PIXEL: ARE YOU READY TO LET GOOGLE ASSISTANT RUN YOUR LIFE?

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The 29th Annual Best of What's New

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Issue #96, November 2016

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You're Probably Going To Need A PA Bot

Welcome to our 29th annual Best of What's New special edition! As we do about this time every year, we've rounded up 100 innovations, inventions, products, concepts - technologies, really - that we feel are set to make today feel just a bit more like tomorrow.

Among them are a few that have some kind of first-generation AI functionality, and we also look at Google's new Pixel phone and its Assistant on page six.

The point is that the home "personal assistant" AIs are coming, and while the first lot might turn out to be pretty basic, I think they're destined to be a lot more than just a gimmick.

Now, you might think that you have your personal schedule established as a routine, all your bills on direct debit, and your life more or less under control... but just imagine for a moment you lost everything.

Something like your house burned down or for whatever reason you had to change your bank, your address, and ended up with a new phone, new home Wi-Fi setup, new everything. Exactly how long do you think it would take you to re-establish all the services you've logged into over the last few years? What would you forget? How many sheriffs would be coming around to demand payment for some contracted thing or other you forgot about?

When Google sent me a Pixel for loan, I realised for the first time how much stuff I have plugged in to my phone now. Banking app, various music and video services, work email, remote access to my home NAS. Sure, I probably have a few more gadgets than the average Australian because of my job (and my obsession with gadgets), but it was when I was crawling into the back of my cupboard where I keep the Philips Hue Bridge to press the button on it to link this new phone to the lighting network that I decided: a little help would be great.

As the Internet of Things becomes more pervasive and more and more devices and even objects like air purifiers (p.16) in your life become connected, managing all this stuff is going to move from fun hobby to chore to pain in the neck to daunting cliff of hundreds of logins and firmware updates constantly demanding your attention.

Seriously, between iTunes, Hue, the NAS, phone, tablet, PC, even the digital radio in the kitchen, there's rarely a day goes by without some device demanding I update it over the internet.

Yes, you can dismiss my "problems" as a simple symptom of having too many gadgets, and that no-one needs a house full of multicoloured LEDs all connected via a wireless network, especially since we pretty much always leave them on "warm white." But my crazy editor-of-a-tech-mag lifestyle will be your lifestyle within the decade (or less). Smart homes are coming, and they have the potential to be really, really annoying.

Which is where a personal assistant AI comes in. Science fiction authors have long predicted the rise of the "house computer".

Mostly this was envisioned as a discrete machine with a core in the basement but in reality it will probably be more like Jibo (see page 54) - an abstractly-humanoid bot that sits on a countertop, connects to the internet, and deals with all your e-paperwork. Done right, it will handle all the upgrades and logons and bill cycles and all the other tedious stuff that humans like me mostly just mess up.

Sure, being too dependent on technology to run your life might be a bad thing. But is having to remember to update the top-up on your weekly train ticket because your credit card has expired really any kind of life at all?

ANTHONY FORDHAM
afordham@nextmedia.com.au

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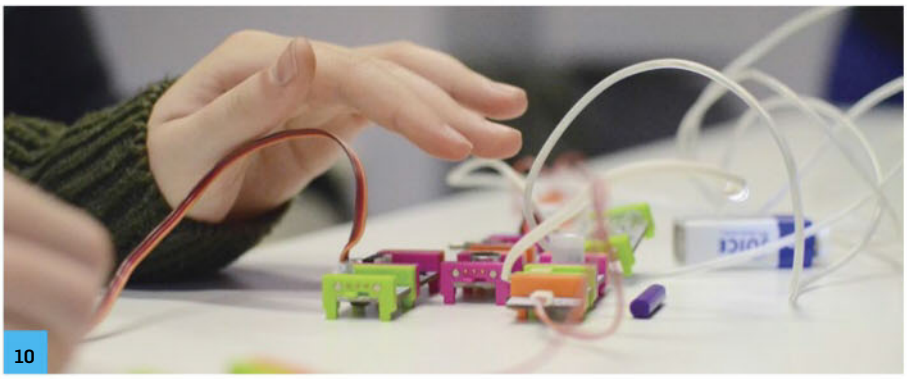

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Your guide to everything

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Don't dream it, build it

THE OTHER BITS
Pre-softened to aid digestion

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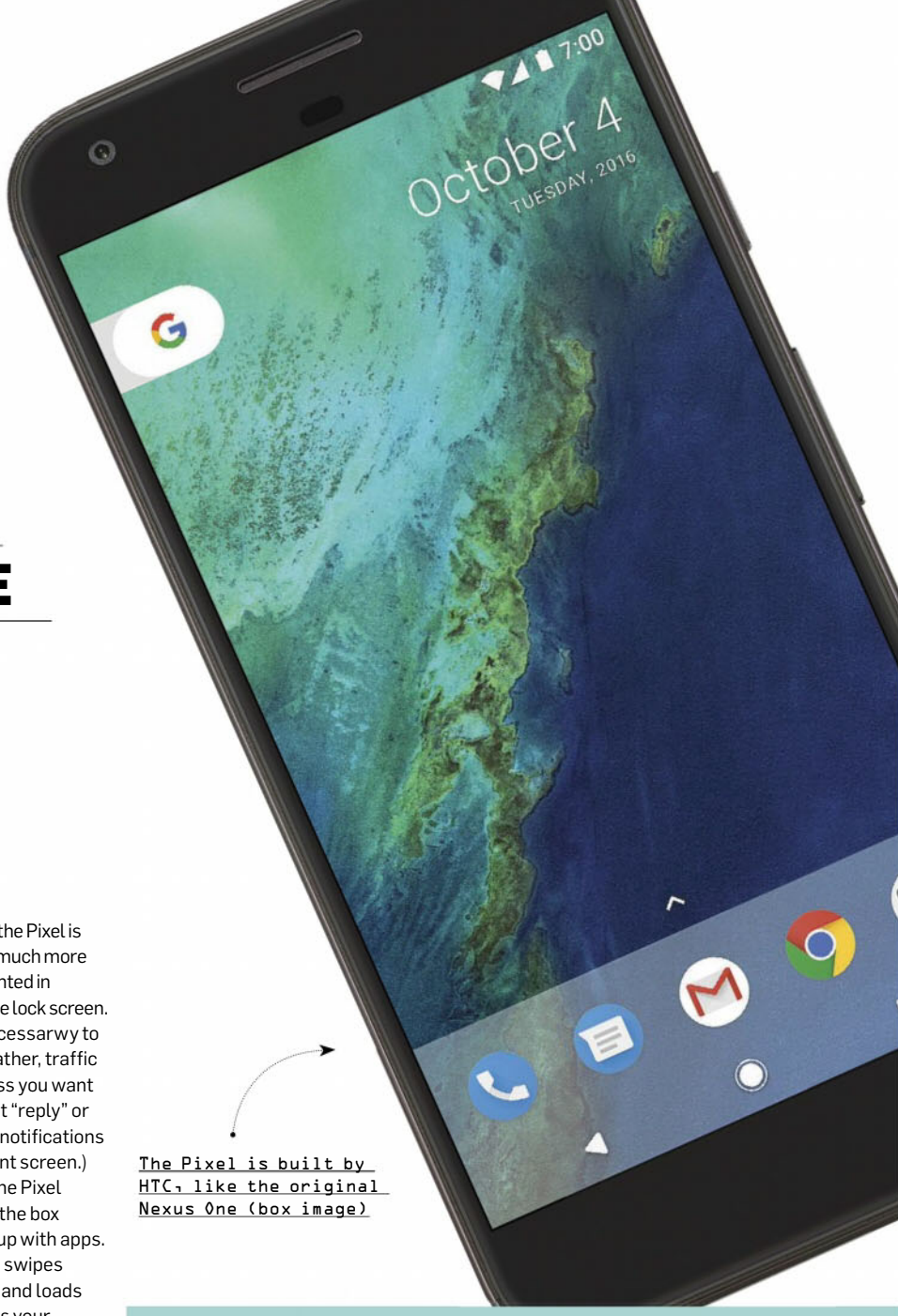
GOOGLE ENTERS THE SMARTPHONE MARKET... AGAIN

by Anthony Fordham



The Pixel is built by HTC, like the original Nexus One (box image)

GADGET ENTHUSIASTS might be a little confused by Google's marketing of the Pixel, especially the company's decision to brand it "the first phone by Google."

That's because Pixel replaces the venerable (in smartphone terms) Nexus line, which began in 2010 with the Nexus One. Like Pixel, the Nexus phones were also branded with a G, although the hardware manufacturers were also allowed a logo on the device, something HTC doesn't get today. So maybe that's the difference.

Pixel is a new direction for Google, though, a technological showcase for presenting Android 7 in the best possible light.

Beyond a beautiful display and what Google boasts has been independently assessed by DxOMark as the "best smartphone camera ever", Pixel brings boosted personal assistant functionality.

In fact, the system is now straight-up called Assistant and can be invoked with an "OK Google" at any point: when the screen is off, when using another app, wherever, as long as the phone is powered on and connected to mobile data.

Android 7 uses slightly thinner fonts now, which take advantage of higher display resolutions (the Pixel XL is 2560x1440, the Pixel is 1920x1080) and allow much more information to be presented in notifications, even on the lock screen.

In fact, it's rarely necessarwy to actually open your weather, traffic or Gmail app now unless you want to reply (and you can hit "reply" or other actions on some notifications to go straight to relevant screen.)

And above all this, the Pixel is FAST, at least out of the box before it gets clogged up with apps. It responds to taps and swipes without a hint of delay, and loads web pages as quickly as your connection will allow.

Lovers of the simplicity of Apple's iOS may find the sheer amount of information that Android 7 can present somewhat overwhelming. But being Android, it's possible to tweak notification settings, widgets and more to get the level of info you want.

There's a reason both Pixels are relatively expensive ($1079 for the base 32GB Pixel, up to $1419 for the top-tier 128GB Pixel XL) - this is a super-premium phone, from the Apple-level fit and finish through to the blazing performance.

We'll take a closer look at Google's new Assistant and what it can do, in the next issue. PS

RELIABILITY WINS THE PRIZE?

While the exact details of HTC's deal with Google to build the Pixel will probably never be released, we're sure it's no coincidence that our Google Nexus One - built by HTC in 2010 - is one of only two Nexi we own that still works. The other is the Samsung Galaxy Nexus, but the Nexus 4 (LG) and Nexus 5 (also LG) both died within two years. Similarly, the Nexus 7 tablet by ASUS refused to turn on again after 18 months of use, while our battered old Nexus 10 tablet (Samsung) just keeps on rocking.

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HOW MUCH DRONE CAN YOU GET FOR $900?

by Anthony Fordham

THE AUSTRALIAN CONSUMER drone market is largely dominated by Parrot (at the toy end) and DJI (at the pro-sumer end). Alternatives like Kiaser-Baas and, soon, GoPro hang on retailer walls across the land, but some of the lesser-known brands offer surprisingly good deals.

Take the Xiro Xplorer V, for example. For $899, budding drone pilots get a quadcopter that's somewhere between DJI's Phantom 4 ($1599) and Parrot's Bebop ($599). It's more solidly built and feature-packed than products aimed at the merely drone-curious, but leaves out a lot of the hardcore functionality that only professional aerial photographers really need.

Xiro's package includes the drone, a custom controller and a hardshell backpack. The backpack takes the drone, its props, two batteries (one 5200mAh battery is included) and the controller.

The drone itself has relatively sophisticated controls for a quadcopter at this price. GPS connectivity means it can "return home" to the controller, as well as take off and land automatically.

The orientation lights under each of the four props change colour depending on flight mode and connectivity conditions. And the included 1080p, 30fps gimbal camera comes with a bracket to lock it in place for FPS flying.

The Xiro won't break any speed or agility records, but it does shoot good quality video and is, above all, easy to fly. It's a taste of a premium drone, without the premium price. PS

AUTOPILOT DEPENDENCE

Like GoPro's anticipated Karma drone, the Xplorer V doesn't have the kind of automatic collision avoidance found in the DJI Phantom 4. Some observers call this a "deal breaker", which we think highlights how dependent we're becoming on automatic systems. Quadcopters are already easy to fly compared to a more traditional helicopter, and most of the popular models before now have had very little automation beyond stability control and autoland. That said, as this market continues to mature, you can expect to see increasing amounts of AI built into these little aircraft. Thanks to mobile data connectivity, future drones will even keep within CASA regulated altitudes and will refuse to fly into restricted airspace.

XIRO XPLORER V

Flight time: 25 minutes (ideal)
Speed: 28.8 km/h
Max altitude: 120 m
Camera: 3-axis, 1080p, 30fps
Battery: 5200mAh
Hovering accuracy: 0.5m vertical, 1.5m horizontal
Extras: Hard shell backpack

PRICE: $899
WEB: xirodrone.com

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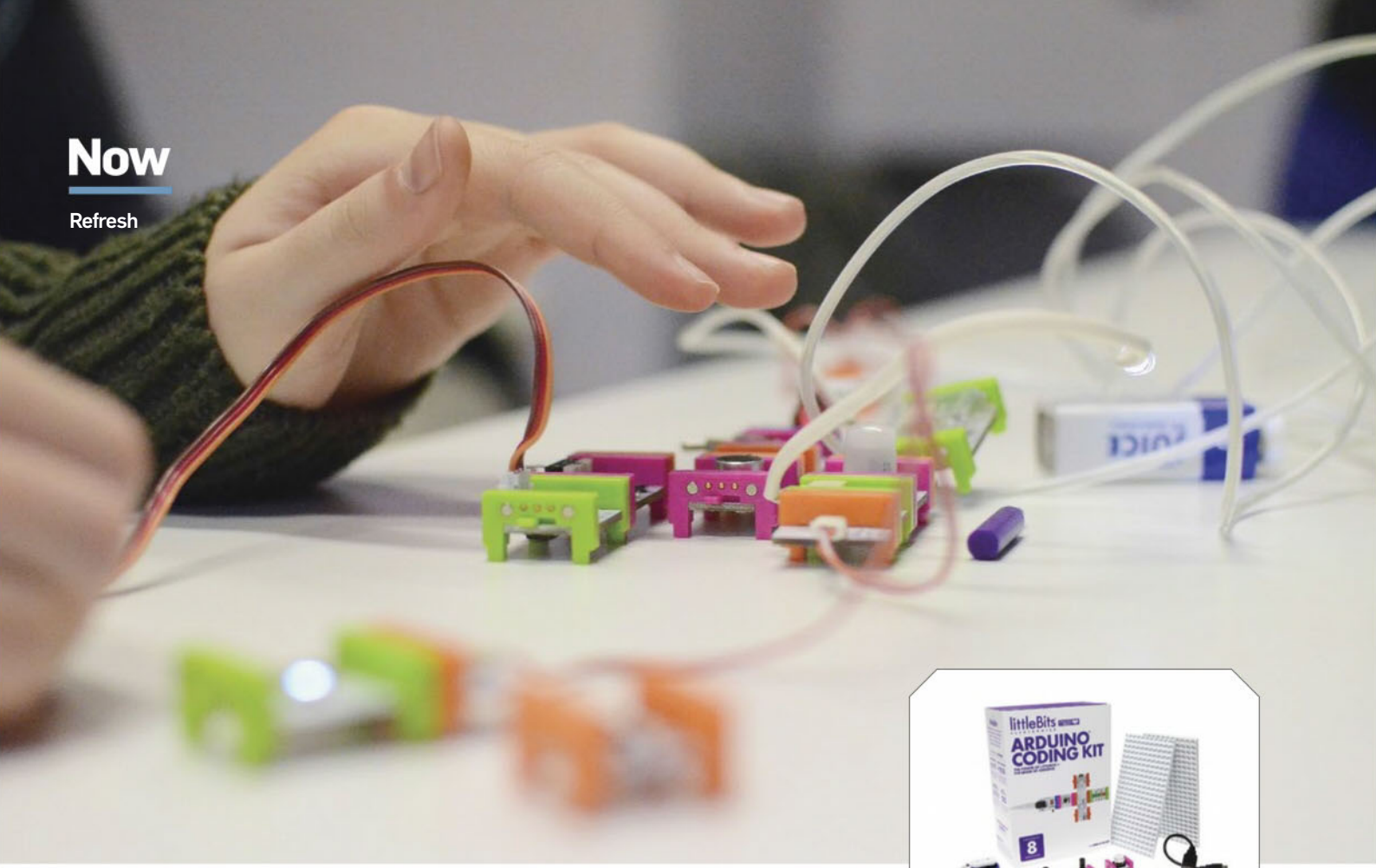

DIY ELECTRONICS GETS BLUETOOTH (AND MORE)

by ANTHONY FORDHAM

WE LOOKED AT LITTLEBITS' musician-focused synth kit last issue, and mentioned that other bundles in the innovative startup's catalogue are pitched more to kids and schools, tinkerers and prototypers.

