PC MAGAZINE

JAIL TECH

DEVICES BEHIND BARS

BACKUP

CHOOSE THE RIGHT PLAN

BLOCKCHAIN:

The Invisible Technology That's Changing the World

DIGITAL EDITION
FEBRUARY 2017

PC MAGAZINE

CONTENTS

FEBRUARY 2017

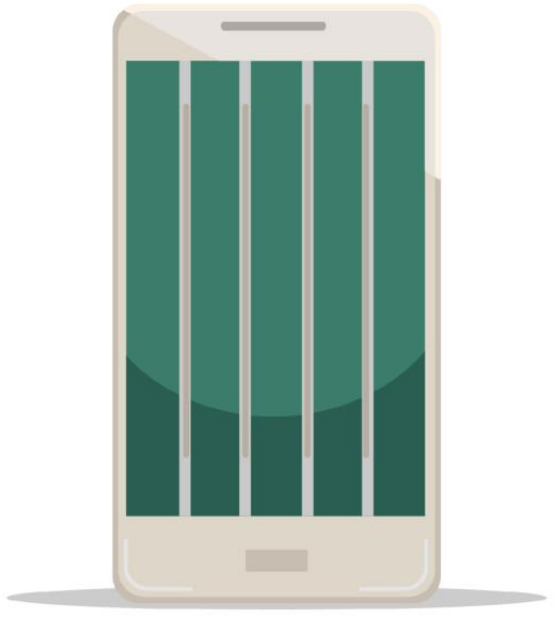
BLOCKCHAIN

THE INVISIBLE TECH THAT'S CHANGING THE WORLD

FEATURES

JAIL TECH

Phones, tablets, and software behind bars.



REVIEWS

CONSUMER ELECTRONICS

Huawei Honor 6X

Misfit Phase

Pico Home Brewing System

HARDWARE

XYZprinting da Vinci Mini

Unicomp Ultra Classic

HP Sprocket Photo Printer

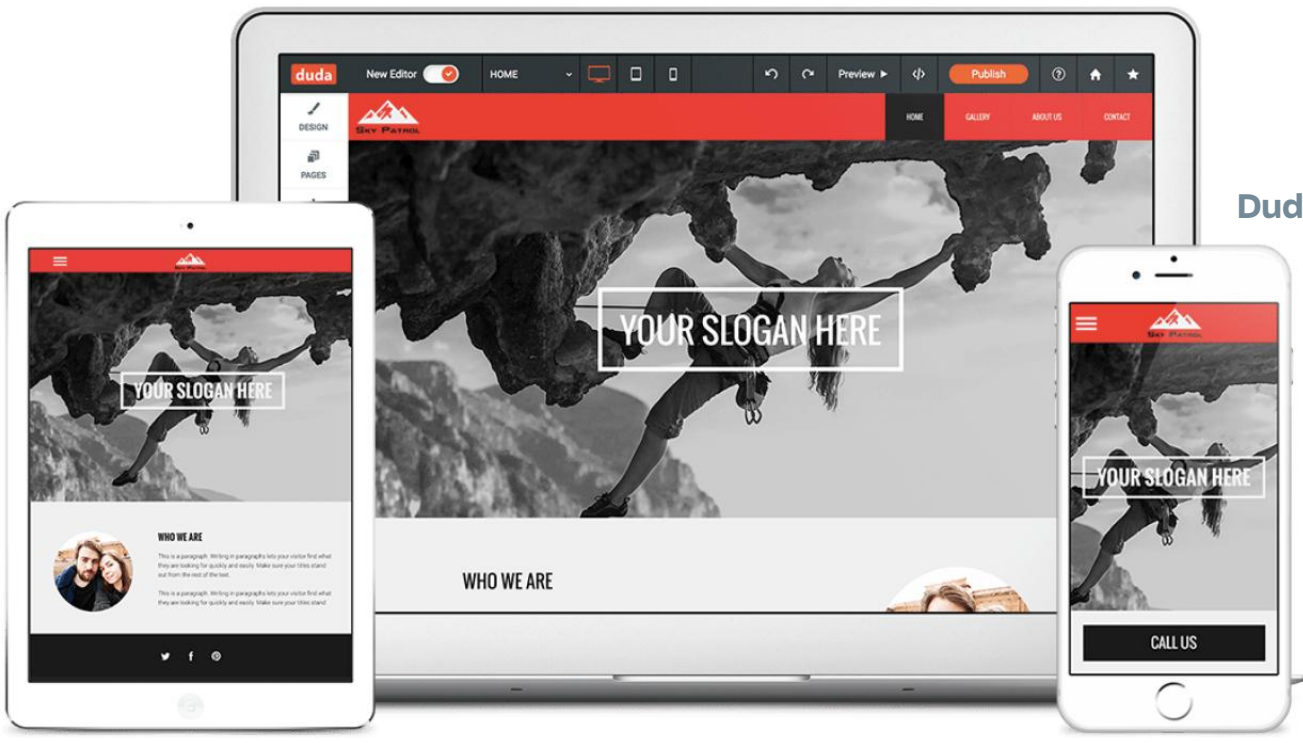
SOFTWARE & APPS

DudaOne

Top 5: Best Online Collaboration Software

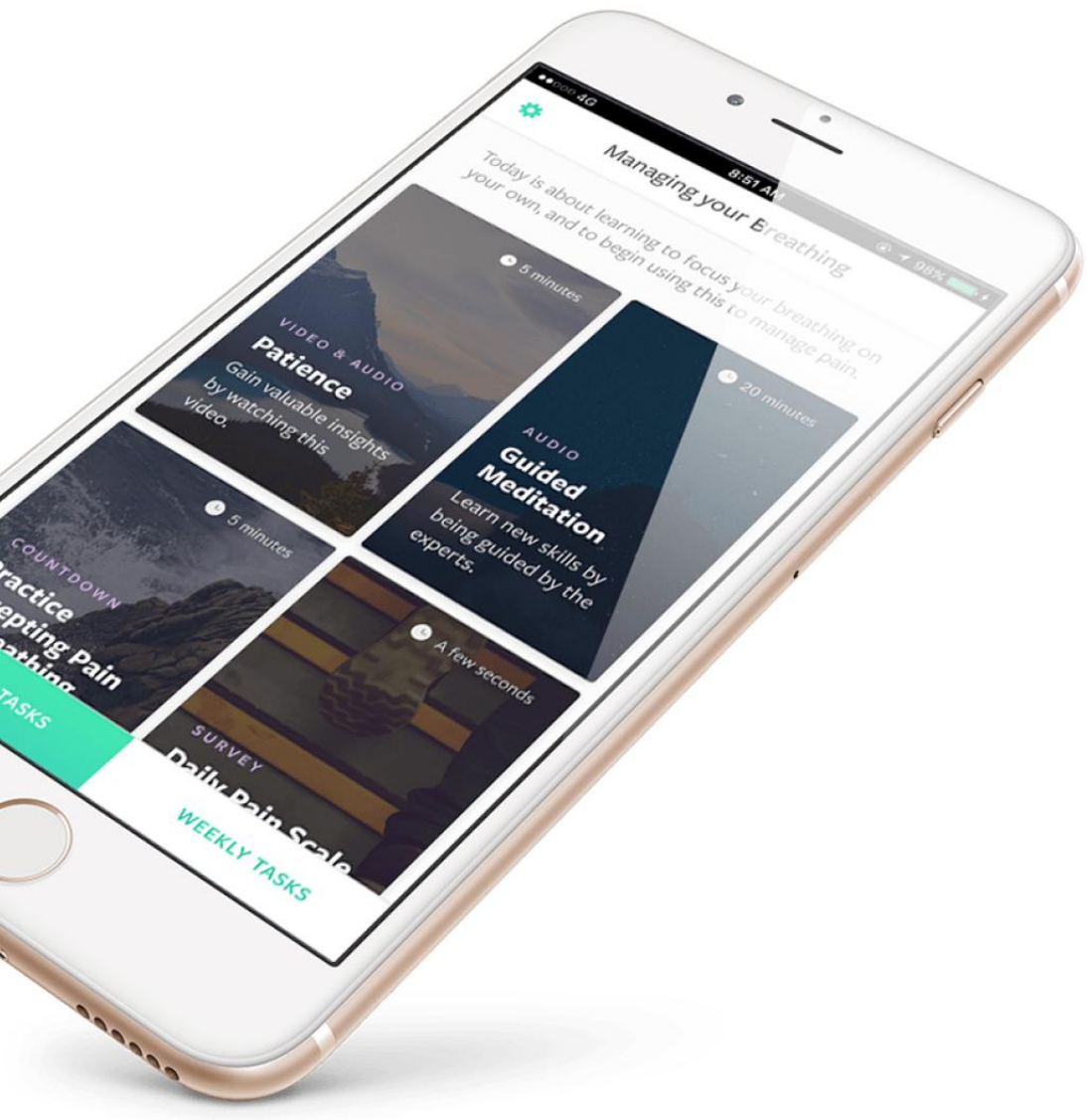
Huawei Honor 6X

HP Sprocket Photo Printer



DudaOne

WHAT'S NEW NOW



GROUNDBREAKING FMRI STUDY Finds 4 Distinct Neurological Subtypes of Depression

HOW VR HOLOGRAMS Can Train Everyone From Hairdressers to Astronauts

MIT: UBER, LYFT Vital in Reducing Congestion

DEALING WITH PAIN? Ella Will See You Now

TOP GEAR: CES 2017 EDITION

OPINIONS

DAN COSTA
First Word

READER INPUT

EVAN DASHEVSKY
Is the Smartphone Already Obsolete?

TIM BAJARIN
Chromebooks: Watch out for These Windows PCs

DOUG NEWCOMB
Autonomous Cars Will Have to Be (Artificially) Intelligent

> **The likelihood of anything good coming from the LinkedIn buyout is improbable, at best.**

JOHN C. DVORAK
Last Word

TIPS & HOW TO'S

GET ORGANIZED
Choose the Right Backup Plan

HOW TO
How to Set Up an Amazon Echo

GET SMART
How to Prep a Connected Home for New Owners

DAN COSTA

On Magazine Publishing

I've been thinking a lot about the future of magazine publishing. I'm the Editor-in-Chief of a brand that stubbornly features "magazine" in its name, so this should come as no surprise. Although *PC Magazine* ceased publishing a print version in 2011, thousands of subscribers continue to pay for our Digital Edition. The question is, with an almost infinite amount of free content online, why pay for it?

The *PC Magazine* Digital Edition is designed for any type of digital display: laptops, tablets, mobile phones. When PCMag.com publishes an article, it is accompanied by advertisements. That's how we make money to pay our writers. In the Digital Edition, we have subscribers to help defray our production costs. As a result, we can deliver our content completely ad-free. Considering how targeted ads can get, I think we can all agree that ad-free is a pretty great perk. We can also feature exclusive stories, mainly longer reported pieces that might get overlooked online.

We keep improving the Digital Edition, but progress isn't a straight line. Recently, we updated it with a new responsive design for iOS on phones; iPad and Android versions are coming soon. The migration has been tricky, and I know some of you have had trouble logging in and downloading issues. (For the most part, these problems have been sorted out, but if you are still having trouble, send an email to *support@audiencemedia.com*.)

This month's cover story—"Blockchain: The Invisible Technology That's Changing the World"—is a perfect example of the value of magazine publishing. Blockchain is one of the most important technological innovations of our time, but almost no one understands how it works.

Part of the problem is that the big brains who do grok it almost never get the opportunity to write long enough to explain it in detail. And when those big brains do write big think pieces, they tend to be incredibly dull. We're hoping to avoid both of those traps with this story.

Rob Marvin has a lot to say about blockchain, and his sources have even more insight. His first draft clocked in at more than 8,000 words and was the best piece of writing I have read in months. At this point, he could have posted it to his blog.

But the story could be better. So Managing Editor Carol Mangis went to work, editing, crafting, and yes, cutting the piece down until it was both informative and entertaining. [Which I never have to do with Dan's column.—*Ed.*]

At this point, we could have posted it on Medium, but we had more work to do. Designer Jose Ruiz took the copy, what little art we had, and created the pages that help the reader through the story. At that point, we had a magazine feature that's worth a subscription fee. Check it out, and let me know if you agree.

I'll share one more anecdote about magazine publishing: I was in a checkout line at a grocery store recently. The clerk was in his early twenties, moving items across the bar code scanner with an

Although *PC Magazine* ceased publishing a print version in 2011, thousands of subscribers pay for our Digital Edition.

appropriate lack of enthusiasm. He noticed the *PC Magazine* hoodie* I was wearing.

"You work there?" he asked.

"I do," I answered.

As I waited for the inevitable—"My dad used to read that" or "Your magazine used to be huge"—I added: "You know, we don't publish the print magazine anymore."

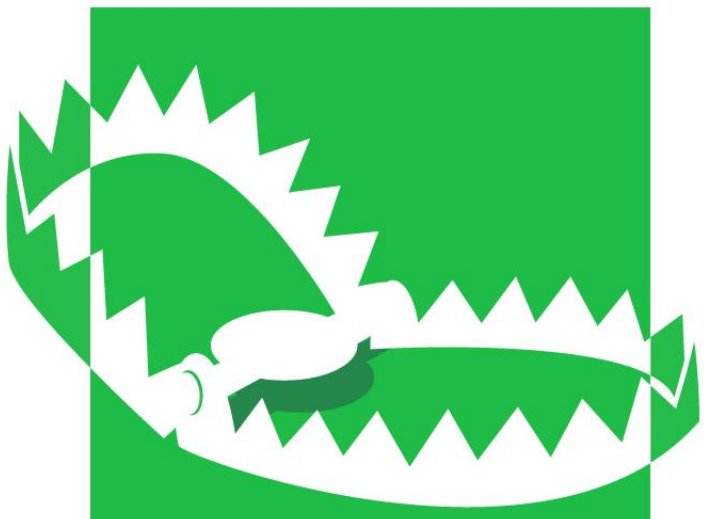
After a beat and another scan, he looked at me and said; "I didn't know you had a print magazine."

*If you want your own PC Magazine hoodie, you can get one on Zazzle.
[[http://www.zazzle.com/pcmag_staff_hoodie-235727585553574892]]

dan_costa@pcmag.com

READER INPUT

/ YOUR COMMENTS



DirectTV Is Now A Trap!

Our Sascha Segan wrote about how AT&T's new DirectTV Now plan transplants the widely hated cable model into the cord-cutter world. Here's how readers see it.

RESPONSES:

This will be a great service once they add a virtual DVR service and ROKU support. At $35 lousy bucks for 100 channels, grandfathered forever with no expensive cable boxes to rent, who cares that it is basically a cable bundle. 60 odd cable channels have a 3 day rewind feature (not yet fully implemented) where you can watch anything "aired" in the last 3 days. Further, is has all the sports networks, bar none (ok, maybe no NFL Network... no biggie)

The real problem with the service is that there is no way to throttle back data usage with the Apple TV app, so if you have a usage cap, be prepared to get threatening emails or pop-ups from your ISP, or big overage charges. Mind you, this isn't a problem for me since I use this on my business Internet service which has no caps.
—SonoranSeeker

The author is very confused on net neutrality. Where were he and others when radio and TV over the air launched and continue today by charging the highest amount for commercials? Based on the author's logic, TV and radio should give commercials for free or charge smaller companies lower fees. What about TSA express lines and toll tag readers on highways? Are they not fair, for the few and privileged? Maybe we want China's net neutrality implementation?
—Tim Courtney

Net neutrality is in place because the Internet is an essential communication service that is required to be competitive in today's world. When you have an effective monopoly on a critical service, like Internet access, or telecommunications, or water, power, etc, then different rules apply to you. That's a good thing. All the products and services that we enjoy today, including this website, exist because the Internet was built on the concept of net neutrality... Capitalism works wonders when there are truly free, competitive markets with low barrier to entry... The problem that people seem to miss is that corporations abhor free markets. Free markets means competing for customers, offering compelling products and services, and actually having to incentivize the customer to choose your product or service over a competitor's product.
—Craig C.

ISPs and cell service providers should not be allowed to own or have any ownership interest in content companies. That way they have no conflicts of interest, and if they want to sell unlimited data to a third party, they could do so without the two-pocket issue Sascha highlights. The other side of this is that major content providers (say those with 10 million subscribers) should be required to offer their channels on an a la carte basis with pricing for the largest bundle that is no more than 10 percent less than the sum of the individual channels... so content companies (like Fox and Disney) and distributors (like Comcast and ATT) should not be allowed to effectively tie the purchase of channels together.
—RightTech

Ask us a question!

Have a question about a story in *PC Magazine*, one of the products we cover, or how to better use a tech product you own? Email us at **letters@pcmag.com** and we'll respond to your question here. Questions may be edited slightly for content and clarity.

Groundbreaking fMRI Study Finds 4 Distinct Neurological Subtypes of Depression

BY JESSICA HALL

New research from Weill Cornell has isolated four distinct neurotypes of depression. But its knock-on effects are much wider in scope. The work establishes biomarkers for depression, and it sheds new light on the physical underpinnings of psychological disease.

The study captured fMRI brain scans from more than a thousand participants in order to answer a question: What's different between the brains of healthy people and those with depression? What it found is that within the umbrella category of "people who have major depressive disorder," are (at least) four

distinct neurotypes, each with its own cluster of associated symptoms. And the neurotypes aren't random. They align with their symptom clusters along two major axes: anxiety and anhedonia (the inability to feel pleasure). The authors refer to the axes as a shared pathological core, by which we can understand the relationship between brain connectivity and the symptoms of depression. These newly discovered patterns of abnormal connectivity are biomarkers for depression: something neuroscience has been chasing for a long while, without much success.

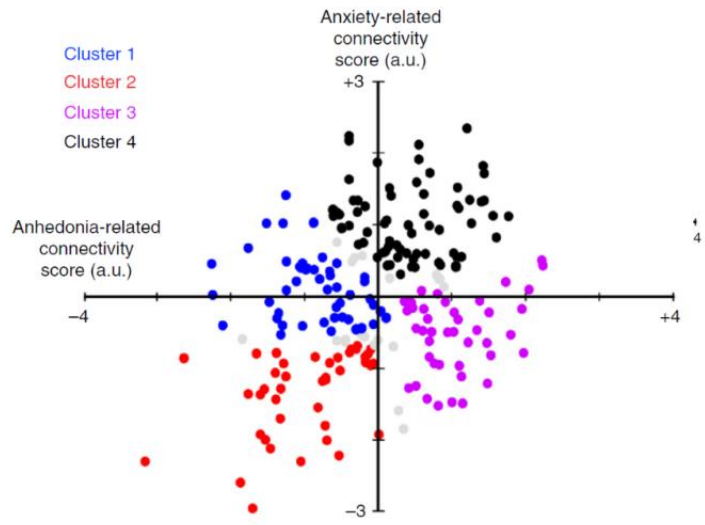
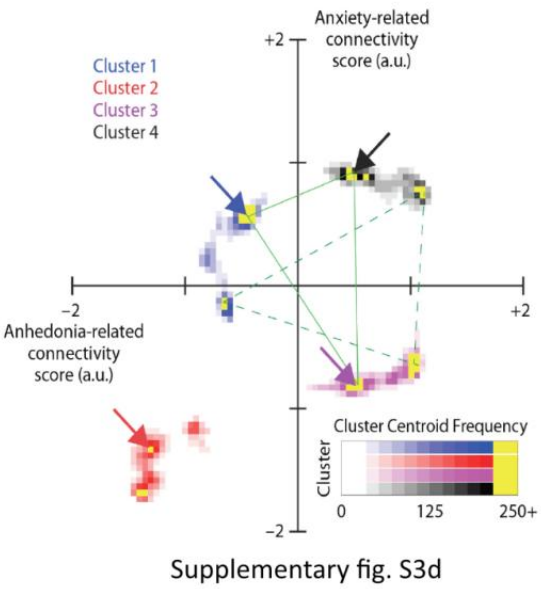


Fig. 1f

From the paper (emphasis ours):
"We found that, superimposed on this shared pathological core, *distinct patterns of abnormal functional connectivity differentiated the four biotypes and were associated with specific clinical-symptom profiles*. For example, as compared to controls, reduced connectivity in frontoamygdala networks, which regulate fear-related behavior and reappraisal of negative emotional stimuli, was most severe in biotypes 1 and 4, which were characterized in part by increased anxiety. By contrast, hyperconnectivity in thalamic and frontostriatal networks, which support reward processing, adaptive motor control and action initiation, were especially pronounced in biotypes 3 and 4 and were associated with increased anhedonia and psychomotor retardation. And reduced connectivity in anterior cingulate and orbitofrontal areas supporting motivation and incentive-salience evaluation was most severe in biotypes 1 and 2, which were characterized partly by increased anergia and fatigue."



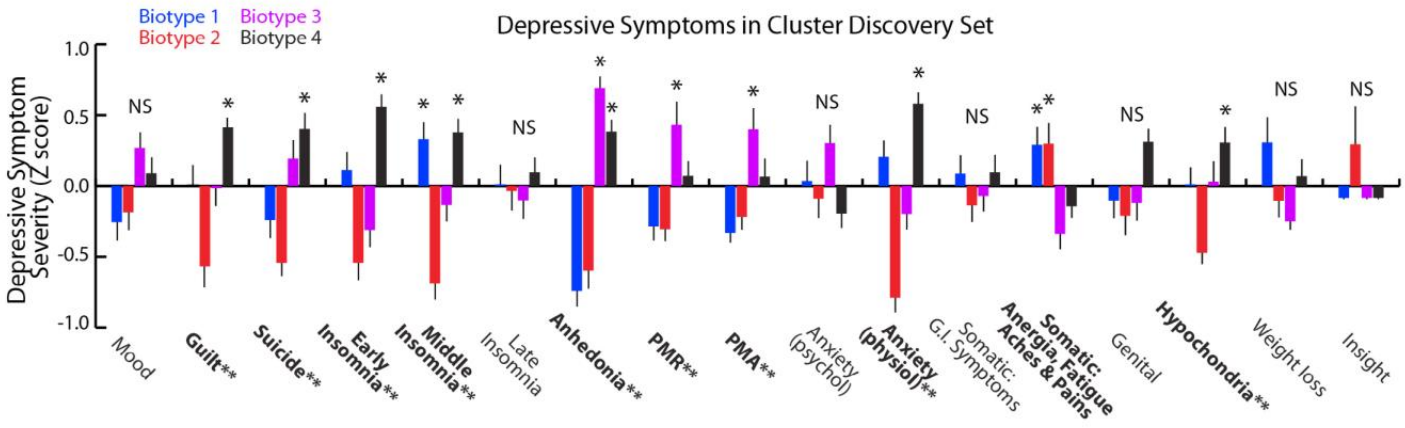
Supplementary fig. S3d

Neurotypes 1 through 4, in this figure called clusters 1 through 4. This study maps each neurotype in two dimensions: anxiety and anhedonia.
Figures: Liston et al, 2016

To parse the results of this study, it's helpful to know the vocabulary. The frontal cortex, also called the forebrain, is associated with executive control: It's what lets a kid prevent himself from reaching for a cookie. It sends inhibitory signals and provides a filter between

what we think and what we say. The limbic system consists of a set of brain regions related to emotion. I often refer to it as the lizard brain, because the limbic cortex was the earliest cortex to emerge, it probably did so in reptiles, and it handles deep motivations like fear and affection. The amygdala is part of the limbic system, and it particularly handles fear. Also part of the limbic system is the deeply buried anterior cingulate gyrus and the orbitofrontal cortex behind the eyes, both of which handle anticipation and motivation; wacky connectivity here can result in the "don't wanna," the feeling that you don't have enough energy for whatever's coming next. Similarly, the link between the striatum and the forebrain enables reward processing and the initiation of physical motion. When the forebrain has too much control, people can experience psychomotor retardation: the feeling that gravity has sort of tripled, and everything is just difficult.

Broadly, you can say that some of the anxiety-related aspects of depression are caused by abnormal connectivity between the parts of the brain that we feel fear with and the parts of the brain that exercise control over what we feel. The amygdala says, in effect, "BE SCARED!" Fear of a situation or circumstance can jolt a person into action; this is important when, for example, there's a hungry lion to be avoided. The forebrain exerts control over the rest of the machine: Immediately dashing away might not be the best course of action, because the hungry lion might see you if you jump up and run, so the forebrain can suppress the signal from the amygdala. This allows feelings of anxiety to be thought through and reasoned past. If the forebrain has too little control over the amygdala during times when there's no threat of a lion, though, that can result in chronic anxiety. In the same way, if the limbic system isn't thoroughly connected, or if it's too inhibited by too much connectivity to the forebrain and striatum, that can result in chronic anhedonia.



Clinical symptom profiles for the four biotypes. ***Supplementary fig. 2a: Liston et al, 2016***

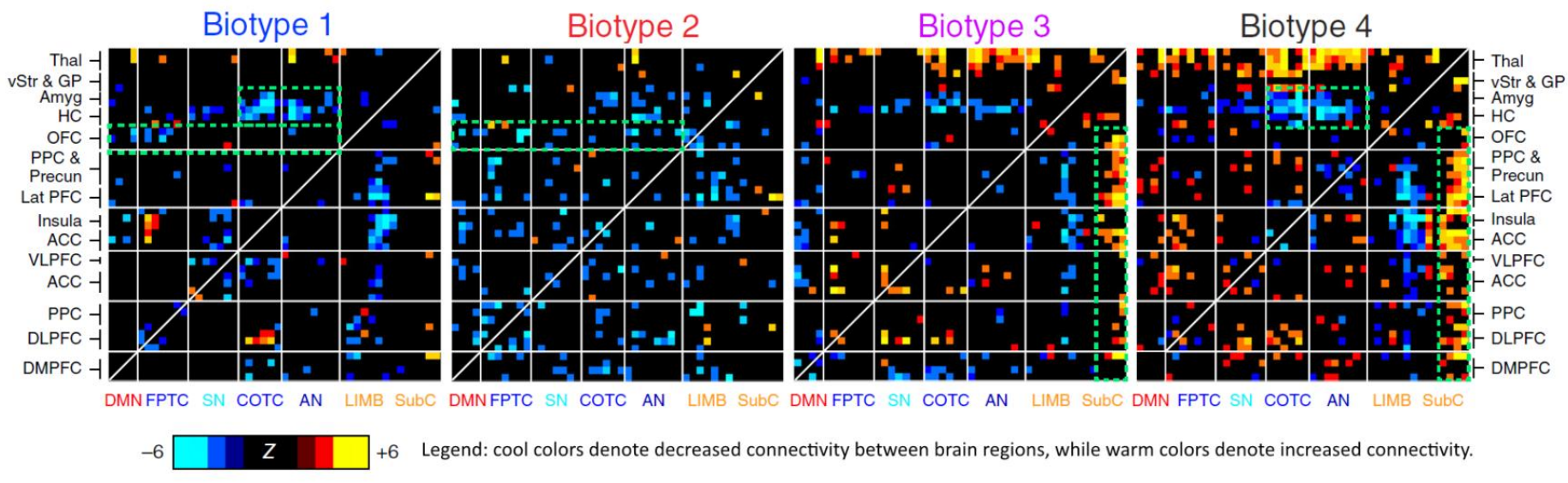
Brain imaging has come a long way from its roots in physiognomy and phrenology, but it's still frustratingly difficult to line up disorders of the mind with disorders of the brain. The study's abstract begins, "Biomarkers have transformed modern medicine but remain largely elusive in psychiatry, partly because there is a weak correspondence between diagnostic labels and their neurobiological substrates." When it comes to things like depression or schizophrenia, for example, there's no easy single neurological cause, no smoking-gun molecule or lesion that can itself explain each person's unique symptoms. This is partly because when we defined psychiatric disorders in the DSM, we did that based on symptoms, not necessarily brain anatomy or biomarkers. "Diagnostic labels don't always line up with the biomarkers," said lead author Dr. Conor Liston, because "the diagnostic labels weren't derived from biology in the first place." The diagnostic mismatch is also partly because despite the fact that you can crystallize these ideas down to too much or too little brain connectivity, brain function isn't just about the way you're wired. What we consciously do with the brain also changes how information flows through it over time, by way of neurotransmitters and changing synaptic links.

When it comes to things like depression or schizophrenia, for example, there's no easy single neurological cause.

The study reinforces a portrait of depression as not just a unitary disorder with a gazillion subtypes, but a syndrome: a collection of associated problems and symptoms that can be understood by how they overlap. As it turns out, science agrees with the idea that there's more than one "legitimate" way to be depressed. Subtypes of depression like bipolar disorder and catatonia still have their own symptom profiles and connectivity problems. But there's also this shared pathological core to be reckoned with, as another way of understanding the origins and symptoms of depression, and treating the disorder.

fMRI technology is both fundamental to this study and a limiting factor in what it can claim. What fMRIs see depends on how much oxygen there is in the blood in a patient's brain. Brains use oxygen when they do their work. If different brain regions consistently light up at the same time, that means that they're both going through oxygen at an elevated rate, so they probably share a functional connection. Areas with too many functional connections, compared to control brains, are shown in warm colors here, and areas that aren't tightly connected show up in blue because they've got a negative correlation in time. Even if two areas don't have a direct anatomical connection via some fiber tract, they can be connected via some upstream brain region, and show that connection by lighting up at the same time when the upstream region sends out its signal. As a result, fMRI studies are brilliantly suited to tell us about the functional relationships between different parts of the brain. But its resolution in time means that even with the best fMRI machines we have, we still can't really use fMRI to tell much about the direction of information flow through the brain.

fMRI studies are brilliantly suited to tell us about the functional relationships between different parts of the brain.



We can, though, make some inferences based on the structure and results of the study. The people who participated in this study had tenacious symptoms of depression that have been resistant to treatment and other clinical trials, so these results may not necessarily carry forward into the garden-variety depressed

Heat maps depicting biotype-specific patterns of abnormal connectivity compared to healthy controls (black), with the relevant areas outlined. *Fig. 2e: Liston*

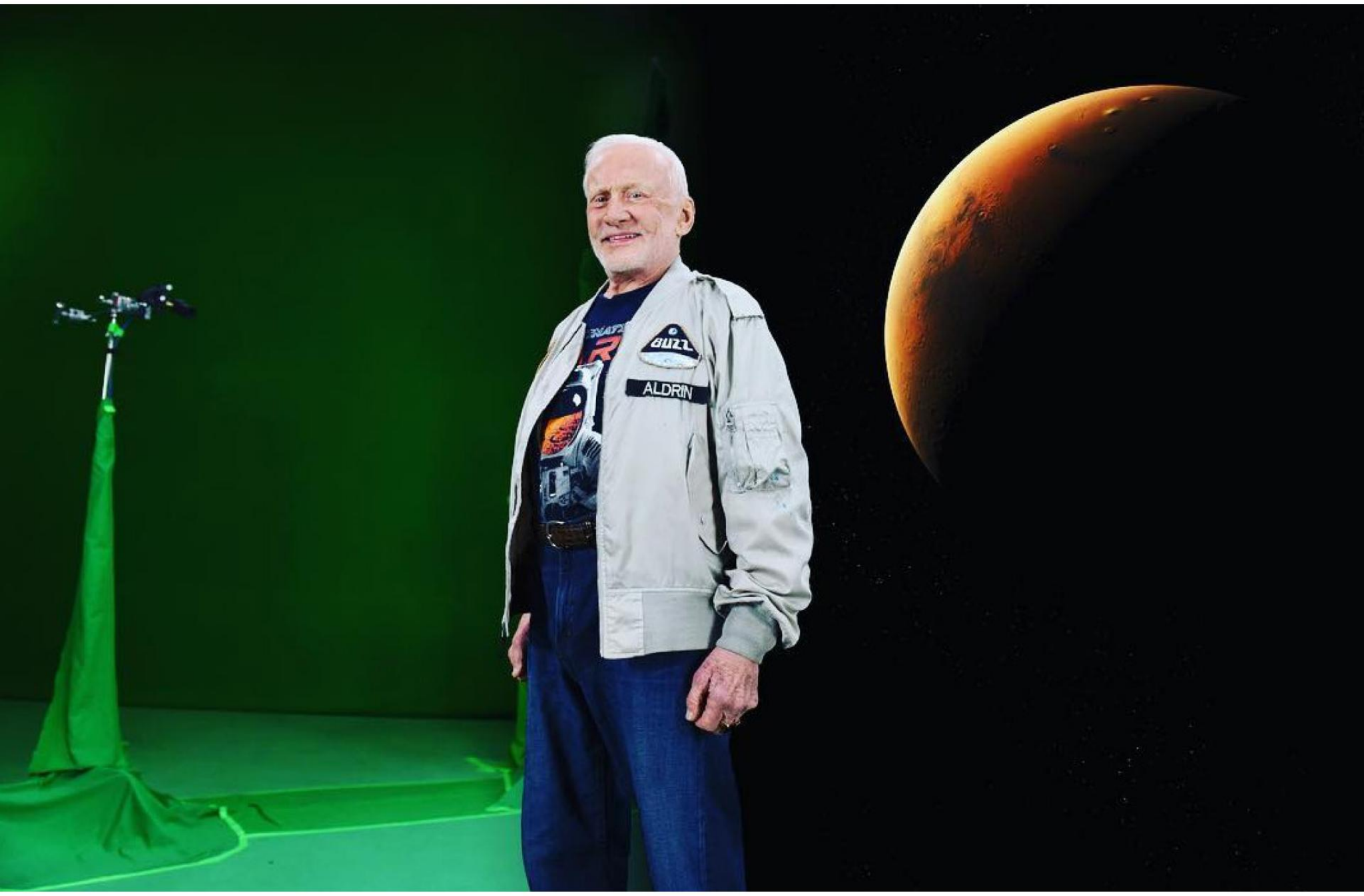
patient's treatment plan. Medication use didn't differ between the four clusters that were discovered, which implies that it didn't change the resting activity of participants' brains enough to show up across the different fMRI cohorts — but also suggests that patients' medication has more of an effect on the active, task-based function of the brain than its resting state. And the study found that of the four neurotypes discovered, type 1 had an 82.5-percent favorable response rate to trans-cranial magnetic stimulation; those patients experienced some relief from their symptoms. This implies that TMS could be a useful adjunct to treatment plans for some patients conforming to the biotype.

The differences between brain activity and brain connectivity leave a lot of important questions that have to be answered before we'll have a robust model of the human connectome, especially one that we can use to diagnose and treat disease. This is new work, and its methods and assumptions have to be tried in the field by other researchers in order to be accepted as valid. It raises specific questions that weren't within the scope of the paper. When there's abnormal connectivity between two regions, is it just because there are too few or too many neurons in the fiber tract? Or are the right number of neurons wired up, but not all of them working right? Could it be because there are pings being lost or echoed somewhere between sender and receiver? Malformed "packets?" Are there similar neurotypes for other psychiatric disorders? How much of this is genetic and how much of it is environmental or derived from life experience? Research will have to integrate our new understanding of the functional and resting connectome with the recently discovered semantic map and our evolving network diagram of the brain, before we'll be able to answer questions like these with confidence.

“The differences between brain activity and brain connectivity leave a lot of important questions.”

