on the Doty case testified that he hadn’t done much to look into the prior reports of pepper-spray attacks.

At the end of the hearing in July, Judge Linda Colfax spoke from the bench. She said she was “troubled, and that’s a somewhat generous word,” that the police hadn’t followed up on any of the previous sprayings. She also didn’t find Carmignani to be credible: He easily recalled details during direct testimony, she said, but then got fuzzy during cross-examination. The video belied what Carmignani claimed happened when he first approached, she said—the purported weapon in Doty’s hand, the circling face-off—and she didn’t believe Carmignani set off the pepper spray accidentally.

Then Colfax turned her attention to Doty: She was troubled that once Carmignani began to run, Doty pursued and kept hitting him on the head. The felony assault and battery charges against Doty would go on to trial, though Colfax called Carmignani “the initial aggressor.”

In the Marina, neighbors around Magnolia were used to keeping a close eye on Roye and Buck. At least one neighbor now considered Carmignani someone to keep an eye on too. In early June, within a few days of Carmignani pushing his walker into the courthouse, the neighbor held up a cell phone and filmed him limping out his door with a cane to a waiting black pickup.

One Friday evening at quitting time, I followed Dana from her Magnolia Street house across a field of golden retrievers and poodles at Moscone Park to a weekly event at the dog run called Yappy Hour. Dana's typical crew sipped rosé from plastic cups and Yeti thermoses. One mutt wore a hot-dog costume. An owner ran to scoop an errant poop from the artificial turf with the intensity of a US Open ball boy. ("You're going to get shamed on Nextdoor if you don't," Dana said.) One exasperated 70-year-old who described herself as third-generation Italian San Franciscan emphasized to me, with hearty smacks to my shoulder, that San Francisco can't become the next Detroit. She said she wasn't sure whether Carmignani had committed any of the prior sprayings: "He could have maybe, who knows? But they can't prove it, so fuck them. He's protecting his family, he's protecting his mother, and we are not going to stand for this anarchy in our city!"

In Vaughey's circle, many people seemed less worried about the harm pepper-sprayers might do to their victims than about the damage they might do to the reputation of people like the Marina photo squad. Vaughey herself disavows vigilantism, but has, on at least one occasion, inadvertently invited associations with it. Last year, she convened a neighborhood meeting about public safety and set off some worry at City Hall when she said—in front of a police captain, someone from the supervisor's office, and about 100 attendees—that the community needed to "militarize against the homeless." She chalks the misunderstanding up to semantics: "You say 'militarize' and this generation thinks pull out guns. It's join together, speak up, and be strong." Their only weapons are phone calls and images.

I asked Dana (who is not part of Vaughey's group): Did she think the first sprayer caught on the Ring cam on Magnolia looked like Carmignani? Her answer was a verbal shrug. "I mean, sure." Her frustrations lay elsewhere. With the Doty attack, the neighborhood had gotten what seemed like unimpeachable proof that its problems were real. "A lot of us were like, 'finally, we have something on camera of these assholes!'" But Carmignani's actions ruined it, nullified their case. It was now just the story of a sprayer.

One day in July, I spotted a camera on the front of a tidy house on Magnolia—the place whose driveway had been the site of the 2021 attack where a man was sprayed in the face for five seconds. I walked up to the open garage and asked the man inside if I could talk to him about the Ring cam footage that had emerged of the incident. He said he'd rather not, that he was thinking he would be subpoenaed. Doty's trial was coming up—it's now set for mid-November—and the man said he had to get an attorney himself. He hadn't authorized the release of his footage to the media, he explained, and he wasn't happy that it wound up on national TV.

The next day, I drove into the Chevron lot across from the Shell where Doty and Carmignani had fought. Then I looked up, and as surprising as any celebrity sighting, there was Nate Roye. Right on Carmignani's corner, under those laundromat cameras, he was balancing a bulky Whirlpool appliance atop a narrow scooter. It was a feat so on-brand that I pulled out my cell phone, hit Record, and kept filming as Roye, in a set of Care Bears—print pajama pants, glided his humongous cargo across six lanes of Lombard crosswalk to the pile where Buck was waiting.

As I became yet another Marina surveillant, I thought of what one regular chronicler of the homeless in the neighborhood had told me—that he doubted all the careful surveillance had added up to much other than “On my phone I have a bunch of stupid photos now.” San Francisco's police chief has called the city's bonanza of surveillance footage a “golden” tool for solving crimes, but it can just as easily set people free: The public defender's office is one of the main requesters of footage from the Tenderloin's camera network. One defense attorney in the city, Elizabeth Hilton, told me that in many of her cases the trove of San Francisco video evidence ends up helping the accused, contradicting victims' and witnesses' accounts of what went down.

Vaughey, for her part, is convinced the Marina's surveillance and activism have made a difference. “I'm proud of my neighbors,” she told me, again and again. In late summer, Walgreens was granted another restraining order against Roye and Buck, this one good for three years. The couple have since moved to the periphery of the neighborhood where, Roye told me, it's “calmer.” But problems in the Marina persist. In September, Dana texted

me from Moscone Park, where firefighters were attending to a guy who had apparently just been pepper-sprayed. I arrived in time to find a shirt and an Oakland A's cap soaked in orangish liquid, lying in the grass. Then, in October, another unhoused regular on Vaughey's radar, Zavein Wright, was charged with assaulting an 80-year-old man. Vaughey told me she was trying to figure out whether anyone had seen or filmed it.

As I kept my eye on the Marina, I couldn't stop thinking about the guy I'd met in his garage that day in July, bewildered that his Ring footage had ended up on the national news, that this little piece of hardware had unleashed something bigger than he'd ever intended. His reaction struck me as genuine and understandable—what *most* people would feel in his position. Yet it also seemed quaintly naive, a reminder that those engaged in citizen surveillance in 2023 still don't totally get what it means to have a camera watching the street.

Photograph: Ian Bates

A camera offers the illusion of a private sentry, serving you and your castle. Control your tiny corner of a flailing city. Yet once you capture something you didn't expect, say, a neighborhood vigilante mystery unfurling on your doorstep, the control is breached. Your cam blasts up and away into the stratosphere of attention. The cops get it, the footage gets passed to the prosecutor, who hands it to the defense attorney, who tosses it like chum to the ravenous media, and before you know it, your house cam is on CNN, it's playing on *All In with Chris Hayes*, it's making rhetorical points against Tucker Carlson, it's basically a live birth on a San Francisco sidewalk, boomeranging the eyes right back on you, threatening to put you on the witness stand, sending a WIRED reporter marching up to your garage on a Friday afternoon, hoping to talk.

You wanted to surveil. You end up surveilled.

And right there, under the little security camera that kicked it off, our garage meeting completed the surveillance media ouroboros. You and I are variations on a theme, our distinctions flattened, our outputs—your footage, my story on all the footage—sucked into the same grasping, greedy, ever-



expanding gyre of internet, the “Lawless San Francisco” section, competing for eyes and for clicks. Watching and watched, all true-crime-casting now.

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*This article appears in the December/January issue. [Subscribe now.](#)*

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Oct 19, 2023 6:00 AM

# Watch This Guy Work, and You'll Finally Understand the TikTok Era

The creator economy is fragmented and chaotic. Talent manager Ursus Magana can (almost) make sense of it, with a frenetic formula for gaming the algorithms.

Photograph: SINNA NASSERI

We were on the patio of a middling Los Angeles taqueria when Ursus Magana tried to talk me out of writing this story. A hirsute fireplug of a man with a slew of anime tattoos, Magana wasn't worried that I'd spill any awful secrets. In the months since I'd first messaged him on [Instagram](#), he'd been endlessly candid about his life as a talent manager for emo rappers, goth [TikTokers](#), and [OnlyFans](#) creators. He just thought I was wasting my time on a project that seemed unlikely to excite the social media algorithms that mean everything in his world. "Do you know how hard it is for an article to go viral?" he warned. "I mean, articles never go viral."

Perhaps fearing he'd bummed me out by implying that my career was pointless, Magana put off eating his last brisket taco to whip up a blueprint for how he would guide me to stardom. It started with me ditching journalism to focus on churning out daily TikToks in which I'd offer tips about storytelling. Magana's talent management startup, [25/7 Media](#), would ensure eyeballs for this content by enlisting its 60-plus clients to drive traffic my way. Once I'd built a decent fan base, 25/7 would produce a weekly podcast featuring my candid conversations with up-and-coming digital creators. I'd then parlay that success into a "big swing": a how-to book or Netflix series that would land me a spot on *The Tonight Show* and a lucrative endorsement deal with, say, a manufacturer of ballpoint pens.

I'm enough of a realist to know Magana was flattering me and that I'm much too boring to pull off any of what he proposed. But he delivered his pitch with such confidence, such zeal, that a dreamy little piece of me couldn't help but see myself telling witty anecdotes on Jimmy Fallon's couch. And when I caught myself flirting with that fantasy, I grasped how a genuinely talented young artist must feel when Magana lays out his plan for making them the richest person in their family by the age of 19.

Magana and his colleagues at 25/7 have made good on that grandiose promise enough times to prove that, despite any semi-delusional schemes for my future, they know what they're talking about. In an entertainment industry still dazed by the chaos of digital platforms, Magana has emerged as a fairly reliable rainmaker.

The creator economy is projected to be worth \$480 billion by 2027. In many ways, that figure represents an enormous redistribution of wealth: a tide of ad dollars and other revenue ebbing away from established studios and publishers, and flooding toward individual creators and the technology giants that host their work. But the corporations are the only ones on a secure footing in this arrangement. If individual creators want to stay afloat for longer than a brief moment, they still need managers to help them navigate the algorithmic churn.

The old-guard talent agencies—the Creative Artists and United Talents and Gershes of the world—ventured into this terrain years ago, forming their own digital divisions to court influencers. They face stiff competition from massive newer firms like Viral Nation and Underscore Talent, which boast that the creator economy is woven into their corporate DNA. In this scrum, the upstart 25/7 Media has fashioned a niche for itself prospecting for viral talent in areas that its larger rivals often ignore—the misfit subcultures of the young, which can often cross-pollinate with other online communities to yield colossal audiences.

Like other self-styled social media gurus, Magana hustles to sign clients by touting his ability to game the platforms that shape our tastes. (“Influence the algorithm, not the audience” is 25/7 Media's slogan.) But part of his pitch, and his gift, is that he's an authentic product of the subcultures in which he operates. An ardent metalhead and community college dropout

who was shaped by a turbulent immigrant experience, the 29-year-old Magana has built his company around supporting artists who are often isolated by their creativity, and by their oddness. “We understand how they feel at home when they’re doing something kind of weird, something that isn’t easily explainable,” he says. “That’s our competitive advantage.” And that is no small edge. Doing something weird at home has never offered such a wormhole to fame.

25/7 clients outside an Airbnb in Los Angeles.

Photograph: Sinna Nasser

the closest thing 25/7 Media has to a headquarters is a WeWork in Playa Vista, a former nowheresville in West Los Angeles that now teems with boxy glass-and-steel office buildings and absurdly pricey condos. On my first day there earlier this year, Magana was joined by his two cofounders: Andrew Alvarado, who oversees finances, and Rafail Luzi, the head of the music division, who’d flown in the night before from his home in northern Connecticut. Rather than spring for a private office, the three men were camped out at a countertop by the common kitchen, amid other entrepreneurs chattering into MacBooks about their drop-shipping ventures.

My tutorial in how 25/7 Media operates began during the founders’ late-morning Google Meet with an executive from the digital music distributor Vydia. The executive was keen to strike a deal involving a 25/7 client named YoungX777, a guttural, nihilistic trap-metal musician with long curly locks that veil his face.

This article appears in the November 2023 issue. [Subscribe to WIRED](#) Photograph: Sinna Nasser

YoungX777 had been discovered by 25/7 in late October 2022, after Luzi and his two full-time music scouts had glimpsed promise in the data for his song “Toxic.” A sludgy sonic wallop about suicidal ideation, the song hadn’t racked up many streams. But its five-second intro, a post-toke cough followed by a throaty scream, had popped up in a few [TikToks of MMA fighters](#) pummeling each other and [weightlifters](#) grunting beneath squat bars. Experience had taught 25/7 Media that when brief “recreates” of these

kinds of songs burble up in those particular TikTok communities, virality can soon follow.

When the number of recreates climbs into the tens or hundreds of thousands, Magana told me, two of 25/7's core tenets become germane. The first: Once a social media user hears an audio snippet nine times, it gets stuck in their head to some degree. The second, which Magana has dubbed the Ten Percent Rule, is that 10 percent of those earwormed users will end up tracking down the snippet's original source.

Confident in the algorithmic potential of the "Toxic" intro, 25/7 Media had rushed to sign YoungX777 even though he had less than 30,000 monthly listeners on Spotify. Taking such risks is an essential part of the strategy: The firm has to snag clients before they appear on the radars of well-heeled competitors. "We're the ones who hit you up before you blow up, so we can say we believed in you before you got big," Magana told me. "These artists, a lot of times the only sign they have of their success is some kids sending them videos of themselves dancing to their song. We're often the first ones who aren't their friends telling them, 'Hey, you're good.'"

Once YoungX777 was on board, 25/7 Media ran its standard campaign to juice a new client's recreates. Rather than pay one or two famous influencers to use the "Toxic" intro in the hopes of producing a trickle-down effect, the firm appealed to scores of MMA and weightlifting TikTokers whose followings rarely top more than a few hundred. (Some were given small payments to push the song, but others were happy to do it for free.) Flooding the zone this way caused TikTok's algorithm to funnel posts featuring "Toxic" into the feeds of users who consume gym-centric content. Inevitably, some of those users were creators themselves, and they began to weave YoungX777's clip into videos targeting related subcultures—like the region of TikTok obsessed with [highlights of soccer players](#) bursting past hapless defenders.