Well, those inventors just got a functionality boost with version two of the popular Gadgets and Gizmos kit. This top-tier kit includes a lot of bits including, now, two Bluetooth modules for wireless control.

The first edition of the kit had two "WiFi" bits, which were actually a remote control radio transmitter and receiver. It was possible to select different channels but overall options were pretty basic.

BITS IN THE BOX

- Bargraph
- 2x Bluetooth
- Low Energy (BLE)
- Buzzer
- 2x DC motors
- Fan
- Light sensor
- Power
- Servo
- 2x Slide dimmer
- Split
- Wire

PRICE: $390
WEB: www.tnsconnect.com.au

These bits are now replaced by two Bluetooth modules. As well as enabling control of one contraption with another (a simple remote controlled car, for instance), it's now also possibly to control a creation via an app on a smartphone.

One of the examples provided by littleBits is the BitBot which can be steered over Blueooth by tilting a connected phone or tablet.

As with all littleBits kits, there are dozens of suggested projects online or via the app, and keener creators can order additional bits - including exotics like logic gates and MIDI controllers - from Aussie distributor TNS Connect. PS

AUDACIOUS ARDUINO

There's also an Arduino littleBits kit which includes a handful of useful bits and a custom Arduino bit based on the Leonardo. Sure, Leonardo might have been retired by Arduino itself, but it's still a useful board for many simple projects. We used the Arduino bit with the KORG Synth kit (see last issue) to create an arpeggiator. It was as easy as plugging the Arduino bit into a PC via USB, uploading a sketch - a small Arduino program - and then clicking the bit into the Synth. Instant effects! The Arduino kit can take littleBits creations to the next level of sophistication, but hopefully an upgrade will come along soon based on a more current design, such as the Arduino ZERO.

BITS IN THE BOX

- Arduino Leonardo
- Bargraph
- Button
- 2x Dimmer
- Fork
- Power
- Servo

PRICE: $190
WEB: www.tnsconnect.com.au

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COMPACT ANALOGUE SYNTHS BRING THE BEAT BACK

by Anthony Fordham

THE ANALOGUE MUSIC renaissance goes well beyond the resurgence in turntable and vinyl sales. Analogue instruments are making a comeback too, including the analogue synthesiser - which to be fair, never really went away, but it did become an expensive and somewhat niche segment.

Now Korg is bringing analogue back to the masses with an ever-increasing list of new products including these: a series of tiny synths called Volca.

Each Volca does a specific job. We tested the Volca Keys (a lead loop generator), the Volca Bass (funky bass lines) and the Volca beats (essentially a drum machine). But there's also the Volca Kick, which is a more specialised drum machine for kick sounds, and the Volca Sample, which brings some digitisation to allow for sample recording, playback and of course manipulation.

Analogue synth veterans may not find the Volca form-factor familiar, but the controls will be second nature. Oscillators, pitch control, voice modes including "unison ring", delays and filters, attack and decay, all the classics are here, all controlled via proper analogue pots.

And unlike the functionally similar synth apps you'll find on iPad which merely simulate, the merest twitch of a pot can radically alter the sound the Volca produces.

New analogue synths also often play off the designer's long experience in the field, and Korg is no exception. For example, it says the circuitry in the Volca Keys' s based on the "legendary" miniKORG700S from 1974. If analogue is all about going old-school, this is a good marketing strategy.

Playing any Volca is about exploration. Set the controls, record a sequence, hit play, manipulate controls. One knob goes this way and the sound becomes airy and ethereal, like 50s SF mood music. Another knob goes the other way and the sound become harsh, intense, with precise timing and an infectious groove, like the best 80s synth pop ever.

At $229 each, the Volcas are very much an entry-level device and so lack some of the options of Korg's more expensive synths. While there's midi input for keyboard control, outputs are limited to a single 3.5mm mono pluq per device. A second 3.5mm port allows the Volcas to connect together via the included cables, for precise synchronisation and the ability to play together.

Each box has a small speaker and is powered by six AA batteries, which makes them very portable. No AC power pack is included, and the Volcas need a centre-positive 9V plug. Korg has one for $49.

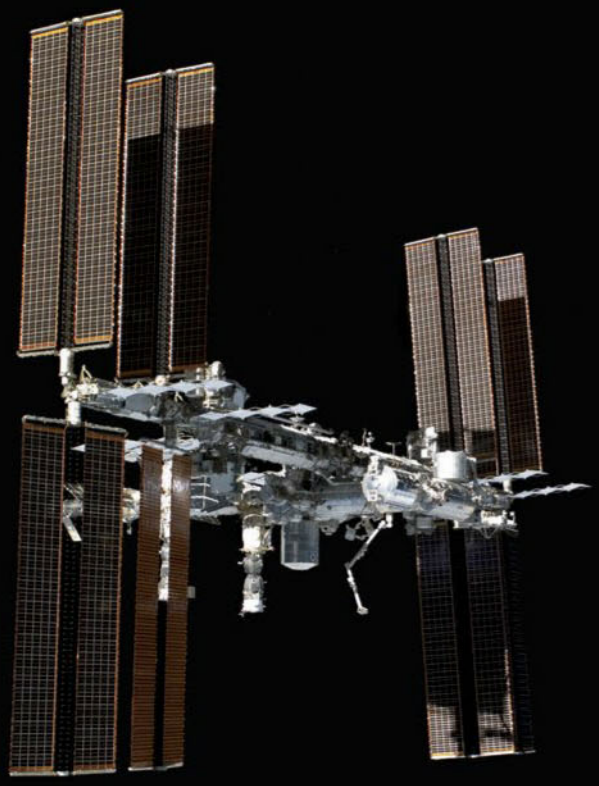
Yet despite this lack of inputs, musicians still manage to integrate the Volcas into their setups alongside bigger Korg or Moog synths costing 10 or 20 times as much. This is thanks to what can only be described as the honesty of the sound these little synths produce. Digital fakes exist via tablet app... but it's not the same.

Synth enthusiasts already love them, but if you're analogue-curious, the Volcas are an excellent way to venture into the groove. PS

ANALOGUE SYNTHS?

Unlike the digital piano you might have had at school, a proper analogue synth makes no attempt to simulate the sound of an acoustic instrument. While some settings can produce a noise reminiscent of strings, mostly these instruments are about starting with a pure sine wave and manipulating it with various voltage settings. Some of the most basic tweaks include making the wave saw-toothed or square, making it repeat itself while fading out (the human can interpret this as the ambience of a large room), or adding complexity to the wave to make it sound harsh and buzzy or soft and melodious. Filters further manipulate the electrical signal and thus the sound, and "polyphonic" synths - the Volca Keys included - can play multiple sounds at once, allowing the creation of chords.

KORG VOLCA SERIES **PRICE:** $229 each **URL:** www.korg.com



THE SKY IS NO LONGER THE LIMIT.

The screens of the Future are available today!

Screen Innovations has worked with NASA to develop a one-of-a-kind, ambient-light-rejecting, zero-gravity screen to be installed in the International Space Station...

Until now, astronauts on the International Space Station communicated with Mission Control and their families back home on tablet-sized 13-inch displays. Now they will have a large roll-out screen from Screen Innovations, together with a laser projector that should last more than 30,000 hours of use – that's a movie a day for more than 40 years.

The criteria for a screen in space were unique, from the obvious need for extreme lightness and easy storage to trickier requirements such as screen rigidity in zero gravity and the ability to reject the bits of food and other detritus that have a habit of floating around zero-gravity environments.

Although the theatre in your home resides in a more-worldly environment with picture quality taking a front row seat it's nice to know that Screen Innovations also delivers the best down-to-earth solution around.

images courtesy: NASA

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AUSSIE R&D CREATES TOUGH SIBLINGS

by Anthony Fordham

Ford Everest Titanium
Drive: 4WD
Engine: 3.2L 5-cyl diesel
Transmission: 6-speed auto
Power: 147kW, 440Nm
Economy: 9.4L/100km claimed (11 tested)
Price: $76,990
URL: www.ford.com.au

WITH THE PRODUCTION OF Australia's own Falcon ended, Ford promised us that our choice of cars will actually increase, as platforms designed for global markets begin to appear in showrooms.

Once such platform is the T6. Designed at Ford R&D in Victoria, it forms the backbone of the Ranger ute and Everest family SUV.

These cars are essentially identical from the front doors forward (styling cues like the grille aside), reflecting a general trend toward "platforms" rather than individual unique models.

In Australia, the Ranger and Everest both get Ford's 3.2 litre 5-cylinder Duratorq diesel, which is good for 147kW and a useful 440 Nm of torque. The base Ranger is available in rear-wheel drive, while the XLT, Wildtrak and Everest models get 4WD.

By consolidating multiple cars onto one platform, Ford is able to pack in a considerable of technology that, just a decade ago, was strictly the domain of high-end European marques.

There's an electronic stability system that includes trailer-sway control, hill launch assist, hill descent control and rollover "mitigation". There's also a locking rear differential, activated by a button in the cabin, and adaptive load traction control.

The Wildtrak and higher end Everests get a selector for different terrain types too, including sand, mud and snow, or rock.

Four-wheel-drive low range is activated by shifting to neutral (in automatic models), pressing a button, and shifting back to drive. No hub locking, no fuss.

While the Ranger XLT and below keep the no-nonsense work ute aesthetic going with basic noise shielding and spartan interior, the Wildtrack and Everest Titanium are almost luxurious. Leather seats, lots of parking sensor and adaptive cruise options, the cabins are car-like and pleasant at highway speeds. Active noise cancellation via speakers mutes the diesel rattle, and is especially noticeable when tackling a steep incline.

The Everest is larger than the average family SUV, sitting up more toward the LandCruiser end of the spectrum, so may not suit city folk. But for everyone living in a regional area, it's hard to argue that its no-nonsense go-anywhere capability doesn't make it an obvious choice over anything smaller.

Ford Ranger XLT
Drive: 4WD
Engine: 3.2L 5-cyl diesel
Transmission: 6-speed auto
Power: 147kW, 440Nm
Economy: 9.4L/100km claimed (10 tested)
Price: $52,184
URL: www.ford.com.au

Our test drive saw us in an Everest Titanium out between Young and Cowra NSW, where exceptional flooding had closed some roads, damaged others, and left dozens of causeways under a few centimetres of water.

In a Falcon, our ability to go where we wanted, when we wanted would have been at least a source of constant stress, if not actually impossible. But with an 800mm wading depth on the Everest, nothing was a problem.

Australians living in country areas also know the tyranny of a bad driveway. On some properties, these can stretch for hundreds of metres, if not kilometres, and are the terror of sumps and mufflers across the land. Again, the Everest switches from comfortable highway cruiser to rubble-crawler without any change of settings. (Much steeper though, and we would have needed to engage 4WD Low and lock the rear diff.)

That you can now get a capable SUV for the equivalent of a mid-priced luxury sedan just shows how platform-based development can pay off, for drivers and Ford alike.

Of course, we'll always miss the Falcon. But a trip to Fraser Island should help us get over it. PS

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THE CARPET IS NOT ENOUGH NOW DYSON WANTS TO CLEAN YOUR AIR...

by Anthony Fordham

WHAT DYSON REALLY IS today, is a company that develops and implements extremely powerful and compact electric motors that drive impellers. Whether these blow or suck air simply depends on the application.

Here, at last, is a product that does both. The Pure Hot+Cool Link uses a compact motor to suck air in through a HEPA filter and blow it out through the distinctive "air multiplier". It's a fan that looks blade-less, but in fact the blades are hidden in the pedestal.

Is there an app? This is 2016, of COURSE there's an app. The purifier now connects via home WiFi to an iOS or Android device running Dyson Connect. This app not only allows control of the purifier (we can finally lose the remote and not have to throw the fan away!), but also goes online to get an estimate of the outdoor air quality in your area.

Using this information, the purifier will then decide when and how hard to run the fan during the day. So the owner should leave the device on Auto and let it choose its own fan speed.

Manual controls are available, of course. Apart from fan speed, there's also "beam control" on the Pure Hot+Cool Link, with a wide dispersal setting and a more direct "personal" setting. And a motorised oscillation control should remind you of the bad old days before ducted aircon.

Despite its diminutive size, the Pure Hot+Cool Link does a very good job of making a stuffy room feel fresher, by a combination of simply stirring the air and also filtering out most of the irritating dust particles. Its also especially effective for people who suffer from allergies or mild asthma overnight – there's a night mode that dims the LEDs and switches the fan to quiet.

Most serious discomfort on a humid night can be alleviated by a bit of air movement, which is why fans have endured so well into the Age of Aircon. The Pure Hot+Cold Link is expensive at $749, but also functions as a little blow heater in the winter.

Under manual control, it probably won't impress overmuch. But the auto mode, assisted by the app, can provide 24 hour relief, if you're the kind of person who needs it. PS

EDDIES IN THE OFFICE

No that's not apostrophe-crime, we're talking about air circulation in a partitioned open-plan office. At Australian Popular Science, it turns out our partition walls are too high for the design of the aircon system in our building. The result? Some desks end up trapped in dead-zones with almost zero air movement. Despite the year-round 23-degree setting, this stillness can become oppressive. The desk version of the Pure Cool Link ($549) doesn't heat, but proves invaluable in shoving our own gross CO_2-heavy expiration over the partition wall to the guys on PC Authority, and letting blessedly cool air flow in to take its place.

DYSON PURE HOT+COOL LINK Purifier **PRICE:** $749 **WEB:** www.dyson.com.au

BY OUR DEEDS WE SHALL HONOUR HIM!

DYSON'S HANDHELD VACS left the competition literally in the dust some time ago, harnessing the company's so-called "digital motors" to create battery-powered suction that rivals most plug-ins. The V8 is quieter, more powerful, collects more allergens, has what Dyson calls a "whole machine filter", and runs for seven minutes in super-suck mode.

That's thanks to a nickel-cobalt-aluminium battery (the aluminium replaces manganese, but otherwise this is still a Lithium-ion battery). Seven minutes might not sound that long, but we usually find it enough to give a wool living room rug a really deep clean after a week of having a Labrador lying on it. And anyway, on regular mode it can run for up to 40 minutes.