How VR Holograms Can Train Everyone From Hairdressers to Astronauts

BY SOPHIA STUART



Wouldn't it have been amazing to sing backup for Bowie, sit in the front row of a lecture by Einstein, visit the lab with Marie Curie, or gaze into outer space with Buzz Aldrin? Sadly, the first three are no longer with us—but Buzz is. And he's been digitized as a volumetric hologram by VR/AR startup 8i, so he's future-proofed for eternity.

TO INFINITY...

In partnership with Time Inc., 8i will create holographic messages from former astronaut Buzz Aldrin to future astronauts.

8i started in New Zealand and has several staffers, including co-founder and CTO Eugene d'Eon, who worked with *Lord of the Rings* director Peter Jackson at Weta Digital. 8i recently opened an L.A. offshoot, in a temporary space on a soundstage at Culver Studios (where Orson Welles's *Citizen Kane* and the 1960's-era *Batman* TV show were both filmed) while its new office is being constructed. PCMag met up with CEO Linc Gasking to get a demo and find out what's on the slate for 2017.

Unlike many VR houses, 8i has an actual business model and clients, including NASA and Time Inc. It recently released a high-profile VR digitization of Matrix Academy, an educational tool for hairdressers, for L'Oréal. The company trained more than 2 million hairdressers globally in 2015, but with the new VR tool, student numbers can increase exponentially.

The off-the-shelf rig 8i used for the Matrix project has "40 Point Grey cameras, with Sony CMOS sensors, pointing in, rather than out," Gasking said. "The cameras capture a multitude of angles simultaneously, which are sent to the cloud for processing using 8i's patent-pending software to create a volumetric hologram."

"Buzz Aldrin has been digitized as a volumetric hologram by VR/AR startup 8i, so he's future-proofed for eternity."

MATRIX ACADEMY
8i created a virtual-reality training program for beauty company L'Oréal to help train budding hairdressers.

Volumetric VR means that “you’re free to move around the person you’re watching as if you’re in the same room, and it has presence which tricks your mind into thinking that you really are there,” he said, which heightens “the emotional connection far beyond the limited experience of 360 video.”

Rachel Weiss, VP of Innovation and Entrepreneurship at L’Oréal, told PCMag she saw 8i’s demo at CES 2016 and was instantly taken with the tech. “We recognized early on that VR could have a profound impact on the highly visual and community-driven beauty industry and wanted to create an experience that was incredibly lifelike. After a few minutes testing the experience [at CES], we knew immediately they were the right partner for us.

“The one technical challenge along the way has been rendering hair, which is one of the hardest aspects to get right in the 3D reconstruction of humans. 8i has worked closely with us to tackle this issue, and we’re looking forward to bringing the full experience to market in 2017.”

Gasking pointed out that the new VR teaching tool will enable top stylists to cut down on physical travel, as well as reach more potential students worldwide, pretty much instantly. “You can get up close and actually see what’s happening without having to physically be there. The other thing that’s important is it’s an actual person. It’s not a computer-generated figure—it feels real, because it is.”
I can attest to this. When I tried the demo, something in my brain wouldn’t let me walk through the hologram, even though, logically, I knew it was digital. It was most curious.

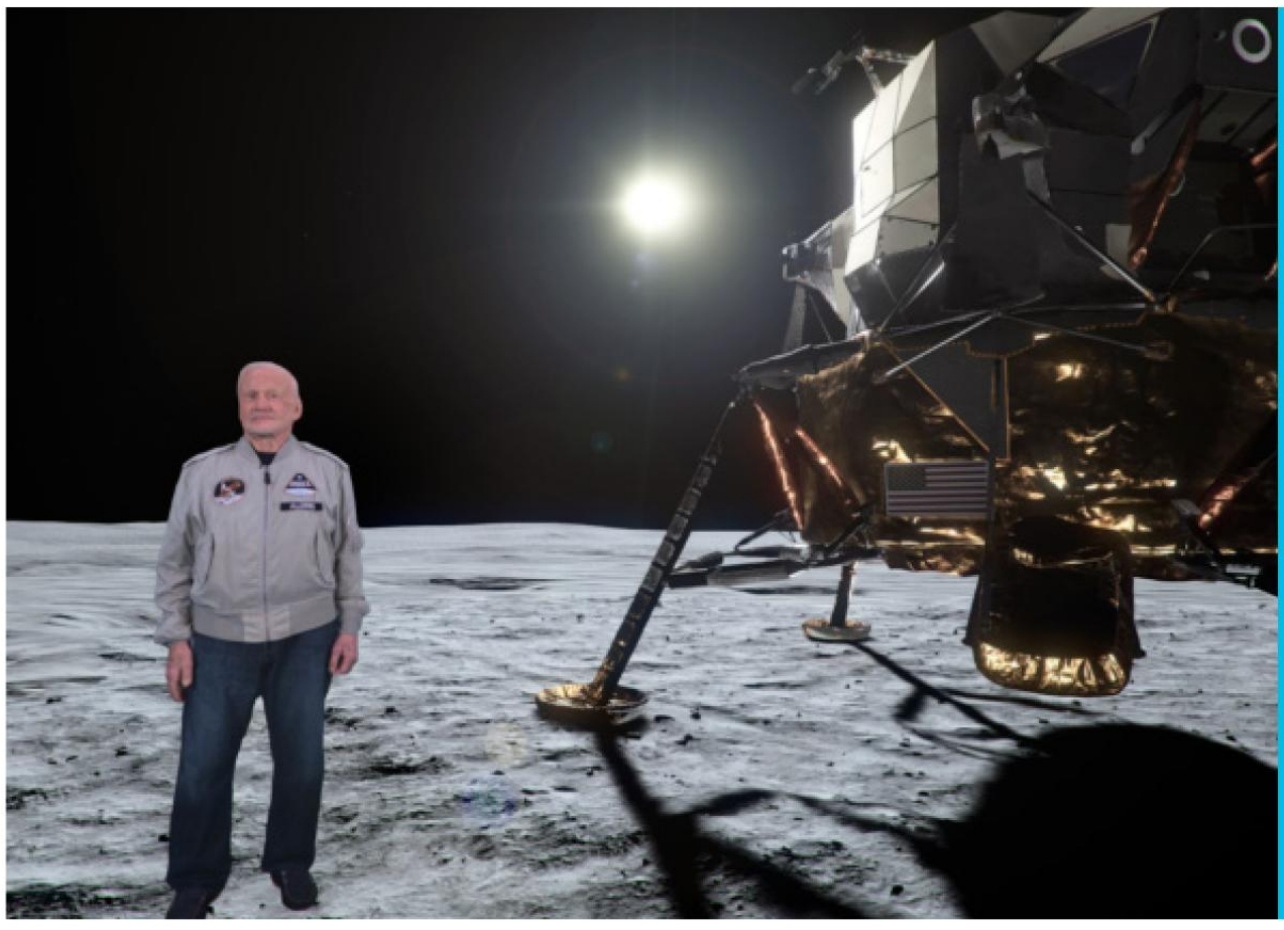
Here’s what happened: I put on the HTC Vive and headphones. Suddenly, a Matrix stylist materialized, welcomed me, and explained the day’s tasks. I quickly took a full 360-degree scan of the room, and the illusion was complete. My head believed it was inside a hair salon. We cut—seamlessly, as if I’d done a time-lapse body jump—to another room, and I peered up close, watching the stylist explain flat-iron techniques on a hair model. I could see how students would find this VR tool entirely normal pretty quickly.

On the soundstage, we got a sneak peek at some more-evolved, high-end holograms for proof-of-concept "wow" pitches, including examples from the R&D lab in New Zealand of upcoming holograms. It's too early to talk about specifics, but 8i Communications Chief Amy Sezak indicated the company will put out a commercial version of its software sometime in 2017.

What's really interesting about 8i is that, unlike many other companies, it has flipped the digital fabrication process. Instead of starting with motion capture and building a digital avatar from that framework, it went the other way, most noticeably with the recent project for Time magazine with Buzz Aldrin, who recorded messages for scientists training for Mars missions.

Six people lived at a University of Hawaii Mars simulation site from August 2015 to August 2016, to study the effects of long-term isolation. They received holographic recordings of Aldrin and vocal artist–comedian Reggie Watts, "which when viewed in virtual reality, simulate true presence and could help mitigate the feeling of isolation," according to 8i.

Those recordings will be released to the public in early 2017 as part of Time's Live VR project. Those with Google Cardboard or VR headsets such as the Samsung Gear VR, Oculus Rift, and HTC Vive can download the app and experience Aldrin and Watts in virtual reality.



IT'S LONELY OUT THERE
8i CEO Linc Gasking says, "We're excited to enable future generations of astronauts to communicate with loved ones, relive memories, and experience archived messages from historical figures like Buzz Aldrin."

"As with the Buzz Aldrin example, we are focused on getting the VR industry to take a leap over the 'uncanny valley,'" Gasking said.

8i cannot confirm or deny this, but one reason a move to L.A. must have made sense is that Hollywood studios are looking to digitize their movie stars for eternity. Bearing in mind that his company's technology now makes this possible, which important figure from history does Gasking wish he could still interact with?

"I'd really like to have heard first-hand from New Zealander Edmund Hillary about his experiences climbing Everest, that's for sure," he told us. Wouldn't it be brilliant, rather than purchasing an audiobook and listening to it on a digital device, to rent a hologram of Douglas Adams, who would sit on the other end of the sofa and read those immortal lines: "Far out in the uncharted backwaters of the unfashionable end of the Western Spiral arm of the Galaxy..."

Adams is no longer with us either, but many geek-favored writers are. Let's hope they are booked into the 8i soundstage by their publishers soon.

"What's really interesting about 8i is that, unlike other companies, it has flipped the digital fabrication process."

MIT: Uber, Lyft Vital in Reducing Congestion

BY STEPHANIE MLOT

Uber and Lyft are more than just a nuisance to taxi and private-hire firms: They play a vital role in reducing traffic, pollution, and energy usage. A new MIT study suggests ride-sharing services could eliminate 75 percent of the vehicles on public roads without significantly impacting travel time.

Led by professor Daniela Rus of MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL), researchers developed an algorithm that found 3,000 four-person cars could serve 98 percent of taxi demand in New York City, with an average wait time of 2.7 minutes. This theory works only if people are willing to truly share their rides, though—not just with a stranger behind the wheel but also with strangers in the backseat.

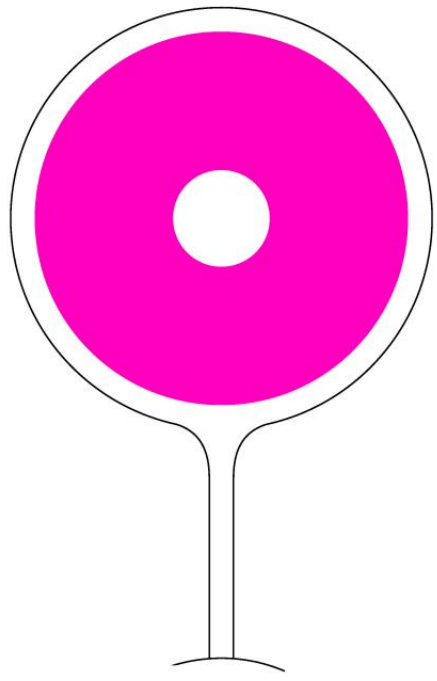
An algorithm found that 3,000 four-person cars could serve 98 percent of taxi demand in New York City.

"Instead of transporting people one at a time, drivers could transport two to four people at once, results in fewer trips, in less time, to make the same amount of money," Rus said in a statement.

MIT is also eyeing buses and shuttles, which can carry up to 10 people at a time.

"A system like this could allow drivers to work shorter shifts, while also creating less traffic, cleaner air, and shorter, less stressful commutes," Rus said.

The algorithm, according to MIT, creates two graphs: one with all requests and all vehicles and one with all possible trip combinations. The computer then assigns cars to trips and can rebalance idle drivers by sending them to higher-demand areas.



"Ride-sharing services have enormous potential for positive societal impact with respect to congestion, pollution and energy consumption," Rus said. "It's important that we as researchers do everything we can to explore ways to make these transportation systems as efficient and reliable as possible."

Dealing With Pain? Ella Will See You Now

BY SOPHIA STUART

There are many apps in the mHealth category. Most are focused on wellness, but some are directly designed to streamline everyday health needs: providing access to medical data, making appointments, checking refills on medications, and exchanging messages with doctors about test results.

Then there's the emergence of the "Internet of Health," a digital layer of technology products, often controlled by patients but monitored by medical professionals and underpinned by data.

PCMag has written about some of these before, including VR trials with wounded warriors returning from combat suffering from extreme burns or the trauma of PTSD. Newer products, such as Ella, a mindfulness-training and medical-support service for chronic pain sufferers—currently in early hospital trials in Los Angeles—are transforming the relationship between patient and medical professionals. PCMag visited the Techstars Healthcare Accelerator, in partnership with Cedars Sinai, in Los Angeles, to meet Peder Sande, CEO of Ella and learn how it (she?) works.

Chronic conditions are expensive to treat and highly debilitating for patients. According to Ella's research team, more than 100 million people in the U.S. are in physical pain on a daily basis, half with moderate to severe pain.

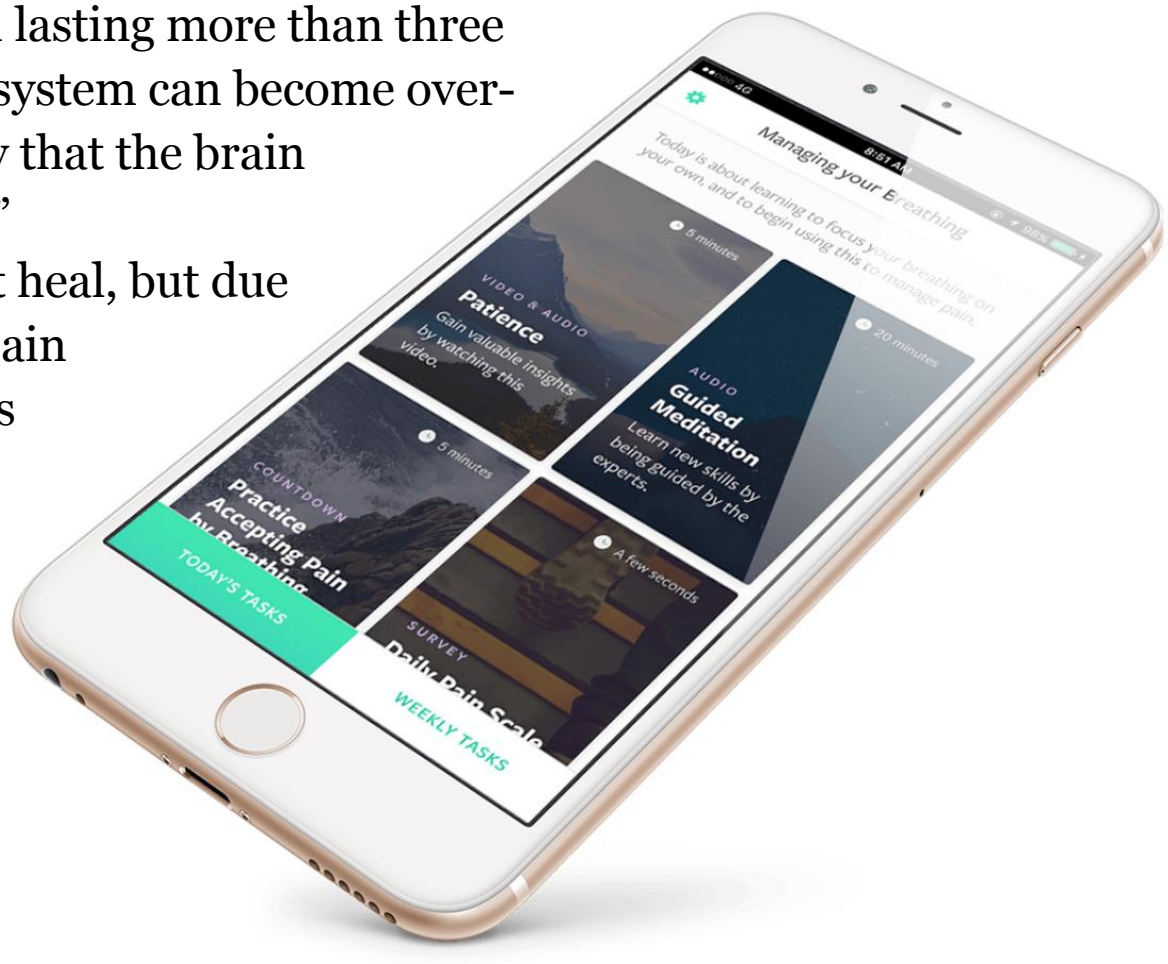
More than 100 million people in the U.S. are in physical pain on a daily basis, half with moderate to severe pain.

"However, the processing of pain is a very complex neurophysical system, which we still don't fully understand," Sande told PCMag. "As a researcher and a scientist by training, I always preface everything by saying that. There's the peripheral nervous system—the body—and the central nervous system—brain—and pain signals move from one to the other via the spinal column. With persistent pain lasting more than three months, the central nervous system can become over-sensitized; it changes the way that the brain processes those pain signals."

So the physical trauma might heal, but due to incessant hammering on pain receptors, the central nervous system undergoes a reorganization, and people may well still feel pain.

AN INTERNET OF HEALTH APP

Ella is a mindfulness-training and medical-support service for chronic pain sufferers.



“But the way that we’ve treated pain hasn’t really changed in a hundred years—namely, opioid prescription drugs,” Sande pointed out.

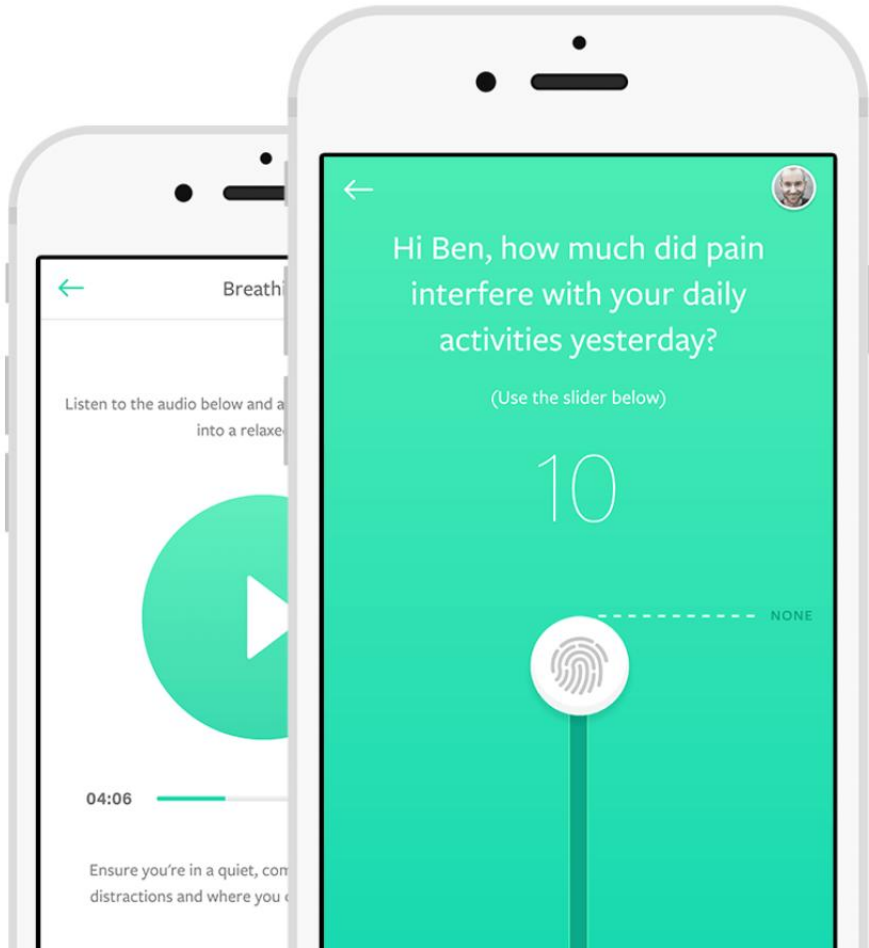
You can see why Cedars Sinai and other healthcare providers are looking for smarter ways to manage an increasing number of patients in pain. Ella is currently in trial with 100 Cedars Sinai patients and their NIH PROMIS (National Institute of Health standardized system) scores for pain intensity, functional status (mobility), depression, and anxiety are showing marked improvement.

Sande has been immersed in complementary interventions that pair well with traditional medical thought for many years now. He’s a global neuroscientist expert who followed his MSc in Cognitive Neuroscience at the University of British Columbia with stints as Science Advisor at the Dalai Lama Center for Peace and Education and Research Fellow at The Mind and Life Institute.

His work has been focused on how ancient mental-training techniques—including meditation—change the actual structure and thus function of the brain. Sande hopes Ella can bring this melding of science, mindfulness, and medicine to chronic pain sufferers and allow them to get their lives back. “We’re not eliminating the pain,” Sande explained. “We’re changing the cognitive and affective processing of the pain in your central nervous system.” So, reformatting a patient’s neural network? “Exactly,” said Sande. Through Ella, we are changing the patient’s relationship to pain as well as the stresses associated with long-term chronic pain, which can exacerbate the problem.”

Here’s how it works: The patient logs into Ella, gets the day’s self-directed audio guide, and leaves feedback when they’re done. They can also remotely check in with a real-life mindfulness instructor on a weekly basis or other chronic pain sufferers.

“We’re also building in a live-streaming function where everyone can participate in a timed guided meditation with an instructor, no matter where they are in the world—making Ella eminently scaleable,” said Sande.



Ella is a Web app for now, using a Firebase back-end to keep the data synced, handle authentication and file storage. But eventually, it will be rebuilt as a native Android and iOS app.

The business model is currently B2B. Ella is available as a managed service for healthcare providers, integrating into their current software setup, allowing doctors to measure and monitor patient outcomes and track cost savings. If the trials go well with Cedars Sinai, Sande hopes to open it up in late 2017 to consumers as a standalone mobile product.

The growth in Internet of Health apps is happening mostly because of a new generation of doctors, surgeons, and nursing staff who are not only comfortable with mobile technology but are also open to using it to improve patient interaction.

His work is on how ancient mental-training techniques change the actual structure and thus function of the brain.

"Due to the epidemic in chronic pain in the U.S., there are openings within the healthcare system for these sorts of mindfulness technology services, where there just wasn't before," agreed Sande.

Perhaps the company could hook up up Ella into a sentient dwelling. Or it could be delivered via a helpful healthcare robot that powers up your Ella mindfulness lesson, makes sure you're in a comfortable position, and reminds you to take the prerequisite three deep breaths, before you begin.

What We Love Most This Month (CES Edition)

BY PCMAG STAFF

HP ELITEBOOK X360

The HP EliteBook x360 is a business laptop with style. Taking plenty of inspiration from the HP Spectre x360, the new convertible model is slim and light but durable and secure. It's just 0.59 inches thick but packs plenty of speed and can be configured with up to a 4K touch display. One of its killer features is the optional HP Sure View, a built-in privacy screen that can be toggled on and off with the press of a button. It works like a charm, thwarting prying eyes without the need for one of those unsightly films .

Shipping in late January; price not yet announced. www.8.hp.com

ASUS ZENFONE AR

Augmented reality is in its very early days, but it may turn out to be even bigger than virtual reality. The Asus Zenfone AR is the first manageable-size smartphone to be able to run both Google's Daydream VR and Tango AR systems. Unlike the gigantic Lenovo Phab 2 Pro, the first Tango device, the Zenfone AR actually feels like a phone you'd want to use, even if you never augment your reality. It has a sharp camera, a high-res screen, a fast Qualcomm Snapdragon 821 processor, and a nicely textured back. Asus doesn't tend to sell a lot of phones in the U.S., but this one shows us where Google wants to push all of our forms of reality.

Shipping in second quarter of 2017; price not yet announced. www.asus.com

MISTFIT VAPOR

Amidst a sea of forgettable smartwatches at CES, the Misfit Vapor truly stood out. From its comprehensive fitness tracking to its understated elegance, the Vapor is an excellent blend of form and function. Its AMOLED display is bright and colors are vibrant, and its circular touch bezel means you don't have to worry about constantly wiping greasy fingerprints off the screen. And it's kinder to your wallet than the Apple Watch Series 2.

$199.00 www.misfit.com

LENOVO SMART ASSISTANT

The Lenovo Smart Assistant is a lot like the Amazon Echo—only it looks better, sounds better, and costs less. Just like the Echo, the Smart Assistant uses Amazon's Alexa voice assistant; it answers your questions, makes grocery lists, and, of course, orders stuff from Amazon. The speaker comes equipped with a 5-watt tweeter and a 10-watt woofer. An upgraded Harman Kardon Edition includes an extra 2-inch sound cavity for enhanced sound quality (pricing hasn't yet been announced). We're looking forward to a head-to-head comparison with the Echo when the Smart Assistant comes out in May.

Shipping in May, $129.99 www.lenovo.com

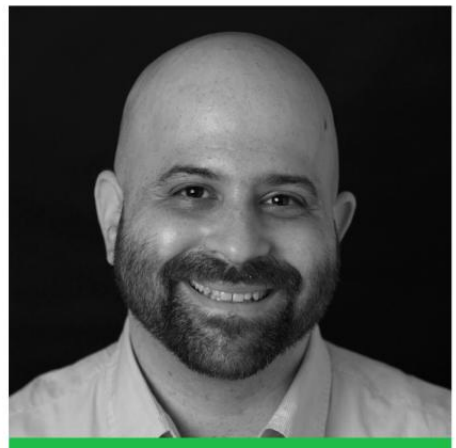
DELL CANVAS

This is a horizontal Surface Studio-like device with a few key differences. It has no PC hardware of its own, which greatly reduces the cost. Instead, it connects to an existing PC and monitor, serving as a second input-focused screen. The 27-inch display is a natural evolution of an artist's analog workspace, complete with a tool called the Totem that allows for physical control of the digital UI. With QHD resolution, it looks sharp but isn't as demanding as 4K, so it's better for working with a wide array of systems.

Shipping in spring, $1,799 www.dell.com

Is the Smartphone Already Obsolete?

Revolutions are only relevant until the next revolution comes along. Over the past decade, the smartphone revolution has fundamentally upended daily life. Walk through any public space and you'll find people of all backgrounds transfixed by pocket-size rectangular obelisks. These little wonder slabs magically connect us to the rest of humanity and are personal windows into the digital ghost dimension that flows beneath civilization's surface.



Evan Dashevsky, a features editor for *PC Magazine*, has been writing about tech since 2010 for such publications as *PC World*, TechHive, ExtremeTech, and Digital Times.

This revolution has been riveting—and it all happened in the relative blink of an eye. So it shouldn't be too difficult to imagine how the next big thing could come along and upend everything just as quickly. The smartphone era turns 10 this year, but the next great form factor may be ready to take its place. Perhaps that sounds like an absurd notion. Don't just take my word for it—look at where Big Tech is placing its bets for the future.

RISE OF THE HIVE MIND

Ten years ago this month, Steve Jobs took the stage at Macworld to announce the Apple iPhone. Under his second tenure at Apple, the company had already managed the twin masterstrokes of reimagining consumer hardware design and reinventing the music industry. This new

undertaking, however, would prove transformative.

Despite its name, the iPhone's chief purpose was never making iCalls—it was untethering the Internet. Smartphones existed before 2007, as did mobile devices that could bring users online. But the iPhone was the first device to strike the right balance of technology and humanity to make the platform worth using.

The first-generation iPhone introduced the masses to the concept of computing everywhere. Following that breakthrough, the Internet would join people at the dinner table, while walking the dog, in line at the post office, while watching TV, while running for the presidency, and in the bathroom.

If a time traveler from the mid-90s arrived in 2010, he'd find himself in an era where no bit of knowable information—or social contact—was out of reach; the hive-intelligence was always present. Not to get all "singularity" on you, but mobile tech has represented a major step toward our inevitable melding with the digital world.

In the 10 years since the iPhone's debut, smartphones have become fixtures of everyday life. A 2015 Pew Research study found that 86 percent of U.S. adults owned smartphones, including a majority of adults who earned less than $30,000 annually. In fact, for 13 percent of adults in this bottom economic tier, smartphones are the primary way they get online—a decent midrange smartphone on a discount mobile plan is more affordable than a laptop and home Internet access.

Smartphone prices have fallen while features expand. Many phone cameras can rival DSLRs, some devices legitimately boast all-day battery life, and mobile processing power can match that of laptops from only a few years back. Looking forward, smartphones are beginning to flirt with UIs not originally intended for phones, such as virtual and augmented reality. Phones are even beginning to use advanced applications including artificial intelligence.

This is where things begin to look familiar. Just as when advancements in a few once-unrelated technologies allowed modern smartphones to come into existence in the 2000s, a new technological convergence appears to be taking shape. In fact, I would argue that the next great form factor is already here.

“Fast forward to 2017, and it feels almost quaint that we are still accessing our virtual world through palm-sized rectangles.”

TIME FOR PHONES TO PHONE HOME

Fast forward to 2017, and it feels almost quaint that we are still accessing our virtual world through palm-sized rectangles. As everything around us inches towards seamlessness (from smart locks to Amazon Go), it seems strange that we still need to reach into our physical pocket to fish out our little friend, unlock the screen, and navigate to the right app just to check our email. I hope I’m not coming off as too #FirstWorldProblem here, but in a world surrounded by silky-smooth automation, using a smartphone to complete basic tasks is beginning to feel clunky and garish.

Smartwatches have attempted to smooth the transition between the physical and virtual worlds. But their tiny interfaces are poor windows to the rich virtual universe.

I want to easily control my gadgets through voice or gesture and instantly be whisked away to the virtual domain of my choosing without having to touch a phone. But I also want to have some privacy so that not every lookie-loo in gawking distance can see where I choose to spend my virtual time (if I want to catch up on The Bachelor during my commute, that's my own business).

As it turns out, this technology actually already exists—albeit in a primordial form. The Microsoft HoloLens projects virtual images (aka holograms) onto a faceplate in front of the user, who can interact with them in three dimensions. So if there's a hologram of an animated dinosaur, the user can walk around it IRL to check it out from all angles. A user can also place a virtual video screen in an arbitrary location in mid-air and and view it from different perspectives.

The HoloLens lets you construct a virtual, explorable environment or walk through a virtual world created by others. That's an amazing new medium.

Microsoft is far from the only company attempting to break into the "mixed reality" face-tech biz. The secretive (and controversial) Florida-based start-up Magic Leap has garnered significant financial backing from various Silicon Valley VCs. Likewise, Intel says untethered "Project Alloy" VR headsets (with front-facing sensors for AR functionality) will arrive by year's end. Even Apple is rumored to be partnering with Zeiss to build some kind of "smart glasses" (which will hopefully be more successful than Google Glass).

I should note that these devices are by no means polished, consumer-ready products (the HoloLens has only three hours of battery life, for example). But man, are they cool! After taking the HoloLens for a test drive, I can imagine how Steve Jobs and company must have felt trying the multi-touch display that would underpin the iPhone UI and seeing the possibilities that lay ahead.

Anyone can pick up their own HoloLens Developers' Edition for $3,000—but you really shouldn't do that unless you're a developer or happen to be burdened with too much money. That's a steep price, but

keep in mind the original consumer-ready iPhone retailed for $499 for the 4GB model—that's about $585 in today's dollars, or slightly more than the current price for an unlocked (and far brawnier) 32GB iPhone 6s. The price of the HoloLens or other face-tech will almost certainly come down with time, just as quality will go up.

There is one advantage that smartphones have over this new technology: Phones don't require you to don bulky, Daft Punk–esque headgear, which can look somewhat ridiculous. One of two things will have to happen for this new form factor to take off: Either engineers will need to figure out a way to shrink it to a size no larger than a pair of glasses, or society will have to get used to people wearing ridiculous things on their faces.

Let's evaluate the second option first. The idea that society might bend to technology has happened before—remember the eye rolls that Bluetooth earpieces used to provoke? Still, the current state of face-mounted tech is particularly obstructive, and it can prove problematic for anyone with hair (I'm not in that club, but I feel for y'all).

The second scenario depends on how quickly engineers can work their magic. In the TV show Black Mirror, computer interfaces are implanted in users' eyeballs, thus obliterating the barrier between man and matrix. We're probably still a ways off from that (though people are trying!), but shrinking this tech to something the size of a pair of glasses is a real possibility. It's just a matter of when. A lot of talented engineers out there routinely turn science fiction into reality.

“The current state of face-mounted tech is particularly obstructive, and it can prove problematic for anyone with hair.”

And the tech companies that employ them are particularly motivated when they catch whiff of a potential financial windfall.

I don't know if the HoloLens, Magic Leap, or even Apple will successfully make the public comfortable with placing the Internet on their faces. But as an observer of how technology has evolved over the past 20 years, I can't help but notice that the trend lines all seem to be pointing in the same direction. It might be later this year; it might be a few years down the road. But I can't imagine that the face-tech era is too far away.

Once this new form factor takes on its final, consumer-ready appearance, the small magic rectangular device in your pocket will begin to look outdated mighty quickly. Perhaps in the future, we'll see retro-loving hipsters insist on the virtue of carrying some kind of handcrafted artisanal smartphone around ("the Internet just works better that way" or some such nonsense), but most people will appreciate the utility and overall future-coolness of this new platform.

The smartphone has had a good run. But even this most ubiquitous of technologies will, at some point, find itself atop the growing pile of obsolete revolutions.

"Perhaps in the future, we'll see retro loving hipsters insist on the virtue of carrying a handcrafted artisanal smartphone around."

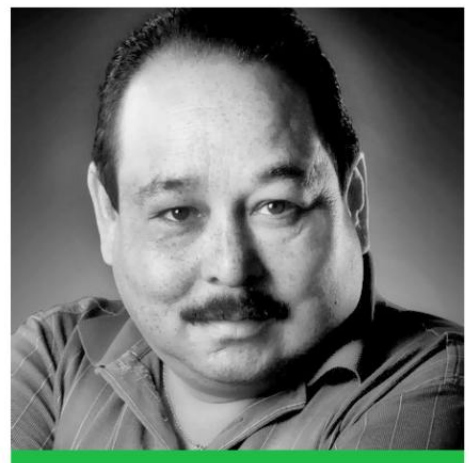
evan_dashevsky@pcmag.com

Tim Bajarin

COMMENTARY

Chromebooks: Watch out for These Windows PCs

Although there is not a lot of money to be made in low-end laptops, some of us need a more full-featured device than a smartphone or tablet but don't want to spend upward of $1,000. That's where Chromebooks and low-cost Windows laptops come in.



Tim Bajarin is the president of Creative Strategies and a consultant, analyst, and futurist covering personal computers and consumer technology.

Chromebooks have been selling well, especially in education markets. These stripped-down notebooks basically provide access to the Internet via your Google account; anything you can do on the Web can be done on a chromebook. Some are priced as low as $179, making them very attractive to the education market, though teachers might find them limited given their reliance on the Web.

At WinHec in Shenzhen, China, a few weeks ago, Microsoft and Qualcomm announced a new reference design for 32-bit Windows-based laptops that use Qualcomm Snapdragon 835 processors and runs a full version of 32-bit Windows 10. One might be tempted to say this is a rehash of Windows RT, but Microsoft has assured its customers that it is a newly designed version of Windows 10 that will work seamlessly with all Win 32-bit apps.