"When you drop one song," Magana told one artist, "there needs to be four other versions of the song right away."

The "Toxic" intro became a TikTok and Instagram Reels sensation in mid-January, at which point the Ten Percent Rule kicked in. By month's end, the

full song was zooming toward more than a million plays on Spotify. Now, Vydia was pitching 25/7 Media on letting it take charge of distributing YoungX777's catalog around the globe. It would use its proprietary technology to collect royalties from disparate platforms and stamp out copyright violators in exchange for a cut of YoungX777's revenue. After much hemming and hawing, the Vydia executive ballparked his offer at around \$200,000, a seemingly vast sum for YoungX777, who'd been eking out a living as a solar panel salesman.

Magana and Luzi seemed underwhelmed. Luzi responded that he was certain a major record label would offer a quarter-million for YoungX777's next album without a second thought. "If I tell one of my artists that I turned down a quarter-million dollars, I might not have that relationship any longer," Luzi said. The call ended with the Vydia executive promising to talk to his team about increasing their offer. (Vydia did eventually reach an agreement with YoungX777, who now has more than 1.9 million monthly listeners on Spotify—a figure that translates into annual revenue that can top \$450,000. Soon after the deal was inked, Vydia was sold to a new media company founded by the former creative director of Apple Music.)

I gleaned more about 25/7's way of doing business during an afternoon call with Ovrthro, a 22-year-old Canadian musician and TikTokker whom Magana was eager to sign. Much of Magana's pitch centered on how, if hired, he would promote an Ovrthro song called "Death," which is based on a sample of the villain's whistle from the animated film *Puss in Boots 2*. He talked a lot, of course, about the tactics 25/7 Media uses to "ride the algorithmic wave," but he also stressed that the ride can be short unless a client is committed to constantly pumping out fresh content. The algorithms are designed to highlight new material, even if its quality is subpar. "When you drop one song," he told Ovrthro, "there needs to be four other versions of the song right away."

The volume of work required to stay in the algorithms' good graces can certainly be daunting. A 25/7 Media creator named Nixxi, who derives most of her revenue from her OnlyFans subscription fees, told me she is urged to post across multiple platforms every day, and that she uploads three folders' worth of content to her manager's server every Sunday so that posts can be

scheduled in advance. Another client, an Oregon-based musician who goes by 93feetofsmoke, said that he was aiming to release around 50 solo songs this year and produce as many as 70 for other artists. “You can’t take weekends off,” he told me. “Like, I don’t take the weekends off, ever.”

Toward the end of his call with Ovrthro, Magana talked about how 25/7 presses its clients to help one another in commandeering the algorithms. His example involved a social media starlet named Emma Langevin, a thickly accented New Jerseyite known for her darkly comic confessional posts about makeup, food, and mental health. An object of untold thousands of crushes, Langevin let a fellow 25/7 Media client named SyKo use her photo as the digital cover for a song of his entitled “[#BrooklynBloodPop!](#)” Magana credits that photo—Langevin’s de facto seal of approval—with giving “[#BrooklynBloodPop!](#)” its initial launch into the stratosphere. Few songs were more omnipresent on TikTok in 2021, when SyKo’s bright “hyperpop” beat became the backdrop for a million videos of teens doing the [10-second dance](#) that had virally attached itself to the track. (The song now has more than 250 million plays on Spotify and 120 million views on YouTube.)

When the Ovrthro call was done, I half-jokingly noted to Magana that the collaboration between Langevin and SyKo sounded like a prime example of synergy. He said he’d never heard that word before but that he loved it and would be incorporating it into his recruitment spiels from now on. He also encouraged me to post a TikTok explaining the concept. (I later texted Magana a vintage GIF from *The Simpsons* to show that “synergy” has been lampooned as corporate jargon for nearly as long as he’s been alive.)

The musician Syko shows off a gold grill given to him by an LA jeweler.

Photograph: Sinna Nasser

Though Magana was excited about the prospect of adding Ovrthro to the 25/7 Media family, he was clearly more passionate about another artist he’d recently unearthed: a 17-year-old musician and TikTokker named Lumi Athena, whose social media profile lists his interests as “sushi, emo girls, and shiny stars.” Magana sensed enormous potential in Lumi’s signature style. His songs were inspired by the same hyperpop genre that SyKo had

capitalized on, but they had a spacier, more haunted edge. A sample from his catchiest track, a singsong ode to debauchery entitled “[Smoke It Off!](#)” was beginning to get recreated on TikToks celebrating the weirder strains of anime.

Magana had first contacted Lumi via Instagram last December, and on their subsequent phone call, they’d instantly clicked. “I’m Mexican, he’s Mexican, we start cracking jokes,” recalled Magana, who teased Lumi for having pale skin. (Magana, who proudly claims that an ocean of Aztec blood courses through his veins, has a much darker complexion.) Lumi felt comfortable enough to reveal that a few record labels had already approached him with offers of \$10,000 for an album—an attempt, in Magana’s eyes, to exploit an undereducated teen’s naivete about how the industry really works.

Magana traces his love for music back to an experience in utero: In the spring of 1993, his pregnant mother attended a Guns N’ Roses show at Mexico City’s Palacio de los Deportes. Both she and Magana’s father served in the Mexican army, but they were much hipper than most of their military peers. Once a year, for example, they’d make the long drive to Southern California to buy flashy clothes that they’d then resell to Mexican entertainers. (When he was a toddler, Magana had his picture taken with Alejandra Guzmán, a famous singer who’d bought sequined outfits from his parents.)

But for reasons that Magana is hesitant to discuss, his parents came to believe their lives in Mexico were untenable. On an early summer day in 2000, Magana’s parents told him they were taking a surprise trip to Disneyland; he remembers being ecstatic as they passed through the border checkpoint. But instead of heading to the park, the family drove to an apartment in a shabby part of Long Beach. For weeks, Magana’s parents told him they were playing a game of make-believe, which the 7-year-old boy took to mean they’d soon return to Mexico City. “And then they signed me up for school,” Magana recalls. “And that’s when I realized like, oh, yeah, we ain’t going back home.”

Clockwise from left: Magana with the musicians Inhygs and Syko.



Photograph: Sinna Nasser

Long Beach proved to be a hostile environment for a chubby kid whose poor English marked him as an outsider. Magana was frequently taunted and beaten up by packs of older boys. He remembers being chased by gang members because his school's bus stop was on a street they controlled. The harassment only got worse as Magana began to develop a taste for bands like Van Halen and Kiss, whose music and fashion were reviled in his rap-obsessed neighborhood.

When he wasn't busy coping with bullies, Magana could often be found in the company of his entrepreneurial ex--military mother. While her husband toiled on construction sites, she sold counterfeit perfumes and sneakers on the streets of Long Beach. Tagging along with her is an experience that Magana credits with nurturing his gift for salesmanship. "That made me so fucking fearless," he says. "Like, you know, walking around LA with a bunch of boxes with shoes, and then going into the projects, literally the projects, and convincing these, like, fucking gangsters to buy these knockoff shoes."

The Maganas eventually saved enough to buy a small home in Pomona, 30 miles east of Los Angeles. Ursus enrolled at an artsy charter high school where he was no longer considered an outcast for his music, his increasingly shaggy hair, or his burgeoning love for the anime series *Naruto*. "Every time you saw him, he had a guitar in his hand," says Ken Smith, one of Magana's high school teachers and a close confidant. "And he always had multiple bands he was in or he was forming." Magana had his heart set on someday making millions by fronting a metal group, a goal that became especially urgent after his family lost their house in the subprime mortgage crisis. He found more immediate success as a promoter of backyard metal shows, scrappy \$10-a-head affairs where sweaty teens smashed one another in the face while dancing to songs about Norse gods and serial killers.

As graduation neared in 2011, Magana realized his future looked bleak. He was an undocumented immigrant, so he wasn't eligible for federal financial aid to attend a university; he couldn't join the military despite having been in his high school's Junior ROTC program; and decent jobs were off-limits

because he didn't have a Social Security number or a driver's license. Magana had also come to terms with the fact that he wasn't quite talented enough to play music for a living. He was fated to be, as he puts it, "a metal kid who never made it." Unable to see a path toward any life he desired, he heeded his guidance counselor's advice to enroll at Pasadena City College.

An introductory film class there altered his wayward trajectory. Instantly fascinated by the craft of stitching images together to tell a story, Magana talked his way into an unpaid internship with a photography studio that had been branching out into video production. Some nights he would work there until 3 am, editing footage for ad campaigns, then crash at his girlfriend's dorm at Cal State Los Angeles before catching the Metro to Pasadena for a 9 am class. En route, he'd earn pocket change by busking for commuters.

His reprieve from that exhausting routine came in 2013, when he applied to the new federal immigration program known as Deferred Action for Childhood Arrivals. For the first time, Magana was able to obtain a work permit without fear of being deported. He soon dropped out of college to accept a paid, full-time position at the photography studio. He also married his American-born girlfriend, a step that allowed him to start inching along the long journey toward US citizenship.

After settling into married life, Magana felt obligated to pull in a higher salary and wound up selling solar panels door-to-door, making upwards of \$80,000 a year. But he missed the buzz of spending his days surrounded by music, the art form he associated with his warmest childhood memories.

"The only time I saw my parents loosen up completely and not give a fuck, not give a fuck about anything, is when they were dancing," he says. "When my mom was head-banging to Metallica while cleaning the house on a Sunday, when my dad was dancing salsa."

Yet Magana had no clue how to gain a foothold in the notoriously shady music industry. He tried to manage a few small-time rappers, but they kept ghosting him after he'd shelled out thousands of dollars to produce their videos. "So I'm wasting all this money," he says. "I get really fucking sad, really fucking depressed."

Then, in 2016, an increasingly desperate Magana created a LinkedIn profile. That profile attracted an inquiry from Fullscreen, one of the first companies to specialize in connecting digital creators with major brands. Fullscreen was looking for a native Spanish speaker, and Magana assumed the job would involve day-to-day interactions with celebrities. “They had, like, Steve Aoki on their website,” he recalls.

Instead, Magana was handed a far less glamorous assignment: doing search engine optimization for Telemundo’s YouTube videos. Through trial and error, he mastered the tricks necessary to inflate a video’s views and thus maneuver YouTube’s algorithm into pushing Fullscreen’s clients to the fore. He figured out how to frame the most alluring thumbnail teasers, for example, and the best place to drop the clickable “end cards” that nudge viewers to watch another video. He also analyzed Telemundo’s traffic data and realized that a lot of viewers were using the channel’s English-subtitled telenovela recaps to learn Spanish. He also knew that those subtitles were automatically generated and often garbled to the point that many users gave up. So Magana persuaded Telemundo to write accurate captions and embed them in its videos, a move that he says boosted the channel’s viewership by hundreds of thousands.

Magana thrust himself into his Fullscreen work, especially as his marriage began to disintegrate: He took to sleeping in his car outside the office so he could put in extra hours. His portfolio expanded as he honed his SEO chops—he was assigned to the Ubisoft account to help launch an *Assassin’s Creed* title, for example, and he produced YouTube content for Telemundo during the 2018 World Cup. But he still pined to carve out a place for himself in art and music. He often talked about that ambition with Andrew Alvarado, a friend and fellow college dropout who managed a stable of YouTubers for Fullscreen. They kicked around some ideas for doing their own thing, like moonlighting as music video producers, but they never followed through.

One night in early 2019, Magana and Alvarado went to a party at a gaudy, largely unfurnished Los Angeles mansion, the sort of place rented by packs of influencers to use as content mills. Magana prides himself on his knowledge of pop music, so he was surprised when the DJ made the dance

floor shake with a song he'd never heard. Everyone belted out the brief chorus at the top of their lungs, but they didn't seem to know any other lyrics.

Magana couldn't believe he was unfamiliar with such an obvious hit, and he asked a fellow partygoer what it was. "Old Town Road," by Lil Nas X, she said, adding that it was currently the biggest hit on TikTok—or, perhaps more accurately, its chorus was a hit, having been woven into countless bite-size videos. That was why the crowd knew only two lines' worth of lyrics.

In that instant, Magana's next move revealed itself to him. "Like a dog, I ran to look for Andrew," he says. "Shoulder-grabbed him. Said, 'We're gonna start a new company! And it's gonna be based on TikTok.'"

25/7 media clients from across the US and Mexico congregate in L.A.

Photograph: Sinna Nasser

magana and alvarado's first stab at managing digital talent was a failure, albeit an instructive one. In the fall of 2019, they signed a popular TikToker named Reagan Yorke, who'd attracted millions of followers by posting videos of herself lip-syncing and playing juvenile pranks. The two aspiring managers thought they could extend her presence onto other platforms, and thereby increase her revenue, by adding music to her creative arsenal. "We created a song from scratch, brought in producers and writers that we knew from the music industry, created this song, coached her how to sing rap, all that stuff," Alvarado says. But the resulting video, starring Yorke's influential friends, was a dud on YouTube.

Chastened, Magana and Alvarado got in touch with Rafail Luzi, a music promoter they knew through Instagram, to help them figure out what had gone wrong. (Luzi was yet another college dropout; his Albanian parents had hoped he'd become a plastic surgeon.) Their conversations led them to conclude that even their clients' finest content would flop unless 25/7 figured out how to game the platform's algorithms and heed the data's cues.

Now a three-person startup, 25/7 Media put its revamped vision into action to support Curly J, a New York-based rapper they'd signed. When they dug into the data on Curly J's YouTube videos, they saw that more than a quarter of the comments mentioned video games—specifically the battle royale phenomenon *Fortnite*. So Magana and his colleagues set about finding ways to have Curly J's music inserted into the *Fortnite* montage videos that were doing huge numbers during the early weeks of the Covid-19 pandemic. Because Curly J was verified on Instagram, they had him reach out to the teenaged creators of those montages, many of whom were thrilled to hear from someone who'd been blessed with a blue check mark.