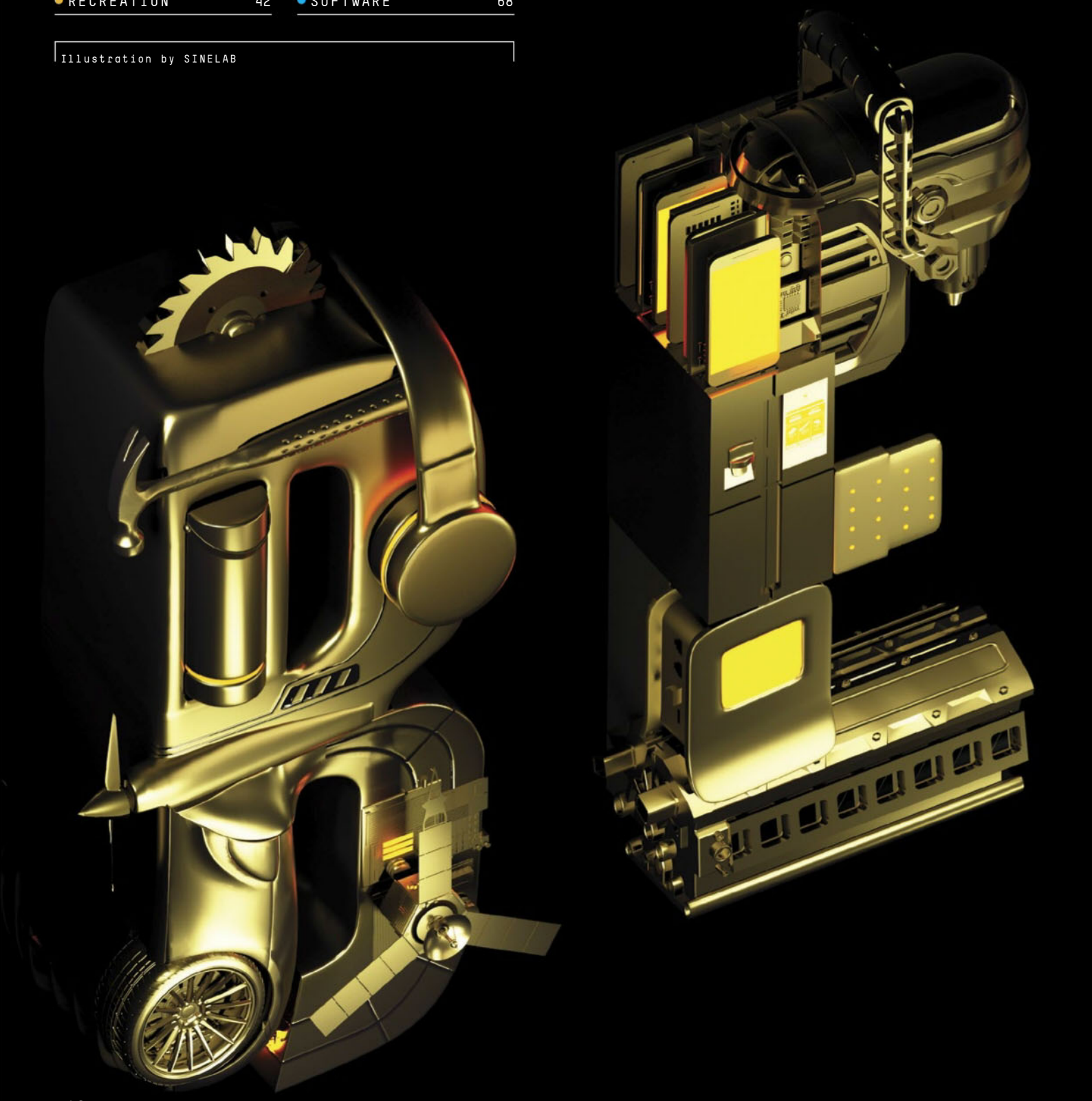
As usual, the funky plastic construction means dog hairs will still leap up and stick to the outside of the brush head thanks to the magic of static (we haven't tested this on non-woollen rugs though), but the sheer power is worth it.

If you're the kind of person who likes to touch-up the floor every evening rather than leave your own gross epidermal flakes to build up over the week, then the V8 could prove invaluable. P/S

DYSON V8 ABSOLUTE
PRICE: $849
WEB: www.dyson.com.au

INSIDE

Illustration by SINELAB



OF WHAT'S NEW

AT *POPULAR SCIENCE*, WE SPEND A LOT OF TIME OBSESSING about the future. What will it look like? How will we get there? (And where the heck is that flying car already?) Our annual Best of What's New awards, now in its 29th year, doesn't have a flying car, but it does have 100 extraordinary innovations—grounded in the here and now—that make us feel pretty good about where things are headed.

BEST OF WHAT'S NEW

B O W N

SANOFI PASTEUR DENGVAXIA

Finally, a Vaccine for Dengue

Dengue—a virus most commonly transmitted by the *Aedes aegypti* mosquito—infects some 400 million people yearly. It causes high fever, severe headaches, vomiting, and sometimes death. About 40 per cent of the world's population is at risk, and as the climate warms and travel increases, that risk will only climb. This year, the World Health Organisation started recommending the first vaccine to prevent dengue, and inoculations have begun in hot zones like Brazil and the Philippines. Four viruses cause dengue, so developing a vaccine that protects against all four took researchers 20 years to do. If 20 per cent of the population gets vaccinated, dengue cases could drop 50 per cent within five years. Controlling dengue could also reduce the $11 billion the disease costs global economies each year.

HEALTH

by ALYSSA FAVREAU + CLAIRE MALDARELLI • Photograph by SAM KAPLAN

ICONS BY MICHAEL BRANDON MYERS; PHOTO CREDITS SEE PAGE 87

A

WITHINGS THERMO

A Friendlier Thermometer

Home oral thermometers take up to three minutes to get readings. Thermo takes only two seconds. Sixteen infrared sensors take more than 4,000 readings from the temporal artery—all without touching the skin.

B

BRAEBURN PHARMA.
PROBUPHINE IMPLANT

Easy Opioid Maintenance

During treatment for opioid addiction, missing one or two doses of withdrawal meds can trigger a relapse. Once under the skin, where they stay for up to six months at a time, four matchstick-size Probuphine implants deliver a constant dose of buprenorphine, an opioid derivative that in small, steady doses combats withdrawal symptoms. The device is currently FDA-approved for patients in active recovery from opioid addiction.

OLIVO LABS
SECOND SKIN

Stick-On Skincare

Sun damage, wrinkles, discolouration: These inevitable markers of age could soon be hidden—or even prevented—with an invisible elastic polymer. Second Skin, or XPL, can be placed directly on the skin as a coating, where it mimics the properties seen in younger skin, such as elasticity. It could also be used as a vehicle for delivering drugs (like eczema meds) or cosmetics (like sunscreen) so that they wouldn't rub off during the day.

C

ABBOTT
ABSORB

A Disappearing Cardiac Stent

Metal stents—small tubes that unclog and heal blocked arteries—are a mainstay in cardiac surgery. But because that metal stays around indefinitely, plaque can rebuild around it. Absorb is a fully bioabsorbable stent that does the same healing work, but it dissolves when it's finished. Made of polylactide—a biodegradable polymer also used in dissolving sutures—the device proved to be on par with its metal counterpart in clinical trials.

CHILDREN'S NATIONAL MEDICAL CENTER STAR

Most Dexterous Robot Surgeon

The Smart Tissue Autonomous Robot (STAR) can suture one of the trickiest areas of the human body: the intestines. A sensing system in STAR's surgical tools feels and reacts to tiny pulls and pressure changes, upping the robot's precision. When sewing a pig's intestine, which is as flexible as a human's, STAR spaced its sutures more evenly than both human and human-assisted robotic surgeons—a sign of a procedure well-done.

ABBOTT
FREESTYLE LIBRE

Prickless Glucose Test

People with insulin-dependent diabetes stick their fingers up to 10 times a day to check their blood sugar. The FreeStyle Libre system eliminates the painful pricking. A small, round sensor on the upper arm contains a tiny filament that, when inserted just under the skin, continually monitors glucose. Patients use a smartphone-size scanner to check their levels. Those who used the system were in a state of low blood sugar 38 per cent less often.

D

ST. RENATUS KOVANAZE NASAL SPRAY

Needle-Free Dentistry

The anaesthetic shot is often the worst part of a tooth filling. Kovanaze does the same work in the form of a nasal spray. Two squirts in the nostril on the side of the offending tooth make the filling pain-free.

E

NIMA

Pocket Gluten Detector

People with coeliac disease normally have to take a cook's word on whether their meal is truly gluten-free. Nima lets them test the food for themselves. Antibodies on the card-deck-size device's test strips react to gluten levels as low as 20 parts per million, the gluten-free limit set by the FDA. In the future, the company plans to expand its ingredient detection to include other common food allergens, such as peanuts.

AMGEN
IMLYGIC

A Virus That Fights Cancer

Scientists have long known that viruses could trigger the immune system to attack cancer, but modifying the viruses without affecting our resistance to them has taken time. In late 2015, IMLYGIC became the first FDA-approved viral cancer drug. Green-lit to treat melanoma, the modified herpes virus is injected into a tumor, where it may ignite an immune response to the cancer. (Turn the page to read about cancer treatment's future.)

F

SHIFT LABS
DRIPASSIST

Simpler IV Control

In developing countries or military outposts, nurses often count IV fluids drop by drop to ensure medicine flows into a vein at the proper rate. Infusion pumps common in hospitals are expensive, large, and require electricity. The DripAssist is a stripped-down, compact infusion monitor that runs on a single AA battery. Attached near the bag end of an IV tube, the 150-mm device monitors flow for a fraction of the cost of traditional hospital pumps.

H

MIT
RAPID ZIKA TEST

Low-Cost Zika Test

Zika's biggest threat is its potential to cause birth defects, yet expectant mothers might not know they're infected. Conventional lab tests take days and require facilities unavailable in rural areas. Researchers at MIT created a paper-based test that gets results within three hours. When exposed to a Zika-containing blood sample, yellow dots on the paper turn purple. Researchers think the same approach can rapidly diagnose other diseases, like malaria.

CARL JUNE IMMUNOTHERAPY PIONEER

Our Bodies Can Kill Cancer

CANCER CELLS SPREAD DUE TO THEIR INSIDIOUS ABILITY TO bypass the immune system. To fight them, oncologists have historically turned to toxic drugs that kill cancers' dividing cells. But over the past decade, researchers have been figuring out how to trick the immune system into attacking tumours. In late 2015, the FDA approved Amgen's IMLYGIC, a genetically engineered virus that might trigger the immune system to kill cancer. For now, the drug is only for melanoma, but it's a harbinger of a major shift in the cancer fight. University of Pennsylvania's Carl June, a leader in immunotherapy research, explains how IMLYGIC, and drugs like it, could change how cancer is treated.

Popular Science: How does immunotherapy differ from chemo and radiation?
Carl June: A reprogrammed immune system could have a lifelong antitumour effect. That sets it apart from short-term therapies, where you get the effect only until the drugs metabolise. Plus, the lessons we learn from the immunotherapy for one cancer will apply to other cancers.
PS: The treatment you developed, CAR (chimeric antigen receptors) T cell therapy, uses engineered T cells (immune cells) to kill tumours. It kills some cancers, but not all. Why?
CJ: Often, the tumour cell mutates, so the modified T cells can't find it anymore. We are now in trials where we give patients a cocktail of cells. Then mathematically, it's about impossible for the tumour to mutate in so many ways that the engineered T cells can't keep up. Our end goal is to pin a tumour into a corner, where it can't escape.
PS: Both CAR T and IMLYGIC use viruses to ignite an immune response. Are there side effects?
CJ: Yes, but we are balancing a sword. In CAR T, patients who get high fevers [from the treatment] are the ones who end up doing best. The fever is your immune response to the virus, which is needed. The patients who never get a fever are the ones who don't do well.
PS: The big question: Could this lead to a cure for cancer?
CJ: In an ideal world, we will have vaccines. For now, there's data showing that if we give immunotherapy early, a single treatment could bulk-reduce or eliminate the tumour. And then hopefully it's one and done. PS

Edited + Condensed by CLAIRE MALDARELLI • Illustration by KYLE HILTON

Extreme Sharpness

Introducing the fully refreshed line up of PENTAX binoculars.

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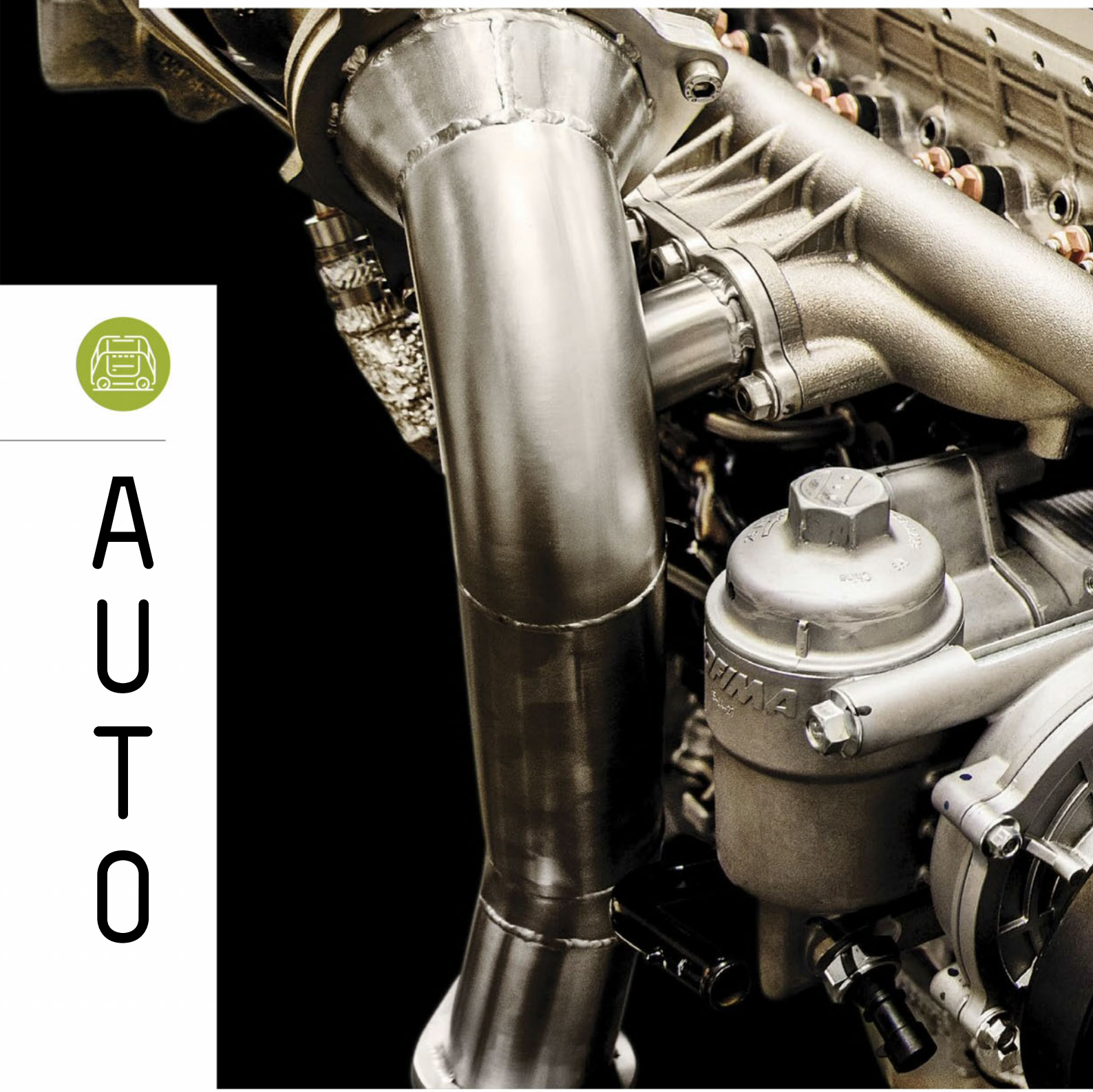
AUTO