While we already see some basic Windows laptops on the market for as low as $299, the

processor and features of those systems are at the bottom of the performance barrel. What makes the Qualcomm-Microsoft spec interesting is that the Qualcomm 835 processor is one of the most powerful mobile processors out there and give low-end laptops more bang for the buck, so to speak. Laptops using this new spec could be a very promising alternative for thrifty shoppers who still want some oomph in their portable computers.

Conceptually, a laptop using this spec could also become a solid alternative to chromebooks, although at the moment Microsoft has not stated how a laptop with these specs will be positioned. Either way, the new spec could evolve into an interesting new laptop option in 2017.

Of course, the proof will be in the pudding. The announcement was just a spec, and we have yet to see any actual products based on this to understand its performance capabilities and how Windows 10 works on this Qualcomm processor. But if Microsoft and Qualcomm pull this off, they could revive the low-cost laptop market in the new year, and give consumers another good option.

tim_bajarin@pcmag.com

Doug Newcomb

COMMENTARY

Autonomous Cars Will Have to Be (Artificially) Intelligent

Even if a trip is only a few blocks, human drivers need to make hundreds of calculations to reach their destination safely—and we do it without much thought. For example, is it raining, sunny, clear, or foggy? Is it early morning when kids are walking to school or later in the day?

Car tech expert Doug Newcomb has written for *Popular Mechanics*, *Road & Track*, and other publications, and is the author of *Car Audio for Dummies*.

For computers to safely drive cars, they must also take these scenarios into consideration. In fact, they must have the ability to consider *every* possible scenario. That's why I predict 2017 will be the year that artificial intelligence (AI) supercharges self-driving technology. In the next year and beyond, we'll see AI take autonomy to unprecedented levels; it will allow vehicles to become fully aware of their surroundings.

"AI means everything for autonomous driving," Ian Beavis, chief strategy officer AMCI, an automotive marketing and testing firm, recently told Wards Auto. "Without AI and machine learning, you can't put vehicles in unknown environments. It allows autonomy to run free."

To get a sense of the impact AI will have on self-driving, just follow the money being invested in the technology.

Toyota alone is pouring $1 billion into AI research over the next five year and has set up an entirely separate division of the company, Toyota Research Institute (TRI), to focus on R&D in the area. Toyota also scored a high-profile hire when it brought in Gill Pratt—a roboticist and former official at DARPA, the research arm of the Pentagon that was instrumental in kick-starting self-driving technology—as CEO of TRI.

Toyota initially is looking to use AI to improve driver-assist systems and help avoid accidents. "The intelligence of the car would figure out a plan for evasive action," Pratt told Reuters in June. "Essentially [AI would] be like a guardian angel, pushing on the accelerators, pushing on the steering wheel, pushing on the brake in parallel with you."

Like other automakers, Toyota plans to leverage its AI investment into self-driving cars and produce a vehicle that can autonomously drive on highways by the 2020 Tokyo Olympics.

Toyota's Japanese rival Honda is also "setting up a new research body which would focus on artificial intelligence," according to Reuters, as are other global automakers including Ford and Volkswagen.

Large automotive suppliers and others in the self-driving race are also pouring resources into AI as well as acquiring startups in the space. Danny Shapiro, senior director of automotive at graphic chipmaker Nvidia, told Wards Auto that AI and the "deep learning" by computers it enables "will truly transform the automotive market."

Doug Newcomb

In addition to developing its own self-driving computers, Nvidia has invested in the startup AImotive. And Uber recently acquired AI startup Geometric Intelligence and named the company's founders as co-directors of the ride-sharing behemoth's in-house AI research lab.

doug_newcomb@pcmag.com

"The REM system uploads data in small bursts that can be easily handled by 4G LTE."

Huawei Honor 6: Affordable Unlocked Smartphone

Huawei Honor 6X

$279.99

●●●●○

2017 is still young, but 2016's trend of affordable, high-performance phones shows no sign of stopping, if the Huawei Honor 6X is any indication. The 32GB unlocked Honor 6X launches at $50 higher than last year's Honor 5X but brings with it a host of improvements that are worth the extra coin, including smoother overall performance and a better camera with a unique secondary lens for bokeh. The UI layer is still heavy, but it's free from the slowdown we experienced on the previous generation phone. That makes the Honor 6X an undoubtedly worthwhile improvement. But depending on your budget, the Moto G4 and ZTE Axon 7 are also worth checking out.

DESIGN, FEATURES, AND DISPLAY

The design of the Honor 6X hasn't changed much from the previous model. The brushed finish is gone, the fingerprint sensor is circular instead of square, and it has two camera sensors on the back. But it's still a metal unibody slab available in gold, gray, or silver.

The phone measures 5.9 by 3.0 by 0.3 inches (HWD) and weighs 5.7 ounces, nearly identical to the 5X and similar to the Axon 7 (6.0 by 2.9 by 0.3 inches, 6.2 ounces) and Motorola Moto G4 (6.0 by 3.0 by 0.4 inches, 5.5 ounces). Like those phones, it's a bit too wide to reach across with your thumb, but Mini Screen mode lets you shrink what's shown and move the keyboard to one side to make use with one hand easier.

Huawei Honor 6X

PROS Affordable. Sleek metal unibody build. Crisp 1080p display. Fast performance. Solid camera with bokeh control. Fingerprint sensor, dual SIM slots, and expandable storage.

CONS Heavy UI layer. No NFC or dual-band Wi-Fi.

The volume rocker and power button can both be found on the right, a 3.5mm audio jack is on the top, and the bottom holds a micro USB charging port sandwiched between a microphone and speaker grille. The left side has SIM and microSD card slots. The latter worked fine with a 256GB card, but it can also take a second SIM instead, in case you want to use two different phone numbers.

SCREEN TIME

The Honor 6 has a 5.5-inch, 1,920-by-1,080-pixel IPS LCD, the same resolution as the Moto G4 and Honor 8's screens.

The fingerprint sensor on the back is as fast and responsive as the one found on the Honor 8. It has a similar set of programmable features that allow you to touch and hold it to take a photo when the camera app is open or to swipe left and right to browse photos.

The front is home to a 5.5-inch, 1,920-by-1,080-pixel IPS LCD, the same resolution as the Moto G4 and Honor 8's screens. That works out to 403 pixels per inch (ppi), so it's not as sharp as the Axon 7's Quad HD panel (538ppi), but text and video still appear quite crisp. Color reproduction is fine and also highly customizable, letting you choose between warm and cold color temperatures. Viewing angles are good, and the phone has a setting that further improves brightness under sunlight. It also has a blue-light filter that can help reduce eyestrain at night.

> **The UI layer is still heavy, but it's free from the slowdown we experienced on the previous generation phone.**

NETWORK PERFORMANCE AND CONNECTIVITY

The Honor 6X is an unlocked GSM phone with LTE bands 2/4/5/12/20/38, like the Honor 8. The only key omission is band 17, which improves building penetration for AT&T users. The phone showed strong network performance on T-Mobile throughout my testing in midtown Manhattan, registering a top download speed of 16.6Mbps. Other connectivity protocols include Bluetooth 4.1, but the 6X offers s no NFC or dual-band Wi-Fi, as you get on the Axon 7.

Call quality is good. Voices come across with a clear, natural tone free from any robotic edge. Earpiece volume is loud enough to be heard in noisy settings, but the speakerphone isn't very strong even when Loud Voice mode is enabled. On the other end, noise cancellation is good, blotting out traffic noise, though occasionally the sound of wind caused some crackling.

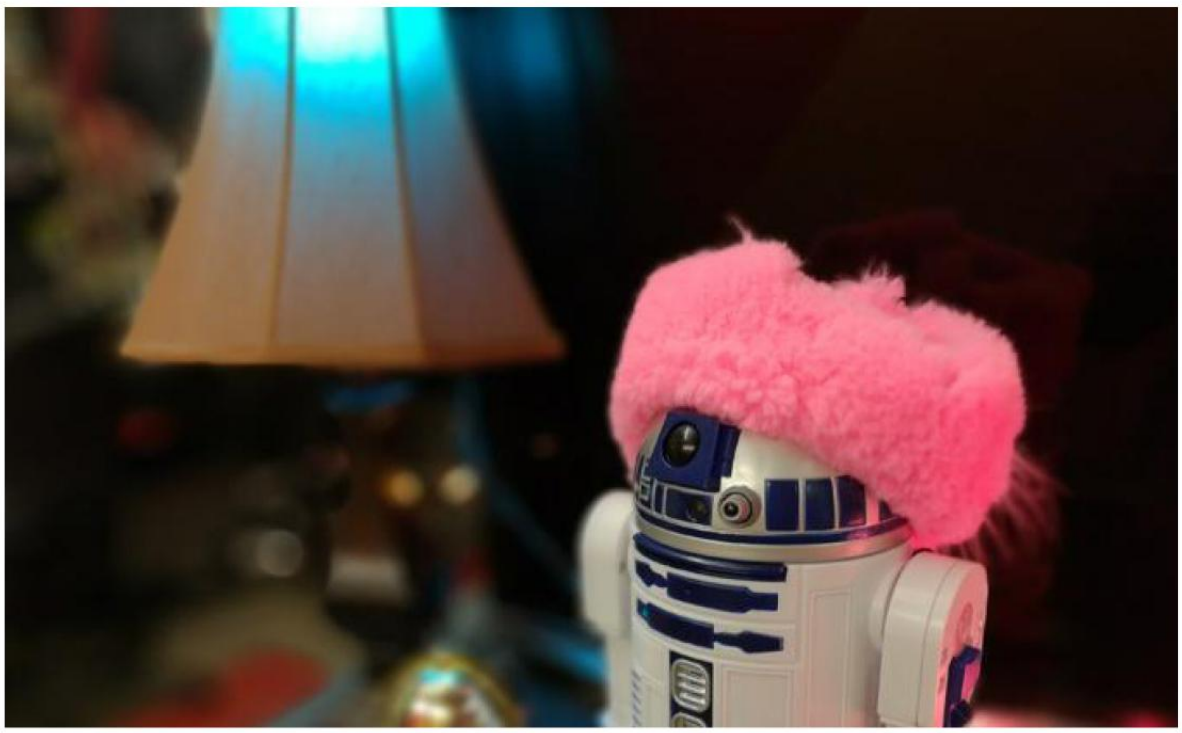
PROCESSOR AND BATTERY

The 6X is powered by Huawei's proprietary Kirin 655 octa-core chipset clocked at 2.1GHz. It's a capable processor, scoring 56,602 on the AnTuTu benchmark, which measures overall system performance. That puts it above the Snapdragon 617–powered G4 (46,260) but below the Kirin 950–powered Honor 8 (91,712). It's also no match for the Axon 7's superior Qualcomm Snapdragon 820 (141,989).

That said, with 3GB of RAM, regular usage is a breeze. The Honor 6X has none of the stuttering or sluggishness of its predecessor. Multitasking is smooth, switching between apps is swift, and I never encountered any instances of slowdown. The phone also handled GTA: San Andreas and Asphalt 8 Airborne without any difficulty, doing better than the Moto G4 in terms of control responsiveness.

Battery life is also solid, but it's nothing to write home about. The phone clocked 5 hours, 35 minutes in our rundown test, in which we stream full-screen video over LTE at maximum brightness. That's just a little less than the Moto G4 (5 hours, 58 minutes) and the Axon 7 (6 hours). It's enough to get an average day's worth of use, but probably not the two days Huawei claims. The phone has fast charging with the included adapter, and a built-in Battery Manager that lets you reduce power drain by controlling which apps run in the background. The phone also has two different power saving modes.

DOUBLE THE CAMERAS
The Honor 6X has a sleek metal unibody design with dual camera lenses and a fingerprint sensor on the back.



CAMERA

The Honor 6X uses a dual-sensor camera setup with one 12-megapixel shooter on the top and a 2-megapixel sensor on the bottom. The camera does a nice job in well-lit settings, matching the Moto G4 in overall sharpness. Pictures are clear and detailed, and autofocus locks on quickly. As with all midrange phones, shots become grainy in dimmer light, but enabling HDR or Night mode helps reduce some of the muddiness (at the cost of longer focus and post-processing times). But in more challenging low-light settings, pictures look dull and have a fair amount of noise and blur.

The camera does a nice job in well-lit settings, matching the Moto G4 in overall sharpness.

The purpose of the secondary sensor is to allow for bokeh in Wide Aperture mode. Wide aperture shots taken by the 6X worked well indoors and out, successfully focusing on objects in the foreground and attractively blurring out the area behind it.

AJAY KUMAR

Misfit Phase Makes Fitness Tracking Fashionable

Misfit Phase

$175.00

●●●●○

Design need not be sacrificed to make a great fitness tracker or smartwatch. That's the idea behind the Misfit Phase: It has the guts of a reliable but simple fitness tracker, with a few features pulled from a smartwatch, in the body of a sophisticated, classic wristwatch. It isn't as ostentatious as a luxury timepiece, but the Phase's stainless steel and aluminum body is eye-catching in its own way. Different bands can dress it up or make it more suitable for the gym. The Misfit Phase isn't as advanced as the Fitbit Charge HR or Apple Watch Series 2, but it strikes a good balance between fitness features and smart functionality, making it one of the finest analog-style trackers we've tested.

DESIGN AND BATTERY

Customizable is the word that best describes the design of the Misfit Phase. The watch face comes in several different colors, including black, rose gold, silver, black with rose gold accents (the perimeter of the rim and the hour and minute hands), navy with gold, and navy with gray. Depending on the color you choose, it comes with either a leather band or a silicone sports band, though you can't mix and match; the sets are predetermined. For example, the rose gold watch comes with a white leather strap and no option to choose something different. A Phase that comes with a leather band costs $195, while one with a sport band costs $175. For $59.95, you can buy a pack of three bands—options include leather, braided nylon, and silicone. Again, there's no mixing and matching to get the exact colors you want.

The watch face is extremely minimal, which I love; it has no extraneous visuals, no secondary dials, not even any numbers around the face. A tiny round window at the six o'clock position reveals a color that changes to notify you of incoming calls, texts, and other notifications. You can set a different color for each type of notification. The window is so tiny, though, that the colors are often hard to see.

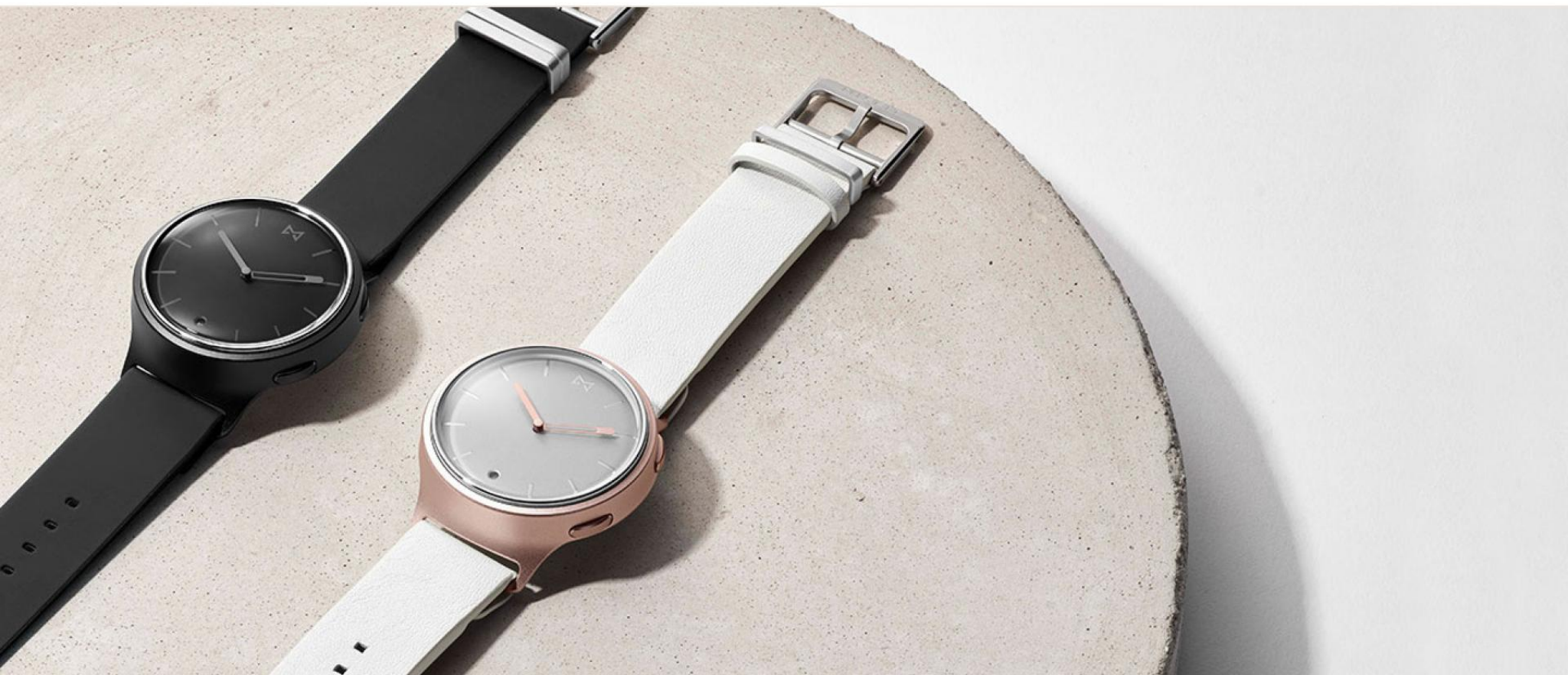
Misfit Phase

PROS High-quality materials. Bands are easy to swap. Tracks activity and sleep well. Supports push notifications. Includes a few special features. Vibration and visual alerts. Good app.

CONS Limited interface. Heavy. Not designed for petite wrists.

KEEPING TRACK OF TIME

The Phase is a high-quality watch with an analog look. But it is also a fitness tracker that comes with some smartwatch features.



Two physical buttons sit on the outside of the watch at the two and four o'clock positions. They have some special functionality, which I'll get into later. The straps swap in and out easily. You can snap one into place using your fingers, no tiny screw drivers or special spring-loaded pins required.

Somewhat predictably, the Phase is a bit heavy for my taste (2.4 ounces with the sport strap). It's a problem I find common with smartwatches in particular, and of course, they need some weight and thickness to accommodate the hardware packed inside. But there are a handful of exceptions, including the Withings Activite Pop, which is comfortably light.

"The watch face is minimal, which I love; it has no extraneous visuals, no secondary dials, no numbers around the face."

I asked a friend who has much smaller wrists than I do to put on the Phase to see how it fit. She pulled the band through the classic watch closure to the very last hole, turned her arm over a few times, and declared that it was indeed heavy on her "tiny bird wrists." My wrists are much larger, and I've been wearing with it with wiggle room fastened at the fourth from last hole. The Phase definitely feels like it's designed for men, and big men at that.

WRIST WATCH
The watch is a little on the thick side; the band comes in a classic watch style. You can easily attach a new band using hole-and-stud fasteners.

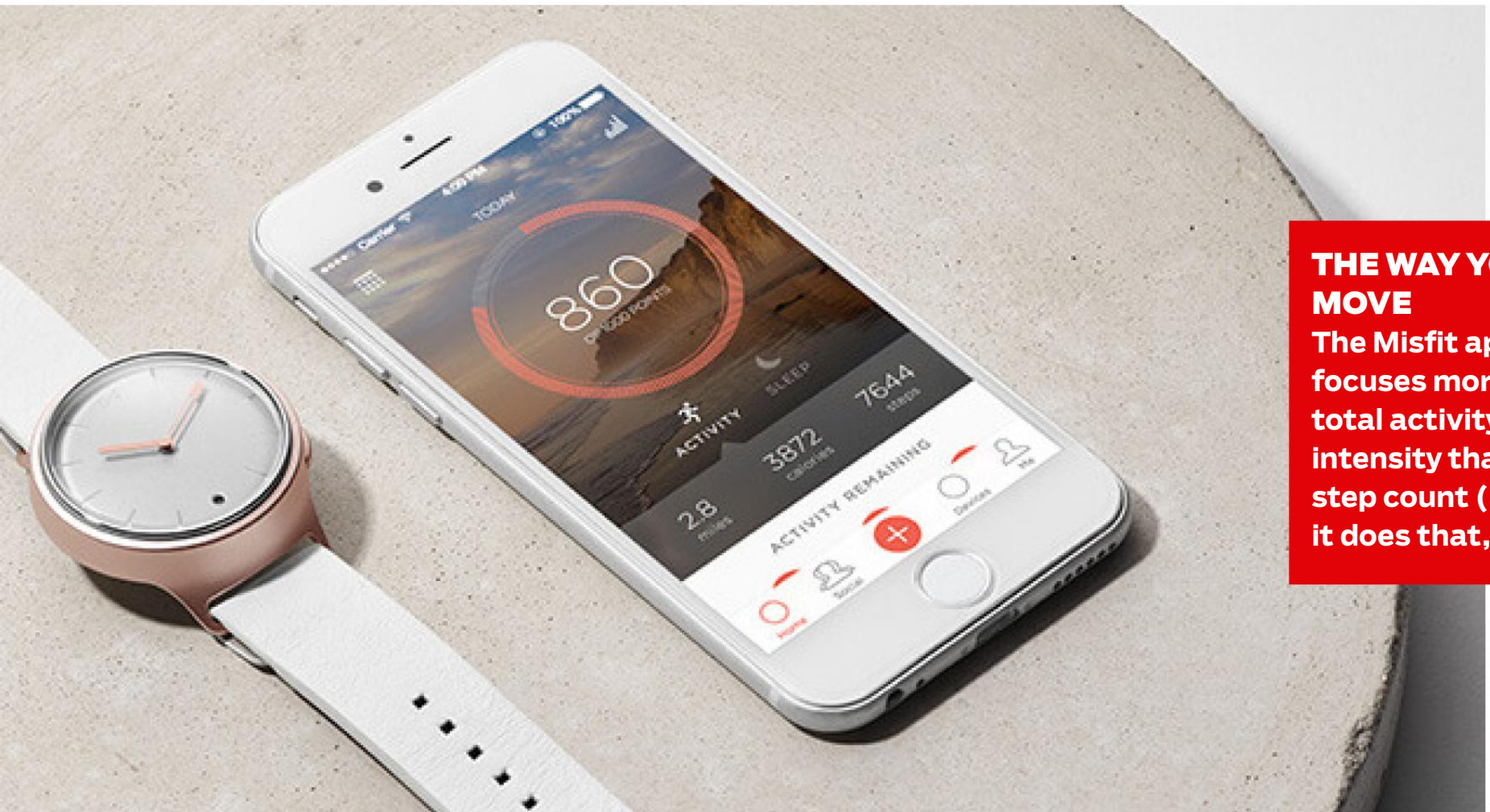
You never have to charge the Phase, as it runs on a coin cell battery, just as classic watches do. One battery comes included and preinstalled, and it should last about six months. The package also contains a little tool to help you remove the back of the watch to replace the battery.

FITNESS TRACKING FEATURES AND ACCURACY

Misfit's devices do basic fitness tracking without going overboard on detail. The Phase tackles steps, distance, calories burned, sleep (light and restful), and total overall activity based on intensity. You can tag an activity, such as a bicycle ride or swim, but there's no real specific detail about it. For example, if you run while wearing the Phase, you won't get your pace, split times—the kind information you would expect from a running watch.

I mentioned swimming; the Misfit Phase has a water resistance rating of 5ATM, which means it's safe for swimming but not diving (either poolside and scuba). I wouldn't wear it snorkeling either. But you can get it wet while washing your hands or taking a shower without worry.

With any Misfit tracker, you end up relying on the app on your Android or iOS device to see most of your activity details, although you can see your progress for the day shown as a percent toward your goal by pressing the top button. For example, if you've reached 25 percent of your daily goal, the hour hand will hang at 12 and the minute hand will shoot to 3. At the halfway point, the minute hand goes to 6, and so forth.



THE WAY YOU MOVE
The Misfit app focuses more on total activity and intensity than pure step count (although it does that, too).

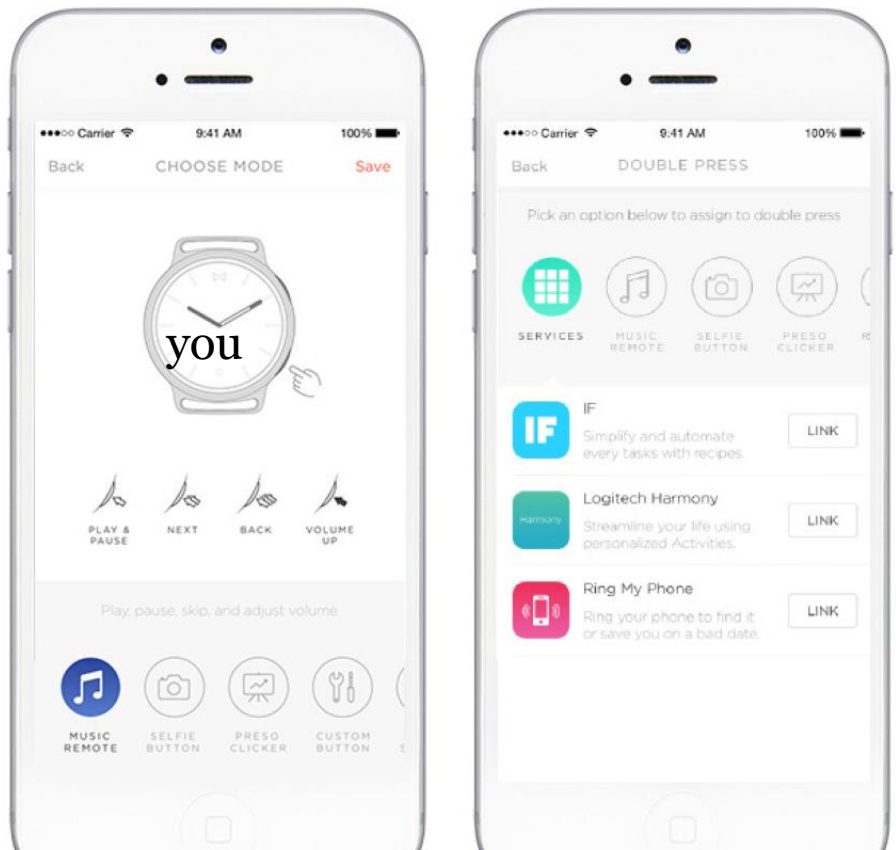
Misfit does a decent job with sleep tracking, showing total time, restful time, and light sleep both in raw numbers and on a chart in the app. The Phase is bulky, though, and while I did wear it to bed to test it, I wouldn't want to on a regular basis. The Misfit Ray, by comparison, may be the most comfortable device I've ever worn overnight.

Based on what I know from having worn fitness trackers consistently since the original Fitbit Ultra debuted, the steps and distance figures the Misfit Phase tracks are reasonably accurate. As for monitoring sleep, most trackers log my bedtime an hour earlier than normal any night that I plop down on the couch to watch an episode or two of my favorite show before bed. Sleep tracking on the Phase is accurate, and you can make it even better because you can fix it if the time you go to bed or wake up is wrong. I also really like that sleep tracking happens automatically. That's becoming a more common feature among trackers, but it isn't ubiquitous.

> **Sleep tracking on the Phase is accurate, and you can fix it if the time you go to bed or wake up is wrong.**

SMART FEATURES

The Phase comes with a few more features, such a wake alarm and an idle alert, in which it vibrates and swings its clock hands around to remind you to move when you've been still too long. Another is the ability to turn the lower button into a remote control that performs an action you select from a range of options. It can, for example, be a music control button, or it can trigger your smartphone's camera to take a picture. If you have a compatible smart home device, can control that instead. The Misfit Flash Link tracker shares the same capability, and it's neat in concept, but I never actually used it beyond testing.



One special aspect that I enjoy using much more is found in the Misfit app. It lets you turn on a variety of white-noise tracks—a campfire, ocean waves, a thunderstorm—to listen to while falling asleep. You can set them on a timer to shut off after, say, 30 minutes, or let them play all night long. The feature itself is simple, but I appreciate the attention to detail.

COMPARISONS AND CONCLUSIONS

For almost $200, you're getting a pretty simple device, technology-wise. The Phase doesn't include an optical heart-rate monitor, as do many other fitness trackers in this price range. A few examples are the Fitbit Blaze, the Garmin Vivoactive HR, and the Polar A360. The latter two also have built-in GPS, giving you more detail about your recorded activities.

Also missing from nearly every fitness tracker I've tested is the ability in the app to include information about menstrual cycles and pregnancy. Considering that tracking one's cycle is perhaps the oldest incarnation of the "quantified self" and that it affects half the population, it really ought to be included. Two devices that include this feature are the Bellabeat Leaf and Leaf Urban.

If you want the look of a class wristwatch with the benefits of a fitness tracker, the Misfit Phase is certainly among the most attractive, right up there with the Withings Activite Steel and Steel HR. It's elegantly understated (though heavy) and comes in several different color combinations. The Phase isn't a fully loaded smartwatch like the Apple Watch Series 2 or Misfit's upcoming Vapor, but it's less expensive and doesn't need to be charged multiple times per week. That makes it a solid buy for those who are focused on looks and reliability.

JILL DUFFY

Pico Home Brewing System

$799.00

Pico Brews Very Good Beer, but It's Not Cheap

As a home brewer, I can tell you that making your own beer is not easy, nor is it cheap. But it is rewarding. To do it right, you have to be prepared to spend the better part of a day on prep and brewing and a fair amount of money on equipment and ingredients. You then you have to wait a week or two for fermentation before you can bottle or keg your finished product. And let's not forget cleanup. With the Pico Home Brewing System, you can brew a batch of suds in around two hours without having to worry about stirring, adding ingredients, and maintaining a constant temperature. It's a cool-looking smart-home appliance that's easy to use, but it requires a fair amount of prep and post-brew cleaning, and you'll end up with only a little more than a gallon of beer. And while the Pico makes very good beer, $800 is a hard price to swallow.

DESIGN AND FEATURES

The stainless steel Pico Home Brewing System looks similar to its pricier sibling, the PicoBrew Zymatic. It measures 16 by 12 by 14 inches (HWD) and weighs 24 pounds. Though smaller than the Zymatic (17 by 21 by 15 inches), it takes up a fair amount of counter space. In addition to the brewing machine, the Pico comes with a brewing keg and keg cozy, a serving keg, metal and rubber brewing keg lids, a CO_2 regulator, a hops cradle, assorted cleaning brushes, wands, adapters, and a detailed instruction manual that walks you through preparation, brewing, kegging, and cleanup. I'd recommend keeping the manual nearby while you're brewing.

The system also comes with a PicoPak of your choosing. PicoPaks are prepackaged, premeasured kits developed by dozens of breweries from around the globe that contain the exact amount of grain and hops needed to brew a recipe. They cost anywhere from $19 to $27 and have an ID tag the Pico machine reads to identify the beer and call up its recipe. PicoPaks also include a yeast packet and a CO_2 cartridge for forced carbonation, a carbonation sugar packet, a stick on temperature gauge, and depending on the recipe, dry hop sachets.

Pico Home Brewing System

PROS Brews tasty beer. Easy to use. Nice selection of premeasured ingredients packages (PicoPaks). Tracks progress via the Web.

CONS Expensive. Makes only a little more than one gallon at a time. Complicated keg cleanup. No mobile app.

WHAT'S YOUR PLEASURE?

One PicoPak come with the home-brewing kit. These contain all the ingredients you need to create specific types of beer.

The front of the brewer holds a clear, removable 7.5-by-9.2-by-13.5-inch step filter and lid, and above that is a 2.5-by-1.5-inch LCD panel, a control knob, and a power button. Pressing the control knob launches the menu system with choices for Brew PicoPak, Sous Vide, Utilities, and Settings. Pressing the Brew PicoPak option walks you through the brewing process, and Sous Vide lets you set the water temperature and cooking time. The Utilities menu contains options for First Rinse, Rinse, Deep Clean, Rack Beer, and Drain Step Filter, and the Settings menu is where you go to select a language and temperature units and to configure network settings.

On top of the machine, a black lid covers a water reservoir, and at the back is a power cord. The right side of the Pico holds two hoses with ball lock connectors; the black connector goes to the Out post on the brewing keg and the gray connector goes to the In post.

“It’s a cool-looking smart-home appliance that’s easy to use, but it requires a fair amount of prep and post-brew cleaning.”

As with the Zymatic, the Pico uses 802.11b/g Wi-Fi to connect to your home network, but it lacks a mobile app. It does offer the same Web portal, where you can track the progress of each brew in a colorful timeline and temperature chart and share your brewing experiences with fellow Pico owners. Here you can also find recipes that show you how to use the Pico for Sous Vide cooking.

SETUP, BREWING, AND RESULTS

Before starting my first brew, I went through all five boxes to verify that I had everything I needed. I then followed the instructions for configuring the machine for Wi-Fi, creating an account and entering my Pico code to register it. Next, I prepared the Pico for its first rinse. I washed the brewing keg, keg seal,

BECOMING A BREWMASTER
Once you've prepped your Pico and added water and ingredients, it takes about 2 hours to brew your beer batch.

step filter, and lid with tap water and added half a gallon of distilled water to the reservoir. I slid the step filter and lid into the slot, added around two inches of water to the brewing keg, connected it to the hoses, and sealed it with the black rubber keg seal. I set the control knob to Utilities and selected First Rinse. When the rinse was completed (around five minutes), I connected a keg wand to the black hose and followed the on-screen instructions to pump the rinse water out of the reservoir and into the step filter. Once the reservoir was empty, I cleaned out the inline filter and rinsed the brewing keg, step filter, keg wand, and lid with tap water. It was time to brew.

My Pico came with a Deaf Turtle IPA PicoPak, a clone of Russian River's Blind Pig IPA. It's an American IPA (India pale ale) that uses four kinds of hops and is 6.4-percent ABV (alcohol by volume). I placed the hops pack in the hops cradle, placed that in the step filter along with the grain pack, covered it with the lid, and inserted the filter into the slot on the Pico machine. I then added one gallon plus six cups of distilled water to the brewing keg, sealed it with the rubber seal, slid the cozy over the keg, and attached the hoses to the keg's In and Out posts.

Next, I filled the reservoir with a gallon of distilled water, covered it, and turned on the machine. The Pico read the PicoPak's ID tag and displayed Deaf Turtle on the LCD panel. I selected Start Brewing and pressed the knob, and the Pico began the brewing session. You don't have to stick around during the brew, which is good—it gets a little noisy. I checked the brewing progress online and was able to see how much time had passed and when the brew would be completed. This particular beer took 2 hours and 25 minutes to brew.

When the brew was finished, I disconnected the hoses from the keg, placed a stopper in the keg seal to make it airtight, removed the cozy, and attached the temperature sticker to the side of the keg. At this point, the keg can sit overnight to cool down before you add the yeast. I cleaned the step filter by removing the PicoPak and dumping it into my compost bin. I rinsed the filter and lid with clean water, filled it with an inch of water, and inserted it into the Pico. I connected keg wands to both hoses, directed the hose with the gray ball lock

into an empty bucket, and used the control knob to begin a rinse cycle and to pump water from the reservoir. After about 10 minutes, the reservoir was empty, and the Pico was clean. To finish up, I cleaned out the inline filter and rinsed the wands, step filter, and lid one more time.