"It was personalized messages to each person," Curly J told me. "Like, to literally over 1,000 different creators." The ones who agreed to promote Curly J's work weren't always reliable; many vanished with the \$100 or so that 25/7 Media paid them. But hundreds of honorable creators inserted songs like "No Hoodie" into their montages, then added a link to Curly J's social media in the description box. What would soon be known as the Ten Percent Rule kicked in as thousands of *Fortnite* aficionados checked out Curly J's music. This, in turn, compelled YouTube's algorithm to push Curly J content into gamers' recommendations.

Curly J (foreground) and Cade Clair at a recording console.

Photograph: Sinna Nasseri

Curly J's connection to the hottest game of the pandemic did not go unnoticed in the corporate realm. In June 2020, Warner Records signed him to a \$4.8 million deal. Shortly after, 25/7 Media hammered out an arrangement with Twitch that guaranteed Curly J thousands of dollars per month if he streamed himself gaming for a few hours each week. Those triumphs became 25/7 Media's calling cards when courting other potential clients—proof that the fledgling firm's approach to manipulating the algorithms could provide a path toward life-changing money.

As 25/7 Media expanded throughout late 2020 and early 2021, brand sponsorships became another handsome source of revenue. One of the firm's biggest deals involved Emma Langevin, the TikTokker who would become the face of "#BrooklynBloodPop!" Langevin first caught Magana's

attention with a post in which she joked about the tribulations of being a girl who wears a Nirvana T-shirt, a sartorial choice that inevitably causes men to question how well she really knows the band's discography. Given Langevin's combination of beauty and self-deprecating nerdiness, Magana thought she could develop a huge following among male gamers. "She didn't really play video games," he says. "But I'm telling you, she's every gamer guy's dream girl." Langevin soon began streaming herself playing games on Twitch, sometimes in the company of a masked, gravel-voiced musician named Corpse Husband, who has nearly 3 million subscribers on YouTube. (Langevin would become both the inspiration and the cover girl for Corpse Husband's most popular song, "E-Girls Are Ruining My Life.") Those streaming sessions earned Langevin a sponsorship deal with the energy drink G Fuel, which bills itself as a performance enhancer for gamers.

He confessed that he had several boxes of silicone vaginas in his trunk, remainders from a failed effort to create branded merchandise for one of his OnlyFans creators.

It was harder, though, for Magana to arrange sponsorship deals for the many 25/7 Media clients whose primary platform is OnlyFans, since brands are wary of sexually explicit content. To increase those clients' subscription numbers, Magana helped them establish Instagram and TikTok accounts where they could post erotically charged recreates of trending memes and songs—including those generated by artists within the 25/7 Media fold. Every Monday, Magana sends his OnlyFans clients a memo detailing the audio bits they should be re-creating to maximize their odds of jacking into the algorithms—for example, an out-of-context *SpongeBob SquarePants* clip that prompts the reveal of an alluring outfit. Such posts persuade only a minuscule percentage of viewers to sign up for an OnlyFans subscription, but that's sufficient to generate fantastic revenue. Magana showed me data for one creator—an Amazonian goth with head-to-toe tattoos and an affection for autopsy simulators—who earns more than \$70,000 per month. (25/7 Media also provides its OnlyFans clients with "chat specialists," contractors who pretend to be the creators when responding to messages from paid subscribers.)

By the time I first spoke to Magana in late 2022, 25/7 Media's success had given him some measure of financial security. "The truth is that I just retired my parents," he told me two days after Christmas. "Let's just leave it at that." He owns a comfortable suburban home with his fiancée, a popular OnlyFans creator with whom he has a 2-year-old daughter. His parents have stayed busy by teaching their granddaughter Aztec dances.

Photograph: Sinna Nasser

Magana also acknowledged that, like so many startups without outside investors, 25/7 Media remains just a few blunders away from the abyss: "If 50 percent of my talent or 50 percent of my staff doesn't work out, my daughter doesn't eat," he said.

In the weeks following that initial conversation, Magana came to view Lumi Athena as the client most likely to get 25/7 Media out of its classic startup bind. Recreates of "Smoke It Off!" were sprouting up in more and more TikTok communities, and it seemed only a matter of time before the Ten Percent Rule guaranteed Lumi more than a million monthly listeners on Spotify. But Magana told me that Lumi's future lay not in creating his own music, but in producing other artists. He saw Lumi as the central figure in a new musical genre called "krushklub," the occult-themed successor to the now-outdated hyperpop. And 25/7 Media was now planning to corner the market on krushklub talent.

as i sped north along the Hollywood Freeway one February night in Los Angeles, a jubilant Magana called to share some news. He and his partners had just gotten out of a meeting with Mike Caren, a former producer for Beyoncé and Kanye West who is now CEO of his own record label, Artist Partner Group. (Caren famously bought Jeff Bezos' Beverly Hills estate for \$37 million.) The 25/7 team was stunned when, toward the end of the conversation, Caren brought up the idea of creating a joint venture with the startup. The exact parameters of the proposed collaboration were fuzzy, but it was Magana's understanding that 25/7 Media would receive millions in funding in exchange for recruiting and developing talent exclusively for APG.

Magana was elated in the moment. A joint venture would guarantee enough capital to cement 25/7 Media's long-term viability. But in the days that followed, he became more measured in his assessment. He was worried about ceding some amount of independence, and maybe even equity, to APG, a company that would clearly be the alpha in their relationship. But he also feared that if he passed up the opportunity, he'd never learn the skills necessary to take his clients to the next level. "You know, I won't know how to get an artist to the Grammys," he told me. "I won't know how to get an artist in, like, you know, Nickelodeon Splash events—like, all the mainstream levers."

Ravengriim, a content creator, cosplayer, makeup artist, and 25/7 client.

Photograph: Sinna Nasser

Magana thinks he needs that expertise because so many of his clients—even some with roots in the most subversive subcultures—aspire to conventional forms of validation and fame. Artists who cut their teeth on digital platforms often idealize the careers of their childhood idols, who didn't have to stress about the exhausting churn of TikTok trends. "I mean, I would love to be in acting and movies and things like that," Curly J told me. "I would love to have, like, major sponsorships, whether it's commercials, you know, that you see around, whether they're from Sprite or Gatorade."

As 25/7's lawyers hashed out terms with APG throughout the early spring, Magana and his partners moved to scoop up the artists in Lumi Athena's immediate orbit—specifically Cade Clair and Jnhygs, the two vocalists on "Smoke It Off!," both of whom had met Lumi on Instagram. Clair, a 21-year-old Detroit native who worships Prince, was an easy get. He was desperate for any sort of career boost, since he had just 12 monthly listeners on Spotify. Jnhygs was trickier because she turned out to be shockingly young: The Metallica-loving Alabaman with a honeyed voice was just a 16-year-old high school sophomore. That meant the 25/7 Media crew had to arrange a Zoom call with her parents, who had no clue their daughter was an artist with a rapidly growing audience. "I didn't even realize that she was making music," Jnhygs' mother told me. "Hearing music coming from a room, I'd think it's just radio or something. I didn't realize that she was actually doing it herself."



Magana walked Jnhygs' parents through the minutiae of how art gets distributed these days and how their daughter's talent could alter their family's fortunes in a spectacular way. "You explain to them that, somehow, that noise their daughter has been making in her room has been picked up on TikTok," Magana says. "And now we're here talking to you about never having to work another day in your life."

Jnhygs, a 16-year-old high school sophomore, needed parental permission to shoot content for 25/7 media.

Photograph: Sinna Nasser

Jnhygs' parents were receptive to that message, but they made Magana jump through another hoop, insisting that he also meet with their family's Baptist pastor, who was willing to fly to Los Angeles for the occasion. Magana and Luzi met him at the airport and cued up a playlist of Christian music for the ride to the hotel. But the pastor, who showed up wearing a jewel-encrusted grill on his teeth, demanded that the duo instead blast classics by Young Jeezy. "I see no devil in these boys," he told Jnhygs' parents, thus granting final approval for their daughter to become 25/7 Media's youngest client.

To celebrate its krushklub recruiting coup, 25/7 Media flew Lumi Athena, Cade Clair, and Jnhygs to Los Angeles so they could spend a few days creating music and TikToks in a space-age Airbnb high in Beverly Hills. (The three artists had never met in person.) Keeping his young clients focused on the tasks at hand proved to be a challenge for Magana. "These are kids," he told me. "Really, we're just trying to stop them from smoking weed all the time."

Lumi Athena, a central figure in a new musical genre called "krushklub," shoots content.

Photograph: Sinna Nasser

artists have a reputation for struggling with the mundane aspects of life, which is partly why managers exist. One evening at the Playa Vista WeWork, for example, I listened in as Magana and Alvarado tried to

explain the basics of personal finance to an important client in Texas. One of six siblings who'd been raised by a single mother, the client had earned a windfall of around \$400,000 after going viral in 2021. Absolutely bewildered by the concept of taxes, he'd brought his 1099s to the nearest outpost of a national accounting chain to seek help. The advice he received there had cost him tens of thousands of dollars. Alvarado, the most financially prudent of the 25/7 founders, promised to set up the client with a limited liability corporation and automatically deduct taxes from his revenue-sharing and royalty payments.

The client was also about to fly for the first time ever, to perform at a club in Los Angeles, and he had no idea how to handle the logistics of air travel. Magana assured him that he'd be allowed to check his massive canvas duffel bag, and that he could safely stow his carry-on in the overhead bin.

Many of 25/7 Media's clients are ill at ease in the world for poignant reasons. As reflected in the inward-looking content they produce, these young artists see themselves as largely defined by their battles with anxiety and depression. "I am going to stop hyper-fixating on my mental illness," Emma Langevin intones in one of her most moving TikToks. "And I will not make jokes about it that make the normal people I hang out with uncomfortable." These mental health issues were compounded by the chaos of the pandemic, an event that Magana refers to, perhaps a bit curiously, as "our generation's Korean War."

"Due to the internet and social media culture and everything these kids grew up in, they don't go outside, they don't interact, they don't want to talk to people," Alvarado says. "They're scared to hop on a call, they have all this social anxiety. And so, you know, the only way to get through to these types of people is to be relatable. And the only way to be relatable is to know what's actually going on in their lives."

Relating to clients can become more difficult after they discover that the fame they crave can't fix their deeper problems. "For a lot of people that become successful, they become successful because of doubt and revenge," Luzi says. "When that's kind of out the window and you already did it, what are you looking forward to next? And you have to look at yourself in

the mirror and you gotta say to yourself, ‘Do I actually like myself?’ And for a lot of people, they really don’t.”

That realization is too often followed by self-destructive behavior. “I’ve broken people out of hotel rooms,” Magana says. “Peeled them off of balconies, gotten their parents on the line looking for them.” A teetotaler himself, Magana believes he was well prepared for the demands of fatherhood because he’d already grown accustomed to making sacrifices to protect his troubled artists.

Thankfully, the krushklub crew got up to only mild hijinks during their time in Los Angeles. In between In-N-Out burger runs, they managed to shoot a black-and-white, frenetically edited video for “Smoke It Off!,” which Magana sent to me a few days after it hit YouTube in July. As the central refrain oozed out of my laptop speakers—“Too much / too much / oh yeah ...”—I clicked over to Lumi Athena’s Spotify account to check on his progress. He now had more than 3.8 million monthly listeners.

The following month, Lumi returned to LA to pursue a fresh musical direction. “TikTok kinda, like, stole my sound,” he told me shortly after he woke up one afternoon in late August. “Like, after ‘Smoke It Off!’ popped off, they just run off with my shit.” When 25/7 Media told him that his songs were getting surprisingly high traffic from users in Chile, Lumi decided to invent a new genre he dubbed “Latinklub”—essentially krushklub leavened with strains of reggaeton. His time in LA was thus being spent writing and recording new tracks, a process that involves hanging out in an Airbnb Jacuzzi until inspiration strikes, then retreating to the studio until 4 am.

“Like, dude, I already made it in the fucking US,” Lumi said. “But if I managed to figure out how to crack the Latin space, shit, it’s gonna be a way, way bigger impact.”

after weeks of internal debate, 25/7 Media’s founders decided to pass on the joint venture opportunity with APG. Alvarado had lobbied for the deal, contending that it would address all of the startup’s financial anxieties. Magana countered that the rapid success of Lumi Athena, whose flagship song “Smoke It Off!” has now been played more than 235 million times on

TikTok, proved that 25/7 Media wasn't yet at the point where it needed to surrender any independence. As is usually the case, Magana won the argument through force of personality. "I'm the Napoleon of the group," he told me with a laugh.

Magana's faith in 25/7 Media's prospects is rooted in his belief that bigger competitors are too stuck in their ways to emulate what the startup does best. "It's going to take CAA 20 years to have enough agents who look like me," Magana says. It is certainly a bit hard to picture someone with his résumé and mosh-pit style climbing the ladder at one of Hollywood's institutional powers. But the status quo always becomes less important to decisionmakers when they realize they're missing out on piles of money.

To keep 25/7 growing as a fully independent enterprise, Magana is seeking new ways to drum up revenue. When I was in Los Angeles, for example, he confessed that he had several boxes of silicone vaginas in his trunk, the remainders from a failed effort to create branded merchandise for one of his OnlyFans creators. "He'll come up with some crazy ideas," Alvarado says. "And some of them I don't even know where to start. But I really appreciate him always just saying what's on his mind, because out of the 10 crazy ideas he has, at least one of them's gonna end up working."

Ravengriim shooting content

Photograph: Sinna Nasseri

I patiently listened to Magana talk through a lot of brainstorming, and many were indeed as half-baked as his plan for reinventing me as a TikToker. But there were also moments like the time on Google Meet when he showed me an electrician's Instagram page. As I perused various photos and Reels of an attractive young woman installing circuit breakers and wiring light fixtures, Magana outlined one of the next phases in 25/7's evolution: managing creators who specialize in performing blue-collar jobs.