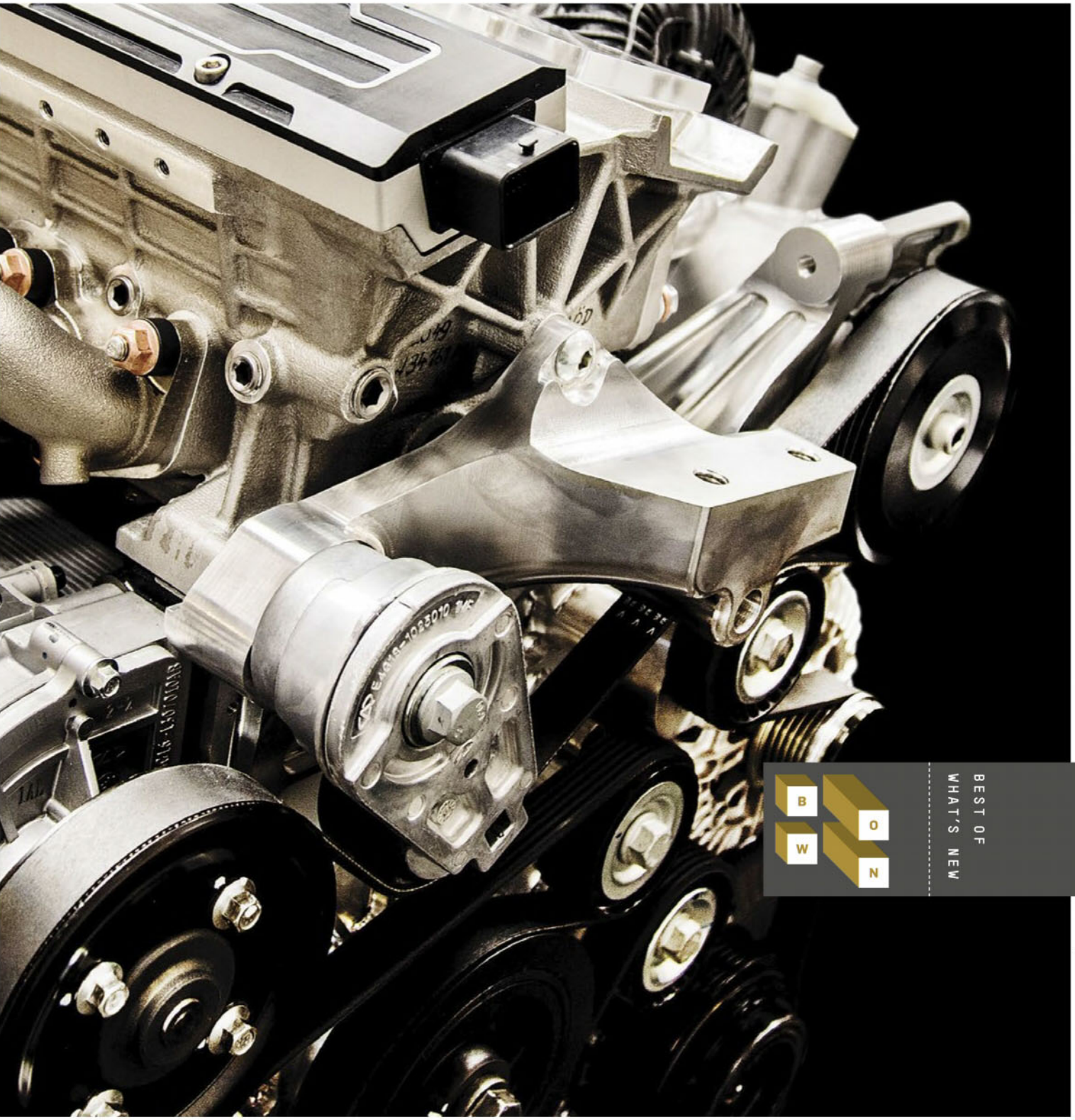
KOENIGSEGG FREEVALVE

New Life for the Gas Engine

For more than a century, the internal combustion engine has relied on the camshaft. This spinning rod with variable lobes sits atop the engine, where it opens and closes intake and exhaust valves during the combustion cycle. But the camshaft has a limited range of motion, so its degree of control over the valves is finite. This is the



root of engine inefficiency. In April, Swedish supercar-maker Koenigsegg debuted the world's first camless engine—the FreeValve—on a Chinese Qoros concept car. FreeValve forgoes the camshaft for electro-hydraulic-pneumatic actuators. They attach right to intake and exhaust valves, so engineers can control combustion within each cylinder. The design gets more power—imagine a four-cylinder getting 185 kilowatts, sans turbo—and greater fuel economy out of otherwise standard engines. Cams, may you rest in peace.



BEST OF WHAT'S NEW

By CLIFFORD ATIYEH

A

4MOMS SELF-INSTALLING CAR SEAT

Foolproof Infant Seat

Nearly half of all infant car seats are improperly installed, according to the US Department of Transportation. Cute-named 4moms' rear-facing seat makes installation idiot-proof. The base contains 20 sensors, including accelerometers and gyros, that work with motors to level the seat and tighten the straps. As long as the carrier is snapped onto the base, it will continually recheck the fit. It's also comfy: The ergonomics are on par with top baby carriers.

B

2017 CHEVROLET BOLT EV

The EV for Everyone

Affordable electric vehicles have struggled to break the 350-km-range barrier. General Motors (no, not Tesla) is getting there first. It all comes down to the battery: The Bolt's 288-cell, 60-kilowatt-hour lithium-ion powerhouse is heavy in nickel, which boosts energy density and extends range to 380 km. Liberal use of aluminium in the hood, doors, tailgate, and suspension keep the car from getting weighed down.

C

2017 AUDI SQ7 TDI

Full Turbo, No Waiting

Powerful as it is, a turbocharger lags before kicking in; it's asleep until exhaust builds up to spool its turbine, blasting pressurised air into the engine. The Audi SQ7 TDI uses a 7-kilowatt electric motor to spin its turbine. Inspired by Formula 1, the system hits 70,000 rpm in less than 0.25 seconds. For now, the electric-powered compressor (EPC) is Europe-only. We can't wait for it to head down under.

D

AIRBUS APWORKS LIGHT RIDER

3D Printed Motorcycle

Helping offset the heavy battery in the APWorks Light Rider is a fully 3D-printed body. The prototype bike's skeletal aluminium frame cuts the weight to a svelte 34 kilos—a 30 per cent dip on conventional manufacturing weight.

E

2016 FORD MUSTANG SHELBY GT350R

Lightest Feet on a Car

Mustangs once shared parts with burly pickup trucks. Now, the classic pony wears ultralight carbon-fiber wheels. The 19-inch rims on the Shelby each weigh some 15 pounds less than regular aluminum wheels. Less weight speeds acceleration, and greater rigidity improves handling. Don't worry about lightenin' 'em up: They're insulated with a ceramic coating similar to the space shuttle's.

HERE HD LIVE MAP

The Most Detailed Maps

Autonomous cars need maps for every lane marker, guard rail, and speed-limit change ahead. The dynamically updating HD Live Map from HERE—a spinoff of electronics-giant Nokia—has already logged 2.9 million km in the US and Europe. The company's fleet of cars maps roads to an accuracy of 10 centimetres—three to five times better than GPS. Next, HERE will start adding data from real drivers into the mix.

F

MCLAREN 570S

A Drivable Supercar

You don't need an airfield to open up the McLaren 570S. A 419-kilowatt engine hits 1000 km/h in less than three seconds (and tops out at a *useful on public roads* 328 km/h), while its carbon-fibre cabin keeps the ride stiff on tight turns.

G

2017 MERCEDES-BENZ E-CLASS

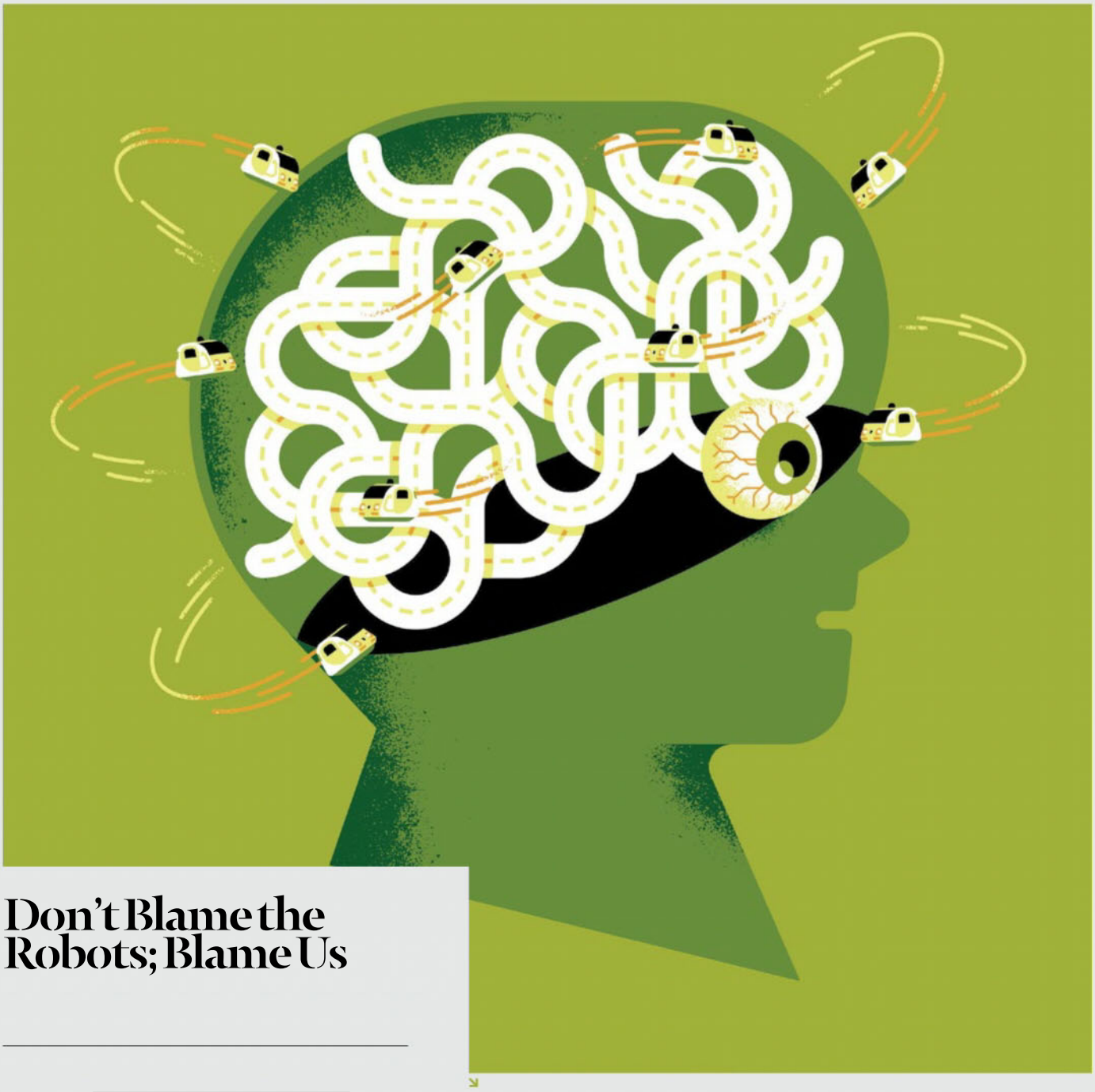
Car Talk

When cars chat with each other, they won't look like Pixar characters. Vehicle-to-vehicle ommunication (V2V) will be standard within a decade, letting cars share alerts—some fool who ran a red light ahead—over encrypted radio signals. Mercedes isn't waiting. The E-class sends traffic updates via 4G to a cloud server, alerting E-class drivers headed in that direction in seconds. It's a Benz-only network—but one that helps make roads safer.

TESLA AUTOPILOT

Your Robot Driving Buddy

A fatal crash this spring cast a shadow on Autopilot. But when used properly (see next page) no system maneuvers better in highway traffic. The hardware is simple: a camera, bumper-mounted radar, and 12 front-and-rear ultrasonic sensors. The genius is the software: Over-the-air updates and input from the fleet help the system hone its skills, such as automatic lane changes.



Don't Blame the Robots; Blame Us

THE SLACK CHANNEL AT THE UNIVERSITY OF PENNSYLVANIA'S human-machine interaction lab, where I work, is typically a steady drip of lecture reminders and wall-climbing robot videos. But this past summer, news of the first Tesla Autopilot-related fatality turned the feed into a Niagara Falls of critical chatter. Graduate research assistant: "It's a habit of all people launching products to claim things are working to keep people excited." Postdoc research fellow: "Such failures are inevitable, at least until the technology improves. Tesla took the plunge first, and therefore is subject to increased scrutiny." Student researcher: "If a driver was attentively behind the wheel, they wouldn't have mistaken a tractor trailer for a road sign."

By CARLA DIANA

Autopilot is not auto. Tesla labeled it a beta program—meaning that it's a work in progress—and told drivers to stay alert and keep their hands on the wheel.

It went on like that for days. All sides of the argument had merit. So I did my homework, reading about the accident—which claimed the life of an Ohio man driving a Tesla Model S with Autopilot active—in more detail. I wanted to understand how the system, among the most advanced public experiments in human-machine interaction yet, had gone so wrong. The man's car crashed into a tractor-trailer crossing US Highway 27A in Florida. According to Tesla's initial incident report, the car's emergency braking didn't distinguish the white side of the truck from the bright sky.

Technically, that's where the fault lay. The more important factor, to auto-safety experts and to Tesla, is that the driver also didn't notice the looming collision. So he didn't brake—and his car ran under the trailer.

As autonomous cars begin to hit the road, it's time to assess some long-held misconceptions we have about robots in our lives. Many of us grew up with the promise of all-knowing partners like *Knight Rider*'s intelligent car sidekick, KITT. Fiction, yes, but our expectations were set—and perhaps cemented further by set-it-and-forget-it home robotics like Roombas and the ubiquitous task-mastering dishwasher.

Autopilot is not that. Tesla labelled it a Beta program—meaning that it's a work in progress—and told drivers to stay alert and keep their hands on the wheel.

Did the public listen? Yes and no.

Early adopters fuelled our fantasies. Ecstatic YouTube videos began popping up, showing adults test-riding the cars from the back seat and playing Jenga in traffic. One review, viewed nearly half a million times, offered this not-so-helpful tip: "The activities performed in this video were produced and edited. Safety was our highest concern. Don't be stupid. Pay attention to the road."

So, in other words: "Don't do what we just did."

Lost in the exuberance: Shared control is the name of the semi-autonomous-driving game.

We can glean a lot about this type of relationship from fighter-pilot training. Pros have flown with fly-by-wire systems, which replace manual controls, and other flight-automation tech, since the Carter administration. Like Autopilot, these are supporting technologies meant to augment, not absolve, the pilot's responsibility to manage the craft. Pilots undergo years of training before taking over the cockpit, learning what the computer is seeing and how it's processing information and making decisions. They also learn to maintain situational awareness and be ready to react, despite the technology—as opposed to taking a let-the-plane-do-the-work attitude.

Drivers can't go through the deep training that pilots do. Or can they? Automakers and regulators must decide. We clearly need to go beyond the pages of fine print that's displayed on-screen when a driver installs an Autopilot software update. Carmakers should create short training programs—like the Saturday courses some states require for a boater's license—to help people grasp how automation works, when it is and isn't designed to work, and why humans need to be ready to step in. "A problem with automated technologies like Autopilot is that when an error occurs, people tend to be out of the loop, and slow to both detect the problem as well as understand how to correct it," says Mica Endsley, former chief scientist of the US Air Force and an expert in automation and human-machine interaction.