You have two options to ferment your beer. The fast fermentation method (4 to 5 days) uses a special metal keg lid and must maintain a temperature somewhere in the 70-to-84-degree range. Standard fermentation (10 to 12 days) uses the rubber seal with an airlock and can ferment at around 65 degrees. I used the Standard method, making sure the temperature sticker read 65 degrees before adding the yeast and attaching the airlock. After three days, I opened the seal and added the hop sachets, which are like tea bags containing hops. I waited another 10 days for the airlock to stop bubbling and was then ready to rack the beer into the serving keg and begin carbonation.

I waited 10 days for the airlock to stop bubbling and was then ready to rack the beer into the serving keg and begin carbonation.

I connected the racking tube to the Out post of the keg and the hose with the gray ball lock to the In post. Once the tube was placed inside the serving keg, I selected Rack Beer from the Utilities menu, pressed the knob, and waited around 10 minutes while the beer was transferred from the brewing keg to the serving one. When the racking tube began filling with air, I removed it and shut down the Pico. I connected the CO2 cartridge to the CO2 regulator, placed a Carbonation adapter in the hole of the serving keg, and attached the regulator to the adapter. I adjusted the pressure to 24 PSI and placed the keg in my refrigerator for the requisite 36 hours. When time was up, I turned off the regulator, removed it, and replaced it with the Dispensing plug. It was finally time to drink up.

The Deaf Turtle IPA was absolutely delicious. The keg delivered a clear glass of beer with a foamy head and a nice, hoppy aroma. I didn't have a bottle of Blind Pig handy to compare, but I've had it in the past, and this recipe was spot-on. My only complaint is that I had only a little more than a gallon of beer for my efforts (I usually make five gallons when home brewing).

The folks at PicoBrew recommend a thorough cleaning, in addition to the steps mentioned above, after each brew session. This involves removing the brewing keg posts, o-rings, and springs with a wrench, brushing them clean, and soaking them in a sanitized solution along with any other parts that were exposed to beer during the fermentation process. You should also clean and sanitize the serving keg and adapters when the beer is all gone. It's a time-consuming process but a necessary one that has to be performed, whether you use a Pico or a traditional steel pot, fermenting bucket, and carboy for home brewing.

CONCLUSIONS

While it's easy to liken the Pico Home Brewing System to a Keurig coffee brewing system, that's not an accurate comparison; Keurig coffee requires no preparation or cleanup, and your coffee is ready to drink in minutes. Although the Pico will brew your beer in around two hours, you still have to prep the machine, wait for the brew to ferment, rack the beer into a keg, and wait for it to carbonate. Cleanup takes time and must be done right to ensure the integrity of your next batch. All told, you'll have to wait around a week before you can sample your suds, depending on the type of beer and fermentation method used. More complex beers will take longer.

That said, the Pico makes excellent beer, and it's very easy to use compared with a typical home-brewing routine. My biggest gripe with the Pico, other than its lofty price, is that it makes just 1.3 gallons of beer at a time—roughly two growlers. In my house, that won't last very long. If you want a higher yield and more control over how your beer tastes, consider the Grainfather[http://www.pcmag.com/review/347171/grainfather] all-in-one brewing system. It's not automatic like the Pico and Zymatic systems, and it requires lots of hands-on involvement while brewing, but it produces incredible beer, and lots of it.

JOHN R. DELANEY

Bargain 3D Printer That's Great for Newbies

PC MAGAZINE EDITORS' CHOICE

The XYZprinting da Vinci Mini sells at a bargain price for a 3D printer, but it provides a more-than-satisfactory user experience to the newbies for whom it's designed. The da Vinci Mini is easy to set up and use, and in our testing consistently printed objects of good quality for the price, with no misprints. Its build volume is modest, its software occasionally stumbled when I tried to launch a print, and completed prints were sometimes difficult to remove from the print bed, but these aren't serious problems. The da Vinci Mini's combination of rock-bottom cost, easy setup, and good print quality and consistency are enough to make it our first Editors' Choice consumer 3D printer.

XYZprinting da Vinci Mini

$289.95

●●●●○

PRICING

Of the handful of consumer-oriented sub-$500 3D printers we've reviewed, the da Vinci Mini is the best. It costs even less than the XYZprinting da Vinci Jr. 1.0 ($299) that I reviewed last year; it has the same build dimensions as that machine but slightly better print quality and less-serious software issues. The Mini is more reliable in printing than another budget model, the New Matter MOD-t 3D Printer, which had several misprints in testing despite having excellent print quality for the price. The M3D Micro 3D Printer is tiny and cute, but unloading filament from its internal bay proved surprisingly onerous.

DESIGN AND FEATURES

The da Vinci Mini, bright pumpkin-orange with black trim, measures 14.2 by 15.4 by 13.2 inches (HWD)—slightly smaller than the da Vinci Jr.—and weighs 24.3 pounds. Its build area (5.9 by 5.9 by 5.9 inches) is similar to those of other budget 3D printers we've tested and only marginally smaller than the 6.0-by-6.0-by-6.2-inch build area of the LulzBot Mini, our Editors' Choice for mid-priced 3D printers. The da Vinci Mini has an open frame with no window or door in front; the build plate is set on a carriage that slides in and out beyond the edge of the frame when a print is in progress.

XYZprinting da Vinci Mini

PROS Very low price. Reasonably priced filament. Good print quality. No misprints in testing. Easy setup and operation. Quiet. Prints over a USB or Wi-Fi connection.

CONS Occasional problems in trying to launch prints. Removing printed objects from the print bed is sometimes tricky.

BEST SUB-$500 3D PRINTER

The da Vinci Mini is easy to set up and use, and in our testing consistently printed objects of good quality for the price, with no misprints.

Despite the open frame, the extruder nozzle is located behind the extruder assembly and is hard to reach, which helps protect you from accidental burns. The da Vinci Mini is relatively quiet and should not bother people seated in its vicinity.

A convenient feature of the da Vinci Mini, one we also saw on the da Vinci Jr. and several other recent 3D printers, is that it automatically levels the print bed before each print. A downside is that it is sometimes difficult to remove finished objects from the print bed. XYZprinting packs with the Mini several squares of tape that are just large enough to cover the print bed, but even using the included scraper, it was not easy to remove objects without damaging the tape. Covering the tape with a thin layer of glue from a glue stick before printing didn't help. I recommend instead covering the print bed with blue painter's tape, a common technique with 3D printers.

The Mini uses the same proprietary "smart cartridges," which detect when filament is low and needs replacing, that we saw in the da Vinci Jr. As with that machine and some other low-priced 3D printers, the Mini exclusively uses polylactic acid (PLA) filament. A 600-gram (1.3-pound) cartridge lists for $27.99, considerably less than the same-size "smart" cartridges used by the CEL Robox, which sell for $49.99 for acrylonitrile butadiene styrene (ABS) and $54.99 for PLA.

SETUP

With the help of the included quick-start guide, hardware setup is pretty straightforward. Once you unpack the printer, you install the extruder module and then the filament guide tube. Before loading the filament spool, unscrew its cover and seat a board containing the spool's sensor chip. You then simply feed the filament, which is automatically pulled into the extruder once the tip is inserted in the extruder module. Then download and install the software, connect the printer, load an object file, and you're ready to print over either a USB or Wi-Fi connection.

SOFTWARE

The software, downloadable from the XYZprinting website once you set up a free, password-protected account, is the company's XYZWare. With it, you can load an object, rescale it, move it on the build platform, save it to the company's 3W file format, import the file to the printer, set the resolution, and add a brim or supports to keep the object secure while printing. Pressing the Print command brings up a dialog box that lets you choose between resolutions. The default setting, Good, is set for 300 microns (where a micron is 0.001 millimeter), Normal is 400 microns, and Excellent is 200 microns. Because 3D printing resolution is a measure of layer height, the lower the number, the higher the resolution. From the Advanced tab in the dialog box, you can access an even higher resolution (100 microns).

The company recently updated XYZWare, and my experience with it was a lot smoother than when I tested the da Vinci Jr. last year. The long hang times are gone; in fact, XYZWare is now quicker than many programs I've used for slicing objects (mapping their individual layers in preparation to printing). There were also none of the software crashes I experienced with the previous version.

PRINTING

I did most of our testing (six objects) at the Good resolution, and printed one object at Excellent. The da Vinci Mini completed all the prints it started and had no operational issues during printing. Print quality was slightly better than with the da Vinci Jr.—especially with one test object consisting of geometric shapes and raised text protruding from an almost-vertical surface—and is about average among the 3D printers we've tested. Several, including even the comparably priced New Matter MOD-t, have produced higher-quality prints, but none have combined solid print quality and misprint-free consistency at anything approaching the da Vinci Mini's price.

The only software issues I had with the Mini occurred when I tried to launch prints. Twice after completing one object and loading another, I received a message that the da Vinci Mini was busy. Several times when I tried to launch a print, instead of seeing the normal Print dialog box that lets you change resolution and other settings, a dialog box for reconnecting to the printer would pop up and not respond when I tried to connect. Every time either of these issues occurred, turning the printer off then on and unplugging then replugging in the USB cable corrected the issue.

RELIABLE PERFORMANCE

The XYZprinting da Vinci Mini completed all the prints it started and had no operational issues during printing.

CONCLUSION

My main issues with the XYZprinting da Vinci Jr. when I tested it last year were its inconsistent print quality and poor software experience. Both have been improved with the da Vinci Mini. Its print quality is solid, and although the software sometimes balked when I tried to launch a print, the issues were easy enough to resolve. The Mini packs a winning combination of easy setup and use, misprint-free printing, good print quality, automatic print-bed leveling, and a price that's little more than what you'd pay for the extruder alone on some high-end 3D printers. The XYZprinting da Vinci Mini 3D Printer earns our Editors' Choice—our first for a consumer-oriented 3D printer.

TONY HOFFMAN

A Mechanical Keyboard Based on a Classic

Unicomp Ultra Classic

$84.00

●●●●○

PC MAGAZINE EDITORS' CHOICE

Few tech products can be called legendary, but the original IBM Model M keyboard unquestionably qualifies. Developed and released in 1985, it's been held up by many (including yours truly) as the ultimate typing device for its unparalleled responsiveness, finger feel, and sound. In fact, many companies making the mechanical imitators of the last decade have been trying to replicate it by other means and have more or less succeeded. But if you crave the real deal, whether because you were there, because you've long wondered what all the fuss was about, or because you simply care that much about typing, you don't have to troll eBay. You can go with the Unicomp Ultra Classic. Because it's made by the company that bought the licensing, tooling,

and designs for the Model M, it could not be more authentic. And don't be surprised if you discover, as I did, that this keyboard lives up to the hype.

DESIGN AND FUNCTIONALITY

Looking at the Ultra Classic, you probably won't notice anything special about it. It looks like a plain old keyboard, with an emphasis on the old: big (about 1.7 by 18 by 7 inches, HWD), bulky (3.18 pounds), plasticky (the deck creaks and flexes a bit when you apply too much pressure, which may not instill confidence), and lacking any visible frills. It has no dedicated media keys, no function key that allows the F1 through F12 keys to double as media keys, no volume adjuster, no USB pass-through, no backlighting. Two pop-out feet let you prop up the keyboard at two different angles, but the biggest contemporary advances are the Windows and Menu keys (daring additions prime for Windows 95) and the presence of a cable terminating in a connector designed for USB rather than AT. The externalities don't define the Ultra Classic, but the uncommon (if not unique) mechanism inside does.

Many keyboards, particularly the inexpensive ones bundled with mass-market desktops, use silicone dome switches: These create characters from the contact that occurs as two membranes are joined when you push down on a key. Newer mechanical keyboards accomplish this instead with physical switches that can be adjusted to provide different amounts of tactile and auditory feedback, depending on the intended usage. The Ultra Classic dispenses with any such fakery: Once you've applied a certain amount of pressure to a key, a hammer beneath it creates an electrical contact that registers your keystroke at the same time the spring beneath the cap buckles and hits the outer key shaft with enough force for you to hear. This design is called, descriptively, "buckling spring."

Unicomp Ultra Classic

PROS Superb for typing. Extraordinarily configurable. Made in America.

CONS May require an adjustment period. Extremely loud. No special features. Unsteady plastic construction.

BUCKLING SPRING
Once you've applied a certain amount of pressure to a key, a hammer beneath it creates an electrical contact that registers your keystroke at the same time the spring beneath the cap buckles and hits the outer key shaft with enough force for you to hear.

This means that, unlike with even the best mechanical keyboards, the feedback you receive (with both your fingers and ears) occurs precisely when the switch is activated. It's for this reason that serious typists have so adored the Model M keyboard: Everything else has felt, however slightly, false and manufactured. With a keyboard like this, the relationship of the creation of characters you see to the motion of your fingers is every bit as intimate and uninterrupted as it was with the manual typewriter.

Unicomp sent us a version of the Ultra Classic with a black body and light-gray keys; a more staunchly traditional version, with off-white ("Pearl") coloring for its deck and some keys and other keys in a brownish gray, is also available for the same price. For a $10 fee, you can custom design your own keyboard with any of 34 different languages and layouts (among them United States variations of Dvorak, Mac, and Linux, and blank keycaps). A number of other styles—with additional terminal keys, for example, or sporting a TrackPoint-like pointing stick—can also be purchased at varying prices.

PERFORMANCE

I moved from dome-switch to mechanical keyboards nine years ago, after the tragic, soft-drink-induced death of the model I'd been using for years. Since then, I've become very much a mechanical keyboard evangelist, willing to preach and demonstrate to anyone who will listen—and many people who won't—exactly what they're missing if all they know are the cheap desktop and laptop keyboards that have become so prevalent. So I thought I was prepared for what the Ultra Classic would feel like: It would be a mechanical keyboard on steroids, right?

Wrong. Compared with the Cherry MX Blue, essentially the typist's switch and the one with which I'm most familiar (it's used in many products from mechanical keyboard company Metadot, such as our Editors' Choice Das Keyboard 4 Professional), the buckling spring switch has a much higher actuation force (65 centi-Newtons, or cN, versus 50cN), a deeper actuation point (2.3mm versus 2mm), and a shallower full travel distance (3.7mm versus 4mm). This combination of factors means you can't expect the same result if you move your fingers the same way. Though I loved how clean and real it felt to type on as soon as I started using it, at first, I found myself making unusual mistakes because the Ultra Classic just wasn't doing what I thought it should be.

> **I moved to mechanical keyboards nine years ago, after the tragic, soft-drink-induced death of the model I'd been using for years.**

I realized that my brain had given expecting a direct connection between my fingers, ears, and eyes, and was letting me phone in my typing. Once I focused on what I was doing, and made the necessary adjustments for how the buckling spring behaved, typing became thrilling and organic once again in a way it hadn't been for years.

My fingers bounced around less than they do on keyboards using Cherry MX Blue switches, but it didn't matter that the buckling-spring keys' activation force was even higher than that of Cherry MX Black switches (60cN, making them ideal for applications where precision trumps speed)—the springs provided the lift my typing needed to be comfortable, zippy, and accurate nonetheless.

Some personal preference comes into play here, of course, as Cherry MX Blue switches seem easier to use. And if you're accustomed to them, you'll need a couple of weeks or so to transition to buckling-spring switches. But others in our office who have not previously displayed any keyboard-snob tendencies tried it and were captivated by its natural feel, too. The difference really is one you can detect immediately, even if you've never thought about it before.

Others in our office who have not previously displayed keyboard-snob tendencies were captivated by its natural feel, too.

KA-THUNK
Buckling-spring keyboards are loud, with a deep, baritone-like sound; warn your officemates before using!

The only potential downside? Even more than super-clicky Cherry MX Blue, buckling-spring key switches are loud. They also have a deep, baritone-like sound: Think of Cherry MX Blue switches as professional tap dancers and buckling-spring switches as sumo wrestlers in training. When used for long periods of time by a fast typist (like, uh, me), the Ultra Classic produces a constant "ka-thunking" that could be distracting or irritating to others. Hopefully they'll understand, but maybe warn them first.

CONCLUSIONS

The Unicomp Ultra Classic earns its name: It really is every bit as good as the IBM Model M keyboard it's been designed to so closely emulate. True die-hards have kept those keyboards for decades. Many reports exist of them working as well as they did when they first came out of the box—a tribute to their timeless construction. I can't say for sure that the Ultra Classic will enjoy that kind of longevity, but I do know that you're unlikely to find a keyboard that's much better for typing than this one. The Das Keyboard 4 Professional combines terrific typing with standalone media keys and even a volume wheel, but it costs twice as much as the Ultra Classic. And any gaming keyboard, whether as basic as the SteelSeries Apex M500 or as fully decked-out as the Corsair K95 RGB, offers a lot more functionality but an inferior typing experience. With an unadventurous design and an impressive lack of post-1995 features, the Ultra Classic can't do anything but type, but at that it excels. When that's what you need (and when those around you are tolerant of sound or have exceptional headphones), the Ultra Classic delivers as few other keyboards can.

MATTHEW MURRAY

“It really is every bit as good as the IBM Model M keyboard it's been designed to so closely emulate.”

Tiny Photo Printer for Phone and Tablet Pics

HP Sprocket Photo Printer

$129.99

●●●●○

The HP Sprocket Photo Printer is a tiny, cute, convenient photo printer designed for printing from a smartphone or tablet. It can fit into your pocket and connects to an iOS or Android device via Bluetooth. The Sprocket falls short of our Editors' Choice, the Canon Selphy CP1200 in connectivity choices, running costs, and print quality. But if you can make do with wallet-size prints and want only to print from your mobile device's photo albums or a social media account, it's the height of convenience.

DESIGN AND FEATURES

The Sprocket is a sleek machine with rounded corners, measuring just 0.9 by 3 by 4.5 inches (HWD) and weighing a mere 6 ounces. In size and appearance, it's very similar to the Polaroid Zip Photoprinter. The Sprocket I tested was black with silver trim; a white version is also available. It has a built-in rechargeable battery, which according to HP will let you print up to 30 photos per charge.

Controls are minimal. The Power button is the only control on the device. It has a micro USB Type-B port for charging and an indicator light that glows white when the device is on. It blinks once when the Sprocket is turned on and twice when a job is sent to it, and it glows red when there is an error.

Connectivity is limited to Bluetooth, as is also the case with the Polaroid Zip. In contrast, the Canon Selphy CP1200 can print from a computer over a USB cable, a mobile device via Wi-Fi or a direct wireless connection, an SD card, or a USB thumb drive. The Sprocket can connect to an iOS- or Android-based smartphone or tablet, and printing is controlled through the HP Sprocket app, downloadable from the iTunes App Store or Google Play.

HP Sprocket Photo Printer

PROS Fast photo printing. Highly portable. Prints from your phone or tablet's photo albums. Easy integration with Facebook, Instagram, and Flickr.

CONS Limited to wallet-size (2-by-3) prints. Can only print from smartphones and tablets via Bluetooth.

PALM-SIZE PRINTER
The Sprocket fits into your pocket and connects to an iOS or Android device via Bluetooth to print.

To connect, you first must pair your mobile device to the Sprocket via Bluetooth. Then you launch the HP Sprocket app. You can either take a photo by pressing a central button and then print it out (or not), or print a photo from your social media accounts (Facebook, Flickr, and Instagram are supported) or your device's photo albums. The first time you access a social media account, you must enter your login information, and then it's saved automatically.

The Sprocket uses Zink (short for "zero ink") paper, which is embedded with clear dye crystals. The printer creates an image by using heat to activate the crystals and cause them to show color. Zink paper is available in a limited range of sizes; the Sprocket exclusively uses 2-by-3 wallet-size sheets with a peel-off sticky back. HP sells packs of 20 sheets for $9.99, which comes to 50 cents per sheet. The Polaroid Zip uses similar Zink media, at the same cost per print.

PRINTING SPEED

I timed the Sprocket at an average of 42 seconds per 2-by-3 print, matching the Polaroid Zip's speed. Timings for individual prints ranged from 39 to 46 seconds. This is faster than the Canon Selphy CP1200, which I timed at about a minute over a direct connection to a computer and 1 minute 32 seconds over a direct wireless connection. Unlike the Sprocket, which prints out a photo in a single pass, the CP1200 takes four passes, one for each color—feeding the paper through, pulling it back, and then feeding it again—to complete a print, as is typical of thermal-dye small-format photo printers.

OUTPUT QUALITY

The Sprocket's print quality was unimpressive in my testing, similar to that of the Polaroid Zip. About half of the prints were of drugstore quality, while the others fell below this standard. Colors, especially reds, tended to look muted, and there was a loss of contrast in some bright areas. There was obvious banding (a pattern of faint striations) in the background of several prints.

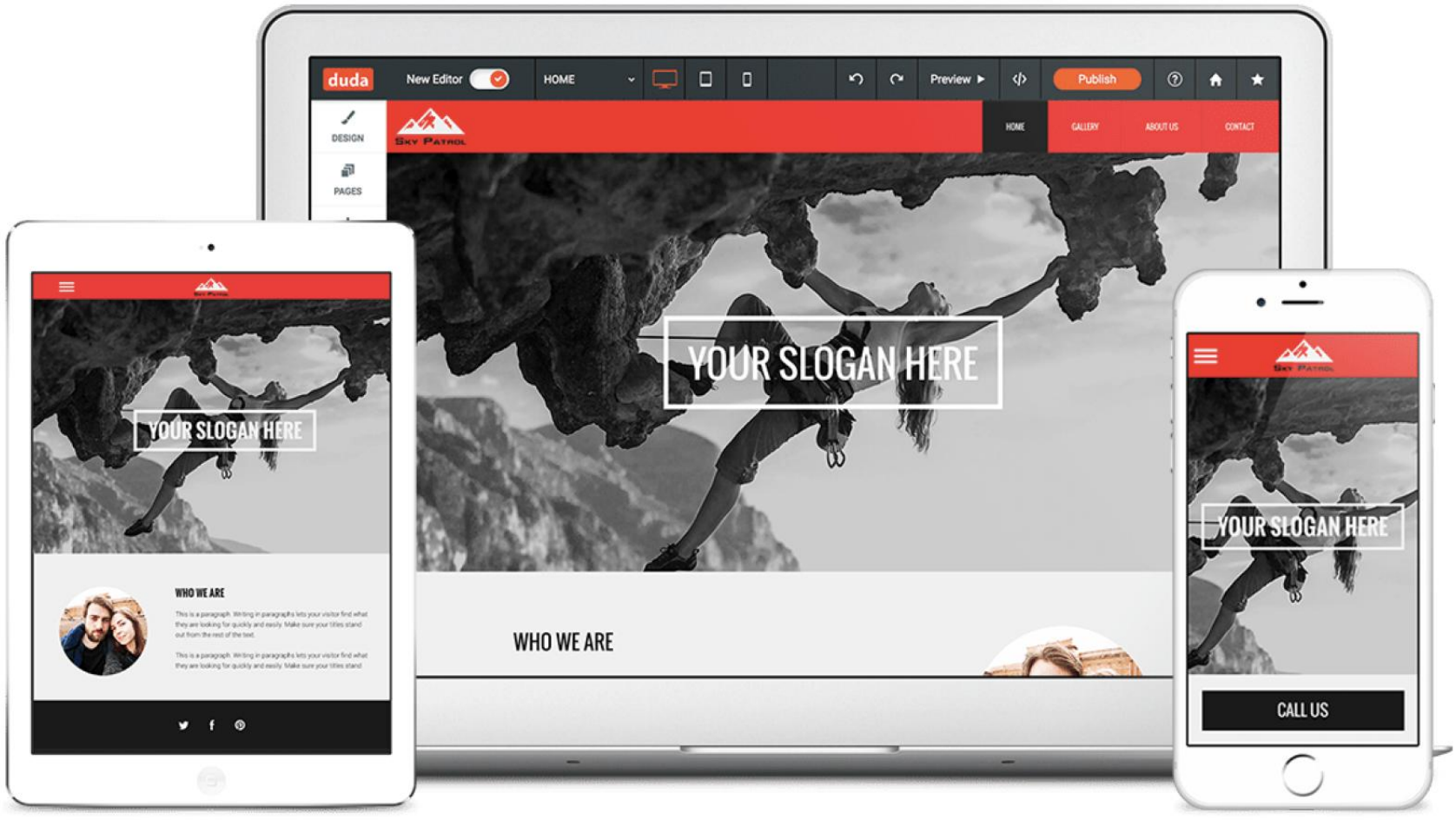
Quality is okay for quick snapshots to hand out to friends, but it's nothing special. In the portable printer world, dye-sublimation thermal photo printers usually have better print quality than Zink printers, as is the case with the Canon CP1200.

CONCLUSION

For those who want to print small snapshots exclusively from a phone or tablet—whether from its photo albums or social media accounts—the HP Sprocket is a convenient and appealing choice. Very similar in most ways (price, dimensions, speed, print quality, connectivity, printing technology, and running costs among them) to the Polaroid Zip Photoprinter, the Sprocket adds easy integration to Facebook, Flickr, and Instagram to the mix. In terms of print quality, though, it's no match for the Editors' Choice Canon Selphy CP1200, which can print larger photos (up to 4-by-6) at a lower cost per print than the Sprocket and has a wide range of connectivity choices, while the Sprocket is limited to Bluetooth. The Sprocket wins on portability, though—you can't fit the CP1200 in your pocket.

If you want only to print from a mobile device's photos or a social media account, it's the height of convenience.

TONY HOFFMAN



Build Functional, Fine-Looking Websites

PC MAGAZINE EDITORS' CHOICE

DudaOne is an easy website builder with an emphasis on sites that change to fit both large desktop and small mobile screens. It was the brainchild of a pair of coder friends who saw that the iPhone would change Web hosting requirements in a big way. The company offers a tool that can take a standard desktop website and convert it to a mobile site. But it's not just about mobile: DudaOne also lets you build highly functional, fine-looking websites for desktop. Web store capabilities make DudaOne a full website commerce solution, too, and a recent site-builder interface makes DIY site building easier than ever. It all adds up to an Editors' Choice–quality service.

DudaOne

Free trial,
various paid tiers

●●●●○

PRICING AND GETTING STARTED

Like Weebly and Wix, DudaOne lets you create an online presence for free. Duda doesn't limit the number of free sites or pages you can create, however, nor the bandwidth of free sites—that's quite generous. Unlike some other site builders, such as Weebly, Duda even lets free accounts sell up to 10 products, though free sites include Duda ads.

The service's paid tiers are Business+ (from $14.25 per month), and Business+eCommerce (starting at $22.50 per month). The premium accounts add email support, custom domains, site backup, HTTPS security, and deeper site analytics. Business+ also adds device-specific editing, a full developer mode, zero ads, and the use of Duda's InSite personalization feature.

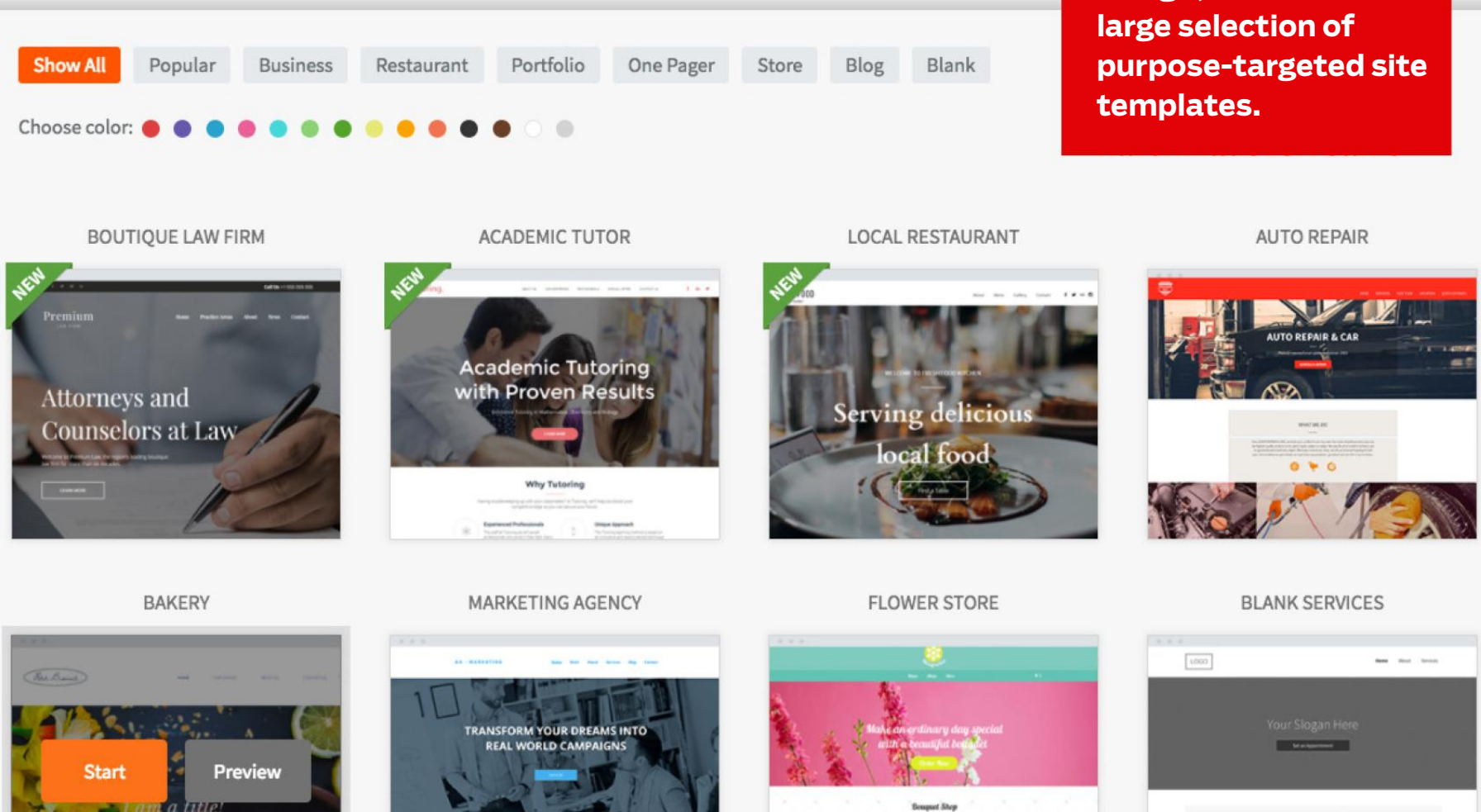
To start a new site, you choose one of 79 attractive, modern templates, which are sorted into categories such as Business, Restaurant, and Portfolio. When you click a template thumbnail, a panel shows you how its look changes for phone and tablet viewing. You can even see how the template looks on all three device types—desktop, tablet, and smartphone—at once.

DudaOne

PROS Clear interface. Strong mobile-site building. Free site option. Social-media integration. Powerful site-traffic analysis. Capable Web store tools. Even free accounts can sell products online.

CONS No third-party widget store. No ability to port site to another host.

TEMPLATES GALORE
To get you started with your website design, Duda offers a large selection of purpose-targeted site templates.



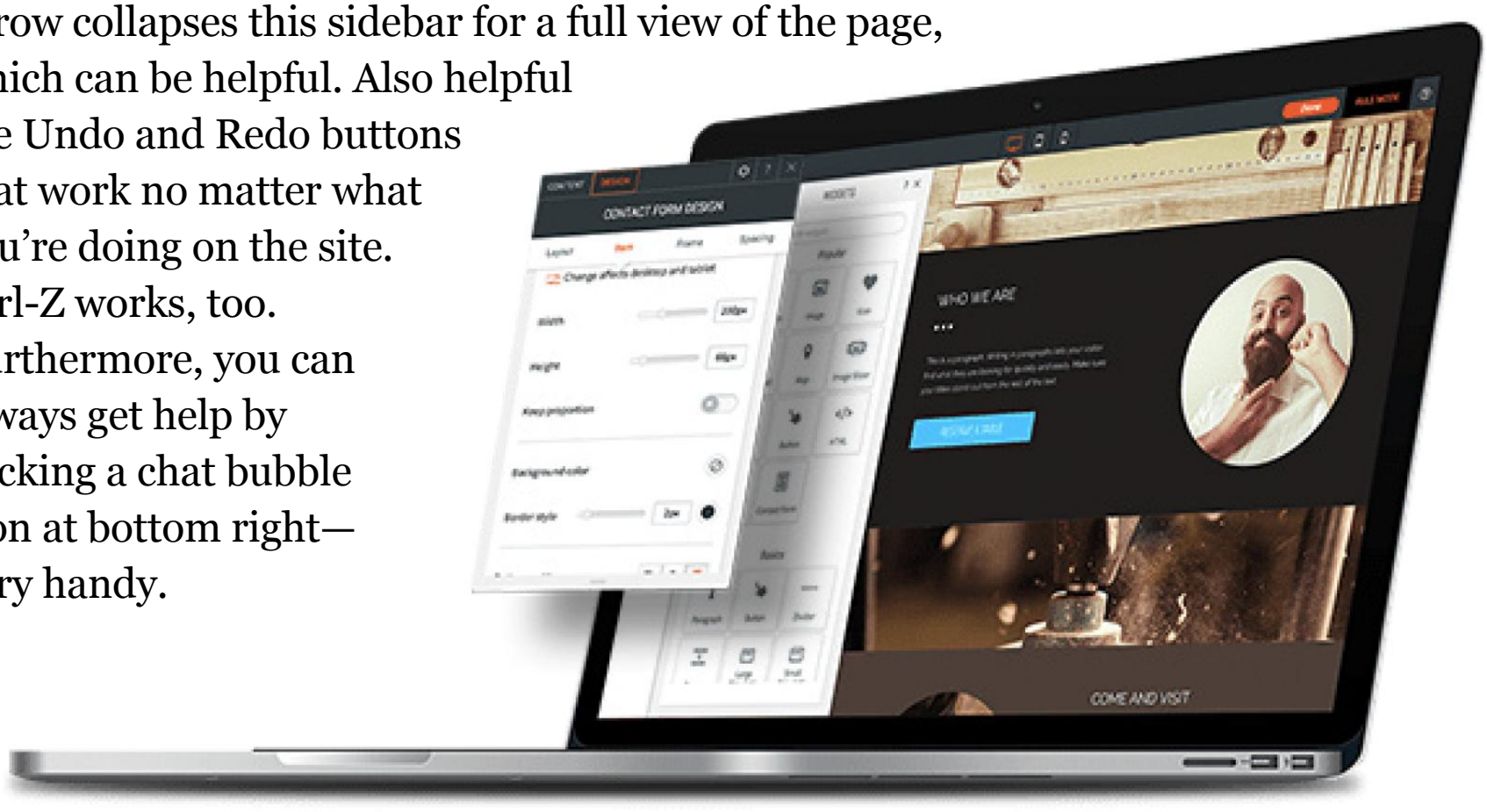
Once you choose a template for your site and start customizing, you can't switch templates later, as you can with Squarespace. This is because Duda sites, though they fit the search engines' criteria for mobile presentation, aren't responsive in the strictest sense—meaning they don't stretch and compress as you resize the browser window. Duda's approach, however, means you get a lot more control over your site design and can tweak it to look different on mobile.