"She is basically glamorizing the freedom of being a self-sufficient woman in an industry that is not female dominant," Magana said. What if he could wheedle the Instagram algorithm into pushing the electrician's Reels onto the feeds of 18-year-olds disillusioned with the idea of going into debt for

college, who fantasized about finding another way to achieve their dreams? Or maybe their 45-year-old parents, who are prone to doomscrolling through Reels about lazy teens? Then 25/7 Media would cut deals to do recreates of music on the account, so that a new song could make inroads with people in the building trades.

“What do you do when you work construction?” Magana said. “I know—because I worked construction when I’d work with my dad—you listen to music. So why the fuck wouldn’t you pay her to just use that song?”

It was only in hindsight that I had questions about all the specifics Magana conveniently elided. While he was stringing together one enthusiastic sentence after another, I was sold on his vision. And if the algorithms truly want me to pick up carpentry rather than type these words, maybe I’m being a fool to resist.

*Magana’s shirt design by Eva Garcia.*

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*This article appears in the November 2023 issue. [Subscribe now.](#)*

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Oct 12, 2023 7:00 AM

# My Kid Wants to Be an Influencer. Is That Bad?

WIRED's spiritual advice columnist advises a parent who's freaking out about their 6-year-old's ambitions to make a life online.

ILLUSTRATION: CÁSSIA RORIZ; Getty Images

“Whenever my 6-year-old daughter gets asked what she wants to be when she grows up, she says, ‘An influencer.’ The thought of it freaks me out. What should I do?”

—Under the Influence

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## [CLOUD SUPPORT](#)

Spiritual Troubleshooting for the Digital Age

*For philosophical guidance on encounters with technology, open a [support ticket](#) via email; or [register](#) and post a comment below.*

**Dear Under,**

Your question made me think about Diana Christensen, a main character in Paddy Chayefsky's 1976 film *Network*, played by Faye Dunaway.

Christensen is a young network news executive who is meant to represent the moral bankruptcy of a generation that was raised on TV (one character calls her “television incarnate”). While charismatic and highly capable, she is also rampantly amoral, viciously competitive, and so obsessed with ratings that she famously has an orgasm while discussing viewership

numbers. The character clearly piqued a pervasive cultural anxiety about TV's corrupting influence, though with a little distance it's hard not to see her depiction in the film as moralizing and heavy-handed. As *The New Yorker's* Pauline Kael put it in her review, "What Chayefsky is really complaining about is what barroom philosophers have always complained about: the soulless worshippers at false shrines—the younger generation."

I mention the film only to get out of the way the most obvious objection to your freak-out, one I'm sure you've already considered—namely, that every generation fears new forms of media are "false shrines" corrupting the youth, and that these concerns are ultimately myopic, reactionary, and destined to appear in hindsight as so much unfounded hand-wringing. Before Diana Christensen, there were the studio bullies in Norman Mailer's novel *The Deer Park* (1955), who represented the degeneracy of Hollywood, and the ruthless newspaper men in Howard Hawks' film *His Girl Friday* (1940), who are referred to as "inhuman." If you want to go back even further, consider the bewilderment often experienced by modern readers of *Mansfield Park*, Jane Austen's 1814 novel whose dramatic apex rests on a father's outrage at coming home to find that his children have decided to put on a play.

Rest assured, Under, that I am not trying to dismiss your question through appeals to historical relativism. Pointing out that a problem has antecedents does not compromise its validity. It's possible, after all, that humanity is on a steady downhill slide, that each new technological medium, and the professions it spawns, is progressively more soulless than the last. The many journalists who've cited the [2019 poll](#) claiming that 30 percent of US and UK children want to be YouTubers when they grow up have frequently juxtaposed that figure with the dearth of kids who want to be astronauts (11 percent), as though to underscore the declining ambitions of a society that is no longer "reaching for the stars" but aiming instead for the more lowly consolations of stardom.

If I were to guess your [objections to influencing](#) as a future occupation for your daughter, I imagine they might include the fact that the profession, for all its vaunted democratic appeal—*anyone can be famous!*—conceals its competitive hierarchies; that its spoils are unreliable and largely

concentrated at the top; that it requires becoming a vapid mascot for brands; that it fails to demand meaningful contributions to one's community; that it requires a blurring between personal and professional roles; that the mandates of likes, shares, and followers amount to a life of frenetic people-pleasing and social conformity that inevitably destroys one's capacity for independent thinking.

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I'm also willing to bet there is a deeper fear humming beneath those seemingly rational objections—one that is related, incidentally, to the very notion of influence. [Parenting](#) is, at the end of the day, an extended experiment in influencing. You hope to instill your values, politics, and moral and ethical awareness in your children, yet as they make their way into the world, it becomes clear that there are other influences at war with your own. Influence, it has been noted in this era of [epidemics](#), shares a root word with influenza, an etymology that echoes the popular notion that ideas are free-floating pathogens that someone can catch without giving their conscious consent. I think this is how many parents regard the social technologies their children use, as hosts for various contagions that must be staved off with more deliberate moral instruction given at home. To realize the extent to which these digital platforms have fascinated your daughter is to feel that you have failed to inoculate her.

Or maybe your uneasiness goes even deeper than that. If I can turn the problem back on you, perhaps your instinctive aversion to your daughter's aspirations has raised more probing questions about the source and validity of your own values. Any serious attempt to think through the perils and possibilities of new technologies forces you to realize that many of your own beliefs are little more than amorphous, untested assumptions, formed by the era in which you were raised. Are the artists you grew up idolizing—musicians, filmmakers, novelists—any less shallow and narcissistic than the TikTok and YouTube personalities your daughter idolizes? The answer to this question is not a given. But if you consider it honestly and persistently, I suspect you will discover that you are not an isolated moral agent but



porous to the biases and blind spots of the decades in which you came of age.

Such realizations can easily inspire fatalism, but they can also lead to a more expansive and meaningful understanding of your own fears. My intent in reminding you of the anxieties of previous generations—all that collective angst about television, movies, newspapers, and theater—is to help you see your situation as part of a lineage, a rite of passage through which all generations must proceed. (If we are to believe Plato’s *Phaedrus*, even Socrates fell prey to griping about the popularity of writing, a medium he feared would “produce forgetfulness in the minds of those who learn to use it, because they will not practice their memory.”) To see this problem historically might also prompt you to consider, as a parent, what kinds of life lessons transcend the particulars of a given economy.

I would like to believe that alongside all the ephemeral inherited assumptions we absorb in our youth, there are some pearls of enduring wisdom that will remain true and valuable for generations to come. Ideally, it’s these more lasting truths that you want to pass down to your daughter, and that will equip her to have an influence, no matter what she chooses for work.

**Faithfully,**

**Cloud**

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Oct 5, 2023 8:21 AM

# In the War Against Russia, Some Ukrainians Carry AK-47s. Andrey Liscovich Carries a Shopping List

Kyiv enlisted a Silicon Valley insider to rush consumer-grade tech onto the battlefield. He's giving a demo of the future of war: the military-retail complex.

Illustration: Lena Weber; Getty Images

In hindsight, zhenya Podtikov realized, he should have known that Ukraine's first Vector [drone](#) was not long for this world. But when it arrived at an army base in Lviv, in April 2022, he couldn't help admiring it. "I was just surprised that drone hardware could look so good," he said. The Vector came in pieces—its sharklike nose, sleek fuselage, and upright tail all polished to a tooth-enamel white. Its manufacturer, a German company called Quantum Systems, had designed the Vector so you could carry it, dismantled, in a backpack. Podtikov needed no tools and just a few minutes to unbox it, put it together, and send it up as a surveillance scout. Entirely on autopilot, it could take off, remain airborne for two hours, and return home, sending back rivers of encrypted video from as far as 20 miles away.

As a test pilot in the [Ukrainian army](#), Podtikov was unaccustomed to such sophistication. He'd been flying drones since 2014—the year [Russia](#) annexed Crimea, the year he turned 18 and joined a unit of volunteers. All of the drones he'd launched were civilian models like the Vector, but they were lesser machines. One had to be propelled by catapult. The army's only military-issue drones, a pair of lumbering aircraft left over from the Soviet era, didn't even have digital cameras. "You had to have a separate room to

develop their film,” Podtikov said, sounding as incredulous as any child of the 21st century.

This article appears in the November 2023 issue. [Subscribe to WIRED](#) Photograph: Sinna Nasser

On the front lines near Barvinkove, in eastern Ukraine, that first Vector lasted just two full flights; on the third flight, Ukrainian friendly fire took it down because the army’s radar units didn’t yet have a way to distinguish their own drones from Russia’s. Days later, a replacement unit took off toward enemy lines, but the Russians jammed its global navigation satellite system. Then the drone’s communications link with its pilot cut out. At this point, it should have abandoned its mission and navigated home, but without GNSS its sense of direction was thoroughly scrambled. The Vector flew north instead of south, right into Russian territory, and was never seen again. Frustrated, Ukraine’s drone pilots turned to the man who had helped procure the Vectors in the first place: a [tech](#) executive named Andrey Liscovich.

Liscovich is a strange, liminal figure produced by a novel sort of conflict. He is a civilian neck-deep in military work, a Silicon Valley emissary to battlefields beset by electronic warfare, a Thomas Friedman character cast into a Joseph Heller world. Having grown up in Zaporizhzhia, in eastern Ukraine, Liscovich went on to a PhD at Harvard and then a career in the San Francisco Bay Area. For a while, he was the CEO of Uber Works, an [Uber](#) offshoot that helped companies find on-demand staffing. When Russia invaded Ukraine, he moved back to Zaporizhzhia and, through circumstance more than intent, became a personal shopper for the Ukrainian army. He deals only in nonlethal equipment—merchandise that’s available off the shelf to everyone, or at most classified as “dual use,” suitable for both military and civilian applications. Generals and brigade commanders tell him what they need, and he roves the global tech souk, meeting manufacturers and inspecting their products. Then he cajoles wealthy friends or friendly nations to foot the bill and arranges for the matériel to be fetched to the front. In the year and a half since Russia invaded, he has wrangled everything from socks to sensors to [Starlink](#) terminals. The two

downed Vectors were among his earliest acquisitions, paid for by a Ukrainian benefactor at more than \$200,000 a pop.

Loosely speaking, Liscovich is an adviser to the general staff of the army, although the most he gets out of that is a military email ID. The army doesn't compensate him for his service. Instead, Liscovich said, he cuts himself a paycheck out of donations from an American billionaire. (He wouldn't say which one, but he assured me it was a household name.) He is one of at least 100 civilians who act as buying agents for Ukraine, an official in the general staff of the army told me. (The official asked to be anonymous: "Our government doesn't like it when military people say something on the record without their permission.") With its defense budget stretched thin, the Ukrainian government isn't always willing to spring for "nonlethal things," the official said. "They're worried that if their partners pay for this, they'll pay for fewer tanks or shells or HIMARS rocket launchers." Civilian fixers are "a way to get around" this problem—and the official described Liscovich as the most effective of the bunch. "He's out there on the front lines, asking questions, taking notes," the official said. "He's always doing his homework." Since the war began, Liscovich has helped the army procure nearly \$100 million in supplies. His is the kind of role that aristocrats played back in the 1800s, when their unelected influence extended to statecraft. Over the past century, as war became a nationalized state function, that species died out. Liscovich is a throwback: a Victorian with an iPhone.

Under the rigors of a live, hot war, commercial products break down. Pickup trucks last a week.

Though Liscovich stays away from lethal technology, his ambit is vast. Never in the history of warfare has commercial technology played as big a role as it has in Ukraine, said Michael Brown, a former director of the US Department of Defense's Defense Innovation Unit. In part, Brown said, this is because Ukraine's army has been innovative and scrappy. ("Of course," he admitted, "they have to be—this is existential for them.") But it's also the culmination of a long, slow-cooked [reversal in the flow of technology](#). A few decades ago, defense researchers built shiny new things—GNSS, for instance, and Arpanet, a precursor of the internet—and eventually

bequeathed them to the general population. Now, Brown said, commercial companies are faster and can develop consumer products so cutting-edge that armies would do well to use them. It isn't just that defense departments move ponderously; the private sector is also awash in far more money. "If you go back to 1960, the military was 36 percent of global R&D spending," Brown said. "Today it's barely more than 3 percent."

Window-shopping is the easy part, though. The wares on the civilian market may be first-rate technology, allowing their users to get close-to-military-grade gear without incurring as much bureaucracy or expense. But they come with a congenital problem: They're designed for peacetime customers—for cops and academics, hobbyists and corporations. Under the rigors of a live, hot war, these products break down. Pickup trucks, of the kind driven around suburban America, last a week to 10 days when they're trying to outrun shelling in areas with no roads, the Ukraine army official said. Portable batteries overheat in the summer sun. The cables and outer shells of Starlink terminals have proven too flimsy for the Ukrainian front, so soldiers have gotten used to swapping them out for more rugged alternatives. It often falls to Liscovich to act as a go-between, shuttling information from soldiers to manufacturers and back again, trying to get them to speak each other's language so the equipment can be hardened for battle. In the summer of 2022, that meant, among other things, figuring out whether Zhenya Podtikov's beloved Vector drones could ever survive in the treacherous, jammed-up airspace above eastern Ukraine.

Liscovich sits on a truck after a delivery of more than 200 drones.

Photograph: Sasha Maslov

To the extent that Liscovich is based anywhere at all right now, it is in a hotel in Zaporizhzhia, where he rents two rooms—one for sleeping and another for working. The building is ugly, he freely admits. He has to use a portable heater in the winter, and summers are so sweltering that he works at night with the windows open, ignoring the gnats and flies that stream in. When Zaporizhzhia was being heavily bombarded last fall, Liscovich moved to a neighboring village, where he slept on hay in the cellar of a house. He still keeps his apartment in San Francisco's Chinatown, although he spends barely two weeks a year there now. Sometimes he flips open an

app and looks at his bedroom through a webcam: the bed made, the blinds drawn, the black-and-white image giving nothing away about whether it is night or day on the other side of the world. He's a man laboring for his homeland without any real home of his own.