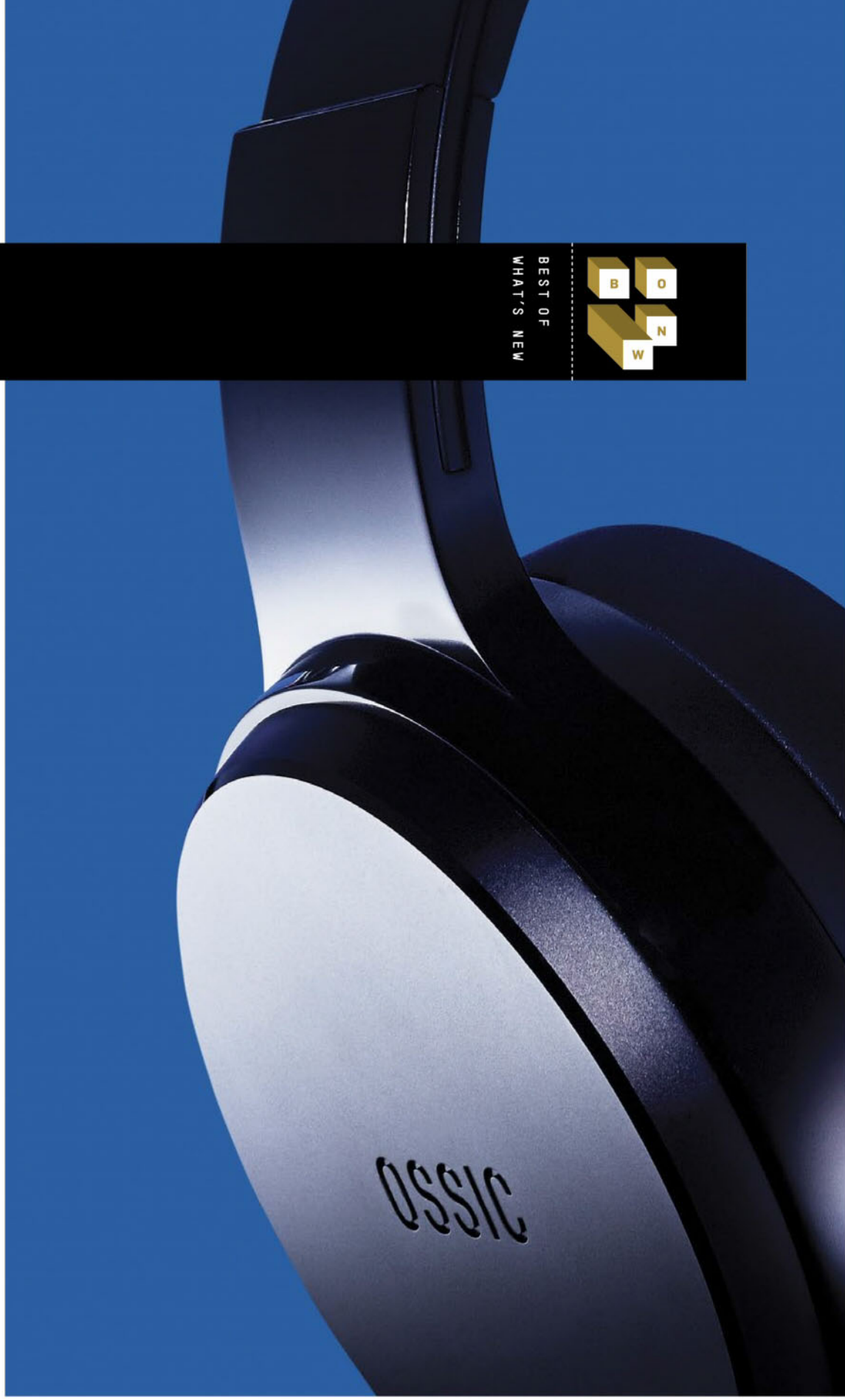
Training drivers is a start. But self-driving software needs to reinforce that training. Engineers need to understand human cognition to become better able to interface with the public. Thankfully, this type of interaction is a growing research field for automakers and academics. At Stanford University, interaction-design specialists are learning how to make an autonomous car's reasoning and camera, radar, and sensor perceptions plainer to drivers. Automakers, they say, should use colloquial vocal cues ("braking due to obstacle") and physical changes to controls (such as shifting the angle of the steering wheel) to make drivers aware of changes—say, a truck about to cut them off—or prevent them from daydreaming themselves into a ditch.

Current handoff signals are subtle, but should become less so. When drivers need to take control of Teslas, a tone and colour change in the Autopilot dashboard icon are all they get. Driver-assistance systems from Cadillac and Volvo vibrate the seat or steering wheel to achieve the same goal. Automakers should be more aggressive. Recent Stanford studies suggest that multisensory tactics—say, a buzzing steering wheel, vocal prompt, and flashing light—might speed reactions.

No one wants to go slowly with new technology. But drivers should proceed with caution (and attention!) into the world of semi-autonomous driving. Tech that might lull people into losing focus—or goofing off—while barrelling down the highway requires both better training for the humans and smarter alert systems for the machines.

May's accident was a worst-case scenario, and a tragic one, but it shows how vital it is that humans learn to share the driver's seat. PS

Illustration by MARCO GORAN ROMANO

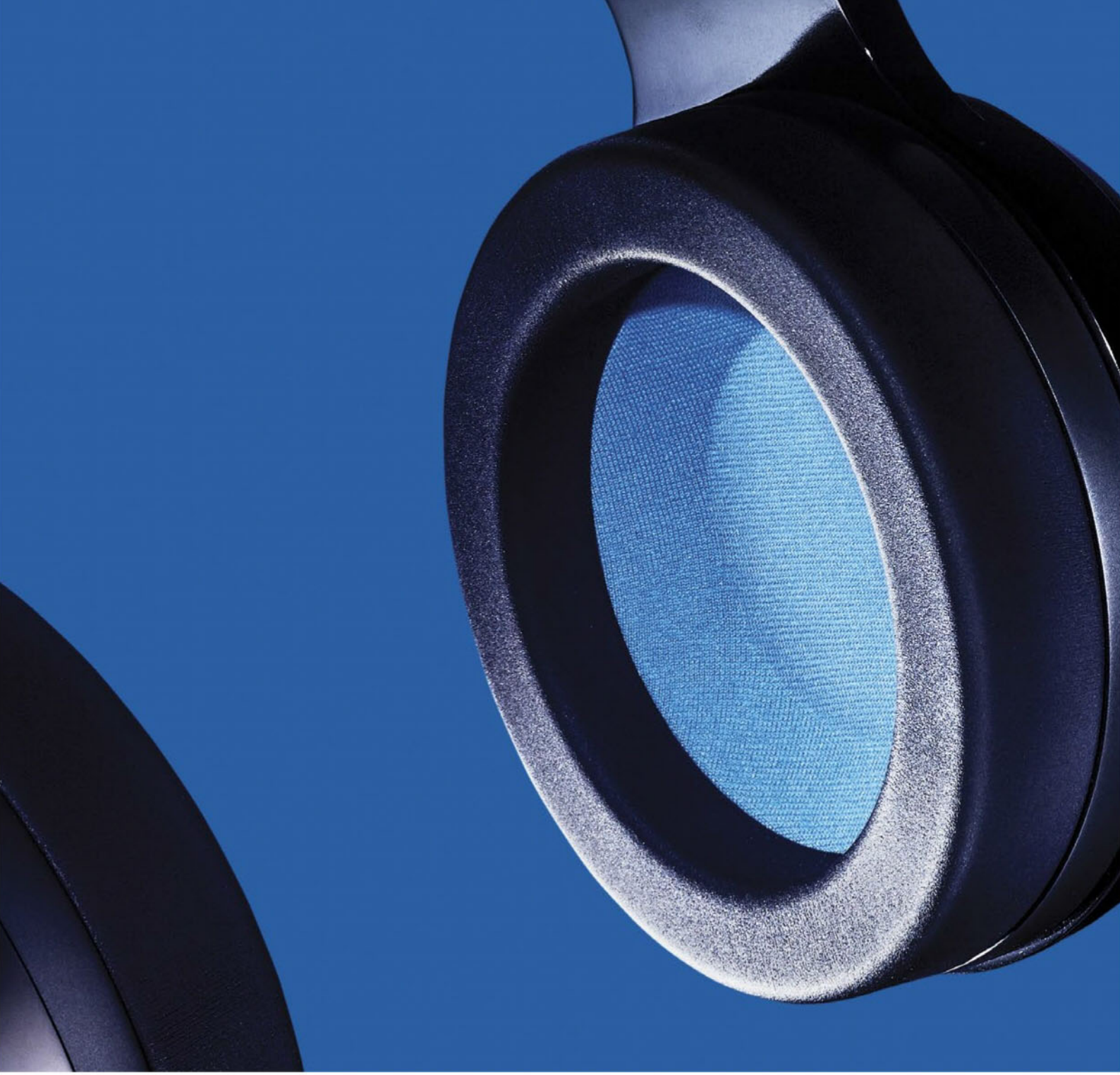


OSSIC X

The Sweet Sound of Virtual Reality

When it comes to virtual reality, video gets all the glory. But hearing in VR—as bullets whiz overhead and floors creak underfoot—is just as key. Heavyweights like HTC and Oculus are working hard on their audio engines, but a San Diego startup is taking multidimensional sound a step further. Ossic's X over-ear headphones adapt to a listener's anatomy, creating the most convincing 3D audio effects yet. First, sensors at the top of the ear cups measure your head size to precisely time audio delays between the ears. Four drivers surround each ear, simulating sound that comes from multiple directions. Finally, the Ossic X's built-in head tracking uses an accelerometer, a gyroscope, and a compass to match what you're hearing to your every move.

BY XAVIER HARDING + ANDREA SMITH • Photograph by SAM KAPLAN



ENTER-TAINMENT

A

SAMSUNG 4K ULTRA HD BLU-RAY PLAYER

The First 4K Blu-ray Player

Ultrahigh-def content is coming, and Samsung's device is the first to handle it all. The player streams 4K video from Netflix, YouTube, and Amazon, along with, of course, playing physical UHD discs.

B

SONY
PLAYSTATION VR

VR for Regular People

The strict requirements of high-def VR gaming require beefy PCs to use. The PlayStation VR makes the experience plug-and-play for Sony's more than 40 million preexisting PS4 owners. Unlike cheapo phone-based systems (think Google Cardboard), the headset delivers full 1080p images to each eye and a wide 100-degree field of view. Titles like *Star Wars Battlefront Rogue One* are the closest you'll get to sitting in an X-Wing.

C

ANKI
COZMO

The Smartest Robot Pet

Not all AI-powered bots need to be virtual assistants: Some can just keep us entertained. Improving the robotic intelligence of playtime is Anki's Cozmo. The baseball-size wheeled robot has a facial-recognition camera behind its friendly OLED eyes, allowing it to learn and recognise its near and dear. Sophisticated machine learning helps Cozmo's personality evolve, while upcoming tools for developers will let them teach it a repertoire of new tricks.

LYTRO
CINEMA CAMERA

Green Screen, Sans the Green

Light-field cameras, which allow users to tweak parts of an image into focus post shot, are increasingly common among consumer cameras. The 755-megapixel Lytro Cinema Camera brings the tech to pro filmmakers, making postproduction effects easier than ever. Among the editing tricks it opens up: shifting focus, adjusting film speed, and removing and replacing any part of the background—no green screen required.

D

PARROT
DISCO

Easiest-Flying Drone

If you've thrown a paper plane, you can launch the Parrot Disco. Toss the 750-gram drone into the sky, and onboard sensors—gyroscope, accelerometer, magnetometer, barometer, and GPS—navigate the fixed-wing craft to 45 metres, where it circles awaiting further command. Users set a course via remote control, and algorithms on board keep the drone on track. A top speed of 75 km/h means you won't be losing any races.

E

YAMAHA
TRANSACOUSTIC GUITAR

Onboard Axe Effects

The acoustic guitar is a perfectly self-contained instrument. No amps, no wires—and no fun for anyone who wants to produce live effects. The Transacoustic Guitar re-creates reverb and chorus, using built-in knobs to control the two. The movement of the strings vibrates an actuator inside the instrument, which alters the guitar's sound on the fly—no electricity required—granting you on-stage rockstar prowess right in your lap.

F

SONY PORTABLE ULTRA SHORT THROW PROJECTOR

Projection on Any Surface

Sony's tiny, laser-based projector turns surfaces into screens. Placed against a wall, the projector shoots up to produce a crisp 55-cm picture. Back up by 50cm or so, and that expands to 200 cm.

G

LG
SIGNATURE OLED TV

The Most Colorful Picture

Even the best 4K TVs can swallow up details in the darkest and brightest parts of the image. High-dynamic range (HDR)—a catchall term for video encoded with a billions-deep colour gamut—brings those nuances into the forefront. LG's Signature OLED TVs render colours better than any other. The sets support both the HDR10 and Dolby Vision HDR standards, so viewers can count on seeing the full rainbow, no matter their content source. So pretty!

H

HELLO GAMES
NO MAN'S SKY

A Game the Size of the Universe

Look, it may have its problems (and the lowest review rating of any game on Steam) but much of the negativity comes from hardcore players who expected so much more than this open-universe game could deliver. Even so, No Man's Sky can generate in excess of 18 quintillion planets—99.9 per cent of which you'll never have time to visit. Your job: Try to see them all while discovering species, trading resources, and surviving the scorn of gamers...

I

YAMAHA
YSP-5600

A Hemisphere of Sound

Most home surround sound is two-dimensional, pinging audio front to back and side to side. When it launched two years ago, the Dolby Atmos audio standard added height to the equation; this year, Yamaha's YSP-5600 became the first to cram the spec into a single speaker. The sound bar's 32 forward-firing drivers are joined by 12 upward-firing ones, which ricochet sounds off the ceiling, like a helicopter flying overhead or birds in a tree. Or simply use the first 7.1.2 channel sound bar to play your favorite tunes off Spotify, Pandora, and more.


A
B
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I
SONY
Parrot

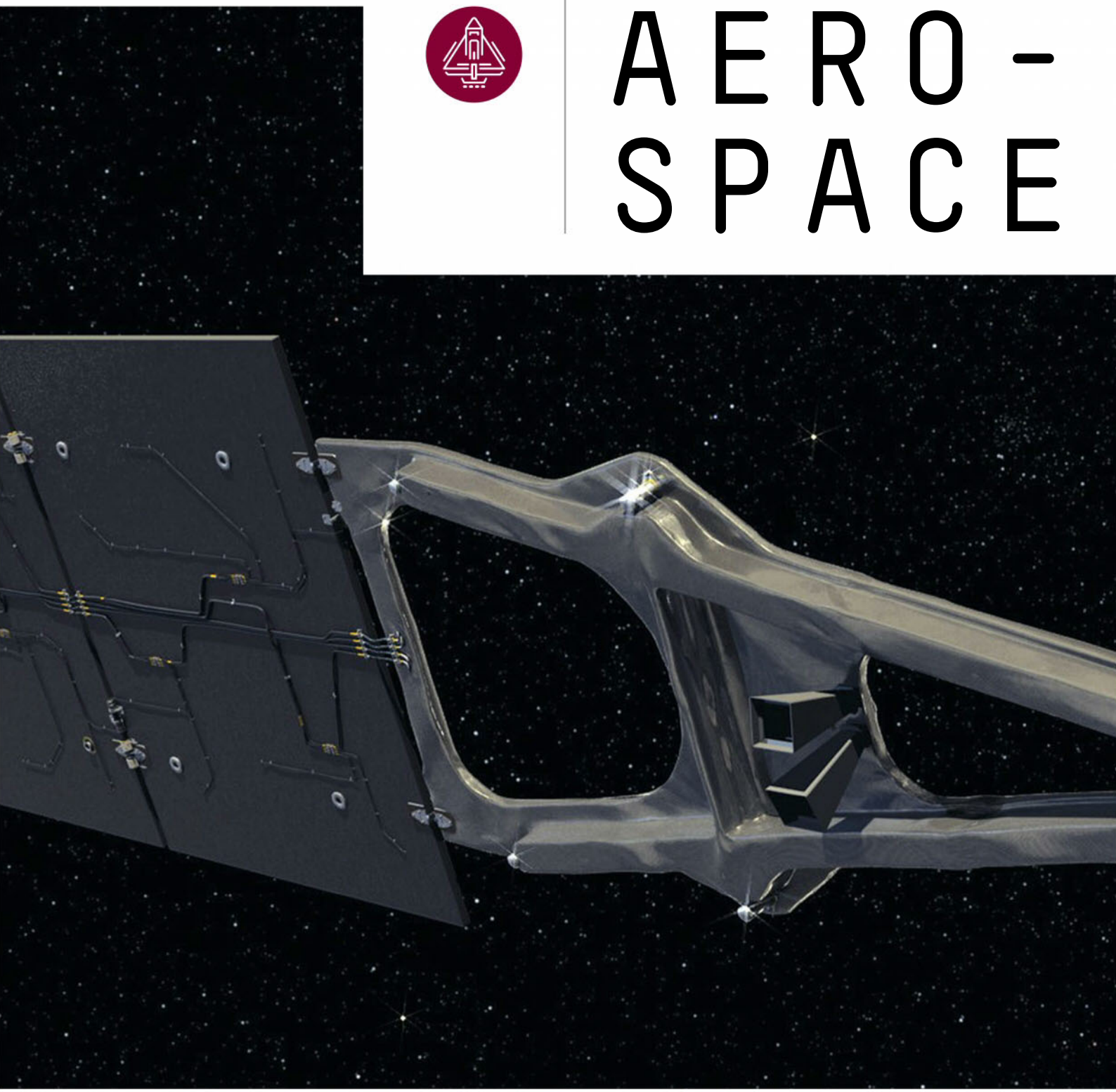
By KELSEY D. ATHERTON + SOPHIE BUSHWICK

NASA JUNO

Journey to the Center of a Gas Giant

On July 4—870 million km from the nearest Independence Day barbecue—the solar-powered Juno orbiter began circling Jupiter's poles, passing 4,200 km above the planet's clouds. "No spacecraft has ever orbited this close to Jupiter, in the heart of the radiation belts, where the magnetic field is this strong," says project scientist Steve Levin. Protected from that

AERO-SPACE



radiation by a titanium vault, Juno's scientific instruments—including a radiometer to study atmosphere and a particle detector to measure magnetic fields—will allow scientists to peer beneath the gas giant's clouds. Over the next year and a half, Juno's continuing observations will tell scientists how much water is on Jupiter and whether the planet has a solid core. This could reveal how the solar system, including Earth, formed. The mission is also taking the highest-resolution photographic images of Jupiter in history.