Next, build your own site using the selected template. It's prepopulated with dummy content, and you replace that with your own assets. You can pull images and so on directly from an existing site or a Facebook page. For testing, I started with the Toy Store template.

Duda doesn't limit the number of free sites or pages you can create nor the bandwidth of free sites—that's quite generous.

THE INTERFACE

Duda's new site-building interface is clean and attractive (if you prefer the old one, a toggle lets you easily switch back). The interface consists of a left sidebar in which you find tools for managing and designing your site. They let you customize your theme colors, text, and navigation, and you can add and manage pages and site settings from the left panel. An arrow collapses this sidebar for a full view of the page, which can be helpful. Also helpful are Undo and Redo buttons that work no matter what you're doing on the site. Ctrl-Z works, too. Furthermore, you can always get help by clicking a chat bubble icon at bottom right—very handy.



The basic page elements—images, text boxes, buttons, dividers—appear when you click the Widgets button. That's a tiny bit confusing at first, for those who consider widgets to be third-party goodies rather than basic site elements. You drag the elements onto your webpage. As with other responsive-design site builders, you can drop elements only in allowed areas, but it's not hard to add columns or change spacing to customize the layout to your taste.

Some third-party items, such as Facebook and Disqus comment modules, are included in the Widgets group, but Duda lacks a large catalog of third-party integrations such as those found in Wix. Duda does, however, integrate with services including Yelp, vCita online scheduling, OpenTable, and PayPal. You can also incorporate social sharing buttons; Facebook Like, comments, and albums; a Twitter feed; and a WordPress feed. When I added the Click-to-Call feature to my test site, it merely displayed my number, which works on mobiles or PCs with the Skype or similar plug-in installed.

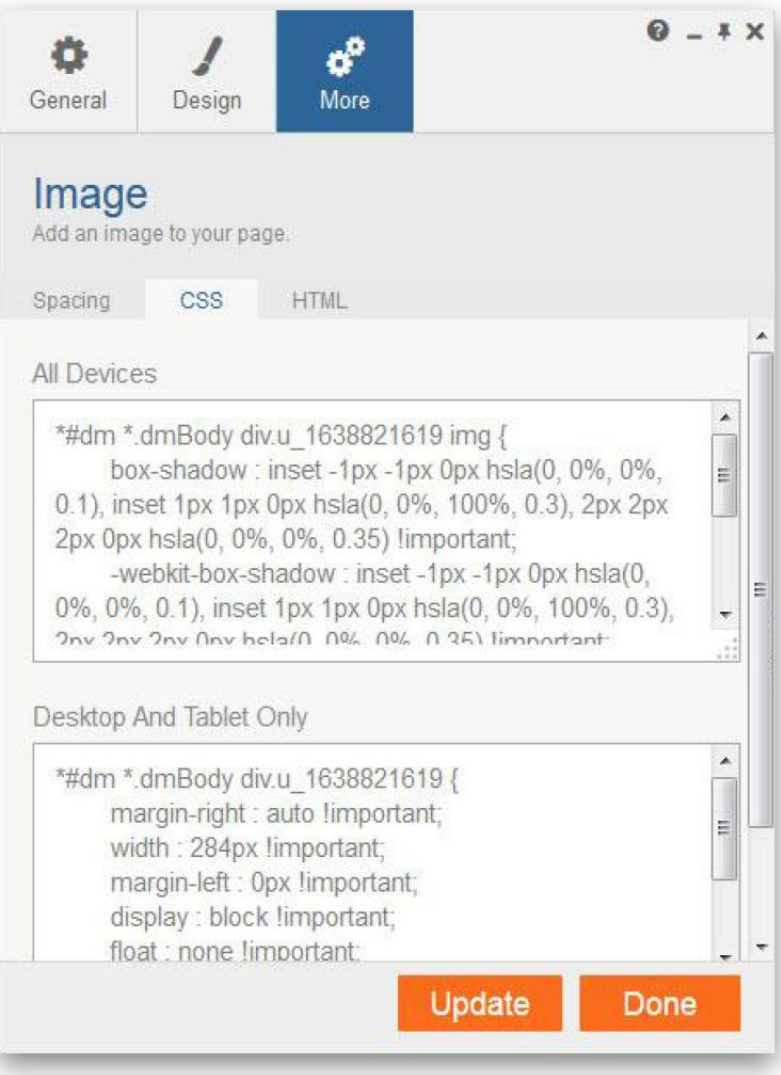
“Duda integrates with services including Yelp, vCita online scheduling, OpenTable, and PayPal.”

Along the top is an ever-present toolbar that lets you switch pages, undo your last edit, save your work, preview the site, publish the site, and view your site in the three different screen sizes. The toolbar also offers access to your Dashboard page, from which you can access all the sites you manage or are building through Duda, start new ones, and connect them to a personal domain. Note that the latter requires a paid account. Duda offers help for using a custom domain obtained from the major domain name registrars.

If you don't choose a custom domain, Duda assigns your site a URL, such as mysite4036.dudaone.com; you can pick another prefix if it's not already taken. When you've built some pages but aren't ready to publish, you can save your edits for later publication. Duda doesn't, however, let you schedule publication at a specific date and time.

For your first build, Duda presents tutorial overlays geared for both people building their own sites and those working on a site for client. You can switch among designs for desktop, tablet, and smartphone views. Wix and Weebly offer only the first two, and Squarespace doesn't offer mobile customization, instead restricting its templates to designs that work well on mobile as well as desktop. My test site looked and felt just as good on an iPhone 6s as it did in a browser.

When you hover over any item on your site, you'll see a button offering relevant editing options. I also really like the builder's right-click support, which provides an easy way to edit, align, or remove content. You can fairly easily move elements around the page and resize them, though as with most mobile-friendly site builders, where you can move stuff is limited. For a paragraph object, the context menu lets you pull content from another site, edit the text, format it, and hide it on a selected device type. The last ability is available only in paid accounts. Clicking a page navigation link in the site designer takes you to that page on your site; you don't have to select it from a page menu as in some other site builders. DudaOne also offers a dropdown menu for switching among your pages.



Every option dialog for every DudaOne site element includes a Settings tab that lets you edit spacing in pixels, the CSS code, and—for premium accounts—the actual HTML code for the element. But it's not just standard HTML. While the code looks fairly simple and standard, you need to familiarize yourself with the proprietary DMLE (DudaMobile Markup Language Extension) to work with it effectively.

Building a site with DudaOne is a pleasure. The interface is mostly quick and responsive, unlike some builders (I'm thinking of 1&1 MyWebsite in particular) that take forever and a day to load modules. As with most such services, moving objects around can be finicky, but in my testing I always managed to get the result I wanted.

MANAGING AND ADDING PAGES

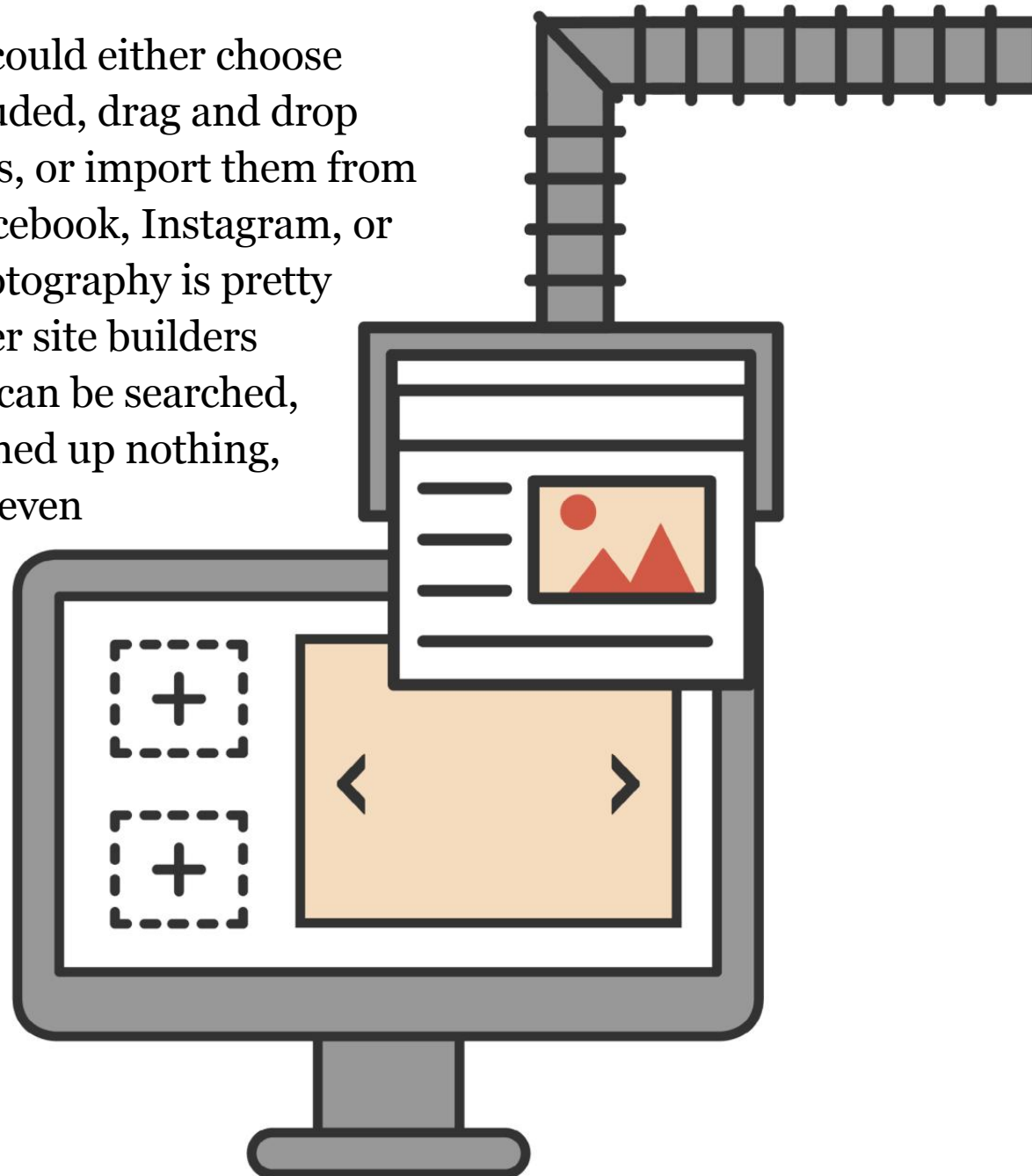
The Manage Pages panel is simple and clear, with SEO and navigation options available under a gear icon. It also lets you import images and site info from an existing site. To add a new page to my site, I simply tapped the +New page button. There's a selection of 10 page types to choose from, including Blank, URL, About, Contact, Photo Gallery, List, and Complex Page. Hovering over a page type's thumbnail shows its layout on the three device sizes. You can also add a page from an existing site.

DudaOne now has a very serviceable blogging tool. This lets you save and preview posts that you can format and add images to taste. Though it does keep track of your customers (see Making Money, below), Duda trails competitors like Wix in terms of site membership and email marketing.

Building a site with DudaOne is a pleasure. The interface is mostly quick and responsive, unlike some builders.

WORKING WITH IMAGES

To add images on my test site, I could either choose from the stock photography included, drag and drop photos from my computer folders, or import them from online sources such as Flickr, Facebook, Instagram, or Dropbox. The included stock photography is pretty limited compared with what other site builders like Wix or Squarespace offer. It can be searched, but a search for "thrift store" turned up nothing, even as separate words. You can even enter an image's URL or perform a Web image search to find the picture you want. Uploading multiple images at once? Not a problem, regardless of whether it's a whole folder or multiple selected images within a folder.



A cool option lets you hide any image on a device of your choice—desktop, tablet, or phone. Some content doesn't work well in the smaller formats, so this is a valuable feature. You can crop, resize, and even open an embedded version of Aviary for some online photo editing and effects. I was able to add a clickable link and tooltip and to change the Alt text in the image-editing dialog. For more control, a gear icon gives access to CSS and HTML code.

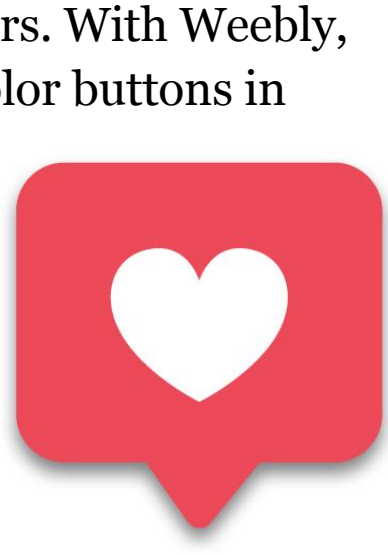
When adding a photo gallery, you can choose either square or original aspect ratios and a background color, but you don't get the choice of slideshow styles offered in Weebly. My test site's photo gallery was attractive, despite this limitation, and I appreciate that it allows full-screen viewing. I also like that, once you add an associated Facebook page, any public images from that appear in the Duda images manager.

The Manage Images option didn't let me edit my uploaded photos, even to rotate or crop them, which would really be great. You're better off using the standard image entry dialog box, which offers Aviary editing along with management options. Those tools are available only for images you've already added to a page. I also noticed that switching from the included stock-photo view to the view of your own uploaded images takes longer than I'd expect it to. At one point, when I tried uploading a JPG, DudaOne told me that it didn't register as an accepted image file type, even though the computer and other apps recognized it as such.

GETTING SOCIAL

With DudaOne, you can add social buttons that link to your accounts on Facebook, Twitter, and so on. A share bar lets you add buttons for those who view your site to post your page to their social feeds.

There's no choice of button designs for this bar of sharing buttons, though you can change the buttons' colors. With Weebly, you get a selection of monochrome or color buttons in different size choices. A final cool thing to get your site out there: DudaOne can generate a QR code that leads to your site when scanned.

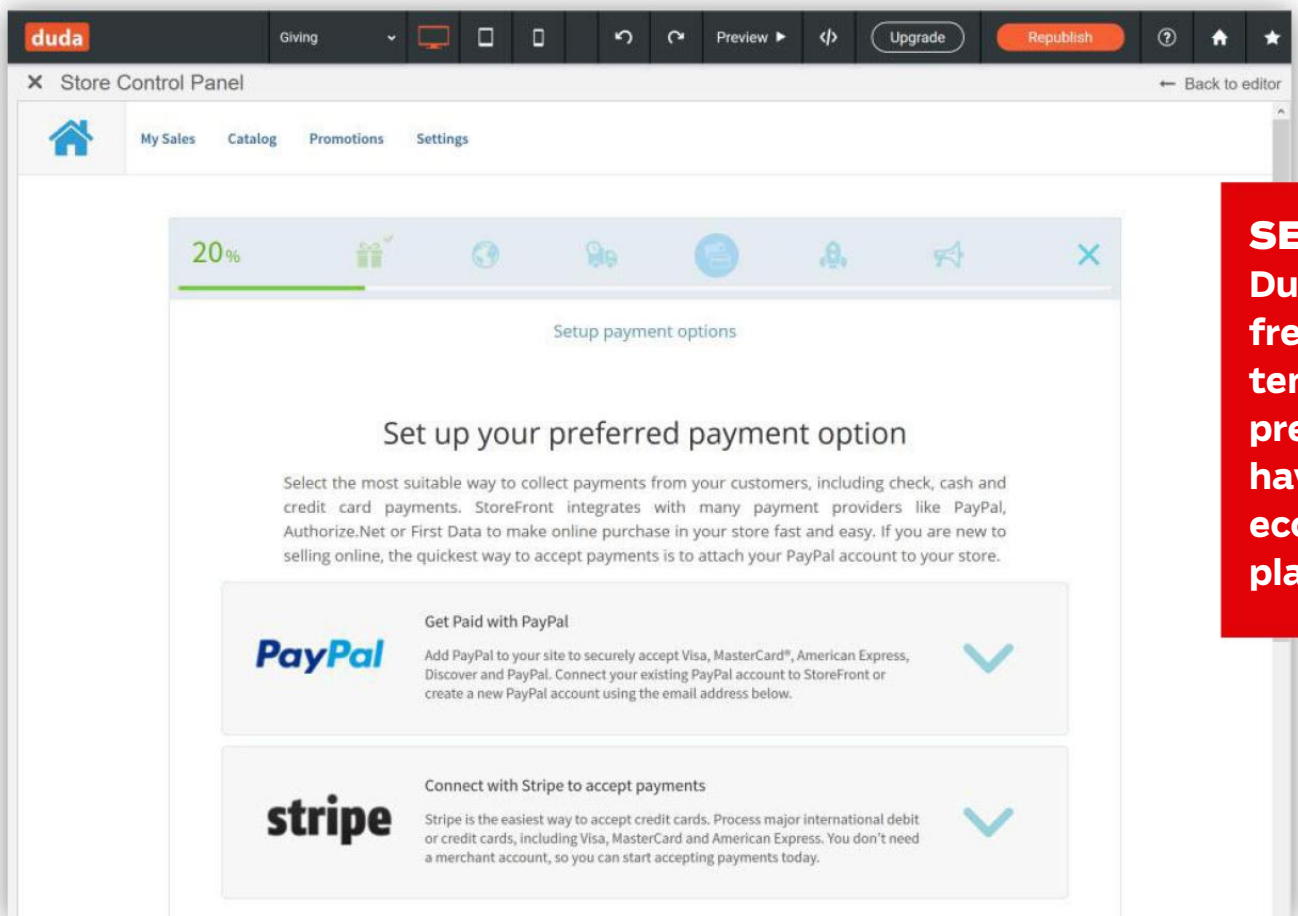


MAKING MONEY

DudaOne includes a full sales system with shopping carts and checkout pages like those you get with Weebly, Wix, and Squarespace. You can also place PayPal buy buttons onto any site page, and you can add coupons, letting your site visitor print out a discount offer. Any DudaOne user, even with a free account, can add a 10-page Web store to their sites. The process is slick, clear, and guided.

When you click Add a Store, Duda builds a new page for your site with a demo catalog, and it displays a Help box explaining how to set it up. A tooltip tour explains your store page, shopping cart, search, and store management features. It has a separate eCommerce Store Control Panel page, too, where you add products and configure shipping and payment options. Credit card transactions use SSL security, but you can't make your whole site use SSL, so users won't see HTTPS in the browser address bar.

Another well-designed wizard takes you through the store-setup process. You can add images and formatted text and assign categories and SKU numbers to your products. You can also change localization for different currencies. Shipping options are integrated with UPS or FedEx, or you can set custom rates. You can use both PayPal and Stripe as payment options and also import product lists in CSV, XCart, and LiteCommerce formats. Finally, you can sell digital downloads (which Duda calls "e-goods") but only if you have the highest-level Business+eCommerce plan ($36.75 per month), which is also required if you want to create coupons for product discounts.



SELLING IT

DudaOne lets even free users sell up to ten items, and premium accounts have access to a rich ecommerce platform.

DudaOne offers deep and detailed site-visitor statistics to its paid users. From your dashboard, you can click a graph icon next to any of your site entries to see its stats, showing all visitor information or just that for mobile and tablet. You can check not only site visits per day but also the number of form submissions, clicks to call, and map clicks. You can track visits as well as views. The left option panel lets you drill even deeper, showing individual pages' stats, including, time on page and bounce rate. If that's not enough, you can see traffic sources, browsers and OSes used, and even geographic location. I haven't seen any other easy site builder with nearly as impressive a level of traffic analysis.

You can check not only the site visits per day but also the number of form submissions, clicks to call, and map clicks.

INSITE PERSONALIZATION

For customers of its Business+ level, Duda offers another perk that goes beyond the standard site builder offering: InSite, which is found in the Personalize section of the main toolbar. InSite lets you customize your site based on where a viewer is located, time of day, whether they're frequent visitors, and more. You can build special promotions, play intro videos for new visitors, and change the display based on what kind of device a visitor is using.

InSite is wizard driven and not scary at all, considering what an advanced capability it is. To use it on my test site, I just chose a trigger, a site action and a result layout.

One limitation DudaOne shares with most online site builders is complete lack of site portability: You can't get the code for your Duda site and host it on another server provider. The exceptions in this class of Web hosting are Squarespace, which lets you export your site to WordPress format, and Weebly, which actually lets you download your site assets in a standard folder structure.

CONCLUSION

DudaOne is a highly capable and user-friendly website building service, offering many cool and impressive features. If your site's look and function on mobile devices is a priority, DudaOne is certainly worth considering. Its site-traffic statistics provide more details than most site-building services, and its InSite triggered-customization feature is rare among easy site-builders. All this earns DudaOne a PCMag Editors' Choice for website builders. Wix, our other Editors' Choice in this category, offers more in the way of promotion through email blasts, however, as well as site-membership abilities and more integration with third-party services.

MICHAEL MUCHMORE

Top 5: Best Online Collaboration Software

When teams use the right tools to work together, they often make improvements in both the process and the final outcome. Using the right online collaboration tools can make teams stronger and more productive. They let remote teams communicate more efficiently. They archive and make searchable old discussions and work history, which helps people learn from the past. They eliminate the back-and-forth nature of email communication. Many of them enable teams to talk about their work within the context of the work itself. And in practice, online collaboration tools give people a place to express themselves, joke around, and get to know one another on a personal level. It facilitates teamwork and team cohesion, and that leads to greater productivity.

The term “collaboration software” has a variety of meanings. It’s not a single, well-defined kind of utility but rather a broad category of apps and services. Enterprises, for example, have very different communication needs than small startups. Collaborating is simply a different beast when it happens among hundreds of people across many offices than when it takes place in a single room. A team of only five or six people might be highly focused on what’s happening in the moment, whereas a large organization with high turnover may make it a priority to preserve past conversations so that newcomers can quickly get acquainted with what has happened to date.

Here are a few of the types of apps we include under this heading. (Note that while project management apps are a type of collaboration tool, we have decided not to include them here.)

COMMUNICATION APPS

Communication apps, sometimes called group messaging apps, borrow ideas from all the best forms of modern communication, such as instant messaging and forums, and put them into one space. The two clearest examples—and two of the best communication tools around—are Slack and HipChat. These apps are real-time communication systems where teammates can message one another, but they’re much more sophisticated than a simple text exchange. For example, they store and archive messages, meaning you can search and find an old conversation if you need to reference it. You can use hashtags to mark keywords in conversations so that other teammates, who might not be in on the conversation now, can easily look up relevant chat histories later. The best team messaging apps also have sophisticated alert systems, so the right people’s ears will prick up when an important conversation is happening around a topic that’s central to their work.

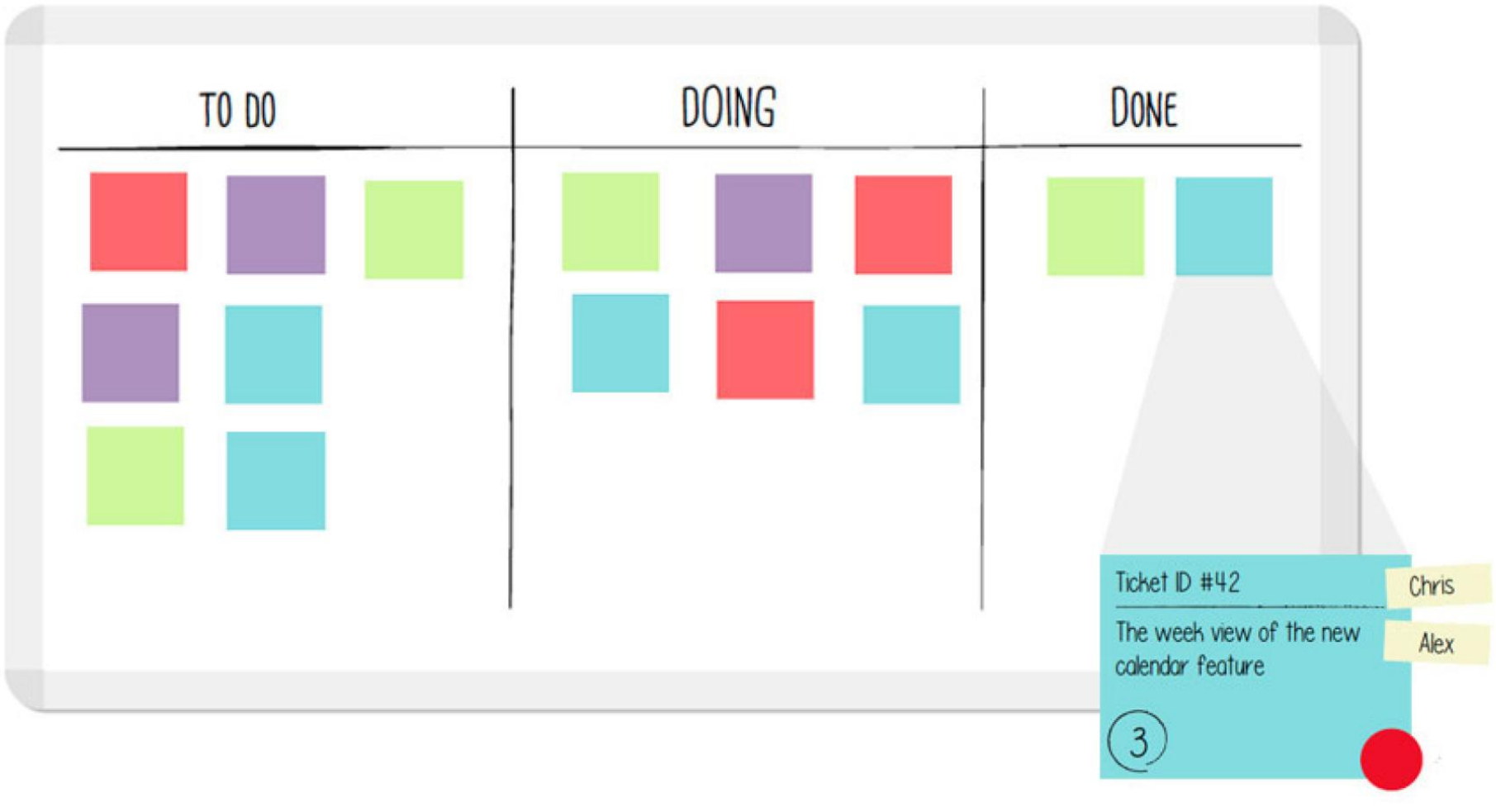
TASK AND WORKFLOW MANAGEMENT

One tool in this list of the best collaboration tools, Asana, might be more accurately classified as a task management or workflow management tool. While dedicated project management platforms usually have within them tools to manage work at the task level, Asana is a little different. It's a unique tool that's incredibly flexible, so it can bend to your will. If you find that all the project management tools out there are too rigid for your work and workflows, Asana is worth investigating.

Another kind of workflow and task management tool that's gaining popularity among software developers in particular is the kanban board. Kanban is a style of work management that focuses on keeping teams from being overwhelmed by competing imperatives, and kanban board tools are designed to let you use the system to its best. This type of collaboration tool is best for teams that work with a just-in-time-delivery state of mind. Volerro and LeanKit are two examples of kanban board tools.

Collaboration software is not a single, well-defined kind of utility but rather a broad category of apps and services.

KANBAN BOARD
This method uses visual management to let teams communicate more easily on the tasks they need to accomplish.



ALL-IN-ONE COLLABORATION

These tools offer a little bit of everything, from project management to a social network for employees. They are often targeted at enterprise companies, but some fill the bill for smaller groups, too. Igloo Software, for example, is a company intranet that offers real-time chat but also has forums, calendars, templates for organizing specific kinds of work, and more.

Podio, another example, is even more complex than Igloo: It's not only an intranet but is also a highly customizable platform with its own apps marketplace, so that you can add tools as you need them. For example, when an entrepreneur finds that her growing company suddenly needs collaboration tools specifically for a human resources department, she can explore Podio's list of apps for HR teams and add the ones her company needs. Podio scales easily as an organization grows.

If your team is already rather large, then Workfront may be a better fit. Workfront is best for large enterprises that need to be clear about the roles of different users and what kind of information they should be able to access once inside the collaboration tool.

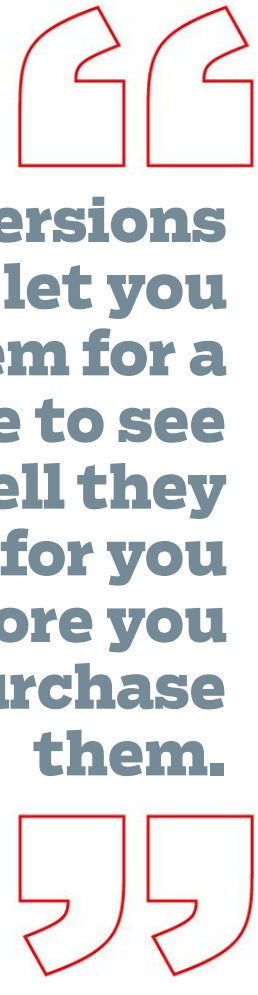
MORE POINTS TO CONSIDER

When it comes time to actually invest in some collaboration tools, there are two ways of thinking. First, you could get an all-in-one system, which might be a company intranet or work-management platform. If you go that route, make sure the system you buy has features that are important to your team—perhaps chat and video calling. Second, you could pick specialized tools for your business and cobble them together. All the tools listed here have APIs that let developers create custom integrations, and many support much simpler, native integration with very popular tools and services, such as Google apps.

If you don't have a wealth of coding skills in your team, try to find tools that are supported by the Zapier network. Zapier is an online service that helps you create simple integrations between different tools without having to learn to program. For example, you can create an integration so that when you receive a new email, the full message will automatically be imported into Slack.

PRICE MATTERS

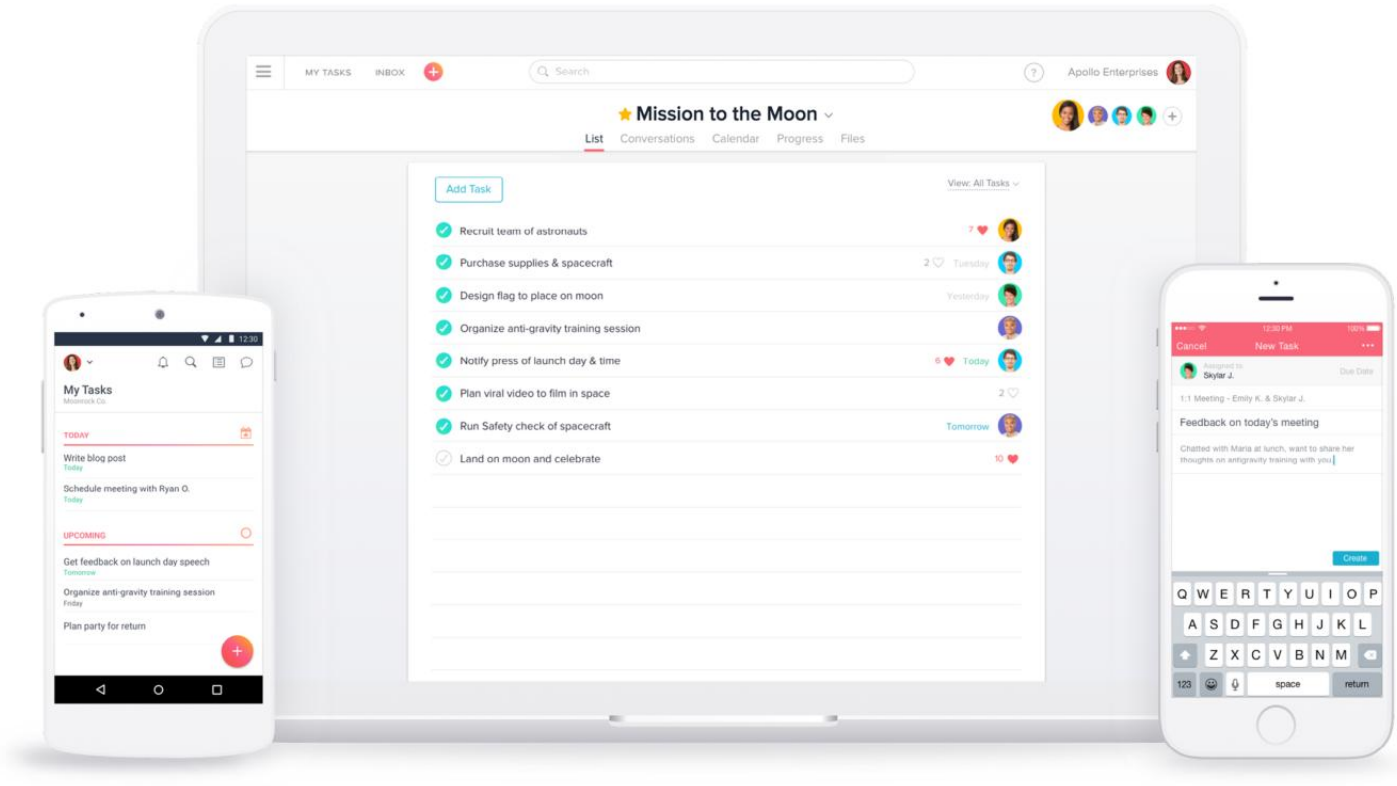
A company or organization's investment in communication and collaboration tools doesn't necessarily require a huge upfront cost. Plenty of collaboration systems offer a free level of service. Free versions of collaboration tools, like those of most other software, typically have some limitations. The package might support, say, only two projects, or it might have a file storage limit. Still, free versions usually let you and your team test them for a while to see how well they work for you before you commit to purchasing them.



CULTURE IS KEY

One important point about collaboration and communication tools is that they must have a company culture behind them. Throwing a new tool at a bunch of people and telling them to use it instead of email doesn't work. To start using a collaboration tool successfully, all the key players on the team need to buy into it. It has to be part of the culture.

When it happens and everything clicks, you can expect to see a much greater sense of teamwork—and probably some animated gifs and emoji, too. Keep in mind that collaboration tools work best when people enjoy using them, so don't try to fight the emoji.



Asana

Various price tiers, including a free level

EDITORS' CHOICE

●●●●◐

Enthusiasts love Asana, and for good reason. This online team collaboration tool specializes in workflow management, but it also handles the nitty-gritty of task management with aplomb. Businesses use it to keep track of the daily to-dos of work while also giving employees a more productive place than email to follow the status of jobs. Asana is one of the best collaboration and productivity apps for teams you'll find, and it's a PCMag Editors' Choice.