Liscovich's duties take him away from Zaporizhzhia for weeks on end as he travels through the US and Europe, either to appraise companies' products or to coax the powerful and wealthy to set aside more money for those products. Getting everyone on the same page, he said, "is like herding cats." He has to be careful about these trips. He turns 40 next year, and under wartime law, no service-age man can leave the country on a business trip for more than 30 days at a time. (At least once he has found himself driving from Poland into Ukraine on day 30.) Fortunately for him, Liscovich appears to be one of nature's born business travelers, built to fold his tall frame into an economy class seat, stride through airports with a wheelie bag that he never checks in, subsist on cold cuts from buffets, and demand Marriott Bonvoy upgrades after arriving at a hotel in the dead of night. He packs a uniform: jeans, sneakers, a number of button-down shirts (rarely tucked), and a blue blazer. The pocket inside his blazer bulges with a mobile hot spot, into which he slips one of several local SIM cards. That enables him to keep his phone on airplane mode and use the hot spot for Wi-Fi, he said. "It's to avoid anyone tracking my location."

In mid-June, I accompanied Liscovich on one of his succinct tours: five cities, four countries, four days. We met up outside Athens in the Greek seaside town of Xylokastro, where a company called Velos Rotors makes drones that look like miniature helicopters. Started by a hobbyist named Aris Kolokythas, Velos occupies the third floor of a short, utterly ordinary building—a space so small it seemed capable of assembling drones at only an artisanal pace. Everywhere we went, in fact, we sat in conference rooms in nondescript office blocks or business parks. The vaunted, hulking might of the military-industrial complex was nowhere in sight.

A few mini-choppers, Velos V3s, had already gone out to Ukrainian brigades on the front lines. But their data links were frequently taken offline by Russian jammers, the scourge of pilots like Podtikov. Most civilian drones flail in the face of such interference; Ukraine loses between 1,000

and 10,000 drones every month, many of them jammed into oblivion. On a schematic map that Liscovich stores as an image on his phone, he showed me how the front is choked with jamming signals. He'd come to Xylokaastro to ask how Velos could make its drones less jammable—a particularly tricky proposition in Europe, where companies find it nearly impossible to obtain permits to activate jammers for testing.

Kolokythas, it turned out, was working on a new flight mode. If a drone's GNSS was blocked, he wanted its pilot to be able to fly it home using tools that weren't susceptible to jamming—barometers, gyroscopes, and other parts of an inertial navigation system. “Well, that's excellent,” Liscovich replied, sounding cautious. In the army's experience, he said bluntly, nearly every vendor misrepresents the specs of their drone. The two talked some more about antennas manufactured in Turkey and gimbal cameras before Liscovich asked how quickly the company could turn out a big order. That gave the Velos people pause. “If someone goes, ‘Hey, here's an order for 500, I need them in nine months,’ well, obviously we're not going to do them here, right?” said CEO Michael Seal, gesturing around his spare headquarters. They'd have to outsource production to other firms, which would need six or nine months to ramp up, Seal said.

Scale is one of Liscovich's nagging problems. As a matter of survival, Ukraine's army needs many things very quickly, but startups and other civilian manufacturers are often too puny to meet its urgent demands—or, for that matter, to find solutions to the electronic warfare raging at the front. (According to Podtikov, some firms learned about GNSS-blocking only after their drones failed test flights in Ukraine. Others flat-out denied that their drones could be jammed at all.) On occasion, companies simply walk away, deciding they would rather not retool their gear for a large wartime order that may never come—that they would rather just keep selling drones to the Walmart shoppers seeking crisp aerial shots of their Sunday barbecue.

After an hour in their offices, Kolokythas and Seal drove us out of Xylokaastro, up a road that snaked to the top of a scrubby hill. On the red earth, one of their engineers set up a workbench and primed the Velos V3 for a demo—a pretty if pointless exercise, because no one really doubted it could fly, only whether it could fly when Russians were hacking its GNSS.

Below the hill, beyond ranks of lemon and olive trees, the Gulf of Corinth lay ironed flat on a still day. Behind us, Kolokythas said, gesturing vaguely over the horizon, was Sparta. Or, to be precise, the ruins of the Spartan civilization, once the most powerful of all Greek city-states until it fell to Rome. Historians propose several reasons for the Spartans' collapse, including an outdated military. They had once been "craftsmen of war," the historian George Cawkwell wrote, but they'd fallen behind and been swallowed. "New ways of war had outdone them."

Liscovich grew up in Ukraine during the thaw in the Cold War. He remembers the shops being so bare that "you'd see a 3-liter jug of birch tree juice and maybe seaweed preserves, or something else that no one wanted, and nothing else." Perestroika was in the air. The Soviet Union fell apart just as he entered primary school. Among other transformations that eventually took place in Zaporizhzhia, a bomb shelter turned into an internet café. Teenage gamers locked themselves into the shelter overnight for marathon sessions of *StarCraft* and *Counter-Strike*. Liscovich didn't play much. Instead, he set himself up as a vendor of essentials: *StarCraft* maps downloaded in advance, snacks, his grandmother's homemade wine, and other nonlethal supplies for these cyberspace soldiers.

After studying physics and economics for six years in Moscow, Liscovich went to Harvard for a public policy doctorate in 2007. He wrote his thesis on experimental economics—the arduous trials that economists run, in which they set up human subjects in simulated real-world situations and study their behavior and motivations. In one chapter, Liscovich suggested that economists could use ready-made video games to run some of this research. You could buy a mid-list game's source code for not very much money and rewire its internal logic to function as an economics experiment, Liscovich explained to me. "Take a poker game and change the meanings of individual cards," he said. "Or it could be, like, competitive rice-growing." He remembers this as his first brush with the notion of dual use. Why should an economist—or a military, for that matter—reinvent the wheel when perfectly serviceable wheels can be purchased quite cheaply next door? "I just take something from one area and apply it in another," Liscovich said. "Interdisciplinary arbitrage is a very powerful thing."



He speaks like this often, in solemn sentences that could have been plucked from the *Harvard Business Review* or a Silicon Valley pitch deck. Fresh out of his PhD, Liscovich joined Shuddle, a now-defunct “Uber-for-kids” service, before joining the real Uber and rising to become head of Uber Works. It can be easy to mistake him for a dour man with an unyielding sense of corporate purpose, but he is mightily amused by bureaucratic absurdities and has an intermittent, impish sense of humor. As befits a former Uber executive, he hates taking ordinary taxis, regarding them as inefficient and exorbitant. Once, in Munich, we spotted an ad for an app called *Die Taxi* painted on the doors of a city cab. “A very appropriate name for a taxi app,” Liscovich said. “Finally we concur.” He took a photo, then gave himself over to gales of giggles.

After Uber Works shut down, early in the pandemic, Liscovich started planning new startups. He was visiting Nepal toward the end of January 2022 when the rumors of Russia’s impending invasion of Ukraine escalated. Counterintuitively, he flew to Moscow. He wanted to see his friends from university before a war made that impossible. The US had warned that the invasion could start on February 16, so Liscovich spent the night of the 15th in a hotel facing the Ministry of Foreign Affairs on Smolensk Square to see whether the windows were bright with hectic overnight work. They weren’t. Then he moved to a hotel room on the 89th floor of a building overlooking the Kremlin and the Ministry of Defense to see whether they were churning with activity. They weren’t. Eventually he left Moscow, reaching San Francisco on the 22nd. Two days later, Russian forces marched into Ukraine.

Any device that had to work in Ukraine required a system to foil the people and machines bent on destroying it.

Once more, Liscovich swam against the current. As thousands of Ukrainians, including his parents, fled westward, he flew to southeastern Poland. He rode a fire truck to the border, caught a train and a succession of buses, then walked the rest of the way to Zaporizhzhia. He fully intended to enlist, but at the army office he saw a long line of new soldiers wearing jeans, thin sweaters, and sneakers. Beyond giving each man an AK-47 and some spare magazines, the army had run out of gear. If Liscovich wanted to

help, the colonel in charge of the army office said, he could get supplies. “He gave me a van and two soldiers, and they drove me around various military surplus stores,” Liscovich said. He showed me photos of long, itemized receipts of his purchases: winter boots, heavy clothing, tins of food, cell phones and tablets, tires. He swiped his Apple Pay everywhere in those early days, spending either his own money or contributions that friends and acquaintances made to the Ukraine Defense Fund, a nonprofit he’d quickly set up.

During the chaos of the war’s early months, Liscovich had to improvise to get his purchases across the border. The first batch of tech he sourced overseas consisted of Motorola radios—98 of them, bought from a store in London and flown to Kyiv by diplomatic pouch. They took a week to arrive. When Liscovich obtained 10 Starlinks from a warehouse in Warsaw, he had volunteers drive them into Ukraine in their cars, hoping customs authorities wouldn’t check their trunks. Such drivers were hard to find: Europeans refused to go into Ukraine, and younger Ukrainian men were being pressed into service, so Liscovich and his colleagues had to round up senior citizens to make their supply runs. Drivers sometimes spent days in line at border posts and crossed well after dark, when paperwork problems were much harder to solve. “I would often have to do these middle-of-the-night calls or pull strings at customs, asking them to let people through and saying I’d provide paperwork later in the day,” Liscovich said. At checkpoints, “there was a lot of fear that if you carry something quasi-military, like drones, your cargo may be impounded,” he said. Polish authorities started to demand extra paperwork for drones en route to the front: special permits, customs duties, transit declarations. At its peak, the Ukraine Defense Fund had 30 volunteers on Slack micromanaging every step of these supply chains. “It was just a huge mess,” Liscovich said.

Eventually, the broken, brittle links in these supply chains were mended. The devices and software that streamed in from the West have been of undeniable value—because they’re inexpensive, but also because they arrive quickly. “Some war technology is military grade, so it’s limited by export controls, and it can take a long time to get licenses and permissions to bring them over,” Yegor Dubynskyi, Ukraine’s deputy digital minister, told me. “We don’t have that kind of time. We need things right now.” The

Ukrainian army, he added, was cobbled together out of men who may have lacked military training but often had experience with civilian tech—certainly enough to follow a radio or drone manual. “The approach was: If you find something you can use, use it.”

At the same time, these products could rarely be deployed perfectly out of the box. Conditions on the eastern front were so different from those in California or Munich that it may as well have been another planet. In the beginning, Liscovich tried to school himself in the demands of war by reading, but one book after another quoted Sun Tzu or Clausewitz—thinkers with plenty of timeless advice for commanders but not much knowledge of 21st-century supply chains. The US Department of Defense’s models on military provisioning, likely of more practical use, are classified. So he took to hanging out at command posts and with battalions, trying to learn what soldiers needed and why.

He saw how the troops disassembled Starlink terminals, put them into stronger cases, and mounted them on vehicles for portable internet. He saw how sensors that detected enemy drones, which usually worked on 4G signals, went quiet in regions with no cellular connectivity, and how engineers had to run a communication wire all the way out to the sensors on the front to get them working again. He saw a batch of Tesla Powerwalls arrive for power storage, only for soldiers to realize that they all had built-in Wi-Fi modules that the enemy could potentially detect and that had to be manually pried out. And time after time, he saw drones lost—shot down, confused over enemy lines, or simply incommunicado. On his phone, he showed me a video of a drone with a jammed GNSS that had somehow been guided back to base. It hovered a few meters in the air, and then, fooled into thinking it was on the ground, switched off its rotors and crashed to earth as if made of stone. Any device that had to work in Ukraine required the ultimate customization: a system to foil the people and machines bent on destroying it.

Illustration: Lena Weber; Getty Images

For all his self-prescribed study of the military, Liscovich asks companies the kinds of questions that have been burnished over years by the venture capitalists on Sand Hill Road. What are the bottlenecks? What will help you

deliver more value per dollar? What is stopping you from making 10 times more impact? He has not only the tech executive's fixation on speed and scale—invaluable in wartime—but the latent wariness of government. For him, the state's chief wartime virtue is not its efficiency or its powers of organization but its pocketbook. Around the time I met him, he was lobbying the US Congress to allocate a budget to fund nonlethal technology for Ukraine. (His fundraising and lobbying work have required him to register as a foreign agent, acting on behalf of Ukraine's government.) That aside, Liscovich appears to believe that the state slows things down and complicates them, and that companies and private individuals do a superior job—not only in running taxis but also in arming Ukraine. In the Warsaw offices of an aerial intelligence company called Radio Bird, while bemoaning a particular inefficiency that had crept into the border controls between Poland and Ukraine, Liscovich trotted out that old Reagan saw: “What do they say about the most scary words in the English language? ‘I’m from the government and I’m here to help.’”

Radio Bird had helped build one of the crossover tech products that Liscovich was most impressed by, and during our visit the product's inventor, whom I will call Alex, Zoomed in. Alex, a Ukrainian physicist who asked to remain anonymous out of concern for possible retaliation, is a professor at a research university in the Netherlands. When the war began, he enlisted some friends and colleagues to develop a sensor for incoming missiles. The sensor consists of a basic microphone—like the kind worn on lapels during talks—that feeds its input into a smartphone, where software compares the audio to a preloaded set of acoustic signatures of Russian drones and missiles. If it detects something, it sends an alert with its position and what it thinks it heard. Liscovich says there are now 6,000 of these sensors in Ukraine. Dubynskyi, the deputy digital minister, said they were crude but successful, although he didn't specify how many missile attacks they helped avert. Liscovich now wanted Radio Bird and Alex to work on a tethered drone: a drone powered by a line from the ground, staying up indefinitely, scanning the airspace for danger.