A

BIGELOW AEROSPACE
BIGELOW EXPANDABLE ACTIVITY MODULE (BEAM)

Inflatable Space House

In May, astronauts attached the BEAM habitat to the exterior of the International Space Station and then expanded it. Made of an internal skeleton and layers of Kevlar-like fabric, Bigelow's pod is small and light—easy packing for space trips.

B

LOCKHEED MARTIN SKUNK WORKS SPIDER

An Airship-Fixing Robot

Before an airship gets inflated, humans have to painstakingly inspect its body for leaks. To shave days off that process, Lockheed Martin Skunk Works wanted this "pinhole check" to happen during inflation. Its solution: a SPIDER (self-propelled instrument for damage evaluation and repair). The autonomous robots magnetically attach to the blimp and crawl over its body, detecting and patching holes with an onboard repair kit.

C

SPACEX
FALCON 9

Rocket Sticks the Sea Landing

The ability to reuse a rocket's first stage—the part that traditionally falls into the ocean—could cut the cost of a launch by two orders of magnitude, according to SpaceX CEO Elon Musk. In April, after four failed attempts, the Falcon 9 rocket landed safely on a drone ship. The winning combination: more liquid-oxygen propellant for increased thrust, and a thruster-controlled landing—as opposed to its former, and rather less-successful, parachute method.

D

PERLAN PROJECT INC
AIRBUS PERLAN MISSION II

Gliding to the Edge of Space

A better understanding of the stratosphere could lead to improved weather and climate models. To gather data without releasing engine emissions that could muddy air samples, scientists are sending the Perlan 2 glider. After a test to reach 55,000 feet, they aim to sustain flight at an altitude of 90,000 feet by 2017. These findings could also help Airbus design aircraft that fly more efficiently in thin air—like, say, in the atmosphere of Mars.

E

ZAPATA INDUSTRIES
FLYBOARD AIR

High-Flying Hoverboard

In 2016, French daredevil Franky Zapata smashed the record for longest hoverboard flight, traveling 2,251 metres. The jet-powered Flyboard Air can stay aloft for 10 minutes at a time, reaching over 160 km/h and an altitude of 10,000 feet. Next, explosive-detection firm Implant Sciences Corporation, which is merging with Zapata Industries this year, will adapt the technology for applications like all-terrain rescue and supply delivery.

F

AERION CORPORATION

Supersonic Returns

The AS2 supersonic business jet promises quiet, efficient travel at about 1,600 km/h, nearly twice the speed of other commercial jets. It will hit the market in 2023—jet rental service Flexjet already preordered 20. (Find out how the AS2 works on the next page.)

G

FACEBOOK
AQUILA

Internet Via Drone

Facebook got one step closer to its goal of universal global Web access in July with its 96-minute test of a full-scale Aquila drone. To stay in the air for long periods, the plane has a massive 41.7-metre wingspan and a light sub-450-kilogram body—longer and leaner than other jets. Aquila's final incarnation will be solar-powered and capable of spending three months aloft as it beams broadband access to an area up to 100 kilometres wide.

H

GERMAN AEROSPACE CENTRE HY4

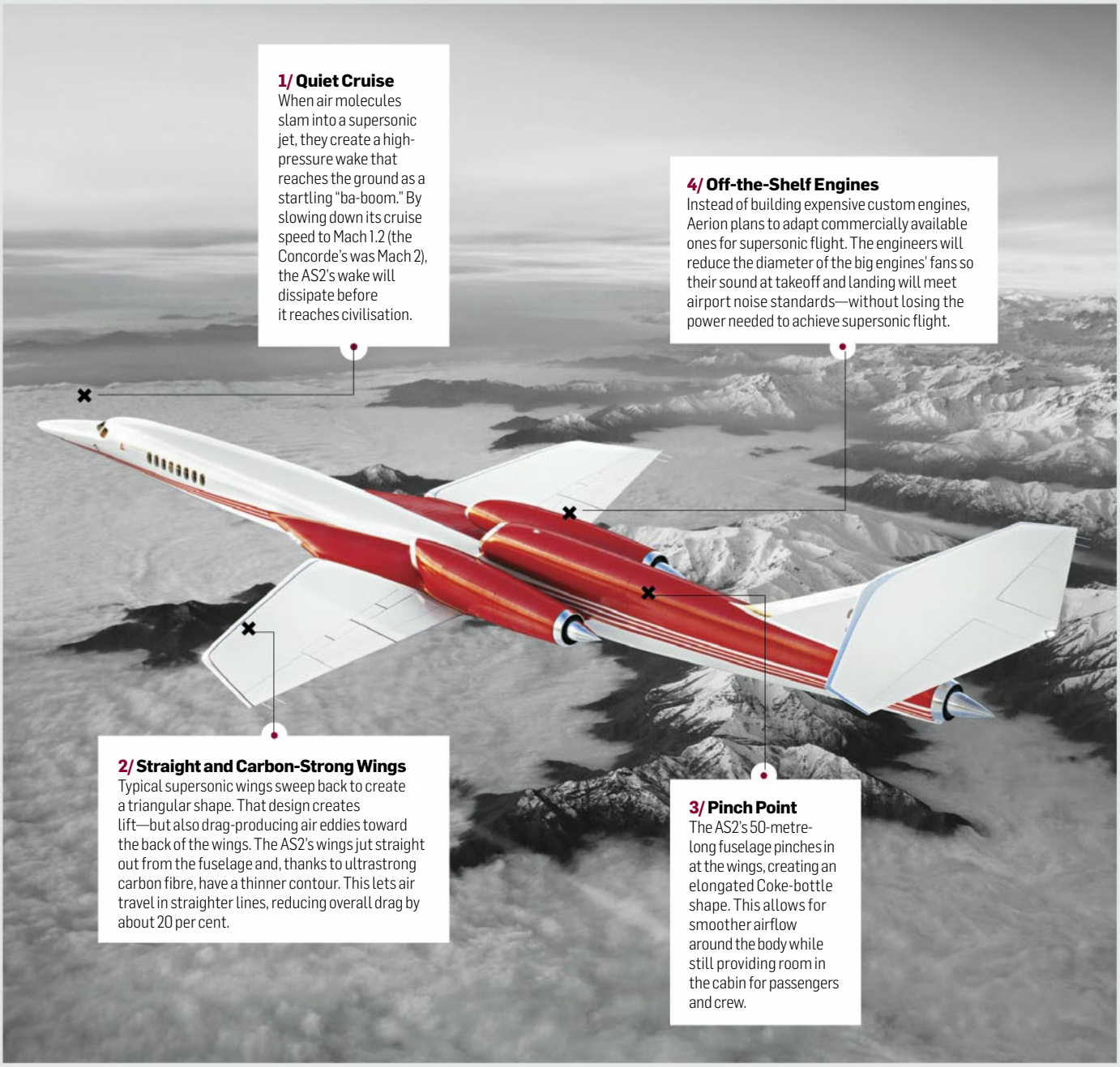
Hydrogen-Cell Four-Seater

All-electric planes lack the power of gas-guzzling craft, which means they can carry only limited passenger weight. So in designing the four-seater HY4 aeroplane, which made its first flight in September, the German Aerospace Centre supplemented the battery with a hydrogen fuel cell. It also split the passenger compartment in two to carry more weight. The zero-emission result has a 1000-km range—much greater than a purely battery-powered plane.

DRAPER
MAJIC

Astronaut Jetpack

Precise work is difficult in zero gravity, where small motions like twisting a wrench can send humans flying. To stabilise astronauts, Draper attached four (one for each direction, plus a backup) softball-size control moment gyroscopes (CMGs)—spinning wheels mounted on gimbals that counteract torque—to its Mobility-Augmenting Jetpack with Integrated CMGs (MAJIC). Draper hopes to develop a space-ready version within a decade.



COURTESY AERION

How to Go Sonic Without a Boom

By RYAN F. MANDELBAUM

Until its retirement 13 years ago, the supersonic Concorde was plagued by two major problems: inefficiency and noise (the sonic booms it produced were only allowed over open ocean; it had to go slow over land). Now, heavyweights like Virgin and Airbus are planning to go supersonic, and NASA began designing a "low boom" supersonic jet this year. But no one is as close as aircraft manufacturer Aerion Corporation, which is developing the AS2. PS

READ & LEARN FROM YOUR FAVOURITE MAGAZINE

JOURNALISM EXPERIENCE RESPONSIBILITY

30 MAGAZINES **15** COUNTRIES **10** LANGUAGES

TIPA AWARDS **2016**

Since 1990 the TIPA Awards logos have been showing which are the best photographic, video and imaging products each year. For 25 years the TIPA awards have been judged on quality, performance and value; making them the independent photo and imaging awards you can trust. In cooperation with the Camera Journal Press Club of Japan. www.tipa.com

VIBRAM ARCTIC GRIP

A Shoe Sole That Won't Slip on Ice

Vibram's Arctic Grip is a new type of rubber shoe sole that stops feet from slipping while walking or running on the most treacherous ice. Vibram designed the treads to mimic

polar bear paws, which have tiny papillae and curved claws to increase friction (and thus traction) on ice. Arctic Grip—which debuted on shoes from six brands, including Saucony and Wolverine—uses an array of lugs crafted out of a unique ice-grabbing rubber compound to increase traction. When the wearer steps, the compound causes a split-second melt-then-freeze reaction; melting disperses the ice, and freezing against the textured sole creates more surface area for the lugs to grab onto.

BEST OF WHAT'S NEW

By BERNE BROUDY + GRENNAN MILLIKEN • Photograph by SAM KAPLAN

A

GIRO
AVANCE MIPS

The Safest Ski Helmet

Two milliseconds is all it takes to injure the brain in a collision. Giro's Avance does more than any other helmet to protect our gray matter. The helmet utilises Multi-directional Impact Protection System (MIPS), a burgeoning head-safety technology. It allows the wearer's head to move inside a helmet like a ball in a socket. An inner shell holds the head steady while the outer shell rotates. This movement deflects the forces that cause the worst brain injuries. For extra measure, Giro made the inner shell of premium foam to protect against successive impacts.

B

ONCOURSE
GOGGLES

GPS for Swimmers

It's tough for open-water swimmers to cut through waves in a straight line. OnCourse Goggles keep them on track, no surfacing necessary. To set a route, a swimmer sights a way-point and clicks a button to lock it into an electronic compass and shore up the path. Green, yellow and red LEDs in the corner of each eye provide direction. Green in both means on course, red in the right eye means veer left, and vice versa.

C

BSX
LVL

Dehydration Detector

Even professional athletes are terrible at staying hydrated. So BSX created the wrist-worn LVL, the first wearable to measure hydration in real time. Other wearables make surface measurements close to the skin, but LVL uses near-infrared light to peer beneath it and record changes in blood colour, which are indicative of hydration levels. If the wearer is dehydrated, it alerts them with an on-screen message. Drink up!

D

AXE ELEMENT HYPERWHIP BASEBALL BAT

Better Grip, Faster Swing

Round bats with round handles are as old as baseball. Now there's a bat with a handle like an axe. Its ovular shape provides a better grip, and the tapered end protects from injuries when clobbering fastball after fastball. (Turn the page to find out what a pro thinks.)

PHOTO CREDITS SEE PAGE 87

E

CALLAWAY
XR16 DRIVER

Aircraft-Grade Golf Club

Callaway wanted a driver that could slice through the air like a jet, so it turned to Boeing. Tiny ridges on the XR16's club head cut air resistance by 30 per cent over Callaway's next-best driver. Speed adds distance to drives.

F

HYDRA-LIGHT PL-500
SALTWATER CHARGER

Beachside Phone Charger

There are no outlets at the beach, but there is plenty of salt water. The Hydra-Light turns seawater into power for a lantern or USB-powered devices. In the reservoir, a magnesium alloy rod slowly oxidises in salt water, releasing electrons in the process. A carbon-based cathode grabs and funnels those electrons to connected gadgets, providing more than 250 hours of power for illumination or charging electronics.

G

SHARKBANZ
WRISTBAND

Wearable Shark Repellent

Muscles emit tiny electrical pulses as they contract. Receptors in a shark's snout and along its flanks detect these minute signals when animals move through water, helping Jaws stalk its prey. Sharkbandz—a predator-repelling wristband—contains powerful magnets that scramble a shark's ability to read these signals—almost like getting a bright light shone in your eyes. But don't worry: It doesn't hurt the animal. Not as much as the animal could hurt you, anyway...

H

THE NORTH FACE
HYPERAIR GTX JACKET

No-Sweat Rain Jacket

Waterproof jackets might keep rain out, but runners and cyclists still end up soaked—in sweat. The North Face and Gore-Tex have made an ultralight waterproof shell that breathes. The fabric has a microgrid backer that airs out perspiration. As sweat condenses, the grid lets it out as vapour. It also has a membrane that's tight enough to make sure water beads on the outside. Once the storm passes, the jacket can be shoved into a pocket.

CHILI DAVIS RED SOX HITTING COACH

Bat Like a Lumberjack

SOME OF MAJOR LEAGUE BASEBALL'S BEST HITTERS HAVE TOSSED ASIDE their old sluggers for something called the Axe Bat. As the name implies, it's part axe—thanks to a contoured oval handle and an angled knob—and promises players a more natural grip, better bat control, more-powerful swings, and a reduced risk of hand injuries. Chili Davis, the Boston Red Sox hitting coach—whose own 18-year MLB career netted 350 homers and three World Series rings—set the shift in motion when he brought one to spring training last year. When Chili swings, players take note, and two Sox are now swatting full-time with the axe. Davis tells us the new lumber has a strong future in the batter's box.

Popular Science: Why is an axe-handle bat better than a good ol' round-handle bat?