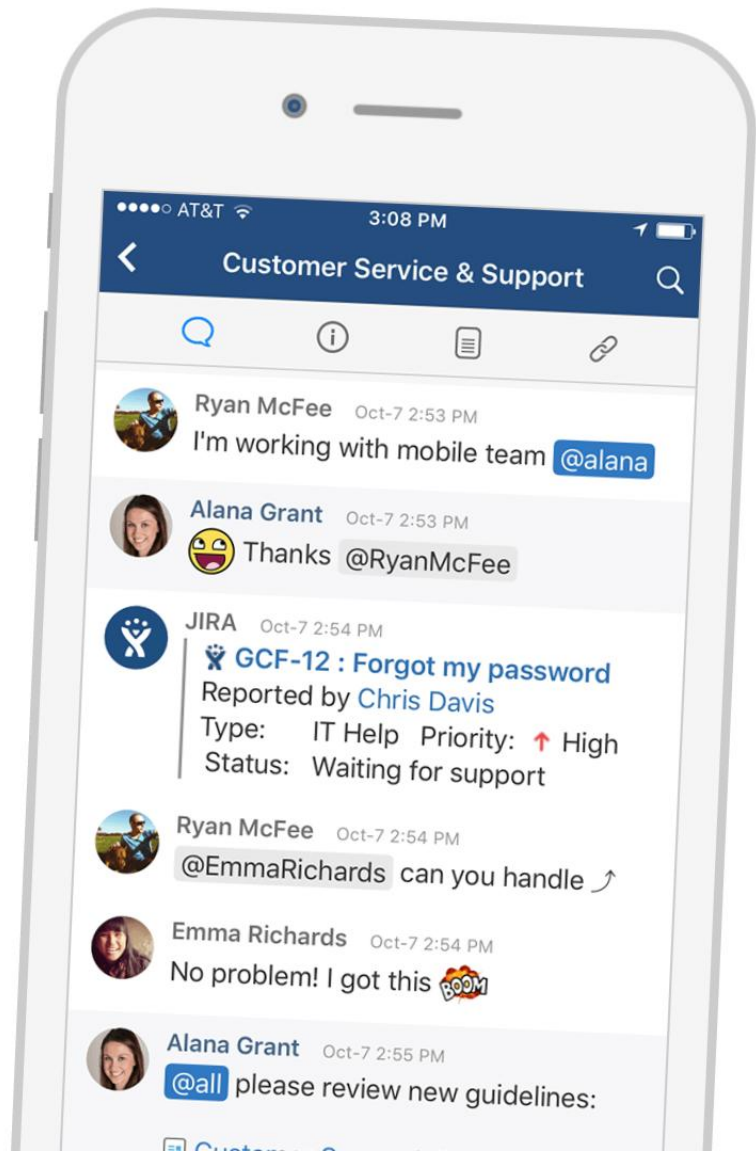
Atlassian HipChat

Various price tiers, including a free level

EDITORS' CHOICE

●●●●◐

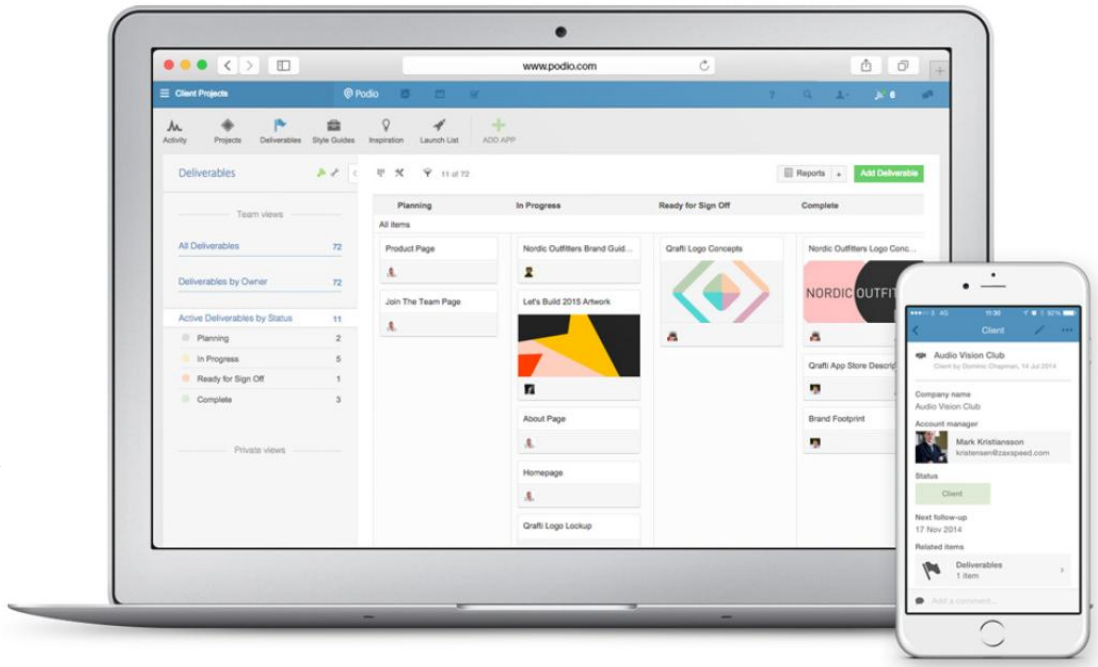
This online communication platform can connect to other tools your team uses and comes with a great set of features. It's very similar to the popular chat platform Slack, except HipChat offers a bit more value. Both HipChat and Slack offer free and paid tiers of service, but HipChat delivers more bang for your buck. Slack is a little slicker, though. They're both excellent communication tools for teams, both deserving of a PCMag Editors' Choice.



Podio

Various price tiers,
starting at $9 a month

EDITORS' CHOICE

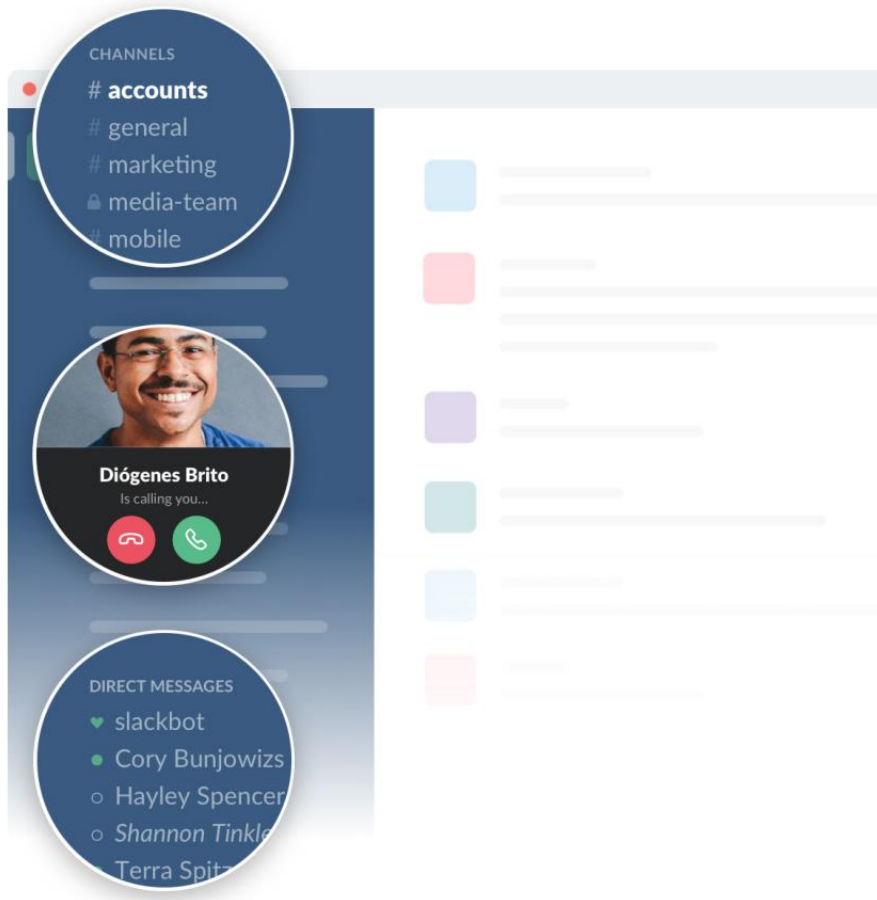


Podio is an extremely flexible and highly customizable online hub for work and communication. It's flexible, with an apps marketplace full of modules that can help a business in all kinds of ways, from sales to human resources to project management. You can add apps for practically any business need. Because it's so user friendly and scales easily for growing businesses, it's an Editors' Choice.

Slack

Various price tiers, including a free level

EDITORS' CHOICE



Slack is an excellent and powerful group-messaging app with a rich collection of settings and options. It won't magically erase all the problems of email, but integrate it intelligently with other software and it becomes a key part of any team's collaboration. Slack works very well as a collaboration tool in business because of its notifications, which are plentiful and customizable. It also supports audio and video calls. We use Slack here at PCMag, and it's our top pick for online communication and collaboration.

Igloo

Various price tiers, including a free level

Igloo is a pre-built company intranet that takes mere moments to set up and start using. If your business needs a central place online to communicate and (lightly) manage work, Igloo offers a very good service for a fair price.

IGLOO

JILL DUFFY

COVER STORY

BLOCKCHAIN: THE INVISIBLE TECH THAT'S CHANGING THE WORLD

BY ROB MARVIN

Blockchain isn't a household buzzword, like the cloud or the Internet of Things. It's not an in-your-face innovation you can see and touch as easily as a smartphone or a package from Amazon. But when it comes to our digital lives—every digital transaction; exchange of value, goods and services; or private data —blockchain is the answer to a question we've been asking since the dawn of the Internet age: How can we collectively trust what happens online?

Every year we run more of our lives—more core functions of our governments, economies, and societies—on the Internet. We do our banking online. We shop online. We log into apps and services that make up our digital selves and send information back and forth. Think of blockchain as a historical fabric underneath recording everything that happens exactly as it occurs. Then the chain stitches that data into encrypted blocks that can never be modified and scatters the pieces across a worldwide network.

Blockchain always has an immutable "ledger" that you can see, verify, and control. At the same time, it has no single point of failure from which records or digital assets can be hacked or tampered with. Because of its distributed-ledger technology, blockchain has applications across every kind of digital record and transaction. And in 2017 we'll begin to see them explode.

First up are the big banks and tech giants. Big business will always drive innovation, and the rise of blockchain-based smart contracts (read on for more explanation of them) turns blockchain into a middleman to execute all manner of complex business deals, legal agreements, and automated exchanges of data. Companies such as Microsoft and IBM are using their cloud infrastructure to build custom blockchains for customers and experiment with their own use cases. On the academic side, researchers are exploring blockchain applications for projects ranging from digital identity to medical and insurance records.

At the same time, dozens of startups are using the technology for everything from global payments to music sharing, from tracking diamond sales to the legal marijuana industry. That's why blockchain's potential is so vast: When it comes to digital assets and transactions, you can put absolutely anything on a blockchain. A host of economic, legal, regulatory, and technological hurdles must be scaled before we see widespread adoption of blockchain technology,

but first movers are making incredible strides. Within the next handful of years, large swaths of your digital life may begin to run atop a blockchain foundation—and you may not even realize it.

BEYOND BITCOIN

Blockchain is the data structure that allows bitcoin, the market-proof cryptocurrency, to thrive through a combination of decentralized encryption, anonymity, immutability, and global scale. Though blockchain is the not-so-secret weapon behind bitcoin's rise, blockchain was always destined to evolve far beyond it. Blockchain has the potential to tower above bitcoin's shadow and to underpin the evolution of our digital future.

Blockchain is the not-so-secret weapon behind bitcoin's rise, but blockchain was always destined to evolve far beyond it.

To explain how blockchain came to be, though, we have to begin briefly with the legacy of bitcoin. For Jeff Garzik, it started the way many a buzzy idea in the tech community has over the years: with a post on "news for nerds" and OG tech aggregator Slashdot.org. Garzik is the CEO and cofounder of enterprise blockchain startup Bloq, but he spent a decade as a bitcoin core developer. He was also recently elected to the Board of Directors of The Linux Foundation (as the first member with a blockchain and cryptocurrency background).

JEFF GARZIK
Garzik is the CEO and cofounder of enterprise blockchain startup Bloq, but he spent a decade as a bitcoin core developer. He was also recently elected to the Board of Directors of The Linux Foundation.

In July 2010, Garzik was working on Linux at Red Hat when what he calls “The Great Slashdotting” occurred. One viral post (https://news.slashdot.org/story/10/07/11/1747245/bitcoin-releases-version-03) introduced programmers, investors, and tech nerd-dom at large to the concept of bitcoin, and thus to blockchain. Garzik had always been fascinated with the goal of making seamless digital payments work on a global scale. When he realized how bitcoin’s underlying technology worked, he said itit “knocked him on his bum.”

“I had already thought to myself about how someone might create a decentralized version of PayPal. When Elon [Musk] and Peter Thiel and the other founders created PayPal, they had this vision of a global ledger that could easily and cheaply add entries between users like a database entry. That vision met reality with banking laws and cross-border friction, with legal hurdles and regulations not only in the U.S. but around the world. It made that kind of decentralized global currency impossible, or so we thought.

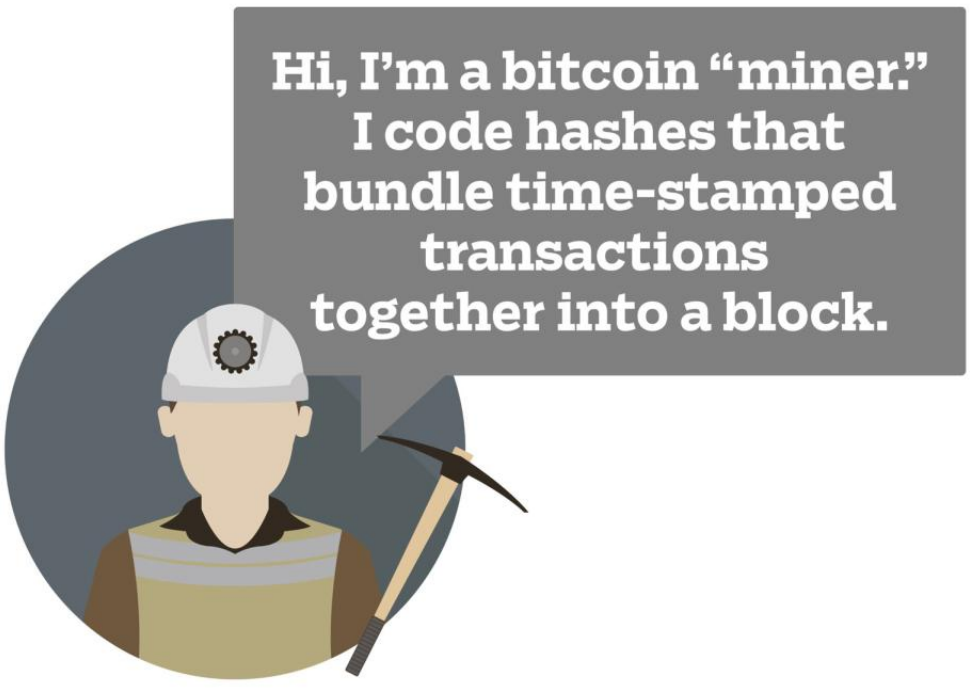
“Bitcoin turned all of that on its head,” Garzik went on. “From an engineering perspective, the proof of work was this very elegant way to elect a leader, the block creator, in this decentralized and potentially adversarial system. Bitcoin layered on top of that engineering a set of economic and game-theory incentives that paid you in the script of the system itself, creating this virtuous cycle where it’s in your best economic interest to to follow the consensus rules and create the longest, strongest chain possible. I didn’t realize until that post on that day how elegantly it could be done.”

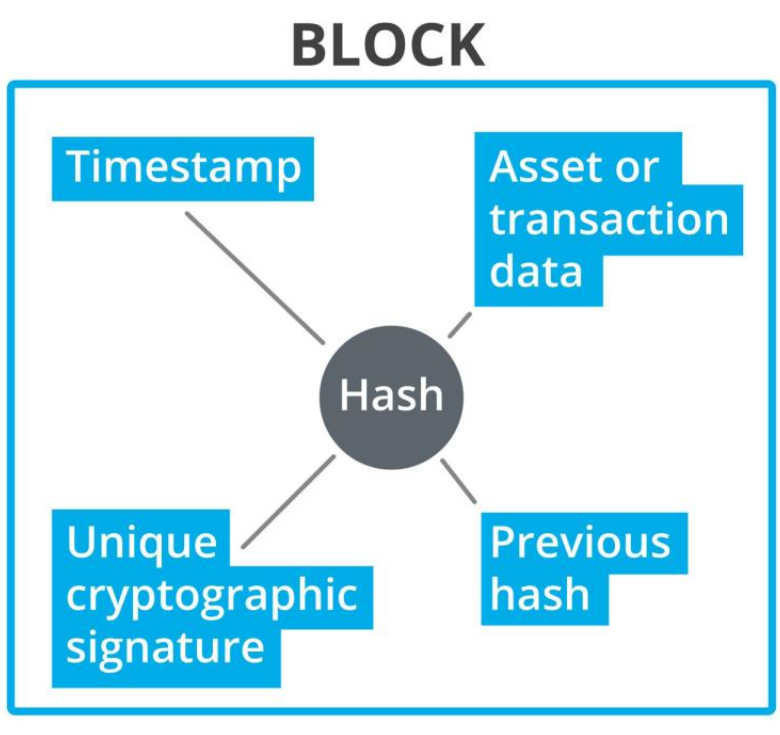
It's important to understand why bitcoin and blockchain are not the same thing. In Garzik's TEDx Talk (https://www.youtube.com/watch?v=vaPgfErzeu0), he described bitcoin as "an organism." It has layers, like other software. On top of the bitcoin blockchain is billions of dollars worth of cryptocurrency, but beneath that is a ledger just like any other blockchain. The underlying ledger works without the currency and can be used to securely transfer any digital asset over the Internet. The currency, on the other hand, doesn't work without the ledger. Garzik said bitcoin was just the first demo application of what blockchain can do. In this case, it built a monetary revolution on the back of an all-seeing ledger, one that's everywhere and nowhere at once, and gave the cryptocurrency its power.

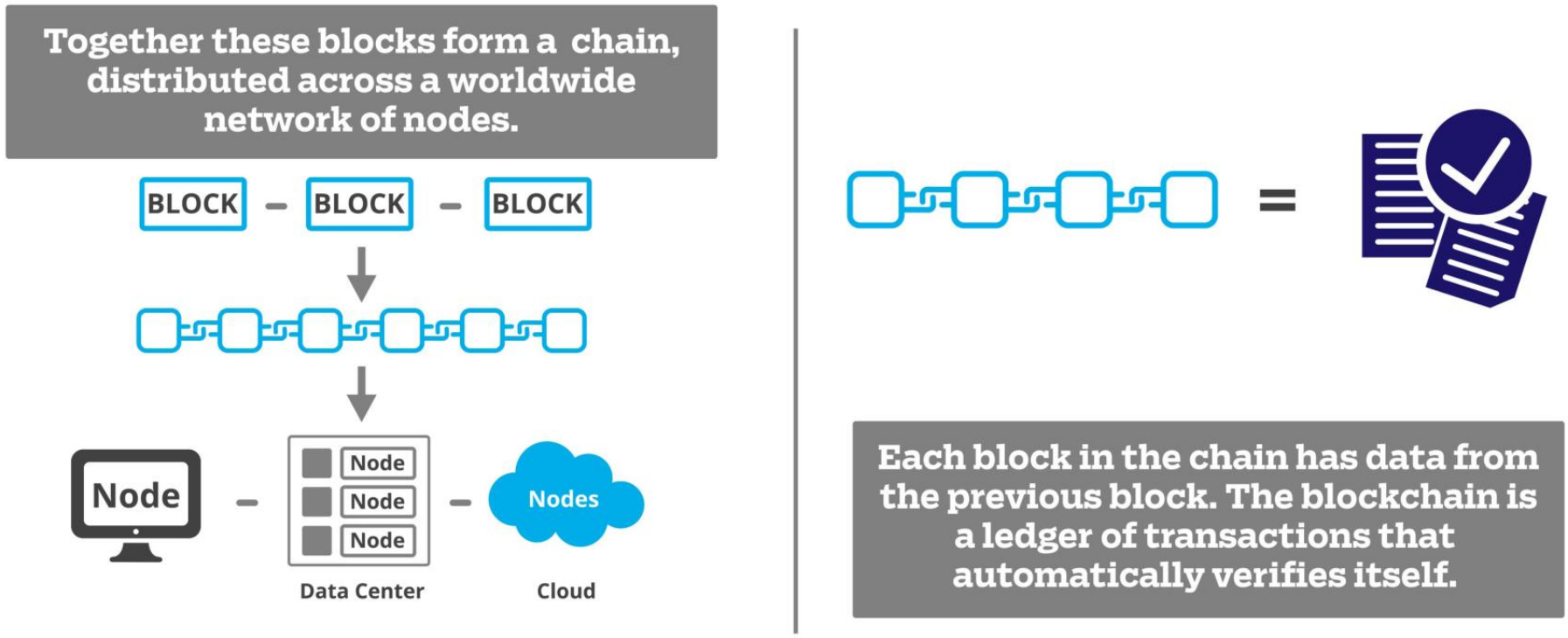
Blockchain gives us a constant—a bedrock we know won't change once we put something on it.

BLOCKCHAIN FOR BEGINNERS

People often get bogged down in technological complexity when trying to understand blockchain, but the basic concept is a simple and universal one. We have facts and information we don't want accessed, copied, or tampered with, but on the Internet, there's always a chance it could be hacked or modified. Blockchain gives us a constant—a bedrock we know won't change once we put something on it and where a transaction will be verified only if it follows the rules.

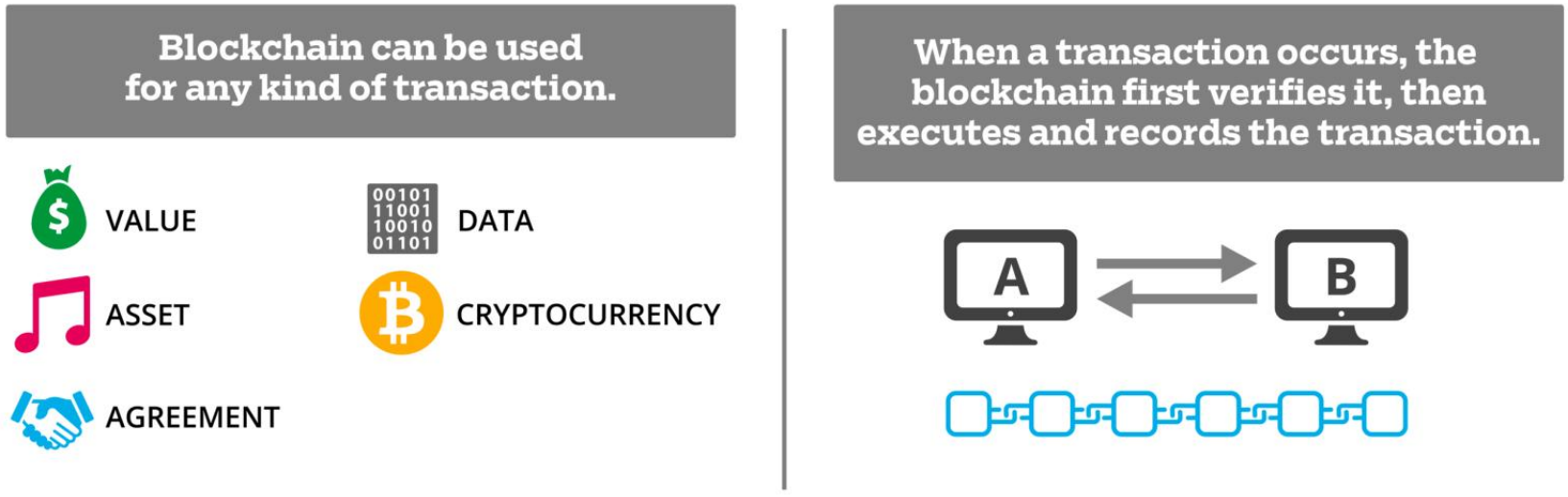






Blockchain's beginnings date back two years before that viral Slashdot post. In 2008, bitcoin founder and still-mysterious Satoshi Nakamoto (a pseudonym) published a famous white paper (https://bitcoin.org/bitcoin.pdf\) explaining the basics of "mining" data into a block, then using a hash (a time-stamped link) to chain those blocks together across a decentralized network of "nodes" that verify each and every transaction. In the 2016 book *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World,* authors Don and Alex Tapscott explain Nakamoto's bitcoin model about as succinctly as one can:

> *Bitcoin or other digital currency isn't saved in a file somewhere; it's represented by transactions recorded in a blockchain—kind of like a global spreadsheet or ledger, which leverages the resources of a large peer-to-peer (P2P) network to verify and approve each bitcoin transaction. Each blockchain, like the [bitcoin blockchain] is distributed: it runs on computers provided by volunteers around the world. There is no central database to hack. The blockchain is public: anyone can view it at any time because it resides on the network… and the blockchain is encrypted… it uses public and private keys (rather like a two-key system to access a safety deposit box) to maintain virtual security.*



Note that nothing is completely unhackable, particularly when you don't use it as intended. Blockchain's security works not only because it's encrypted but also because it's also decentralized. Victims of the biggest blockchain breaches and cryptocurrency heists (Mt. Gox in 2014 and Bitfinex in 2016) were targeted and pilfered clean because they tried to centralize a decentralized system. Another recent blockchain security incident, the DAO hack, came down to exploited loopholes in smart contracts written atop an established blockchain, Ethereum, not within the blockchain itself. Blockchain's underlying security and encryption model is a sound one. How that security is executed is a story for another feature.

So we've explained how the network functions and how security works, but how do the blocks actually connect to one another? Why does a blockchain get stronger the longer it gets? Where does the immutability come in? The Tapscotts' explanation continues:

> *"Every ten minutes, like the heartbeat of the bitcoin network, all the transactions conducted are verified, cleared, and stored in a block which is linked to the preceding block, thereby creating a chain. Each block must refer to the preceding block to be valid. The structure permanently time-stamps and stores exchanges of value, preventing anyone from altering the ledger… so the blockchain is a distributed ledger representing a network consensus of every transaction that has ever occurred. Like the World Wide Web of information, it's the World Wide Ledger of value… This new digital ledger can be programmed to record virtually everything of value and importance to humankind: birth and death certificates, marriage licenses, deeds and titles of ownership, educational degrees, financial accounts, medical procedures, insurance claims, votes, provenance of food, or anything else that can be expressed in code."*

The concept of immutability is maybe the most crucial to understand when trying to wrap your head around blockchain and why it's important. An object that once created can never be changed has infinite value in our editable, ephemeral digital world.

Harking back to the "strength in numbers" principle, the more nodes a blockchain is distributed over, the more stronger and more trusted it becomes. It's verification on top of verification to infinity. Bloq's Garzik talked about how the network effect of blockchain is key to its immutability, and why it's the reason the public bitcoin blockchain is still the most popular and trusted blockchain out there:

DON TAPSCOTT
Along with son Alex Tapscott, Don cowrote *Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World.*

"The immutability factor is very much dependent on the network effect. You see that with bitcoin very specifically. The cost of creating a new digital asset is essentially zero. Therefore you have to demonstrate an overwhelming amount of value in overcoming that network effect if you want to convince someone to switch away from the bitcoin blockchain, which not only has a good track record but high security value from a technical perspective. Security and immutability are a direct function of the economics—how much investment there is in the ecosystem, and how many people are using it."

Once you understand what a blockchain is and how it works, the next question an everyday tech user would have is how it'll affect them. If you're not a business that's building a blockchain-based product or service, why should you care? As Don Tapscott explained it in Blockchain Revolution and in a 2016 TED Talk of his own, it's because blockchain brings us from the Internet of information into the "Internet of value." From his TED talk:

> *"For the past few decades, we've had the Internet of information,. When I send you an email or a PowerPoint file, I'm actually not sending you the original; I'm sending you a copy. That's great, and it has democratized information. But when it comes to assets; things like money, financial assets like stocks and bonds, loyalty points, intellectual property, music, art, a vote… sending you a copy is a really bad idea. If I send you $100, it's really important that I don't have the money afterward… Today, we rely entirely on big intermediaries; middlemen like banks, government, big social media companies, credit companies, and so on to establish trust in our economy. These intermediaries perform all the business and transaction logic of every kind of commerce, from identification and authentication of people through to clearing, settling, and record-keeping… they capture our data, which means we can't monetize or use it to better manage our lives, and our privacy is being undermined… so what if there were not only an Internet of information, but an Internet of value. Some kind of vast, global, distributed ledger running on millions of computers and available to everybody, and where every kind of asset from money to music could be stored, moved, transacted, exchanged, and managed, all without powerful intermediaries."*

That, in a nutshell, is blockchain.

WHAT ARE SMART CONTRACTS?

If you think of blockchain as an operating system for data, then smart contracts are its killer app. Smart contracts add complex logic and rules atop a blockchain that can automate traditional contract management and digitize the world around us the same way apps like Uber are automating away the need to wave your hand in the air to hail a cab.

You can't talk about the future of blockchain without explaining the role smart contracts will play. If the world is going to run on blockchain, much of it will rely on smart contracts to execute the data exchanges and program in rules to

govern how each code-triggered agreement works. Smart contracts are also a flexible mechanism that can serve as the blockchain middleman for all manner of agreements and data exchanges. At the inaugural Smart Contracts Symposium in New York this past December, panelists were asked to describe smart contracts as though they were explaining them to a teenager.

JERRY CUOMO
Vice president of blockchain technologies at IBM.

“Think about getting carded at a bar,” said Jerry Cuomo, vice president of blockchain technologies at IBM. “From an identity perspective, I can imagine a blockchain managing verification of a citizen’s identity. A smart contract could ensure something like my daughter going out for her 21st birthday and the bouncer only being able to see her age, not her address. Blockchain could set up a centralized identity verification system that could make the world safer for dads like myself.”

Symposium experts pointed to identity management as an application to watch in 2017, but the list goes on. The Chamber of Digital Commerce, the leading trade association that represents the blockchain industry, organized the symposium and also runs the Smart Contracts Alliance. The Chamber and Alliance (with Deloitte) recently released a white paper entitled “Smart Contracts: 12 Uses Cases for Business & Beyond” detailing a dozen broad areas and industries where smart contracts could change the game.

In a broad legal sense, smart contracts provide what Bloq’s Garzik calls ““adjudication-as-a-service:” a real-time version of the court system that, for finance scenarios, can cut time on deal closings, banking and securities transactions, and even global trade finance from weeks or months to days, hours, or minutes. On the digital identity front, the white paper calls smart contracts a “user-centered Internet for individuals”

giving users control over the data, digital assets, and online reputation associated with them. Blockchain also affords the ability to decide what personal data is and isn't shared with businesses—the same concept behind the driver's license analogy.

Beyond identity, the white paper also talks about how smart contracts can be applied to getting a mortgage and instantaneously processing auto-insurance claims. In the medical research field, they can serve as a mechanism to ensure better patient privacy in clinical trials while promoting more open data-sharing in the cancer research community. Another of the paper's use cases is land titling. Countries around the world, including Ghana, Georgia, and Honduras, that are typically rife with property fraud and land disputes are already implementing smart contracts to facilitate property transfers and land ownership.

Real-world smart contracts are also gaining traction in a few other interesting ways. Everledger is a blockchain-based fraud-detection system for valuable physical assets, particularly jewelry and diamonds. It uses a hybrid blockchain that combines the bitcoin blockchain with its own private blockchain to build smart contracts that certify physical diamonds. It combats the sale of conflict diamonds by keeping a transaction history for each gem.

"Everledger takes a diamond or a piece of art and hashes it to the blockchain," said MIT's Forde. "For something like a diamond ring, Everledger takes an image of it—like a unique diamond fingerprint—which can then be scanned against the blockchain to verify it's the same one."

Once you open the door of tracking and manage physical assets, smart contracts can tackle the whole supply chain. IBM and Walmart are even partnering in China to track the movement of pork (seriously) to keep people from eating tainted meat.

You can also use smart contracts for digital content such as music. Mycelia, a "collective of creatives, professionals and lovers of music" founded by musician Imogen Heap, is a blockchain-based protective ecosystem pushing smart contracts as a way for musicians to share free-trade music and to ensure the profits go back to the artists.

Mycelia is an example of blockchain and smart contracts' potential for digital rights management (DRM). Smart contracts in digital music files or other copyrighted material might enable artists to better sell directly to consumers without the need for labels, lawyers, or accountants, with royalties paid out automatically.

A sleeping giant in this conversation is the effect smart contracts could have on the Internet of Things. Think about all the data that your smart devices collect. Fitness trackers collect your body's vital statistics. Thermostats collect temperature data. Alexa has records of every search and request you've ever asked of her. If the IoT ran on a blockchain, and smart contracts governed that real-time data, it could create a whole new class of lending and other usage-based agreements, according to Erin Fonte, Head of the Financial Services Regulatory and Compliance Practice Group at corporate law firm Dykema.

A sleeping giant in this conversation is the effect smart contracts could have on the Internet of Things.

"If you had smart and connected cars that could report back actual usage stats, you could tie pricing into real-time usage and have it automatically adjust over the length of your vehicle lease and financing," said Fonte.

Think about how connected devices enable mobile payments without traditional credit card swiping at the point of sale. Instead of swiping your card at a terminal, you touch a thumb to your iPhone to use Apple Pay. The automated payment system is authenticating individuals and providing verifiable legal proof of transaction authorization, just as a smart contract using those same two permissions—authorization and permission—in an IoT device can make a transaction legally enforceable against a buyer or seller, which is particularly applicable in machine-to-machine (M2M) communication.

ERIN FONTE
Head of Financial Services Regulatory and Compliance Practice Group at corporate law firm Dykema.

“Amazon Dash buttons are a prime example,” explained Erin Fonte. “It’s one little branded button you stick in your house, and then you don’t have to log onto Amazon to reorder. Just press the button, and it repeats its last order. For connected homes and cars, blockchain’s ability to monitor, to collect, and to make sense of data for transactions will drive the ability for humans to authorize machines to carry out activities like this as agents.

“The next step is that you don’t need a button,” she went on. “Manufacturers will create customer and end-user [smart contract] agreements on the back end. “Your washing machine will have that feature built into the product itself.”

HOW WE BUILD A BLOCKCHAIN-BASED WORLD

Blockchain is still in its infancy. Before we see widespread adoption on the scale the technology is capable of, a lot needs to happen. We must have buy-in from government (which in the U.S. means working state-by-state on policies and legislation). The industry has to clear a labyrinth of legal and regulatory hurdles before blockchain can power better banking, identity, records, or anything else requiring official documentation that now runs on legacy government systems or even (still) on paper.

“Before we see widespread adoption on the scale the technology is capable of, a lot needs to happen.”

We also need open standards to tie the blockchain industry together. The most prominent coalition working to make that happen is the Hyperledger project. Hyperledger is an open-source initiative to create an open, standardized, and enterprise-grade distributed ledger framework and code base to be used across industries. Overseen by The Linux Foundation, its members include tech companies (Cisco, IBM, Intel, Red Hat, Samsung, VMware, and more), big banks (JPMorgan, Wells Fargo, and so on), blockchain startups such as Bloq, and a host of others.