The threat posed by Russian GNSS jamming hasn't gone away, but some drone manufacturers are finding ways to diminish it. Two days after Warsaw, Liscovich and I went to the Munich headquarters of Quantum

Systems, the manufacturer of that early pair of doomed Vectors. Quantum, whose offices lie beside a highway leading out of the city, has sold dual-use drones to the police forces of Los Angeles and Bavaria and to German rail companies. By now I'd become familiar with European drone company chic—ascetic interiors, unadorned walls, huge windows that bathed rooms in light on fine summer days—but Sven Kruck, Quantum's chief sales officer, stopped outside the CEO's office to point out an unusual accessory: a Ukraine flag hanging behind the desk.

After the first Vectors failed on the front, the Ukrainians sent Quantum their notes—but it was nothing like the tidy, structured feedback that tech companies ordinarily receive. Communications took weeks to make the trip to Munich and back, Kruck said. The drone operators passed their comments up to their leaders, who sent them upward and upward until they were finally sent to Quantum via the Ministry of Defense. “We got a letter saying, ‘Change this, this, this, this, this, and this. If not, you’re out,’” Kruck said. He had served in Afghanistan and encountered electronic warfare before, but nothing like what was going on in Ukraine. Quantum needed more than a letter. It needed flight logs, videofeeds, and telemetry data, all in a much tighter response loop with the end users, the drone pilots.

Liscovich holds a hobbyist drone that will be deployed on the front lines.

Photograph: Sasha Maslov

For Liscovich to be the courier of this information was insufficient. When he visited Quantum in October 2022, he found he couldn't be precise enough about the problems pilots were encountering. “They had an issue with the battery duration indicator, which was jumping around,” Liscovich said, by way of an example. At Quantum, they asked him: Under what conditions did this issue occur? But Liscovich hadn't seen it for himself. Eventually, Quantum's engineers were added to a Signal group with Ukraine's drone pilots so they could speak directly to each other. With the pilots' help, Quantum realized last winter that if the Russians jammed a Vector's satellite navigation, pilots could radio their own stable coordinates to the drone, allowing it to orient itself. The Vectors also began using onboard lidar sensors to check their altitude so that they stopped plummeting to earth, and Kruck's colleagues are experimenting with a

visual navigation system to work in tandem with GNSS. Out of the first 40 drones that Quantum sent to Ukraine, it lost 15 or 20, Kruck said. In January 2023, it sent another 100-odd Vectors, and it has since lost only five. Just before I met Kruck, Ukraine had ordered another 300 drones, and Quantum had posted six of its engineers, pilots, and support technicians to its new service and training center in Ukraine. “This is a cat-and-mouse game,” Kruck said. “It really matters how fast your iteration cycle is.”

Quantum’s story sounded like rousing progress when it was narrated in a comfortable conference room in Munich. But Liscovich knows how easily these undertakings can wilt. An army and a tech company are culturally different: the first lumbering, cautious, and preoccupied with compliance, the second obsessed with moving fast and breaking things. To get them to talk to each other is difficult, Liscovich said. In fact, soldiers were sometimes reluctant to tell even him about the problems they were facing. In the summer of 2022, after Liscovich supplied a battalion with a few drones made by a US company called Skydio, a commander sent him a thermal-camera video showing a Russian tank being blown up. A Skydio had helped find the tank and had taken the video, the commander said. Pleased with this, Liscovich helped procure several more of the same model—only to find, after a couple of months, that the video was from another source altogether, and that Ukraine’s cellular network interfered so thoroughly with that particular Skydio model that the drones lost connectivity as soon as they went up. “They wanted me to feel like I’d made some kind of difference,” Liscovich said.

“That’s quite sweet, actually,” I told him.

“It’s incredibly counterproductive,” he shot back. “It’s not accomplishing anything. It resulted in a massive waste of resources.”

For a staunch advocate of the private sector, Liscovich also let slip flashes of exasperation at how *corporate* corporations can be. Sometimes a company isn’t willing to commit to testing its products in Ukraine or investing in service centers and training resources in the country unless it knows big orders are in store. In the final analysis, this was Quantum’s motivation too, Liscovich said. Being on the same side of a war, it turned out, was no assurance at all of being in sync.

In the most-watched war in recent history, Ukraine's alacrity at filling the gaps in its military resources with civilian products has prompted other governments to rethink their own laggard adoption of commercial technology. European officials have chewed over how to nurture startups that might, one day, offer the kind of rapid, inexpensive communications alternatives that Starlink did in Ukraine. Taiwan set out to buy thousands of new drones off the market to counter Chinese air power. And in the US, the Defense Innovation Unit, a long-neglected office founded in 2015 to help the military adopt commercial technology, has enjoyed renewed interest from the Pentagon.

Historically, and famously, the US military's purchasing apparatus has been riddled with inertia. "The whole process is designed to buy an aircraft carrier that will keep for 50 years," said Raj Shah, a former DIU director. Even as the military's technological needs expanded beyond the lethal and the gigantic, the Pentagon was slow to respond, another former DIU staffer said. In the DIU's early years, people entrenched in their jobs came to seem like barriers to the unit's work, and its funding languished. The staffer quit, he said, because he "didn't have the energy to push anymore."

This year, the DIU got a new director—a former Apple vice president—and a budget of \$112 million, more than double the \$43 million it received last year. The US House Appropriations Committee wants to lavish even more money on the office, as much as \$1 billion. Mike Madsen, a strategic adviser to the DIU's director, attributes part of this new energy to Pentagon officials "watching the speed with which Ukraine has been able to deploy this kind of technology." The eastern front is a live laboratory, and every military's eyes are fixed on it.

But the war is also shifting in a direction that leads away from Liscovich and his efforts. In the fear and shock of the first few months, "speed was paramount," said Stephen Biddle, a defense policy scholar at Columbia University. Any technology, procured in any way at all, that kept Ukraine in the fight for another day was welcome. But coordinating artillery strikes over WhatsApp and Signal, for instance, was hardly ideal. "Over time, I'd still be concerned about hacking and security," Biddle said. Similarly, the rate at which Ukraine has lost its off-the-shelf drones has been staggeringly

high, he said. While that damage was once tolerable, it has felt increasingly inefficient as the military digs in for the long haul.

Biddle also argued that the cumbersome pace of government, which the tech industry gripes about, has a purpose: It keeps officials accountable to the people who elect them. This is “particularly necessary in Ukraine, where you have a massive problem of corruption,” he said. While Liscovich and others like him—“the heroic entrepreneurs of the early period”—have been vital, he said, the Ukrainian state has to take over their work to ensure efficient long-term spending. (Yegor Dubynskyi, Ukraine’s deputy digital minister, said something similar. “We have to start buying these things through a governmental approach, and we have to think about building specific testing grounds of our own and equipping them, even though this will take a little time.”) I wondered how Liscovich would react to that, and then recalled that he’d told me, very firmly, “I don’t plan to do this forever.” He has a startup to build and other ideas to chase. He gave me the impression that he’d be glad to hand his beat back to Ukraine’s defense ministry, to whom it belonged in the first place. “I’m just doing it now because it needs to be done.”

Illustration: Lena Weber

On the last day of our trip, Liscovich and I took a taxi out to the headquarters of a “drone defense” company called Dedrone, in Kassel. (To his disappointment, Uber didn’t operate in the city.) Before breakfast, he’d been browsing a Signal group of Ukrainian drone pilots, and he was worried by their speculation that the Russians were learning how to jam a particular drone’s radio link. Dedrone was part of a strategy to do unto the Russians as they were doing unto Ukraine. More than 100 Dedrone sensors had been installed around the front, each capable of identifying and detecting the radio signatures of nearly 250 models of drones. Ordinarily, the sensors resemble white buckets on a pole, and facilities like power plants and prisons buy them to discourage aerial snooping and delivery of contraband. For a live war zone, though, they had to be painted a much more inconspicuous shade of milky latte. A team in Kyiv now manages a network of these sensors all along the front, including in Donbas and Zaporizhzhia. In one case, Liscovich said, a sensor close to the front had



managed to latch on to a radio signal from a drone operator on the other side. He'd been standing by an ammunition silo, although the Ukraine army didn't know that when they decided to shell him. "They tried to hit the operator, but they blew up the storage of ammo," Liscovich said. "There was a massive explosion ... I have a video of this." It was as pleased as he'd sounded all day.

A few weeks later, I read that a Russian missile had hit one of the few hotels in Zaporizhzhia, killing one person and injuring at least 16. In dread, I texted Liscovich, and then fretted for half a day until he replied. It wasn't his hotel, he said, and in any case, he wasn't in Zaporizhzhia. He was headed back out of the country and had stopped for a day and a half in Lviv, in western Ukraine, to visit another drone company. He knew some investors who might want to fund its development of a new product: a low-cost tactical plane. It was, he thought, something Ukraine could use.

*Updated 10-05-23, 1pm EST: This piece has been updated to protect the safety of a source.*

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[Science](#)

Oct 4, 2023 2:00 AM

# This Is the World’s Largest Digital Camera—and It’s Hunting for Dark Matter

When completed, the Vera Rubin Observatory in Chile will image some 40 billion cosmic objects and will look for warps in spacetime that could be the telltale signs of dark matter.

What would you do with the world’s biggest camera? Take the greatest Instagram selfie ever? Capture a stunning wildlife scene? What about probing the very structure of the universe ?

That’s what astronomers at the Vera Rubin Observatory in Chile have opted for. Under construction at the peak of the 9,000-foot-tall Cerro Pachón in the Chilean Andes, the observatory will sport the largest digital camera in history, a pristine telescope mirror as wide as a London bus, and a fast-moving mount to study the universe like never before.

“The major strength of this technology is to see faint objects and the dynamic universe—things that are changing,” says Sandrine Thomas, deputy director of Rubin Observatory Construction. “That gives us a lot of information about the beginning of the universe, galaxies, and objects in our own solar system.” Construction on Rubin—named for the late astronomer Vera Rubin, who pioneered work on dark matter—is set to be completed next year, when it will take its “first photons,” says Thomas, referring to its initial glimpse of the universe. In 2025, it will then begin work on its primary goal, the Legacy Survey of Space and Time, for which it will spend a decade taking exquisitely detailed images of the heavens.

Over those 10 years, the telescope will take 700 pictures a night, totaling some 20 terabytes of data every day. After a decade, it will have captured 800 pictures of each portion of the southern sky. To do this, it's been designed to move quickly, switching between targets in just five seconds, instead of the minutes required by other telescopes. There are 189 charge-coupled device sensors in the telescope's camera, each sporting a 4,096 x 4,096 pixel sensor, which will snap an image of the light collected in the 8.4-meter-wide primary image to create a 3.2-gigapixel snapshot of the universe.

No survey of the sky has ever deployed such a fast-moving telescope coupled with such a powerful camera, giving Rubin an unparalleled ability to study the universe. Over 10 years, the telescope is expected to snap some 40 billion cosmic objects, including billions of galaxies. This will enable astronomers to learn more about dark matter, the mysterious, invisible substance that accounts for 85 percent of all matter but that we can only discern from the way it distorts the appearance of galaxies.

Astronomers like Rachel Mandelbaum at Carnegie Mellon University in Pennsylvania will use Rubin's galaxy images to study an effect called weak gravitational lensing, where massive objects "distort spacetime and change the paths that light rays would have taken," she says. "Dark matter doesn't interact with light, but it has a gravitational effect, so weak lensing is a great way to map out the distribution of dark matter in the universe."

Rubin is particularly well-suited to this technique because of its wide field of view, which makes each snapshot it takes as wide as seven full moons. With this capability, it can do much more than explore the distribution of dark matter. The telescope will image millions of asteroids in our solar system, many undiscovered, and perhaps confirm or deny the existence of "Planet Nine"—a hidden planet that's theorized to be lurking at the edge of the solar system. Rubin will also provide rapid alerts on supernovae exploding throughout the cosmos, as well as charting an accurate map of stars in our own Milky Way.

Construction will have taken nearly a decade by the time it's completed, but results from the telescope will be timeless. "It's extremely exciting," says

Thomas, “and stressful at the same time, because we want to make sure that it all works.” Now, the end is in sight. Space and time await.

*This article first appeared in the November/December 2023 issue of WIRED UK.*

*This article was originally published by WIRED UK*

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Sep 30, 2023 9:00 AM

# Lego Is a Company Haunted by Its Own Plastic

While the toy brand kills its plans for an oil-free plastic alternative, it's still pumping out billions of non-biodegradable bricks a year. Can Lego ever be sustainable?

Boxes of Lego are stacked 23 meters high in storage rooms holding around a billion bricks in total. Robotic cranes fetch decoration or packaging parts (shot in 2013)Photograph: TOM NAGY

Lego has built an empire out of plastic. It was always thus. The bricks weren't originally made from wood, or metal, or some other material. Ever since the company's founder, Ole Kirk Christiansen, [bought Denmark's first plastic-injection molding machine](#) in 1946, Lego pieces have been derived from oil, a fossil fuel.

The fiddly little parts that the company churns out—many billions every year—are today mostly made from acrylonitrile-butadiene-styrene, or ABS. This material doesn't biodegrade, nor is it easily recycled. If a smiling mini figure gets into the environment, it will likely very slowly break down into highly [polluting microplastics](#).

What was once considered a miracle material, so versatile, tough, and easily dyed in a searing array of technicolor hues, has come to haunt Lego, a family friendly brand [recently valued at \\$7.4 billion](#). Plastic is [increasingly taboo](#) and, in the rush to dispense with fossil fuels and protect Earth's precious natural habitats, there's a growing urgency to find alternatives, or otherwise reduce plastic pollution.