Chili Davis: Visualise some guy chopping a tree. The last thing he wants is to lose his grip on that handle. This thing allows you to lock grip and never lose it. With a rounded-knob bat, there are times, through the swing, where you make contact and the bat is vibrating and the knob is spinning. You can miss-hit balls because of that. You don't get the full force of contact as you do with an axe handle.

PS: So the upshot is players get more-consistent hits?

CD: Yes. Look at our right fielder, Mookie Betts. He's having a tremendous year using it. He's surpassed his career high in home runs, and he's hitting over .300. Our second baseman, Dustin Pedroia, was a good hitter, but with this bat, he has more pop. He has been driving the ball to the opposite field nicely.

PS: We've played with round bats for a hundred years. Are they really so bad?

CD: With the round knob, you get big calluses on your hand, big blisters because of that knob moving around in your hand. I know you get used to that; it's what you've grown up with. But it can cause a hamate bone (the tiny bones at the base of our hands) injury. You never know when you're getting it. It just happens as a consequence of the pounding in your hand. This bat minimises the risk of injury.

PS: So it's all upside.

CD: I don't see a downside. This bat has the possibility to become something special in the future. Hitters are very superstitious. If they're doing well with a bat, they'll keep using it until it breaks. PS

Edited + condensed by JOE DELESSIO • Illustration by KYLE HILTON

Heritage II CONNECT

BUSH

WINNER 2016 SOUND IMAGE AWARDS

STANDALONE SYSTEM SOLUTION
Bush Heritage II Connect

MORE THAN A DIGITAL RADIO

Classic design and unmatched performance combine in the new **Bush Heritage Connect** range. Enjoy digital radio, but also the very latest in network streaming and multiroom capabilities – DAB+ and FM radio with Spotify Connect, Bluetooth, NFC Connect and Wi-Fi multi-room audio via the Undok app for iOS and Android.

Whether your preference is listening in to thousands of radio stations from around the world or streaming your favourite tunes from your own collection, the Heritage II Connect and Heritage P1 Connect offer unprecedented power in a classic radio design.

"...We reckon the Bush Heritage II Connect qualifies as a new entry in the ranks of multiroom wireless systems to rival the likes of Sonos, HEOS, Bose SoundTouch and the rest. And it is an entirely Australian product and project. Even more impressively, it is rather brilliant."

Sound+Image magazine on the Award-Winning Heritage II Connect

Heritage P1 CONNECT

The Bush Heritage II Connect for the home has now been joined by the smaller Heritage P1 Connect, able to stream via Bluetooth on rechargeable battery, but retaining all the streaming and multiroom playback abilities of its big brother when at home.

Features: DAB+ & FM Tuner · Spotify Connect Enabled for access to over 30 million tracks
Built in Wi-Fi · Internet radio with access to over 16,000 radio stations worldwide
Audio Streaming – stream your own music from home networked PC/Mac
Expandable Multi-room Streaming · Bluetooth Audio streaming with NFC Connect
Large easy-to-read OLED display · Dual alarm clock with sleep and snooze
New D Class amplifier with DSP (Digital Signal Processor) built in, for improved audio performance · Aux In & Headphone Out · UNDOK Control App for iOS & Android.

For more information visit: www.bushaustralia.com.au

OPENWORKS ENGINEERING
SKYWALL 100

The Drone Catcher

The majority of hobbyist drones - from the DJI Phantom 4 down to a Parrot minidrone- are harmless. Then there are the flame-throwing ones that star on YouTube. The SkyWall 100 shoulder-mounted net launcher is law enforcement's best bet for grounding those malicious fliers. The gun, which uses auto-aiming software to lock onto targets up to 100 metres away, can fire three types of projectile nets: one that captures the drone, one with a parachute to lower it to the ground, and one that also jams the craft's electronics. It can nab drones flying as fast as 37 km/h and weighing up to three kilos (twice a DJI Phantom 4). In a recent demo for the US Army, SkyWall hit targets in 10 out of 11 shots. Sorry, backyard commandos: This one's only for professionals.

By KELSEY ATHERTON + SARAH FECHT

SECURITY

SECURITY

A

SCOTT SAFETY
SCOTT SIGHT

Firefighter SuperVision

Hand-held thermal cameras have guided firefighters through smoke-filled buildings since the '90s. Scott Sight moves the camera and display into a face mask, freeing first responders' hands for more important things, like saving lives.

B

METASENSOR
SENSOR-1

Motion Sensors for Your Stuff

Most object trackers can help you find something you've already lost. The Sensor-1 lets you know when you're about to lose it. Armed with an accelerometer, gyroscope, and magnetometer, the quarter-size device alerts you to your gadget's slightest movement. Connected to a phone or other device via Bluetooth, the trackers can catch snooping houseguests or stop laptop thieves while you're getting a latte. Or drunk.

C

DARPA AND OFFICE OF NAVAL RESEARCH
SEA HUNTER

The Military's First Drone Ship

The *Sea Hunter* warship is probably big enough for a human crew, but it doesn't need one. It's the US Navy's first ship designed to autonomously patrol the sea in search of submarines—a task too vast and tedious for even a ship full of trained human sailors. *Sea Hunter*'s custom navigation algorithms ensure the 40-metre-long craft obeys maritime right-of-way rules to avoid collisions with other vessels. If a two-year trial is successful, the Navy might consider developing drone ships for other tasks, such as deactivating unexploded mines.

D

KNIGHTSCOPE
K3

Autonomous Robot Mall Cop

Robotic guards already patrol empty lots at night, but navigating constantly changing indoor environments is trickier. The 1.3-metre-tall K3 robot uses multiple lidars (the laser range-finders on self-driving cars) and other sensors to build live maps and find its way around shopping malls, offices, and server farms. Soon this R2D2 of building security will get facial-recognition to compare suspects to a database of people it knows.

BROADBAND DISCOVERY RONIN

Eagle-Eyed Checkpoint

Last December, New Orleans Saints fans passed between pylons embedded with security scanners that work faster and are more thorough than ordinary metal detectors. Adapted from military checkpoints, Ronin uses magnetic and pulse-induction sensors, which record minute changes in a magnetic field, to spot contraband and weapons. By reducing the need for pat-downs, Ronin could make lines at public venues move up to five times faster.

RED BALLOON
SYMBIOTE DEFENSE

Universal Anti-Virus

The more gadgets we put online, the more backdoors we give hackers into our data. The Symbiote Defence software protects anything—from printers to cars—regardless of their operating system. The program can spot malicious activity and remove threats continually. Developed with support from DARPA and Homeland Security, Symbiote debuted on HP printers this year, and more devices will roll out in 2017.

QUALCOMM
SNAPDRAGON SENSE ID

Unhackable Print Scanner

Hackers have shown they can trick common biometric scanners with faked fingerprints. The SenseID sensor makes that nearly impossible. It ultrasonically scans a fingerprint's depth, reading a detailed 3D map of every nook, cranny, and pore.

E

ROOST
SMART BATTERY

Not Just a Battery

Inactive smoke detectors lead to almost 900 fire-related deaths a year in the US. Roost's Wi-Fi-enabled 9-volt battery will alert you when it's about to die—no more annoying chirps. Plugged into any old smoke detector, Roost sends alerts to a companion smartphone app if the alarm goes off while you're away. It can also talk to other smart-home gadgets, so it can carry out tasks like automatically unlocking the front door for police or firefighters.

HOME

ESTWING AL-PRO FRAMING HAMMER

Light Hammer, Heavy Hitter

House framers can drive hundreds of nails a day. For them, a heavy hammer means more fatigue—and possibly more missed hits (and injuries). Estwing's new Al-Pro Framing Hammer lightens the load. Designers crafted the shaft out of aircraft-grade aluminium, making it half the weight of its pricier titanium competitors, and letting workers hit longer without getting worn out. The team also filled the head with steel shot, which dampens vibration from blows and allows for maximum force in every swing. To avoid crippling the tool's nail-pulling ability with a softer aluminium claw, Estwing opted to make the teeth out of sturdy steel. All this adds up to a lifetime hammer for the tradie who has to wield it all day—as well as for the weekend home-improvement wannabe.

By DAVE GERSHGORN + HARLAN MURPHY • Photograph by SAM KAPLAN

BOWN

BEST OF WHAT'S NEW

A

NWI CUBIT

Math-Whiz Measuring Tool

The hardest part of picture hanging is finding a wall's centre. Cubit calculates it for you. Slide it along any surface to find exact middle—or if you're the asymmetrical type, a third, or any "look-at-me" variation.

B

BOSCH
REAXX

The Safest Table Saw

Humans are careless. Machines are here to help. Bosch's Reaxx 250-mm job-site table saw retracts its blade if it detects the presence of a wayward human appendage. A low-voltage current runs through the blade, and if the system detects a disruption—indicating human flesh—the blade retracts to mitigate potential injury. The blade isn't damaged which is new: previous injury-preventing tech would save its owner, but kill the saw.

C

DEWALT
FLEXVOLT BATTERY

A Battery for Every Tool

Cordless power tools are handy. But each requires a unique voltage, leaving DIYers with a lot of power bricks. DeWalt's self-regulating battery is the only one you'll need. It recognises the DeWalt tool it's mated with and delivers the correct voltage. It even regulates output for older DeWalt tools. The batteries max out at 60 volts, and a pair can create a new class of 120-volt cordless tools—like table saws—or dial down for less power-thirsty tools.

D

NELSON
SOLAR-ACTIVE FACADE

Energy-Saving House Exterior

Goodbye expensive energy bills. Made of wood and glass, Nelson's home exterior can both warm a home and cool it. In winter, the sun's rays pass through a glass facade and warm an internal layer of louvered wood, which traps the heat to create a thermal buffer against the nighttime cold. In summer, when the sun is higher in the sky its rays strike these angled wooden slats, which create a shading effect for the home, keeping it cool.

E

SHERWIN WILLIAMS
PAINT SHIELD

House Paint That Kills Disease

Why should house paint just look pretty? Now it can protect you and your family from invaders. Sherwin Williams' new Paint Shield kills 99.9 per cent of staph, MRSA, E. coli, VRE, and Enterobacter aerogenes—the type of microscopic bad stuff that can make you sick, and even kill you. The paint does this by way of a quaternary ammonium compound (the same substance used in many home cleaning products). The first EPA-registered microbicidal paint, it remains effective for years. Sleep tight and don't let the Enterobacter ulcerate your soft tissues.

F

SAMSUNG FAMILY HUB REFRIGERATOR

A Fridge That Helps You Shop

As you travel home from a hard day, you can't recall if you ate that last artisanal pudding. The Family Hub refrigerator has three internal cameras that spy on your supplies (or lack thereof). Tap an app, and there's a picture of your shelves.

G

MOLEKULE

An Air Purifier That Actually Purifies

Most air purifiers trap airborne particulates, leaving them stuck in filters where they can escape or breed into lung-hacking spores. Molekule annihilates them. The cylindrical aluminium-clad device uses low-energy ultraviolet light and a nano-coated filter in a process called photoelectrochemical oxidation—basically zapping bacteria, allergens, dust, and pollutants into their base elements. That means bacteria and viruses can't breed in your machine. No bacteria is small enough to safely pass through Molekule's defences. Breathe deep and easy.

H

LIGHTING SCIENCE
HEALTHE GENESIS

Just-Right Light

Light affects your body's circadian rhythm, which in turn dictates your energy level, sleep cycles, and overall health. The HealthE Genesis lamp keeps things in sync with a super-precise lighting spectrum that can fluctuate based on the time of day or night. It keeps your biology so well in time that NASA is installing a custom version of it on the International Space Station to regulate astronauts' sleep with precision.

I

EMBER

A Mug That Brings the Heat

Temperature will influence a coffee's flavour. A few degrees off, and your precious pour-over might as well be a street-corner bodega brew. The Ember mug gets taste right every time, because phase-change materials (a substance akin to candle wax) embedded in its walls deliver precise temperature control—from an optimal 48 to 65 degrees—set by a handy dial on the base. Taste that, bodega coffee man.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REAXX
BOSCH
PAINT
SHIELD
INTERIOR LATEX
FLEXVOLT
DEWALT
BRUSHLESS
60V MAX
BRUSHLESS
ember

The Internet of "Meh"

Everyday objects like lightbulbs and locks and yoga mats—supercharged via computer chips and WiFi—have delivered a golden age of automated, secure, and efficient homes. Or so the marketing copy reads. And we're buying it. Literally. This year alone, we will install some four billion "smart" things in our homes. While some of these connected doodads do indeed make life easier, many others are better left boxed.

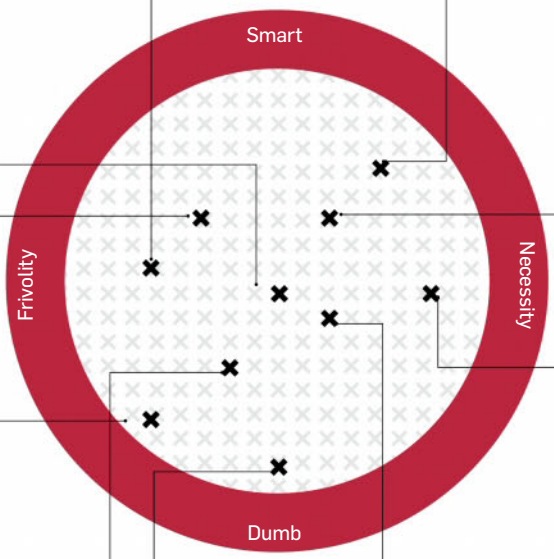
Netatmo Welcome
This stationary camera can spot burglars, but records only if they're in front of it. Sorry, no perp IDs: Its facial recognition knows only your family.

Delta Leak Detector
Put this moisture sensor where a leak might occur (under the sink?); it'll ping to validate your dripping paranoia.

Awair+
This climate-control assistant tracks temperature, humidity, CO_2, volatile organic compounds, and dust in the air—and can adjust your aircon accordingly.

ResetPlug
"Did you try rebooting it?" When the ResetPlug notices your WiFi network go down, it proactively carries out an IT guy's go-to solution—so you don't have to.

August Smart Lock
Smart locks are super-handy when the kids are locked out. And, to almost no one's surprise, they're also super-hackable.



Philips Hue Lights
When you're too sleepy, tipsy, or lazy to get up to turn off the lights, you can just order Siri or Alexa to do it.

CleverPet
Too busy to exercise your portly pug? This treat dispenser withholds goodies until he plays simple games, like "catching" a light flashing atop the bowl.

SmartMat
Pressure sensors in this yoga mat track your posture. Just a guess, but checking an app midpose probably won't help.

Amazon Dash
These buttons order stuff like soap—or Red Bull—assuming you think to hit 'em.

Nespresso Prodigo
Because pod coffee apparently needs to be easier, you can use the Nespresso app to brew your espresso from bed.

ALL IMAGES COURTESY MANUFACTURERS

By DAVE GERSHGORN

USE NEW TECH!

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GADGETS

BEST OF WHAT'S NEW

GOOGLE PROJECT FI

The United Nations of Mobile Networks

Inconsistent service is the great Achilles' heel of our ultraconnected lives. In urban canyons, signals can be fickle; overseas, trying to stay online can be fruitless and costly. Google's Project Fi, an experimental mobile network that rolled out earlier in 2016, fills in those connectivity gaps. Instead of relying on one carrier's towers,

By XAVIER HARDING + ANDREA SMITH • Photograph by SAM KAPLAN

Project Fi connects to the strongest signal from among T-Mobile, Sprint, US Cellular, and a number of international partners. When the connection from one of Google's 1 million trusted Wi-Fi hotspots is stronger, the call—or webpage or video stream—will go from cellular to Wi-Fi completely uninterrupted. Google hopes other carriers will one day adopt similar service-jumping schemes, but for the time being, data-hungry consumers can try it out on one of the company's flagship Nexus or Pixel phones.