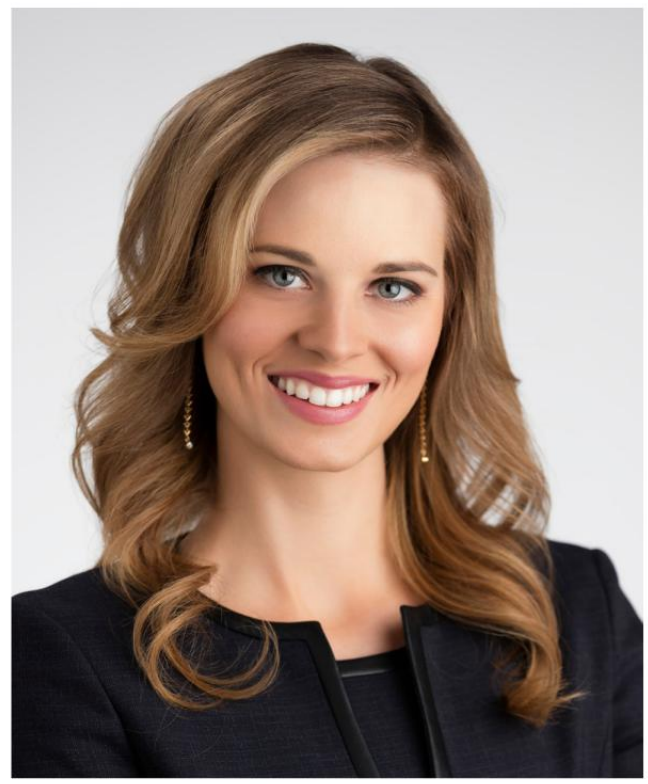
“The Linux Foundation is the key layer of governance for shepherding and maturing open-source products,” said Garzik. “There are many blockchain peddlers out in the market right now, and one of the biggest pain points we see is incompatibility; a large bank that has merged 10 businesses over the past decade and has a lot of halfway-compatible internal legacy systems. That’s where the foundation and Hyperledger really come to the fore. As young as the blockchain industry is, the kind of technical standards-making we need for interoperability has so far been absent.”

“R3 is a consortium dedicated to research and development of advanced distributed ledger technologies.”

Another important Hyperledger member is R3, the wealthy elephant in the room when it comes to blockchain standardization. R3 is a consortium dedicated to research and development of advanced distributed ledger technologies for global financial markets. It also represents most of the biggest banks and financial institutions on the planet: Barclays, Credit Suisse, J.P. Morgan, the Royal Bank of Scotland, UBS, Bank of America, Citi, Deutsche Bank, HSBC, Morgan Stanley, Wells Fargo, and a number of others.

We’re already beginning to see the kind of blockchain-based international trading R3 is after. This past

October, the first cross-border transaction between banks using multiple blockchain applications took place between the Commonwealth Bank of Australia and Wells Fargo, resulting in a shipment of cotton to China from the U.S. R3 is also becoming an example of how difficult standardizing blockchain can be. Goldman Sachs and Santander both left R3 in late 2016 in the midst of big-bank jockeying over control of a new funding round for the consortium.



PERIANNE BORING
President of the Chamber of Digital Commerce.

Few know the challenge of pushing for blockchain adoption better than Perianne Boring, president of the Chamber of Digital Commerce. The Chamber is currently engaged in lobbying and advocacy efforts in 14 states and counting. In North Carolina, the chamber's efforts helped pass the North Carolina Money Transmitter Act in July 2016, which updates the state's existing laws to include a defined "virtual currency."

Boring said the law is a big win for blockchain and digital currency but still only a drop in the bucket of patchwork state-by-state regulations and the even more muddled web of federal agencies. In the past year, Chamber representatives have testified at cryptocurrency regulation hearings in New Hampshire, lobbied regulatory proposals in New York and Washington states, and made official comments on virtual currency acts and regulatory frameworks from the Uniform Law Commission and the Conference of State Bank Supervisors (CSBS).

"How is digital currency supposed to be regulated? This is a huge national debate around how states can effectively regulate virtual currency and money transmission, and every state has its own opinion and a completely different way of doing things," explained Boring. "New York says businesses need a separate digital currency license to operate in the state. North Carolina said that's way too complicated and regulatory overkill and decided instead to take their existing money transmission laws and incorporate digital currency into the existing regulatory framework. We side with North Carolina in that debate."

Boring stressed the importance of keeping blockchain technology and policy on the same page. The Chamber is also a Hyperledger member, and Boring said the Chamber will work to actively bring Hyperledger into policy discussions, to ensure lawmakers understand the pros and cons of regulations.

Yet as difficult as overcoming entrenched legacy systems and regulations can be, we already have a blueprint of how it can be done. Over the past two years, the state of Delaware has shown how governments can legislate, sanction, adopt, and implement blockchain technology to power core services.

MARK SMITH
CEO of Symbiont, a blockchain fintech company.

As with much of the legislation, regulation, and business drivers behind blockchain, it starts with fintech (financial technology). More than a million companies and 66 percent of Fortune 500 companies are incorporated and legally headquartered in Delaware, in large part because of the state's largest export: uncertified shares (meaning the ability to own shares in a company without holding the actual stock certificate). In partnership with blockchain fintech company Symbiont, the Delaware Blockchain Initiative announced in 2016 will completely automate stock issuance and recordkeeping on a blockchain ledger.

'Before the Delaware Blockchain Initiative, there was no technological solution to support digital representation of share ownership," explained Symbiont CEO Mark Smith. "From what can only be described as a forward-thinking agenda from the state, they embraced that they could reimagine how to deliver their marquee service on a distributed ledger, using Symbiont's technology to create a new type of share and change the way a corporation works from now into the foreseeable future."

A little finance background: The genesis moment of a private equity is when you incorporate a company. As

Smith explained, now companies will have the ability to carry that equity all the way from incorporation up to and including an initial public offering (85 percent of IPOs happen in Delaware), all via the blockchain, with complete financial transparency for state lawyers and regulatory agencies. The entire process will run automatically on smart contracts.

Even greater implications lie in what the Delaware Blockchain Initiative is doing beyond digital shares. At the Consensus blockchain technology summit this past year, Delaware Governor Jack Markell gave a keynote speech announcing the initiative and laying out a blockchain roadmap for the next five years, including a new joint effort with Symbiont to digitize and store the entire Delaware Public Archives on a blockchain ledger in 2017.

The state [Delaware] has gone from knowing nothing about blockchain to embracing it in its biggest export.

Symbiont's Smith, who is also a co-chair of the Chamber of Digital Commerce's Smart Contracts Alliance, explained how Delaware is building cryptographic document control that will ultimately overhaul how city, county, and state municipalities share information that in many cases still exists on paper in filing cabinets. Smith's first conversation with Delaware officials was in October 2015, and between then and now, the state has gone from knowing nothing about blockchain to embracing it in its biggest export and mobilizing to push new legislation and initiatives around it.

"The state is completely reimagining how it stores and distributes public records to its citizens. Land and property titling, licensing, birth and death certificates, automobile VIN numbers, heavy machinery and luxury good registrations, all these things are being incorporated into Symbiont's technology stack behind

the Delaware blockchain," Smith explained. "Distributed ledger technology is not a silver bullet—it's not going to solve every problem—but it does solve some very big ones.

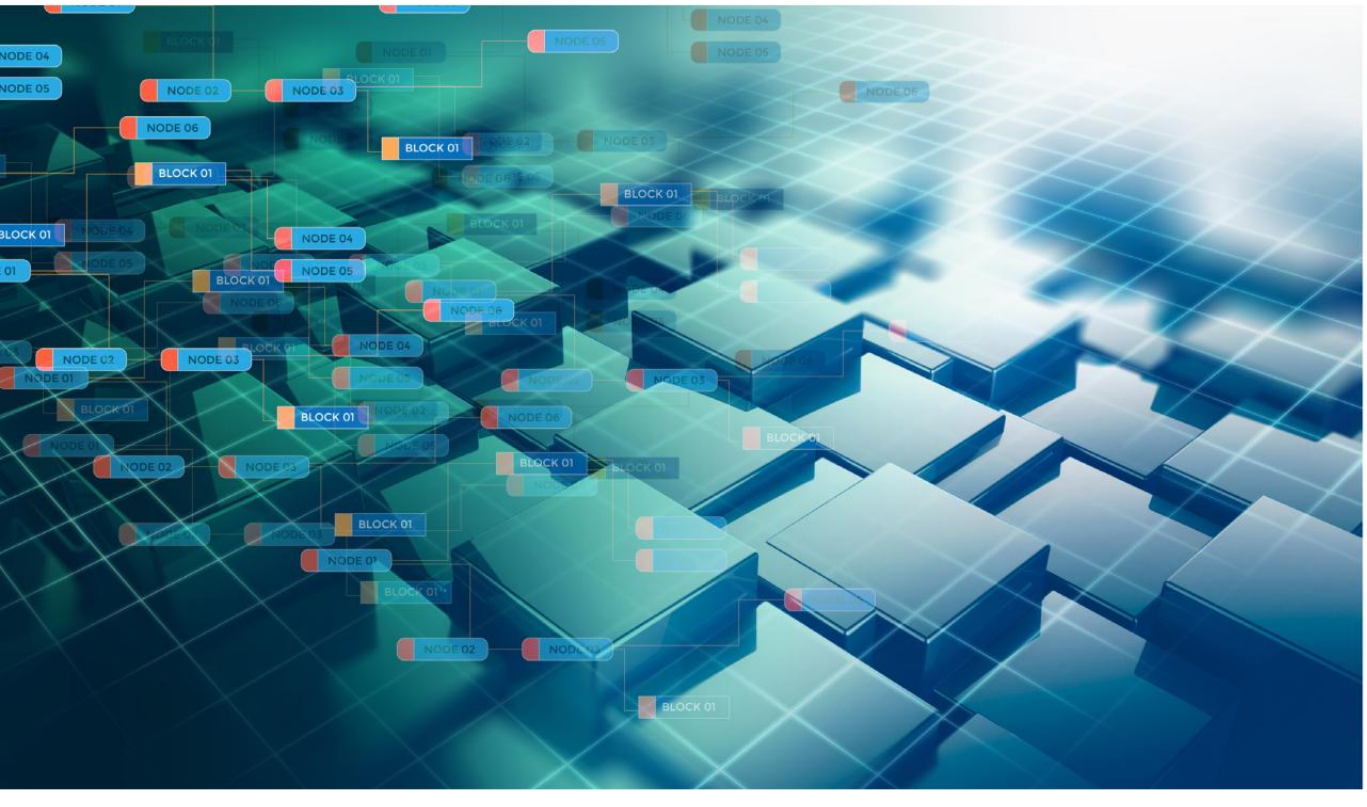
"When [Delaware] Governor Markell came out publicly announcing the initiative, he said he wanted to challenge us to use this powerful technology," Smith continued. "Delaware should serve as a blueprint for many other states, each of which could operate a node right next to Delaware and build critical mass and momentum from a government perspective that could lead to other nations joining in."

> **Blockchain is broad and coming to the fore on such a massive scale that explaining it often falls back on the abstract.**

WELCOME TO OUR BLOCKCHAIN FUTURE

The change blockchain represents to our digital world is tectonic. Blockchain is broad and coming to the fore on such a massive scale that explaining it often falls back on the abstract, rather than grounding it in the kind of foundational change the technology will have on the culture of how we interact online.

The Web 1.0 was a read-only Internet of static web pages. Web 2.0, where we are now, added dynamic user-generated content and the rise of social media.



Web 3.0 has many definitions, but one of the most popular is that of connective intelligence: where the next generation of applications, data, concepts, and people are connected by an unmediated fabric where you don't need a trust broker like a bank or tech company in the middle to ensure privacy and security. In blockchain, we finally have the technology to power Web 3.0.

"The first four decades of the Internet brought us email, the World Wide Web, dot-coms, social media, the mobile web, Big Data, cloud computing, and the early days of the Internet of Things," the Tapscotts write in Blockchain Revolution. Through that lens, MIT's Brian Forde said, we can understand where blockchain fits into our lives.

"People have forgotten how powerful it is not to have to worry about what email app you use. When I email you, it doesn't matter if you're using Gmail or Outlook or Yahoo—you just give me your email address and go. Now think about sending money today. If I want to send you $20, we're going to play a game of 20 questions. Do you have PayPal? How about Venmo?" said Forde.

"Imagine if we still chose our cell phone carriers and ISPs based on whether our friends and family were using Sprint or AT&T," Forde went on. "That's still the world we live in today for most digital services. You joined Facebook because your friends did. You're not going to sign up with a new payments startup if your friends are all on PayPal. It's going to be incredibly powerful for consumers to have more choice when everything running on blockchain just works."

Blockchain is taking root within a wide swath of industries. To discover which ones, all you need to do is follow the money. A Deloitte survey released in December 2016 polled blockchain-knowledgeable senior executives at organizations with $500 million or more in annual revenue. Of the 308 respondents, 28 percent reported that their companies have already invested $5 million or more in blockchain technology, with 10 percent investing $10 million or more.

Although the fintech industry was early to show interest in blockchain and accounts for a significant amount of investment and activity, the survey revealed other industries aggressively pursuing blockchain.

Within the consumer products and manufacturing industry, 42 percent of respondents said they're planning to invest $5 million or more in 2017, compared to 27 percent in the media and telecoms industry, and 23 percent in financial services. Put together, 30 percent of consumer manufacturing and media/telco industry respondents said their companies have already deployed blockchain into production.

Yet the industry the Deloitte report identifies with the most aggressive deployment plans is healthcare and life sciences: 35 percent of respondents in that industry say their companies plan to deploy blockchain in production within the next calendar year. When you look at some of the blockchain healthcare initiatives already out there, that stat starts to make a lot of sense.

“The industry the Deloitte report identifies with the most aggressive deployment plans is healthcare and life sciences.”

One exciting project Forde pointed to is MedRec, an MIT initiative creating a blockchain to serve as a digital family history of medical records.Think about sitting down in a doctor's office and being asked your family medical history for a certain illness. You might, off the top of your head, have no idea of the answer. But with MedRec blockchain, families and medical providers can create a shared medical history that can be passed from generation to generation.

“With medical records, we’re all asked that question: Is there any family history of this? The answer is usually ‘I don’t know,’” said Forde. “What’s interesting here, as a result of the Affordable Care Act (ACA), we now have this mandate for electronic health records, and the government subsidizes doctors to get those records. But that data is still siloed. There needs to be a technology or protocol allowing all that data to be shared, regardless of provider. MedRec helps facilitate that. It’s not just about the interoperability of your data; it’s also about the protection of your data from fraud.”

Forde said the project is also evolving as a way for hospitals and medical practices to interface with consumer tech. Think about all the real-time health data collected by wearables and fitness trackers and even apps like Apple Health. MedRec is exploring the possibility of using blockchain to give doctors and hospitals access to that data, if you consent.

“You’ve got Fitbit, Apple Watch, all this consumer tech collecting data on your blood pressure, heart rate, etc,” said Forde. “Then you go to the hospital or your doctor and they have their own system. You see the allergist and they’ve got their own system, and none of it is connected. If there’s no interoperability between any of these systems, how are you going to get the best possible care?”

The federal government recognizes blockchain’s potential for health care, and the Department of Health and Human Services (HHS) is already doing something about it. The HHS Blockchain Challenge gathered more than 70 submissions of academic papers on blockchain usage in health IT and health-related research, announcing 15 winners this past September spanning organizations including Deloitte, IBM, MIT (MedRec was one of the winners), and The Mayo Clinic. The winners, who presented to the HHS for possible development and implementation, proposed blockchain solutions for everything from health insurance claims and payments to data interoperability and Medicaid applications. The Chamber of Digital Commerce, which participated in the challenge, sees blockchain’s potential to transform healthcare and beyond.

“The HHS received so many amazing ideas,” said the Chamber’s Perianne Boring. “In the healthcare industry, we are seeing a huge influx of interest and a lot of major problems blockchain is addressing, from patient privacy and electronic health records to tracking pharmaceuticals and doctor shopping.

Blockchain is also extremely powerful when it comes to victims of identity theft. Using the security of blockchain provides a degree of certainty that can be used to confirm your digital identity as we do more and more of our daily activities online."

The security of blockchain provides a degree of certainty that can be used to confirm your digital identity.

That notion of identity is key. Through the digital "wallet" a blockchain creates around not only virtual money but the pieces of data that make up your identity, blockchain will act as a gatekeeper of sorts to how we interact with the digital world. Blockchain-based identity is being explored and experimented with in a host of ways, from the IoT governance model to more secure voting, and in the case of Blocksafe, as a way to reduce gun violence by securing firearms with "smart locks."

"These digital wallets will become control centers," explained Bloq's Jeff Garzik." In a multi-chain, multi-network world, you wind up with a digital experience that secures itself with several factors of authentication. Then once [the blockchain verifies] that I'm Jeff Garzik, it'll say things like, 'Do you want to send your autonomous car from home over to your wife's office? Do you want to unlock the door for a guest coming over? Are you allowed to drink at this bar? Are you licensed to carry a gun?'"

One of the futures envisioned in *Blockchain Revolution* is a "second era of democracy," one in which blockchain technology can create the conditions for fair, secure, and convenient digital voting that galvanizes the citizenry by removing so many of the systemic voting roadblocks plaguing our current system. Putting democracy on a blockchain is complicated, but startups including Follow My Vote and Settlemint are already laying out frameworks centered around blockchain-based tokens serving as votes, dropped in digital wallets for each candidate.

At a time in America when the integrity of our voting process is under intense scrutiny, blockchain—and every manifestation of the technology laid out in this story—could provide a new way forward. The book points to a 2015 paper published by the University of Athens introducing DEMOS, an end-to-end e-voting system, and an organization and "political app" in Australia called Flux that's already using blockchain voting to try to transform the political process. When I spoke to Don Tapscott for this story, he discussed how the opportunity to "reinvent democracy" speaks to the universal power of blockchain:

"Young people didn't vote in [the 2016 presidential] election because they're not engaged. We urgently need to fix this. In the book, we argue for a new era of democracy based on accountability, smart contracts, and a culture of public deliberation and active citizenship enabled by the blockchain," said Tapscott. "We should move many things onto blockchains. I think governments could move toward creating a blockchain-based identity. Think about your health records, your academic records, your citizenship and ability to vote, all unified and facilitated via blockchain. As a voter, you need 100 percent assurance that your vote was counted for the person whom you voted, that it can't be reallocated, and that it was private. In e-voting, only blockchains can guarantee that level of assurance.

"But it goes far beyond e-voting," Tapscott continued. "Leaders could come to power with a smart contract where they're accountable to citizens and have to abide by the terms of the contract. There are opportunities everywhere. Look at the different hats we all wear every day. You're a parent, a consumer, a listener of music, an employee, a voter, a citizen. Blockchain affects you in every way."

PUBLIC VS. PRIVATE BLOCKCHAINS

People within the industry talk a lot about public versus private blockchains. On a basic level, public blockchains are cryptocurrencies such as bitcoin, enabling peer-to-peer transactions and, therefore, a revolution in seamless global payments. Private blockchains (those being built by distributed ledger consortium R3, for example) use blockchain-based application development platforms such as Ethereum or blockchain-as-a-service (BaaS) platforms such as those offered by Microsoft and IBM, running on private cloud infrastructure.

Brian Forde, Director of Digital Currency at the MIT Media Lab, likens public versus private blockchains to the relationship between an open-source technology, such as Linux, and companies like Red Hat that build on that tech for enterprise use. Public blockchains like bitcoin were the open-source movement that started it all, and private blockchains such as R3 are taking that technology and commercializing it for businesses.

“A private blockchain is an intranet, and a public blockchain is the Internet. The world was changed by the Internet, not a bunch of intranets. Where companies will be disrupted the most is not by private blockchains but public ones,” said Forde.

Bloq’s Garzik echoed a similar thought when explaining the difference between public and private blockchains, but he uses the open-source analogy a bit differently. Bloq bills itself as a “Red Hat for blockchain” of sorts, but its platform is built atop the bitcoin blockchain rather than a private or “permissioned” one. (Permissioned blockchains include an access control layer governing who can participate in the network.) Garzik’s biggest question when looking at cloud providers and others building private blockchains and BaaS offerings is: Who’s running that network?

“On the private and permissioned side, it’s very much a question of who the referees are,” said Garzik. “I use that term specifically because what blockchains really provide is a neutral, level playing field for the execution of rules. Those rules are applied to transactions that the actors create from that network. For bitcoin, it’s rules like the monetary supply; the number of transactions that can fit into a block. All of that forms the economic incentives and ultimately consensus rules that everyone in the network complies with and cross-checks to create this system of checks and balances.

“Some of the other blockchain networks, whether it’s [open-source project] Hyperledger, Ethereum, or a bank chain [such as R3] are opening the question of trust and trust shifting. It’s less about the technology, and much more about a rapid, near real-time adjudication of rules between actors on a network. That’s what blockchains do.”

BLOCKCHAIN IN THE REAL WORLD

Nothing helps to bring abstract concepts (say, for example, blockchain) down to earth and accessible like actual examples of how they manifest in real life. Here are how companies you’ve heard of (and many you haven’t) are putting blockchain to work.

OVERSTOCK BETS BIG ON BLOCKCHAIN

E-commerce retail giant Overstock.com became the first publicly traded company to issue stock on the blockchain this past December, selling 126,565 shares through its subsidiary, tØ: It’s the first-ever blockchain-based trading platform for stocks and securities. Overstock has been developing tØ for more than two years to serve as a distributed immutable ledger for capital markets.

Overstock CEO Patrick Byrne has called tØ a blockchain version of Wall Street, and in a Q&A with PCMag, the outspoken executive talked about how the platform works, making history with tO, and how blockchain could turn capital markets into Game of Thrones.

"I think what's going to happen is similar to what English common law did over a century ago. Blockchain is going to disrupt all kinds of legal work, notary publics, contracts, lawyers, judges, you name it," said Byrne. "You're going to start seeing open-source, self-executing contracts gradually improve over time. What the Internet did to publishing, blockchain will do to about 160 different industries. It's crazy."

"Blockchain is helping fill in gaps for entrepreneurs, particularly when it comes to banking and legal protection."

POTCHAIN: WHERE BLOCK-CHAIN MEETS MARIJUANA

Medical and recreational marijuana is being legalized in more and more states across the U.S. This new, fast-growing sector of the economy presents challenges we haven't dealt with before, partly because even in states where it's legal, there are still a lot of things cannabis-related businesses can't do. Blockchain is helping fill in gaps for entrepreneurs, particularly when it comes to banking and legal protection.

Current federal banking regulations still preclude banks from doing business with cannabis companies, leaving them without a dedicated banking system. Tokken, a digital bank startup, gives cannabusinesses a bank account and blockchain-based transaction history that's linked to brick-and-mortar banking institutions and seed-to-sale systems, with Tokken as the middleman.

More interesting is what Medical Genomics is doing on the science side of the potchain. The life sciences company is mapping and sequencing the DNA of different cannabis strains, then storing and registering that info on the bitcoin blockchain. The company lists this information on its public-facing Kannapedia strain database, but of far greater importance is how the company uses blockchain-based strain DNA as intellectual property (IP) protection for growers. The government makes it very difficult to obtain trademarks and patents for weed strains. But a blockchain provides irrefutable legal proof a grower can use to prove ownership of a strain if challenged by other growers or the pharmaceutical corporations that will ultimately enter the legal industry.

10 BLOCKCHAIN STARTUPS TO WATCH

Tons of innovative startups are pushing the envelope of what's possible with blockchain technology. Here are other 10 exciting companies to keep an eye on as the space evolves:

ABRA: A blockchain-based digital wallet that lives on your smartphone. Abra allows you to send or receive funds from any source in the world, without requiring bank accounts or transfer fees, using its own community of "tellers."

AUGUR: Through Augur's decentralized prediction market, you can bet on events in the real world. Using blockchain-based tokens, you can make wagers on pretty much anything, from the score of a game or winning lottery numbers to whether or not an Antarctic ice shelf will collapse (that's a real betting market on the site).

BLOCKCYPHER: This company is a cloud-based Web services platform for blockchain apps. What Amazon Web Services (AWS) is to cloud infrastructure, BlockCypher wants to be for blockchain.

BLUZELLE: Between bitcoin, Ethereum, and all the other blockchains out there, the industry already has interoperability issues. Bluzelle is middleware that supports all blockchain protocols and smooths out banking and payments transactions in what CEO Pavel Bains describes as the "Red Hat of blockchain."

BRAVE: Founded by Mozilla co-founder Brendan Eich, Brave is a new kind of browser that automatically blocks ads and trackers and instead helps drive publisher revenue through blockchain-based micropayments. As ad revenues for the digital media industry continue to decline, Brave's micropayments model could be one solution.

CREDIT DREAM: Access to credit can be difficult to come by in developing nations, and carry enormous interest if you're lucky enough to get it. Currently active in Brazil, Credit Dream is a mobile-based blockchain platform for connecting investors in any country to loan borrowers in any country for affordable, verified loans.

ENIGMA: A stealth startup from MIT Media Lab, Enigma takes the blockchain's privacy and security advantages and rolls them into a decentralized cloud platform that guarantees privacy. Enigma encrypts and protects data even when you share it with others, allowing data to be stored, shared, and analyzed without ever being fully revealed to any party.

“Credit Dream is a mobile-based blockchain platform for connecting investors in any country to loan borrowers in any country.”

SLOCK.IT: Slock.it is the manifestation of how blockchain and the IoT fit together. Built on the Ethereum blockchain, the startup is embedding smart contracts in connected cars, homes, and other IoT devices with the goal of enabling anyone to rent, sell, or share their connected property without a middleman. Think about renting your apartment on Airbnb with Slock.it automatically opening and locking your door.

PLEX: Plex uses the Ethereum blockchain, machine learning, and artificial intelligence to give insurance companies real-time remote diagnostics on cars and drivers.

ZCASH: As cryptocurrencies go, Zcash is the most exciting one this side of bitcoin. Zcash uses something called zero-knowledge proofs to create truly anonymous digital transactions. While it's mined on a public blockchain just like bitcoin, Zcash provides a fully anonymous cryptographic key in which no private information needs to be exchanged. Next to bitcoin, it currently has the highest price of any cryptocurrency.

JAIL TECH: PHONES, TABLETS, AND SOFTWARE BEHIND BARS

BY JUAN MARTINEZ

You've just been arrested for the first time. You're sent to a holding facility where you'll be detained until it's your turn to stand before a judge. As you enter the facility, your iris is scanned and stored in the facility's database. This is how you'll gain access to every room for the duration of your detainment; it's also how guards will make sure you are who you say you are as you're moved from facility to facility.

A bracelet is strapped to your wrist to continuously monitor your biometrics: Have you been fed? Have you taken your medication? Is your heart rate accelerating? Are you breathing? You're strapped into boots with magnetic strips that can be remotely latched to the floor by a corrections officer. A metal collar is wrapped around your neck. This collar has only one job—if you leave the facility without permission, the collar explodes.

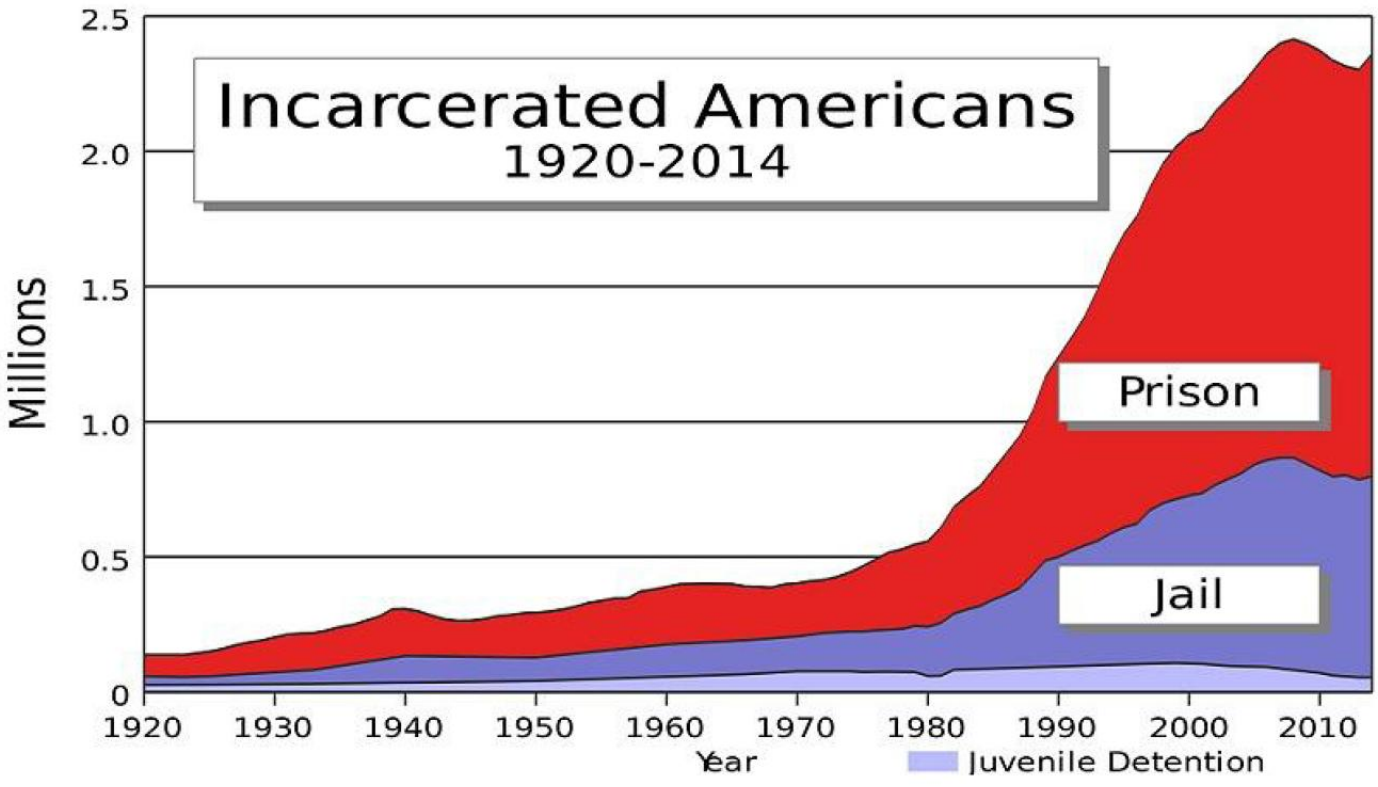
Like much of the rhetoric surrounding incarceration, the scenario I just described is a combination of hyperbole and fiction. Thanks to Hollywood and science fiction, it's easy to imagine detention centers, prisons, and jails running the most advanced technologies known to humanity. In reality, most prisons are run on a simple combination of software, hardware, paper, and pen, nearly all of which require manual data entry.

"There's a lot of hesitancy to provide technology to people in prisons," said Christopher Grewe, CEO and Founder of American Prison Data Systems, a company that provides tablets to inmates. "You don't become the leader of a correctional system by being great at technology. There aren't a lot of people who understand technology very well. They're a lot more comfortable buying pepper spray than they are in investing in technology."

The problem with technological hesitancy as it pertains to detention is that the prison population in the United States has exploded in recent decades. The U.S. currently incarcerates 707 people per 100,000 residents, or 2.4 million people, which is the highest rate in the world, according to the Center for Economic and Policy Research. More than 7.5 million Americans—or one out of every 31 adults—are either incarcerated, on parole, or on probation. And prison hasn't helped to rehabilitate the imprisoned. Of the 700,000 prisoners who will be released within the next year, around 40 percent will reoffend and be sent back to prison within three years, according to the PEW Center. Life inside prison is

hell for most: In 2012, 1.2 million violent crimes committed outside of prisons were reported to the FBI by police, while 5.8 million violent crimes were reported by prison inmates.

Technology has solved a number of important social issues that affect humanity. Education has become democratized and health information can be distributed to doctors around the world via the internet. Vaccines are delivered via drones. Apps predict earthquakes. The world is changing because of technology.



IN THE JAILHOUSE
More than 7.5 million Americans are either incarcerated, on parole, or on probation. *Image via Wikipedia Commons, Data via BJS*

> **This collar has only one job—if you leave the facility without permission, the collar explodes.**

Unfortunately, U.S. prisons rely on mostly outdated solutions. Many of these are unregulated and operated by engineers who haven't been scrutinized, and some technologies are designed to take advantage of prisoners to make money. A select few are built to truly help and empower inmates. I spoke to a number of companies that build and maintain prison technology. Much of the tech is focused on real-time inmate tracking and management, but some companies are creating solutions designed to educate, enrich the lives of, and hopefully rehabilitate prisoners.

A consistent effort must be made by local, state, and federal government to update old technologies, introduce new and innovative technologies, and use these tools to improve the lives of prisoners. This urgency is not just about safety and security, it's also about enriching prisoners' lives inside facilities in order to reduce violence, and to hopefully provide the foundation necessary to ultimately reintroduce ex-convicts to society. As Mike Cornstubble, VP of Technology at Edovo, puts it: "Technology should not be considered contraband."

ON THE INSIDE

Behind every institution is what's called a Jail Management System (JMS), essentially the data repository for prisoners who enter the facility. Think of it like a customer relationship management (CRM) tool, but for prison. The JMS can capture an endless amount of fields, all of which are designed to track, improve the safety of, and manage the health of prisoners. Standard fields like Name, Crime, Past Crimes, Outstanding Warrants, Gang Affiliations, and Release Date are entered into the system as prisoners arrive. Additional fields like Medications, Allergies, Dietary Restrictions, and Medical Conditions are logged to maintain the prisoners' health.

To track the information entered into the JMS, and to make sure protocol is followed by guards, the JMS can interface with tablets and an RFID tag housed on a prisoner's bracelet or uniform. These digital interactions are designed to track prisoner movement in order to maintain safety, but they're also built to account for prisoner health. If a guard scans a tag and sees that a prisoner is in a restricted area, the guard can remove the prisoner from the location. Alternatively, when a prisoner goes for his or her medication, the doctor can scan the tag to make sure the prisoner is actually due for a new round.

Ken Dalley Jr., President of Guardian RFID, an inmate-management solution, said his company helps protect inmates and detention centers both physically and from litigation during disputes. "We automate the processes corrections officers perform multiple times an hour," he said. "Paper and pencil is still the most used tool in jails, prisons, and correctional facilities. But if there isn't a good area of documentation it's legal exposure to the facility."

Guardian RFID can track the standard items I previously mentioned, but it also gives prison managers the ability to log if and when inmates have been given access to the law library, had the proper amount of exercise, and given access to recreational activities. As inmates are led into and out of each area of the facility, their tags are scanned and a record is logged. “If [a corrections facility is] legally in trouble,” said Dalley Jr., “paper-based platforms don’t help you mitigate risk. Staff can falsify records. Records can get lost.”

The tags, in combination with tablets and the back-end JMS, also provide guards with real-time notifications. Are all inmates accounted for? Has an inmate received a medication for which he or she is scheduled? If these actions aren’t logged at the proper time, a real-time notification will be sent to the appropriate staffers.

JMSes are particularly important for monitoring and tracking recidivists. When someone is arrested, the offender’s institutional history can be delivered via the JMS, especially if the jail is tied to the same JMS that is being used by other facilities. Does the prisoner have an issue with any other prisoners in the facility? Has he been targeted by a gang that has a presence in the facility? This kind of information can help to properly and safely place new inmates within the facility.