Things aren't going to plan. On 18 September, Lego Group CEO Niels Christiansen [announced](#) he was joining Danish business leaders in calling for companies and policymakers to “stand together globally for a just and green transition to a net-zero future.” This week, Lego [revealed to the \*Financial Times\*](#) that its much-hyped project to switch away from ABS and instead make toy bricks from recycled plastic bottles has ended in disappointment. Only two years ago, [the company told WIRED](#) it had made impressive progress in developing a suitably robust version of this alternative plastic, known generally as recycled polyethylene terephthalate (rPET).

“We had worked very hard on it,” says Tim Brooks, Lego’s vice president of sustainability, looking back. “It is hard to color, it’s hard to scale the production of it.”

But there were bigger problems than that. In their quest to make rPET bricks that were rigid enough to clip together firmly, what Lego refers to as “clutch power”, engineers discovered that the material required significant pre- and post-treatment. The process involved extreme drying of the rPET to remove moisture—an energy intensive step. After doing the sums, Lego’s researchers realized that rPET manufacturing, and installing new equipment to make it all happen, would actually carry a higher carbon footprint than sticking with plain old ABS.

Lego declined to specify to WIRED how much bigger rPET’s carbon footprint, per kg of toy bricks, would be versus ABS, but it has said that ABS requires 2 kg of petroleum for every 1 kg of plastic toys produced. Nearly 200 softer pieces in Lego’s current range are made from biobased plastic, derived from Brazilian sugarcane. Brooks says the company remains keen to pursue the development of a more environmentally friendly version of ABS for its many more rigid parts, for example by incorporating biobased plastic into them. But this is still in development.

Some 200 pieces in Lego’s current range are made from biobased plastic, derived from Brazilian sugarcane.

Photograph: LEGO

“In the future, they should not make these kinds of announcements until they actually do it,” says Judith Enck, president of [Beyond Plastics](#). Global plastic production has been projected to double in the next 20 years, according to the World Economic Forum, and yet in the US, for example, advocates claim that the vast majority of plastic, [95 percent, is never recycled](#).

Paolo Taticchi, a corporate sustainability expert at University College London, says Lego can be considered “quite credible” in its efforts to decarbonise because the company has invested so much in this endeavor. For instance, in 2015 Lego put down \$155 million to establish a Sustainable Materials Center. Despite the foundering of the rPET work, 150 engineers are still employed there working on alternative initiatives, the company says.

But Taticchi doesn’t mince his words. Today, decarbonisation is not just a nice-to-have: “They are not going to survive as an organization if they don’t find a solution.” Incidentally, last month, Lego reported [its operating profits had plummeted by 19 percent](#), the biggest dive since 2004.

It’s very hard to find a practical alternative to ABS, says Gregg Beckham at the US Department of Energy’s National Renewable Energy Laboratory. He and colleagues are working on a biobased functional replacement for ABS. Would it have all the special properties required for a top quality Lego piece? “To be determined,” he says, noting that “multiple companies” are now working on scaling up similar technology.

Awareness is growing of how plastic can persist in the natural environment. Long-forgotten toys made from plastic materials, including possible Lego pieces, have even turned up [at a former nuclear missile base in Poland](#), where the families of Soviet officers once lived in secrecy.

And don’t forget all the Lego in the ocean. Every month or so, Tracey Williams, an author and founder of the [Lego Lost at Sea project](#), catches up with local fishermen in Cornwall, England, who save bits of Lego that have got trapped in their nets. In 2020, she [co-authored a study](#) that suggested dinky little pieces of ABS Lego could remain in the sea, generating microplastic particles, for between 100 and 1,300 years.

Some of the parts collected by Williams are as much as 50 years old. However, most originate from a lost shipping container that was stuffed with nearly five million Lego pieces. A rogue wave hit the [vessel \*Tokio Express\*](#) in 1997, causing cargo to tip into the water.

“You can only really tell that they’ve been lying at the bottom of the sea for 26 years by the marine life growing on them,” she says. “They do survive remarkably well.”

The weathering of recovered pieces varies, but, remarkably, some are in good enough condition to be used again, despite their lengthy sojourn beneath the waves or stuck in sand dunes. And that, the sheer durability of ABS, may just provide Lego with an answer, or part of an answer, to its problems.

“We want to ensure that the bricks have the longest possible life,” says Brooks, as he lays out the goals of [Lego’s Replay initiative](#), in which secondhand Lego pieces are returned to the company, sorted, washed, repackaged and—at present—donated to children. Lego declined to clarify exactly how many people are employed in this effort, which is currently live only in the US and Canada. The scheme sometimes requires disassembly of Lego sets, and sorting of bricks both by machine and by hand. Quality control is key. “We once found a little Lego pirate treasure chest with a set of children’s teeth in it,” says Brooks.

Photograph: LEGO

What sets Lego apart from many other toys is that it is often, if not always, kept by a family for many years. Perhaps even passed on from generation to generation. Bricks made decades ago remain compatible with those produced today.

Last year, Christie Klimas, who studies sustainability at DePaul University, co-authored [a paper estimating the environmental impact of various children’s toys](#), including three Lego sets, a Barbie doll, a Jenga game and two plush dog toys. The study made multiple assumptions, including about the transportation required for each item, and estimated that the largest Lego set, a Star Wars fighter ship, had the highest greenhouse gas emissions



of all the toys—due to the volume of ABS. A Lego spokesman describes the work as “flawed” and says assumptions about the playing time associated with the toys (20 hours) do not represent the long life of its products.

Klimas points out that the analysis was based on international standards for product life-cycle assessments, and, in additional estimates provided to WIRED, she adds that once the three Lego sets are played with for between 32 and 64 hours, the carbon footprint of each product, per hour of play, becomes “practically negligible”, despite the considerable size difference between them (they ranged from 61 g to 374 g).

However, the original analysis did reveal certain trends, she says, including that plastic, in particular, appears to be associated with a higher overall environmental impact for a product. Take the plush dog toys, one of which required a battery. “The nylon casing—the plastic component, not the battery—really grows the impact of that stuffed animal,” she says.

Many people who spoke to WIRED mentioned that they have kept Lego for many years, or even sold it on. UK-based artist Andy Morris, who makes artworks out of Lego, sold his own childhood collection to help pay for university. Now [he designs custom sets and dioramas](#) that people purchase as gifts.

In 2021, economists in Russia estimated that the value of secondhand Lego sets [grew by 11 percent year over year, on average](#), with some fetching many times their original price after just a few years, further indicating that it wouldn’t be quite right to judge Lego in the same league as more ephemeral, or disposable, applications for plastic.

“We’ve done a pretty good job as a society of vilifying all plastics, I don’t think that’s right,” says Sharon George, a senior lecturer at Keele University. Carefully developing a market around the existing Lego bricks out there in the world, reducing the production of new pieces, or maybe even renting out Lego sets, could all help the company lower its environmental impact, she suggests.

Lego acquired BrickLink, an online marketplace for new and secondhand pieces, in 2019 and its Replay initiative, if it can be scaled, could vastly increase the circularity of these toys.

Enck, upon hearing of the existence of the Replay scheme, expresses enthusiasm. “That’s wonderful,” she says, emphasizing the need for Lego to simultaneously reduce new ABS plastic production. “I think that’s the future.”

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Sep 28, 2023 6:00 AM

# Scientists Have an Audacious Plan to Map the Ancient World Before It Disappears

Buried civilizations could soon become inaccessible forever. Archaeologists have to move fast, so they're turning to the latest ground-scanning tech. Technologies such ground-penetrating radar allow archaeologists to peer down into the past without lifting a shovel. Photograph: Jimena Peck

In the center of Siena, Italy, a cathedral has stood for nearly 800 years. A black-and-white layer cake of heavy stone, fine-cut statuary, and rich mosaics, the imposing structure—now visited by more than a million tourists each year—would seem to be a permanent fixture of the city's past, present, and future. Most people call it, simply, “the cathedral.” But Stefano Campana, a 53-year-old archaeologist at the University of Siena, calls it something else: “the church that is visible now.”

Campana has seen his fair share of excavations, along with the dust and sunburns that accompany them. But [archaeology](#), for him, is not always about digging up the past; it also means peering down into it using an array of sensitive electromagnetic equipment. One device Campana uses is ground-penetrating radar, which works by transmitting high-frequency waves into the earth to reveal “anomalies”—subsurface features that are potentially architectural—in the signals that bounce back.

This article appears in the December 2023/January 2024 issue. [Subscribe to WIRED](#). Illustration: James Junk and Matthew Miller

In early 2020, when [Covid](#) lockdowns emptied Italian tourist sites of their crowds, Campana and his collaborators received permission to survey the Siena cathedral's interior. Using instruments originally developed for studying glaciers, mines, and oil fields, they spent days scanning marble floors and intricate mosaics, on the hunt for walls and foundations in the deep. With the selfie-stick brigade gone, Campana and his crew were able to find evidence of earlier structures, including, potentially, a mysterious church constructed there nearly 1,200 years ago, lurking like a shadow in the radar data.

After seeing how much they achieved during Italy's lockdown, Campana and his collaborators got to thinking about what else might be possible with the technology. [Ground-penetrating radar](#) waves travel at a fraction of the speed of light, so the entire process—transmission, reflection, recording—takes nanoseconds. With these new tools, archaeology is no longer a stationary activity, limited to one site; even while zipping by at highway speed, field surveyors can produce an accurate snapshot of what's beneath centuries of cobblestone and brick, chewing gum and litter.

“We thought, why not scan everything?” Campana recalled. “Why not scan all the squares, all the roads, all the courtyards in Siena?” Unlike the cathedral and its shadow church, these everyday sites are not protected, which means they are threatened by modern construction and development. In the public imagination, they are what Campana calls “emptyscapes”—places wrongly considered insignificant to the human story. He wanted to change that. Campana partnered with Geostudi Astier, a geophysical surveying firm in Livorno, to launch an initiative called Sotto Siena (“Under Siena”). True to its acronym, SoS, the project aims to create a complete archaeological record of Siena before more of the city's deep history is destroyed.

Last spring, I traveled to Siena in the midst of a heat wave to see SoS in action. Campana and I met in the central Piazza del Campo to fortify ourselves with espresso before walking toward a park in a more modern part of the city. To see Siena through Campana's eyes is to exist in overlapping worlds. As we strode up stairs and down alleyways, past restaurants and through piazzas, he explained that [radar](#) can reveal

foundation walls beneath busy streets and back gardens. Corner shops can hide Etruscan ruins under their cash registers. Even temporary structures, lost long ago to war, fire, and history, can be rediscovered using radar. Some of the first SoS scans, he said, found evidence of small pavilions in the Piazza del Campo, likely set up for public fairs and festivals as far back as the 15th century.

When we reached our destination, a white cargo van was waiting for us. Campana introduced me to Giulia Penno and Filippo Barsuglia, geophysicists from Geostudi Astier, who were unloading equipment for a survey that evening. Their city-scanning setup consisted of an electric utility vehicle the size of a golf cart and an array of sealed boxes, studded with ports and wires. As Barsuglia carefully backed the utility vehicle out of the van, Penno gave me an overview of the gear. The boxes contained several heavy racks of radar equipment, which we'd tow a few inches off the ground. A Wi-Fi antenna would relay the data to a hardened laptop. We couldn't count on clear satellite signals in Siena's twisty streets, so the system was equipped with inertial navigation, which uses gyroscopes and accelerometers to track every stop and turn. Barsuglia claimed it was the only such system in all of Italy, outside the military.

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We began with a quick scan of the park. I stood beside Campana and watched, curious what I was getting myself into. Penno took the wheel and began her survey, elegantly weaving the cart around benches, light posts, trash cans, and the occasional baffled Siena resident. "She's like a painter," Campana said approvingly. As she finished up, Campana excused himself, riding off on a motorcycle to meet his family, leaving Penno, Barsuglia, and me to our task.

With Barsuglia now at the wheel, we lurched ahead into the heart of nighttime Siena. The experience, I quickly realized, was going to feel less like painting than like being asked to mow a very large, very crowded lawn. People seemed unsure what to make of us as we passed, at times mistaking our cart for a street-cleaning machine or some sort of mobile art installation.

Our vehicle bottomed out over and over, the radar gear's protective case scraping loudly against the city's cobblestones and concrete. People stopped, laughed, and took videos.

As the sun went down, we drove toward Siena's Piazza Salimbeni, home to the world's oldest bank. On our way there, the equipment was glitching in and out—a signaling issue, Penno explained. The solution, Barsuglia said, was to drive around in large figure-eight patterns that would trigger a recalibration process in the equipment. These wide, drunken loops attracted even more attention. At one point, he reached up and attached a small rotating orange light to the cart's roof, explaining that this was to prevent a prowling police car, which had already driven past us several times, from pulling us over.

Our survey that evening finished well past midnight, so late that all three of us seemed on the verge of sleep, circling around in an archaeological fugue. I thought of *Civilization and Its Discontents*, in which Sigmund Freud compares psychoanalysis to an archaeological investigation, suggesting that other, forgotten versions of ourselves lie buried in a past that can be made visible once again through careful analysis.

In SoS's case, that analysis took a few weeks. Gigabytes of data had to be processed for every stretch of road and piazza, matching what lay below to its precise geographic coordinates. Visualization software completed the job, overlaying our discoveries onto updated satellite maps. Our initial glimpses of what appeared to be structural features became refined enough to make archaeological sense. In the end, we found numerous modern pipelines and countless piles of historic masonry, most likely pillars from buildings that had been razed long ago. Sadly, the survey of Piazza Salimbeni revealed little. I was hoping we might uncover a secret bank vault or a lost medieval crypt. All we found were some drains.

Slapstick as it seemed, my experience with SoS offered something of a bellwether for archaeological investigation in the 21st century. The tools and methods of the discipline are shifting toward increasingly sophisticated—and increasingly hands-off—means of finding, mapping, and preserving human historical sites. “The problem with excavation is that it destroys the thing you're studying,” Eileen Ernenwein, a professor at East Tennessee

State University and coeditor of the journal *Archaeological Prospection*, told me. “You can take excellent notes and keep good records and preserve any artifacts that you find, but you’ll never get to excavate another time.”

The immense capabilities of these new surveying tools, in terms of both accuracy and speed, have inspired archaeologists such as Stefano Campana to dream of what previously seemed like a fairy tale. If the SoS project seemed ambitious, with its goal of uncovering everything beneath the surface of an entire European city, there were other archaeologists on the continent who were preparing for a project far larger.

“The average tourist doesn’t see or understand the wealth of a landscape like this,” said Immo Trinks, gesturing over an empty field that, to my eyes, seemed windswept and bleak. We were 25 miles east of Vienna, in—or on—the ruins of a city called Carnuntum, which once lay along the northern border of the [Roman Empire](#). The city was sacked and abandoned centuries ago, and 99 percent of the site still lies unexcavated. But Trinks has seen Carnuntum’s every wall and doorway, its every road and square, without ever digging a hole. “A very large Roman building has been detected here,” he said, pointing into open air. “This was a dense Roman town.” He described a sequence of structures we had apparently been stepping through for the past few minutes, their halls and rooms known only from electromagnetic data.

A visualization of a building in the Roman Forum captured with ground-penetrating radar.

Courtesy of GeoSphere Austria

A radar scan of part of a Roman governor’s guard.

Courtesy of GeoSphere Austria

In 2000, when Trinks was a graduate student, he and his colleagues set what could be called a land-speed record for archaeology at Carnuntum. Serving as an assistant at the site, he helped map nearly 15 acres in a single day using magnetometry, which works by detecting tiny differences in magnetic field strength between, say, a brick wall and the soil around it. Since then,

Trinks has been part of a loose group of international geophysicists working to transform modern archaeology. He teaches at the University of Vienna and, until recently, served as deputy director of the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology, or LBI ArchPro. He is also immensely ambitious, encyclopedically knowledgeable about his field, and nerdishly obsessed with the technical details that ensure huge undertakings actually work as planned.

Immo Trinks and Alois Hinterleitner take radar scans in Carnuntum, a ruined Roman city outside modern-day Vienna.

Photograph: Michaela Nagyidaiová

The Heidendor (“Heathens’ Gate”) at Carnuntum.

Photograph: Michaela Nagyidaiová

For Trinks, who is 50, using electromagnetic tools to record and save the human past is a moral responsibility. All over the world, he pointed out, archaeological sites are disappearing beneath a relentless tide of urbanization and economic development, not to mention climate change and military conflict. In Europe alone, never-excavated Roman towns have been smothered beneath supermarkets and big-box stores. Globally, unmapped Stone Age villages have been erased by freeways, airports, and industrial agriculture. Every year, humanity loses more and more of its heritage. But now that entire landscapes can be mapped in a matter of days using off-road vehicles, the data processed in near real time with the assistance of feature-recognition algorithms and image-processing software, a tantalizing possibility comes into focus: We may be on the verge of a total map of all archaeology, everywhere on Earth.

“We want to map it all—that’s the message,” Trinks told me. “You’re not just mapping a Roman villa. You’re not mapping an individual building. You are mapping an entire city. You are mapping an entire landscape—and beyond.” Trinks means this quite literally. In the summer of 2022, he wrote a manifesto calling for the creation of an International Subsurface Exploration Agency, whose initial role would be to scan every mappable square meter of land in Europe, even the bottoms of lake beds.



Trinks adjusts a satellite receiver during fieldwork in Carnuntum.

Photograph: Michaela Nagyidaiová

“Look at the [European Space Agency](#),” Trinks said to me over lunch near the Danube River, flowing just over a ridge, downhill from the Roman city. The ESA costs individual European taxpayers only about €15 annually. “Fifteen euros is the price of a good pizza and a beer,” Trinks pointed out. “I am happy to pay the price of a beer and a pizza every year to have thousands of people looking downward instead of up.” If we don’t, Trinks warned, “our grandchildren will ask us: Why didn’t you do more to map what’s still out there? Because they will not have the chance to do so once it’s gone.”

Trinks’ vision requires not only the hardware to scan an entire continent but the software to make sense of the resulting data. One morning in his office at the University of Vienna, Trinks introduced me to Alois Hinterleitner, whom he described as a “magician.” Hinterleitner is a software engineer with GeoSphere Austria, a partner of LBI ArchPro. Austrian by birth, he is also an avid mountaineer. Trinks half-joked that countless terabytes of geophysical survey data would be left stranded if something were to happen to Hinterleitner on one of his multiday expeditions. He is so integral to the process that Trinks has turned his first name into a verb: Over the course of my visit, he would often say they needed to “Aloisify the data” in order to make it archaeologically legible.

Hinterleitner at GeoSphere Austria in Vienna.

Photograph: Michaela Nagyidaiová

Over coffee and cakes, Hinterleitner led me through the program he uses. It allows him to filter radar results according to various properties in the signals that bounce back. One function, called Remove Stripes, was designed to clear out flaws in the data set caused by shifts in the measuring instruments or the use of different scanning methods. These changes can cause bright lines—stripes—to appear in the scan. While the filter does take care of them, it can also inadvertently eliminate traces of walls or foundations, including telltale signs of Roman architecture, whose straight

lines can resemble stripes. If you're not careful, in other words, you might not even notice that your software has erased the very thing you're looking for.

Hinterleitner pulled up images on his screen from various expeditions to the island of Björkö, Sweden, made between 2008 and 2012. The makers of Trinks' radar equipment had warned him that scanning a large meadow there would be pointless. The data would be unmanageable, they told him, the results impossible to interpret. "They actually used the term *forbidden*," Trinks said with a laugh. "But I didn't care, because we had Alois."

Using towed radar gear, Trinks and his group scanned not just Björkö's main meadow but the entire island and got the data processed, filtered, and developed into images in just three weeks. Although Björkö was already known to contain more than 3,000 Viking graves, Trinks' survey scanned those tombs—former burial mounds with no visible surface features—in such detail that the outline of a coffin was visible. "We cannot see the horns on the helmet yet," Trinks told me, "but, for the first time, we can see there is something inside the coffin."

A researcher from GeoSphere Austria drives a ground-penetrating radar system around the organization's garden in Vienna.

Photograph: Michaela Nagyidaiová

The big-data approach to archaeology is not without controversy. When LBI ArchPro got its seed grants, more than a decade ago, some younger students were "repelled," Trinks told me, by what they perceived to be a focus on fancy machines at the expense of longer-term institutional goals—such as paying for full-time staff or offering stipends to graduate researchers. Even proponents of geophysical tools caution that large-scale data collection can overwhelm interpretive rigor: With so many shadows to chase down, how can you be sure which ones are real?

One such critic is Lawrence B. Conyers, arguably the world's foremost expert on the use of ground-penetrating radar in archaeology. He is the author of multiple reference books on the subject, one of which is now in its fourth edition, and he has led site surveys all over the world, from lost

villages in Costa Rica to ancient Roman ports drowned in Portuguese marshes. While Trinks and his colleagues drive six-figure machines across historically rich landscapes at 50 mph, Conyers does his surveys in sandals. He often arrives on site with his own radar unit, which he stows in his hand luggage. He tells airport security it's a tool for looking inside walls. "Never use the word *radar*," he advised. "That raises all sorts of red flags."

I met up with Conyers on the island of Brač, off the Croatian coast, the site of an ancient hill fort. He had traveled there to join an international team of archaeologists and historians who were looking for evidence of pre-Hellenistic settlement and trade, going back as far as the Bronze Age. The blue waters of the Adriatic Sea were visible to the west and an enormous gorge led away behind us, deep into the island's interior. Wild asparagus sprouted in tangled clumps.

Although Lawrence B. Conyers may be the world's foremost expert on the use of ground-penetrating radar in archaeology, he cautions against relying too heavily on the newest, fastest machines.

Photograph: Jimena Peck

As a light rain fell, Conyers began pulling his radar unit—an orange box on wheels—across the grass. He viewed the scan on a portable computer screen, which he wore strapped to his chest like a baby. Conyers saw something and called out for one of his colleagues. "Vedran!" he shouted. "Vedran! You're going to want to see this." Vedran Barbarić, an easygoing historian wearing a Black Sabbath T-shirt, ambled over to look. "There's all kinds of walls in here," Conyers said. Barbarić peered down at Conyers's radar screen. On it, black and white hyperbolas formed a zebra-like pattern, indicating structures of some sort underground.

The earliest moments of a geophysical survey, I would see, can be intoxicating. There appeared to be buildings everywhere. Beneath our feet might be a room or a corridor. Over there might be the edge of a courtyard or perhaps a gate. We might be inside; we might be outside. Invisible architectural shapes seemed to loom beneath every step.

Conyers, independently wealthy from an earlier life in oil and gas prospecting, and abrasively informal in the American way, offered a brash contrast to Trink. More than once, as we walked together on Brač, Conyers railed against the approach of “the Viennese.” “With those folks, it is all about the newest, the biggest, the brightest, the largest, the most amazing hardware,” he said. Their approach, he complained, was to throw new machines at old problems. Conyers thought it more useful to reframe those problems.

Conyers at his home in Denver, Colorado.

Photograph: Jimena Peck

Conyers sees the ground as a transmission medium, something waves pass through and echo within. The behavior of radar energy inside the Earth is, for him, a field of study in and of itself, whether those waves reveal signs of lost settlements or not. “My game is geology, geophysics, and archaeology last,” he later told me. “I want to think about the ground. I want to think about reflections and about what creates reflections.”

This approach, Conyers explained, also helps make clear what radar *cannot* see. Some underground objects can reflect radar waves away from the receiving antenna, which means that archaeologists will never see them. Deeper walls and foundations can also be blocked by rocks or masonry that settled above them. Conyers fears that today’s emerging school of high-speed electromagnetic archaeology risks being blinded by its own technical ambitions. With radar, just because something is there doesn’t mean you will see it—but just because you can see it doesn’t mean it’s there. Campana told me that electromagnetic surveys are most informative when paired with what he called “biopsies,” in which small, representative samples of a landscape are excavated to ensure that what you see is actually there. Eileen Ernenwein told me a story from her own doctoral research, focused on an Indigenous site in New Mexico. There, she said, she had found clear evidence of an adobe house in her radar survey data, but when she attempted to find the walls through excavation, they had eroded so thoroughly that there did not appear to be anything in the soil. It was a structure that existed only in radar. She called it “the invisible house.”

My final evening in Croatia, the project leaders gathered at a local townhouse for an update. Conyers had spent several hours that day going back through his data. He looked mischievous but focused, with the cheerfulness of a man who believes he's won a bet. "We got it all wrong," he said. He was grinning.

What followed was a masterclass in interpretation and its dangers. Conyers drew our attention to what we had thought were architectural features. Those, he clarified, were just bursts of interference from a nearby cell tower. "We saw this," Conyers explained, pointing at his screen, "and we said, 'Wall! Wall!' I wanted to see walls. I wanted walls and floors to be banging back at me. But"—he clicked through a few more radar profiles—"I see *no* walls. We're doing geology here, not archaeology." He described an area at the top of the hill that he had been particularly excited about, thinking it might be the floor of an ancient room, but it was just a natural depression framed by boulders, buried under soil and plants. The group would go on to discover pottery sherds and evidence of inhabitation, spanning thousands of years, but grandiose architecture was in short supply. It might not be a building, but for Conyers it was still a puzzle, something to solve.

In her book *The Ruins Lesson*, Susan Stewart, a poet and historian at Princeton, writes: "It is not ruin, but preservation, that is the exception." Empires fall, cities are abandoned, buildings crumble. But the tools of geophysics change Stewart's equation. Seen through devices such as ground-penetrating radar or magnetometry, it is preservation, not ruin, that is the rule. Even the most temporary village or house—even the briefest of human lives—leaves a signature behind in the soil. The unexpected lesson of these new instruments is that none of us ever fully disappear. Our homes and apartments, even our campfires, leave traces in the ground that someone, someday, will be able to find. Thanks to geophysics, the Earth is an archive of electromagnetic shapes, a hidden collection of the human past.

And that past is about to get more democratic. Instead of relying on picturesque ruins—the accumulated riches of aristocrats, military leaders, and religious authorities—geophysics helps us explore even the most ephemeral lives of everyday people, in high resolution. Eras that historians

might have previously overlooked, even entire cultures and peoples, may finally get the attention they deserve. Just as lidar technology allowed archaeologists to look through the dense rainforest canopies of South America and Southeast Asia and reveal ancient cities, the tools of geophysics are now doing the same for cultures in sub-Saharan Africa and Indigenous North America. The people in these regions tended to use organic and biodegradable building materials, creating the illusion, millennia later, that they were not sophisticated, did not build significant works of architecture, and had no true lasting legacy. A truly global International Subsurface Exploration Agency, of the kind Trinks proposes, would radically expand our understanding of who has left a mark on human history.

Before I left Vienna, Alois Hinterleitner had showed me what this new archaeology actually looks like, how lost cities reappear, from their abandoned streets to their ovens and farms, when seen through the lens of geophysics. Stationed in front of a large-screen TV hooked up to a laptop, with his sinewy mountain-climber's forearms, Hinterleitner had clicked through a series of radar surveys recorded at Carnuntum. As he turned different filters on and off, what began as a random fuzz of black and white pixels became a clearly defined maze of walls and building foundations, dark architectural forms lurking in the data. Someday, this could be the entire Earth's surface, I realized, a screen through which we can see the past. Then Hinterleitner reversed the process until everything we'd seen or thought we'd seen, from Roman ruins to modern plow marks, disappeared again into a sea of white noise.

*Research for this article was supported by a grant from the Graham Foundation for Advanced Studies in the Fine Arts.*

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