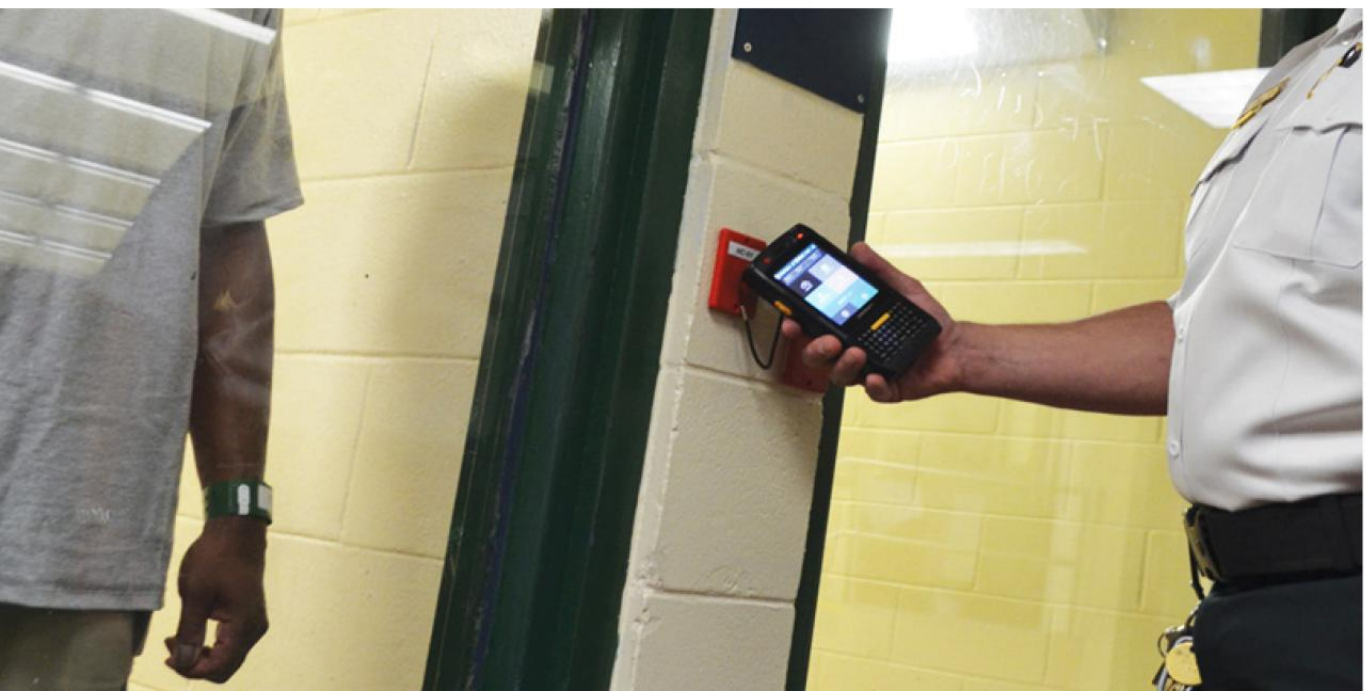
> **Companies are creating solutions designed to educate, enrich the lives of, and hopefully rehabilitate prisoners.**

“One of the things you have to realize about a jail is that the business is restricted by the wall of the jails,” said Bob Kolysher, Product Manager for Tyler Technologies Jail Manager. “Paper can’t flow freely from one location to another. If an inmate files a grievance and files a manual document, how do you move it from the cell to the administrator? In an electronic format, it’s moved freely. If a single piece of documentation is available to only the person who is looking at it, you can’t send it to multiple people [or locations] at the same time.”

A Jail Management System (JMS) is essentially the data repository for prisoners who enter the facility.

Unfortunately, the U.S. doesn’t have the kind of expansive JMS ecosystem that would allow for this kind of record-keeping to span every facility. Records are typically shared only by facilities using the same JMS, or because local regulation requires record sharing between institutions.

“The biggest reason [you don’t see this kind of national network] is that there is not a single decision-maker,” Kolysher explained. “The sheriff is an elected official in many jurisdictions. He’s got the budget and the authority to determine what [system is] good for him. The police commissioner may be doing something else. Building one giant system that meets everyone’s needs is tough to do. It’s much more likely to be successful to build small systems that connect to one another, to customize each piece to the needs of its constituents.”



GUARDIAN RFID SCAN

This scanning system protect inmates and detention centers both physically and from litigation during disputes.

SECURITY PROTOCOLS (AND LACK THEREOF)

The same inability to connect local, regional, and state-wide systems prevents the kind of national scrutiny required to oversee who manages the technology and the sensitive data it's storing. Most corrections officers and police officials are given thorough background checks and mental health screenings prior to working in a facility. The original technologists who install JMSes and other forms of prison-specific technologies within an institution are also given a background check. However, the same regulatory oversight isn't extended to those engineers who have retroactive access to the data these systems create.

Miro Macho, President of BIS Computer Solutions, said his company and its employees are run through the National Crime Information Center database when they're in the running for a government contract. But there isn't much more to the screening process. "If I don't tell [the institution that] this guy [in my company] is working on the system, and he gets access to the system because I needed him to fix a problem, that kind of thing could turn into a big problem. We do our best trying to figure out who our people should be. But any company or government agency doesn't know who is who. A lot of people could play nice for years and they're waiting to blow up something. In the future somebody could slip through and [use the information in our systems for nefarious purposes]."

Dalley Jr. said his company is required to be Criminal Justice Information Systems Certified (CJISC) in order to compete for government contracts. This standard was developed in 2011 by the FBI in order to protect the data delivered to federal, state, and local law enforcement agencies. But here's the problem with CJISC: The FBI's CJIS Division doesn't evaluate products or services, and it doesn't assert certification. Instead, the vendor submits documentation of how it follows CJISC procedure and the FBI scrutinizes the self-audit and awards certification.

Even if we are to believe the self-audits are 100 percent truthful, there's still the possibility of a Trojan Horse. Somewhere within the vendor company, someone who has passed a background check and has all of the appropriate IT certifications may aim to do harm with the data he or she can access.

"We do our own screening and background checks as well," said Dalley Jr. "But there's no regulatory requirement and it's based on internal oversight within my company. Homeland Security and the government do not audit employees of public safety software."

The New York State Office of Information Technology Services, the New Jersey Office of Information Technology, and the Connecticut Department of Correction were each contacted for this story. We did not receive a reply from the organizations.

HELP FROM THE OUTSIDE

Companies like APDS and Edovo work with correctional facilities to literally put technology into the hands of prisoners. APDS packages and delivers secure tablets loaded with educational and entertainment-based content designed to give inmates positive technological interactions. The tablets are secured via United States Military Standard cases and operated under closed, isolated networks, and secured with back-end mobile device management (MDM) software.

To deliver on safety, the tablets can't be physically damaged. If they're disabled or shocked via physical drop, an alert is sent to prison staff. The devices never connect to public Wi-Fi, and all of the content on the devices has been pre-approved by prison staff. Edovo offers a tablet-based education and entertainment package via tablet.
"We see wardens and sheriffs reaching out to us because it's working," said Edovo's Cornstubble. "They're seeing the benefit from an engagement perspective and a reduction in violence because a population is working toward something and not just wasting time."

Grewe, of APDS, said he believes the tablets his company provides to institutions are not only decreasing violence, but they're also changing lives. APDS tablets are in all kinds of correctional facilities, from juvenile detention centers for young girls to Riker's Island in New York City.

“Violence in jails is caused by idleness and hopelessness,” he said. “But [the argument has always been] why give a tablet to an incarcerated person when kids in school don’t have technology? Now, it’s not a luxury, it’s a necessity. We’ve seen a very significant decrease in acts of violence in all of the institutions where we’ve been.”

A ROCK AND A HARD PLACE

Unfortunately, even the systems in place to give inmates access to tablets can be exploited. Unlike APDS and Edovo, which earn their money only from institutional payments, companies like GTL (which provides phones, tablets, and video kiosks to inmates) are funded by direct inmate payments. This is similar to how inmates pay a fee to use landline phones to call home. In Edovo’s case, the inmates pay to rent a tablet, and in GTL’s case payment is made for purchased services on the phones, tablets, and kiosks. For example: GTL offers inmates a library of music that can be downloaded onto the application.

“GTL has little to nothing to do with education, and life improvement,” said Grewe. “They want to be iTunes for inmates, but instead of 99 cents a song it will be something like $1.99.” GTL disagrees, pointing to courseware it announced in July of this year intended to enrich learning opportunities for inmates.

Brian Peters, Executive Director for Enhanced Services at GTL, refused to disclose how much a typical song on a GTL tablet would cost an inmate. While there is no indication GTL is exploitive, any time a company charges inmates for a product or service, it will automatically be compared to the prison phone system, which was, until recently, brutally exploitive of inmates and their families in terms of calling costs.

Grewe said he believes the tablets his company provides are not only decreasing violence but also changing lives.

JUDGMENT CALL
Some prison phone companies were taking advantage of this captive clientele to charge up to $14 a minute or $500 a month for prisoners make calls.

New FCC regulation recently capped the cost of a phone call from 11 cents a minute for debit or prepaid calls in state and federal prisons. For a both a 15-minute in-state call and a 15-minute long distance call, the cost is now capped at $1.65. This regulation was deemed necessary because some prison phone companies were taking advantage of this unregulated market, and captive clientele, to charge up to $14 a minute or $500 a month for prisoners to call lawyers and family members. Sadly, even this small measure didn't last long as the regulation was stayed while this article was being written. That means it's effectively overturned, with the alleged reason being that a calling provider complained it would be "harmed" by the price cap.

Worse, regulation of this nature doesn't exist at all for inmate tablets and apps. Combined with the lack of oversight into who can access prisoner data from the back-end of a JMS, the lack of regulation over funding prisoner-held devices is disconcerting. However, if the U.S. prison system is ever going to move from pen, paper, and database to biometrics, education-based digital hardware, and a national ecosystem of data, government agencies will have to continue to warm up to new technologies.

"Technology has not been adopted in the space because the first adopters were exploitive," said Grewe. "And technology has never been a core competency for government and the correctional space. That's changing a bit now."

It's imperative that correctional facilities, government agencies, and technology manufacturers unite in adopting and improving these new solutions in order to better the lives of guards, prisoners, and society alike. Equally importantly, these institutions must all work together to ensure that neither the technology nor the prisoners are exploited in the process.

JUAN MARTINEZ

Choose the Right Backup Plan

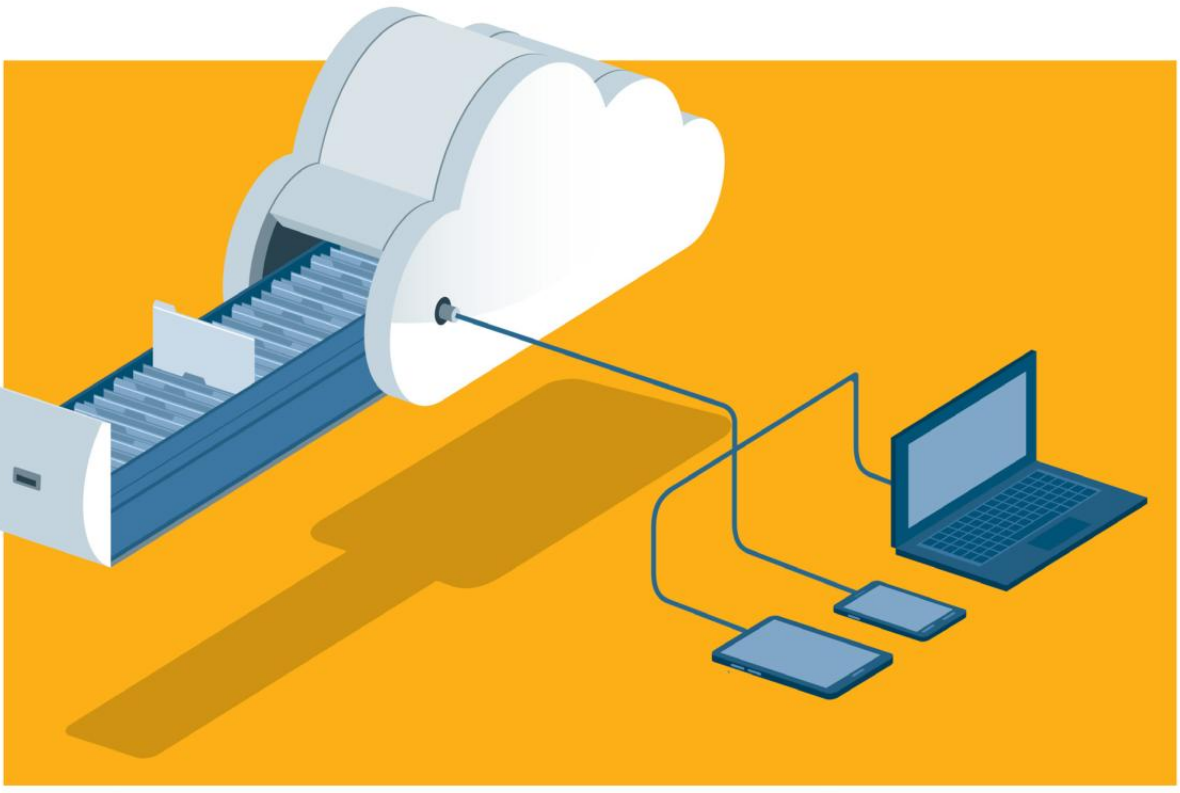
BY JILL DUFFY

There are two kinds of people: those who back up their data and those who haven't lost anything yet. That joke is painfully true. Losing your files can be heartbreaking, career-ruining, and expensive if you try to recover them with the help of an expert. Backing them up yourself is a preventive measure that avoids all those issues. While backing up your data sounds like a tedious chore, it doesn't have to be. There's a backup solution for every kind of person—the lazy, the diligent, and people somewhere in between.

Take me, for example. I haven't gone to every possible length to make sure I have a watertight plan, but I've covered my bases by making sure my most important computer files, such as photos and current work documents, are saved and synced with a cloud storage service. My phone contacts are saved to iCloud DriveFree at Apple, Google Contacts, or both. If any one of my computers or phones were to crash, get stolen, or burn up in a fire, I'd be able to put the pieces of my digital life back together again, although it wouldn't be fun and it would take some time and effort. My backup plan isn't ideal, but it's better than nothing and good enough for the time being.

There are two kinds of people: those who back up their data and those who haven't lost anything yet.

That's my take on backing up: Something is better than nothing.



MULTIPLE METHODS
The safest route is to back up your important data in more than one way.

The much more ambitious among us (or those who have been burned by data loss in the past) might want a thorough plan that makes it easy and nearly effortless to restore all their data at once. That kind of plan would probably involve making both an online backup and using local backup software to save everything to a dedicated hard drive.

Such plans cost more to maintain and take a little extra time to set up. Many people would rather take their chances with a solution that's easier to implement but factors in a little more risk. And that's okay! You don't have to be perfect to be better off than you are now.

MINIMAL BACKUP

Can you back up your stuff with minimal effort and no expenditure? The answer is, yes, but your plan will have some weaknesses. A lazy cheapskate who wants some level of protection will want to back up their most important data. An online syncing service with a good amount of free storage is the place to start.

A few services that my colleague Michael Muchmore (he tests these services) and I recommend are Box, Dropbox, Google Drive, IDrive, and OneDrive. Here's how much free storage each one offers:

Box: 10GB
Dropbox: 2GB
Google Drive: 15GB
IDrive: 5GB
Microsoft OneDrive: 5GB

You don't have to pick just one; you can have accounts with all of these services. If you don't want to spend money, try spreading out your data by using one service for a particular kind of file: say, backing up mobile photos only to Dropbox but using Google Drive or OneDrive exclusively for work files. That way, you're less likely to hit the free-storage limit. (Another good choice for photo backup is Flickr, which allows 1TB of full-resolution photo backup for free.)

What makes these services excellent for lazy people is that they take minutes to set up and no time at all to maintain. They're set-and-forget products. You install a piece of software and either select which files you want to back up or drag your chosen files and folders into a new folder the service created for you. That's it.

From there on out, you let the apps do their thing in the background. If your machine crashes, gets stolen, or falls off a boat and sinks to the bottom of a lake, you can go to the website of the service you're using, log in, and get your files back.

Of course, if you spread your files out among a few different services, it will take longer to restore them than if you had all your data backed up to one place.And there's always a chance that a catastrophe could obliterate the company storing your data. Like I said, this plan has holes. But they may be holes you're willing to tolerate.

What makes these services excellent for lazy people is that they take minutes to set up and no time at all to maintain.

MID-LEVEL BACKUP

If you're willing to do just a little more work or pay a little bit of money, you can get a lot more value out of your backup plan. A good mid-level effort backup plan would be to pay for ample storage in one online backup service or online syncing service so that all your files are consolidated into one place. Then you can restore all your files to a new laptop and phone later in one fell swoop, in case the devices crash or you lose them over the edge of an ice cavern while mountaineering in Nepal. You don't have to hunt around to different services to reclaim your data the way a cheapskate who is using only free services would.

For this kind of backup, you'll end up paying some money to get enough storage. A rough estimate is less than $100 per year.

One option that retains all the benefits of file-syncing is to simply pay for more storage with the file-syncing service of your choice. Or you could use an online backup service, such as Crashplan or SOS Online. Both are PCMag Editors' Choices.

The difference between file-syncing services and online backup programs is that the first focuses on syncing as its primary job and the second emphasizes backup and restore issues. A file-syncing service makes the most recent version of your files available to you across multiple devices and provides a backup by default. But it doesn't typically provide truly robust tools for restoring your files in the case of a data loss. Online backup services have a lot more tools for choosing which files you want to back up and how often and tools for easily and quickly restoring your files.

The weakness in this plan is that you are trusting your files to one company. If the company hosting your files goes kablooey, what do you do then? How do you create a stopgap for that problem? Simple: You back up all your files to more than one place, which is more of a perfectionist's approach.

“The weakness in this plan is that you are trusting your files to one company.”

HIGH-END BACKUP

Perfectionists will tell you the three rules of backup are redundancy, redundancy, and redundancy. So let's talk about making three copies of your files.

Your first copy is on your devices. The second copy is with an online backup service or file-syncing service. And the third copy is backed up to a hard drive. Several online backup providers also offer software that saves your data to local storage for this kind of redundancy. But a true perfectionist will want to have a local copy of their data, too.

Why? In addition to creating a third copy of your files, a hard drive also makes it easier and faster to get your files back. You don't need to rely on having an Internet connection, and you aren't waiting for hours while files download from the cloud to your computer. You'll want to use local backup software for this, and PCMag's current Editors' Choice in this field are Acronis True Image and StorageCraft ShadowProtect 5 Desktop.

How much will this kind of plan cost? You'll pay around $100 a year for the online service, around $100 to $200 for a quality hard drive (though you can also easily spend thousands of dollars on something much grander), and $50 to $100 for the backup software. A great hard drive option that doesn't break the bank is the 4TB Seagate Backup Plus Portable Drive.

Does this all sound like too much work and expense to you? That's fine. This level of protection isn't for everyone.

GET STARTED TODAY

The important thing isn't so much having a perfect backup plan as it is having a backup plan at all. And it helps to have the right plan for your budget, your willingness to actually carry out the plan, and your tolerance of risk. There's no shame in going with the quick-and-dirty minimal option, because anything really is better than nothing. The only truly bad plan is putting off getting started, because you will eventually suffer a crash, a theft, or a disaster. It's only a matter of time.

How to Set Up an Amazon Echo

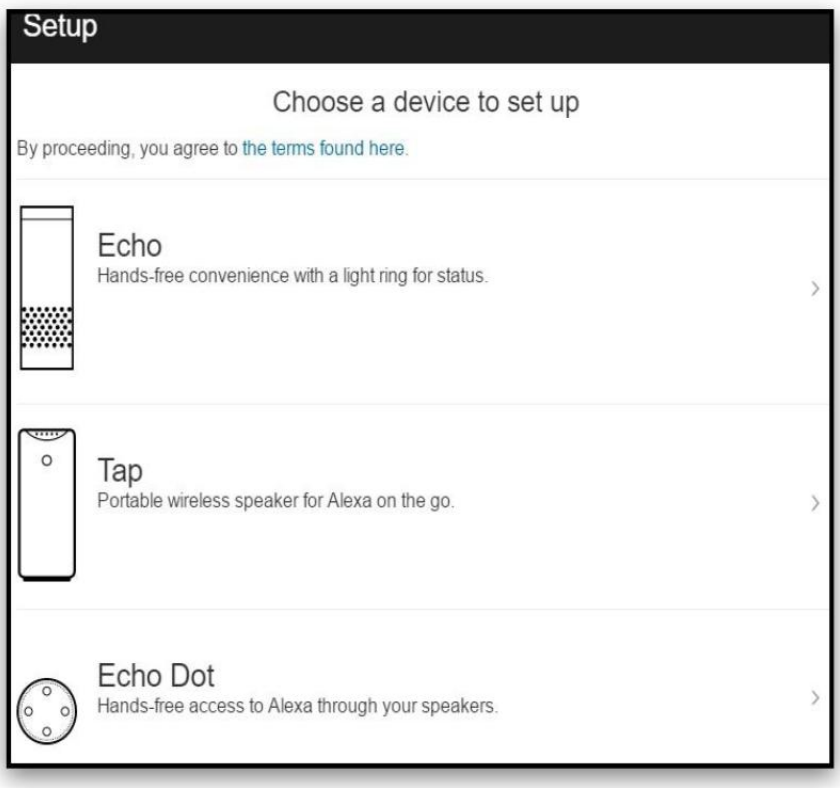
BY ERIC GRIFFITH

It's not enough just to talk to Siri, Google Assistant, and Cortana. These days, the audio assistant of choice seems to be Alexa, the technology inside the Amazon Echo, the smaller Echo Dot, and the portable Amazon Tap, not to mention a few other select products—including the Amazon Fire TV and Fire TV Stick media hubs and the third-party Invoxia Triby speaker for mounting on kitchen appliances.

But it's the Echo line of sleek, cylindrical speakers that really showcase Alexa's capabilities. The Echo is a standalone, kickass wireless speaker that needs nothing more than a power connection. The Echo Dot can stand alone but shines brightest when plugged into a bigger speaker. The Tap is the only one you have to push a button to activate (rather than just saying "Alexa"), as it's a portable battery-powered unit meant to go with you on the road, to the beach, by the pool, and so on. They have differences, but when it comes to setup, they're essentially identical.

1. DOWNLOAD THE AMAZON ALEXA APP

It's free for iOS or Android devices, and of course, for Fire OS on Amazon's own tablets—in fact, newer Fire tablets should probably include it already. (The Alexa app is not supported on the first- or second-generation Kindle Fire.) If you're not into smartphones, a Web app can also handle the setup, and some people find that easier.

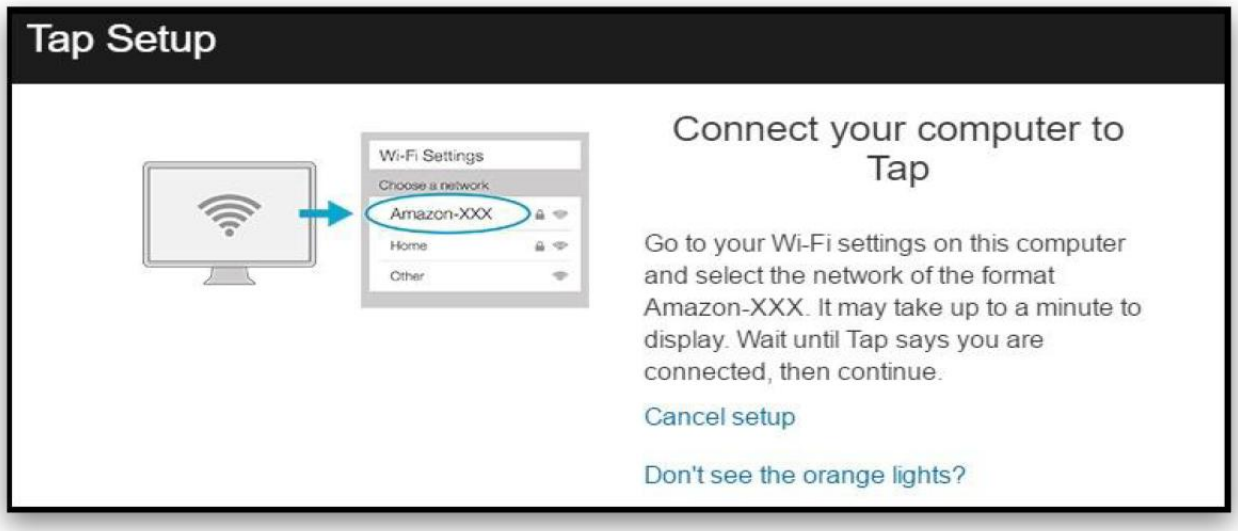


2. PICK A DEVICE TO SET UP

You have to have an Amazon account to use Alexa, but you don't need Amazon Prime. Sign in on the app. Click Settings, then "Setup a new device" (or click the link). You're presented with the three Amazon-provided Alexa options: Echo, Tap, or Echo Dot. Choose your device, then pick a language (English for the U.S. or U.K. or German are the only options right now).

3. ENTER SETUP MODE

For setup, the Echo/Dot/Tap's light ring (or the five lights on top of the Tap) will be orange. If it's a brand-new setup, it should come up after you plug in. If you don't see orange, press and hold the Action button on top for five seconds—that's the one with the single dot in the middle. On the Tap, no orange means you should hold the Wi-Fi/Bluetooth button on the back (below). Eventually, Alexa will perk up and tell you she's "Now in setup mode."



4. CONNECT YOUR SMARTPHONE OR PC

Connect the app to the Wi-Fi network now being served up by the Echo/Dot/Tap. It'll be called something like "Amazon-2Q3," but the last three digits are always different. Once you connect, Alexa says, "You've connected to Echo. Go ahead and finish the setup in the Alexa app."

5. SET UP HOME WI-FI

Back in the app, you'll see a list of all the Wi-Fi networks available; pick your home Wi-Fi. Enter your Wi-Fi password when asked, if you have one. (You *really* should have one.) Once all the info has been sent to the device, Alexa will say, "Your Echo is ready," and the orange lights go out. Note that if you set up an Amazon device at home, you may have already saved the Wi-Fi password. Wi-Fi password-saving works across tablets and Kindle ebook readers as well.

6. SAY "ALEXA"

As the final stage of setup, the Alexa app pulls up a video to walk you through some basics of using the Echo, Dot, or Tap. Of course, that's just the start. Now go into the app to change the wake word (call her "Echo" or "Amazon" instead of "Alexa"), connect to music services such as Spotify and Pandora, connect to mobile devices via Bluetooth for audio playback, sync with your Google Calendar, set up news briefings from your favorite sources, set up Alexa to control your smart home, play audio books from Audible, and so much more.

Amazon is adding options to Alexa all the time, so watch for the newsletter that comes with owning an Echo—it shows lots of new options all the time. Also check out the skills and tricks Alexa has in store for you. You'll be chatting with her like old friends (or yelling when she doesn't hear you) in no time.

How to Prep a Connected Home for New Owners

BY STACEY HIGGINBOTHAM

So you've got a decent number of WeMo devices installed in your house—including cameras, light switches, plugs, and light bulbs. But you've decide to sell your home. What's the best way to pass on the credentials for all of these devices to the next owner?

There are really two questions here: One is specific to WeMo, and the other is generally about moving and trying to figure out what to do with your smart devices. Let's start with the WeMo question.

To help your home buyer, first delete from your account all WeMo devices that you want to leave in the house. To do so, open the WeMo app, select the edit button, and select the device to remove it. There will be a button called Reset Options; choose “erase all content and settings,” and it will remove the device from your cloud account and disassociate it from your network.

From there, the new owner has to download and run the app from whatever home network they set up. They shouldn’t do this until they have set up a Wi-Fi network and have an SSID and password. Then they can set up the devices.

Let’s say you forgot to delete the devices you’re leaving behind, and the new owner wants to ensure that the devices are associated only with their email account. They can simply hard-reset the device by following these instructions.

What’s the best way to pass your connected home credentials for all of these devices to the next owner?

The other question is a lot broader. Basically, anyone who is installing smart home devices should be thinking about what happens to their devices when they move. For example, are you going to take your Nest thermostat off the wall and bring it with you to your new home? Once you’ve established which devices you want to keep in the house, you’ll need to disassociate them following the steps provided by the manufacturer.

NEST THERMOSTAT
The third generation has a larger display, geofencing support, a furnace monitor, and a few more sensors.

I don’t recommend keeping a device associated with your account and sharing the information with the new owner of the house. Some people have even gone so far as to create an email account for their house and associate all the devices with that email account, the credentials to which are transferred when you move. But not every new homeowner is going to want to mess with connected stuff.

The best resource I found on this topic is from the OTA Alliance. Last year, it worked with the National Association of Realtors to create a smart-home moving guide. This is a checklist that helps you track what you need to do before closing to ensure your connected devices don’t leak your information. Not only does it remind you to decommission devices, but it also reminds you to update them before you do, so the new owners get a cleaner install.

“I don’t recommend keeping a device associated with your account and sharing it with the new owner of the house.”

And if you’re a new owner in a home with smart devices, you could do a hard reset on everything before you add it to your own network—just in case.

JOHN C. DVORAK

Why LinkedIn Under Microsoft Is Doomed

Microsoft's $26.2 billion acquisition of LinkedIn seems like a stab in the dark, an effort to get Microsoft Dynamics 360 CRM off the ground by adding a social network. But really, it just kept Salesforce from buying LinkedIn.

For some reason, I'm a LinkedIn Premium user, although I was skeptical of the whole idea when the product launched, and I don't currently get much out of it. I've never gotten a job or contract from LinkedIn, received a good lead or contact for a story or a column, or booked a public speaking engagement. One economic blip, and I'll cancel the extra expense.

The so-called improvements the company keeps making, insofar as the interface is concerned, have never been improvements at all. Earlier versions of LinkedIn made it quite easy to browse through your own network alphabetically in a casual manner, but now everything is awkwardly search-based.

There are two things Microsoft will most likely do to LinkedIn. The first would be to leave it alone, which—from what I can tell—will worsen the product. But Redmond could also come in and ruin the product with a few years of meddling, just as it did with Nokia and WebTV.

So the likelihood of anything good coming from the LinkedIn buyout is improbable, at best. This, despite the fact that Satya Nadella is at the helm.

The problem is the corporate culture, not the bosses.

If you do any research on why Microsoft bought this company or what it expects to do with it, you'll find a laundry list of ideas, which will be reflected by Microsoft itself. In other words, nobody knows. The real reason still seems to me to be a useless and expensive potshot at Salesforce.

So what should users do? If LinkedIn is subject to the usual decay, it takes from one to three years. In the meantime, you should build the biggest network you can and download it into a spreadsheet that you can use internally. You will lose all the personal information and phone numbers, which you are not allowed to download. But hopefully someone will come up with a workaround to obtain this data before the whole operation is shuttered.

john_dvorak@pcmag.com

EDITOR-IN-CHIEF, PC MAGAZINE NETWORK Dan Costa
MANAGING EDITOR, DIGITAL EDITIONS Carol Mangis
SENIOR PRODUCER Mark Lamorgese
PRODUCTION DESIGNER José Ruiz

NEWS & FEATURES

EXECUTIVE EDITOR Chloe Albanesius
FEATURES EDITORS Evan Dashevsky, Eric Griffith
SENIOR FEATURES WRITER Chandra Steele
NEWS REPORTERS Tom Brant, Angela Moscaritolo

REVIEWS

EXECUTIVE EDITOR Wendy Sheehan Donnell
MANAGING EDITORS Sean Carroll (software, security), Alex Colon (consumer electronics, mobile), Matthew Murray (hardware)
LEAD ANALYSTS Michael Muchmore (software), Neil J. Rubenking (security), Joel Santo Domingo (desktops, laptops), Sascha Segan (mobile)
SENIOR ANALYSTS Jim Fisher (digital cameras), Will Greenwald (consumer electronics), Tony Hoffman (printers, scanners), Jeffrey L. Wilson (software)
ANALYSTS Max Eddy (software, security), Ajay Kumar (mobile), Victoria Song (hardware)
JUNIOR ANALYST Matthew Buzzi (hardware)
INVENTORY CONTROL COORDINATOR Alice Newcome-Beill

BUSINESS

EDITOR Oliver Rist
MANAGING EDITOR Suzanne Kattau
SENIOR EDITOR Juan Martinez
ASSISTANT EDITOR Rob Marvin

ART, MEDIA & PRODUCTION

DIRECTOR OF PRODUCT MANAGEMENT Sarah Shaiq
PRODUCER Gina Latessa
COMMERCE PRODUCER Arielle Rochette
SENIOR DESIGNER James Jacobsen
STAFF PHOTOGRAPHER Paul Maljak
SENIOR VIDEO PRODUCER Weston Almond

CONTRIBUTING EDITORS

Tim Bajarin, John R. Delaney, Jill Duffy, John C. Dvorak, William Fenton, Tim Gideon, Bill Howard, Edward Mendelson

ZIFF DAVIS INC.

CHIEF EXECUTIVE OFFICER Vivek Shah

CHIEF OPERATING OFFICER Steven Horowitz

CHIEF FINANCIAL OFFICER Brian Stewart

CHIEF TECHNOLOGY OFFICER Joseph Fortuna

CHIEF STRATEGY OFFICER James Yaffe

SENIOR VICE PRESIDENT, SALES AND MARKETING Eric Koepele

SENIOR VICE PRESIDENT, BUSINESS DEVELOPMENT Anurag Harsh

SENIOR VICE PRESIDENT AND GENERAL MANAGER, ACCOUNTING Fredrick Rolff

SENIOR VICE PRESIDENT, CONTENT Dan Costa

SENIOR VICE PRESIDENT, COMMERCE Jason Steele

GENERAL COUNSEL Stephen Hicks

VICE PRESIDENTS Frank Bilich (media sales), Lucas Deryckx (engineering), Melissa Hart (marketing), Mike Kane (product experience), Diane Malanowski (human resources), Michael Pantoliano (business intelligence), Jennifer Riccio (FP&A), Archer Rosenblum (technology), James Steven (operations), Suzanne Sypulski (Operations), Marc Von Holzen (software development)

THE INDEPENDENT GUIDE *PC Magazine* is the Independent Guide to Technology. Our mission is to test and review computer- and Internet-related products and services and report fairly and objectively on the results. Our editors do not invest in firms whose products or services we review, nor do we accept travel tickets or other gifts of value from such firms. Except where noted, *PC Magazine* reviews are of products and services that are currently available. Our reviews are written without regard to advertising or business relationships with any vendor.

HOW TO CONTACT EDITORS We welcome comments from readers. Send your comments to pcmag@pcmag.com or to *PC Magazine*, 28 E. 28th St., New York, NY 10016-7940. Please include a daytime telephone number. *PC Magazine*'s general number is 212-503-3500. We cannot look up stories from past issues, recommend products, or diagnose problems with your PC by phone.

PERMISSIONS, REPRINTS, CONTENT, AND TRADEMARK RIGHTS For permission to reuse material in this publication or to use our logo, contact us at Brand_Licensing@ziffdavis.com. Material in this publication may not be reproduced in any form without written permission. Copyright © 2017, Ziff Davis Inc. All rights reserved. Reproduction in whole or in part without permission is prohibited.