A

SECURIFI
ALMOND 3

Wi-Fi for Huge Houses

Most wireless routers struggle to deliver consistent, fast Wi-Fi to every corner of our McMansions. The Almond 3 can blanket an entire 450-square-metre house with powerful Wi-Fi. With one unit setup as a base and establishing the network, two additional Almonds act as Wi-Fi extenders. The router also doubles as a smart-home hub, communicating with connected devices like lights and thermostats.

B

MOTOROLA
MOTO Z

Swappable Phone Features

If you've ever wished your phone had more memory, a massive zoom lens, beefier battery life, or improved speakers, the Moto Z makes it possible—all without having to buy a new phone. Any of five accessories, called Moto Mods, magnetically attach to the back of the Android handset, including a pico projector. It's a platform for builders and makers too: check out our article on the Moto Development Kit on page 77

C

EORA
3D

Portable 3D Scanning

DIYers looking to copy parts have had a tough choice: Buy an expensive industrial scanner or settle for a low-res scan of stitched-together photos. The Eora 3D is aquality, compact scanner that connects a phone via Bluetooth. The soda-can-size device uses a laser to capture eight million depth readings, while the phone's camera takes over 1,000 images. Eora 3D's app merges both into formats for 3D printers and various CAD software packages.

D

ACER SWITCH
ALPHA 12

Liquid-Cooled Laptop

Many ultrathin laptops pack a punch but have no room for fans, leading to overheating. So Acer turned to liquid cooling in the Switch Alpha 12, a laptop-tablet hybrid with Intel's latest processors. As the system heats, so does coolant moving through a circular pipe; as the liquid condenses, the CPU cools down. In tests, the underside of the computer remained a comfortable 29 degrees after 30 minutes of video playback.

E

JIBO

An AI Bot for the Countertop

Query-answering virtual assistants are nothing new. (Right, Siri?) But an AI that can recognise who's talking, swivel in response, and emote with abstract but effective icons is rare. Add on top of this the ability to take messages, video chat, shoot family photos, and serve up calendar reminders, and you have Jibo. A developers' kit allows third parties to create skills for the 300-mm feller. Welcome to the era of the social robot.

F

PEBBLE
CORE

Apps on Your Keychain

When dashing out the door for a quick run or to grab some eggs, the Pebble Core, announced in May and launching in January, lets you leave your phone behind. Equipped with mobile data, GPS, 4GB of storage, and Spotify playback for songs stored on the device, the tiny dongle keeps the essentials in tow. Fire up Amazon's Alexa voice assistant to hear the weather, or to summon an Uber or Lyft to whisk you back to your phone.

G

CANON
1DX MARK II

Fast-Snapping 4K

Recording 4K video means filming at data rates that stress most memory cards. The 1DX Mark II is Canon's first consumer camera that keeps up. Support for the new CFast 2.0 card means capturing video at a blazing 350MB/s.

H

DOPPLER LABS
HERE ONE

A Volume Knob for Life

The world is a noisy place. And traffic, jackhammers, planes, and trains aren't only annoyances, they can also do real harm to your eardrums. The Here One earbuds let listeners tune out the noise. Paired with a smartphone app, the 'buds allow users to raise or lower specific sounds from the environment around them and better hear exactly what they want. Turn down the world and crank Kanye to 11.

I

SAMSUNG
GEAR ICON X

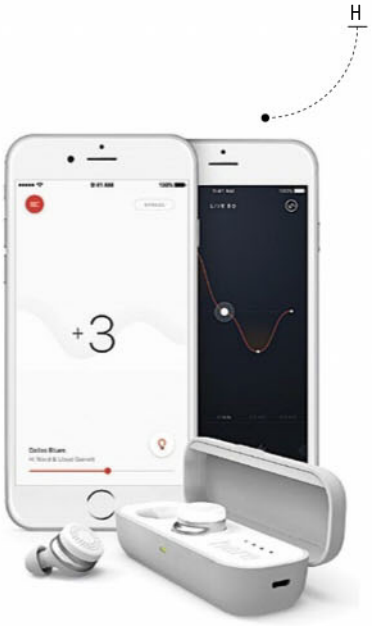
In-Ear MP3 Player

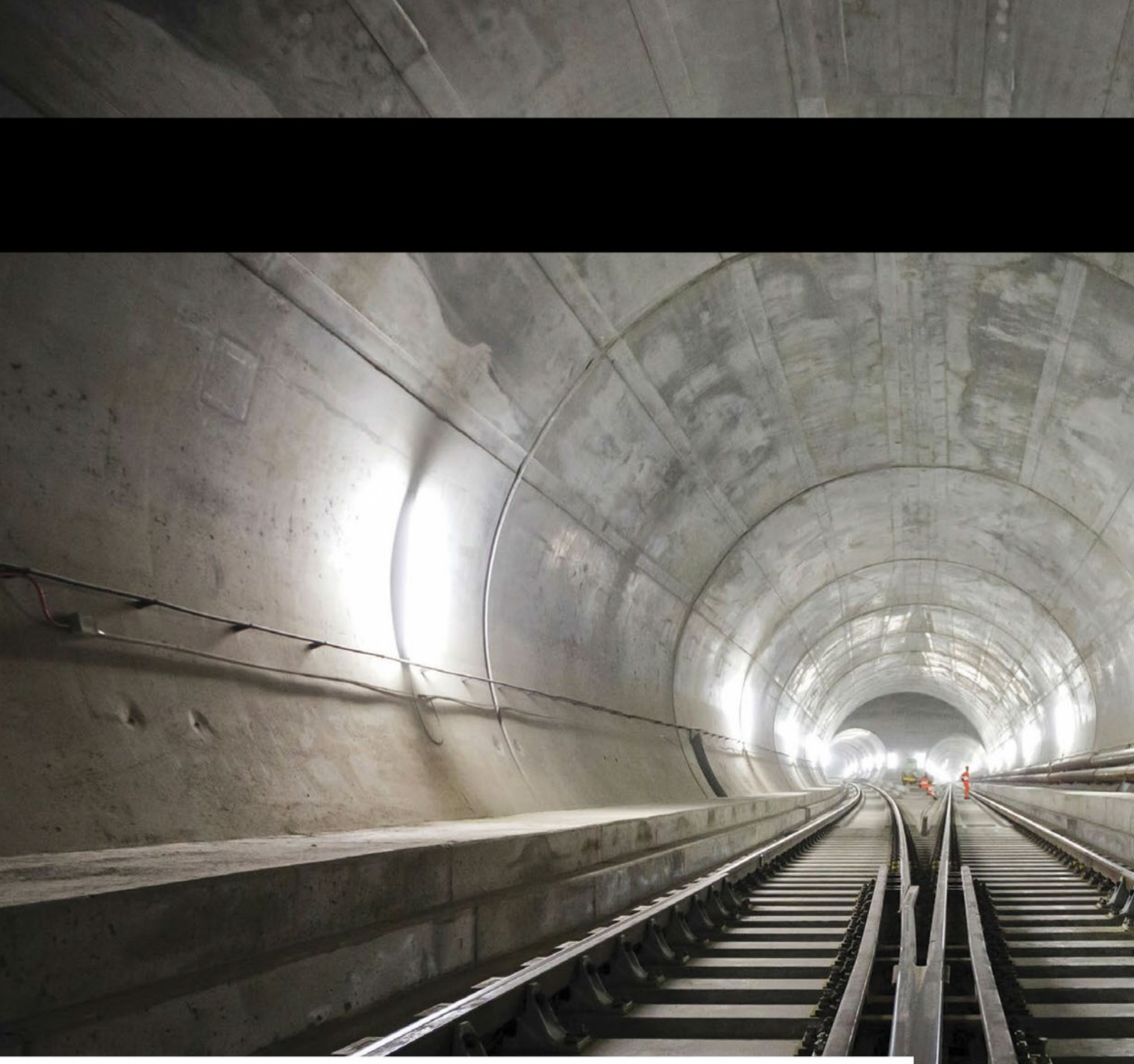
Samsung's wireless, heart-monitoring fitness earbuds are a completely self-contained music system. Four gigabytes of onboard storage hold your workout playlist—go for a run without your smartphone.

LENOVO
PHAB 2 PRO

A World-Altering Phone

Augmented-reality apps have had a big year, but as satisfying as it is catching Pikachu, experiences can fall flat. The Phab 2 Pro phone uses new software from Google, called Tango, to give AR extra depth. Three imagers (a 16-megapixel sensor, infrared sensor, and fisheye lens) let your phone create a 3D map of the world—for apps that superimpose engineering schematics or video-game worlds onto the actual one.



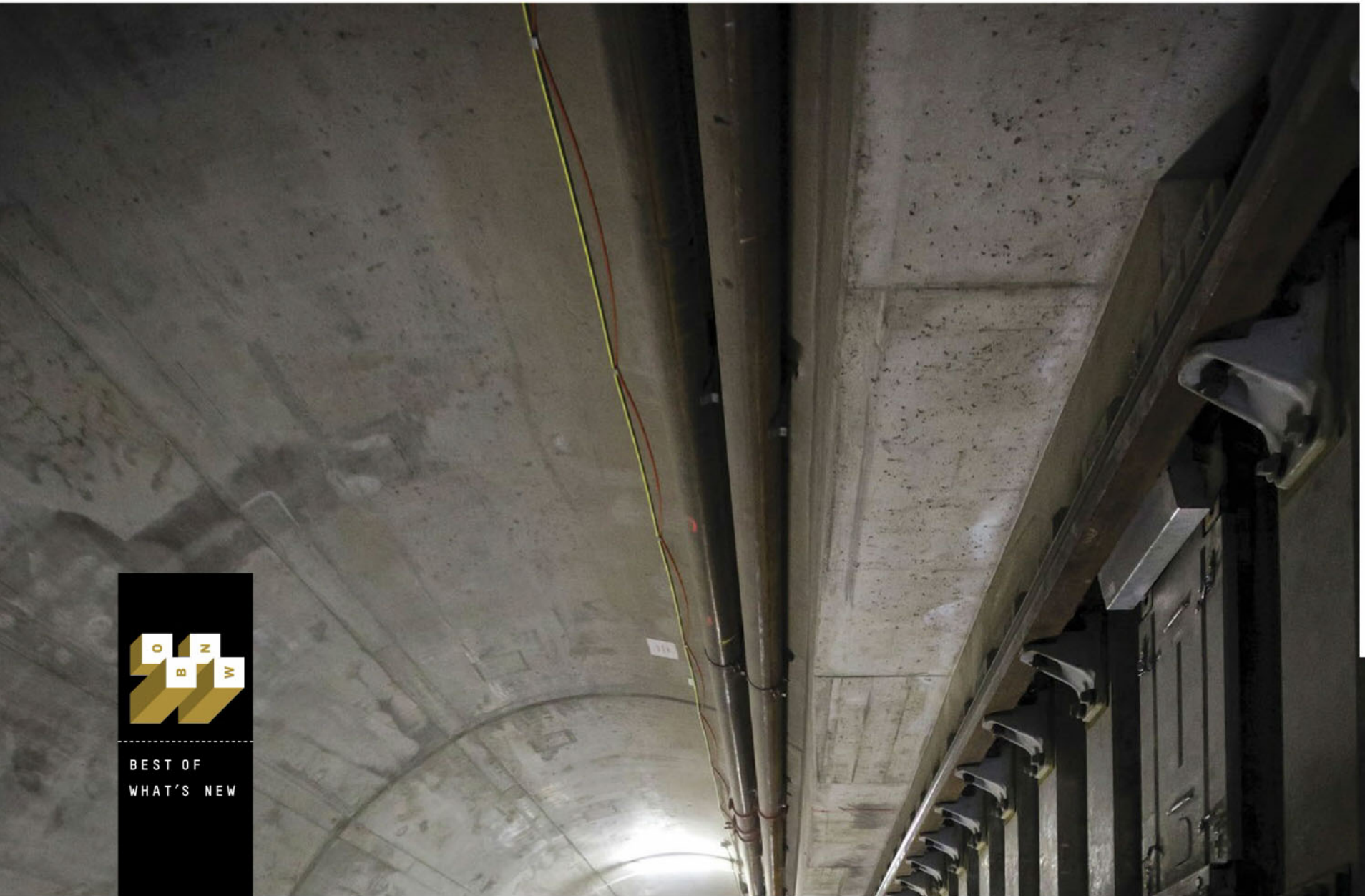


ALPTRANSIT GOTTHARD
GOTTHARD BASE TUNNEL

Tunnel Through the Alps

In 1999, the Swiss government broke ground on the most ambitious tunnel-building project in history. The dual-tube Gotthard Base Tunnel, which opened in June, follows a route that has a long history of schlepping people and goods over the Alps—it just happens to do it as deep as 2.4 km below the icy massifs. Thanks to the precision of boring machines with 9-metre heads, engineers excavated 28 million tonnes of rock (60 per cent of which was recycled into the tunnel's lining) to dig the 56-km train passage, ushering in an era of efficient travel between points in Europe. Passengers can rocket from Zurich to Milan in three-and-a-half hours (down from just over four), and the shift of freight from roads to rails could put a real dent in air pollution. You're not claustrophobic are you?

ENGINEERING



BEST OF WHAT'S NEW

By SHANNON PALUS + JEN SCHWARTZ

A

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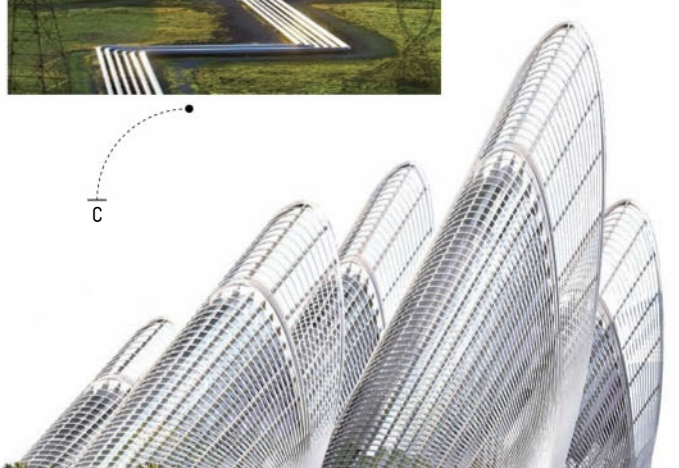
C

D



A

TEB TECHNOLOGY TRANSIT ELEVATED BUS

Traffic-straddling bus

B

PENN STATE
CRISPR-CAS9 FOR FOOD

'Shrooms with Shelf Life

Up to 40 per cent of food goes to waste, often due to spoilage. A plant pathologist at Penn State used the versatile gene-editing tool called CRISPR- Cas9 to design a button mushroom that resists browning, might have a longer shelf life, and could ultimately cost the same as regular old mushrooms. Though the product is not yet on sale, the tech behind it skirted USDA regulation last spring, paving the way for future gene-edited groceries. Month old tomatoes are the best!

C

COLUMBIA + UNIV. OF ICELAND CARBFIX

A Speedy Way to Store CO_2

Capturing carbon from the atmosphere is an alluring solution to our climate woes, but we need to figure out how to store it quickly and permanently. CarbFix —a system currently in use at one power plant in Iceland—dissolves greenhouse gases in water, and then pumps them into nearby basalt-laden volcanic rock, where both convert into limestone within a few years. The ocean floor is rich in basalt, so the method could scale worldwide.

D

FOSTER + PARTNERS ZAYED NATIONAL MUSEUM

Underground Oasis

E

GENSLER
SHANGHAI TOWER

Extra-Green Skyscraper

The bigger the building, the harder it gets to efficiently heat and cool the interior. So architects gave the world's second-tallest skyscraper, which opened this year in Shanghai, a double-walled facade that "acts as a thermos, keeping occupants warm in the winter and cool in the summer," according to project director Grant Uhlir. The twisty shape creates room for 21 "sky gardens" that reflect the natural landscape and purify the internal air.

HARVARD
ROBOTIC STINGRAY

The First Cyborg Animal

Biologists want to make artificial organs. But to do that, they need a deep understanding of how muscle cells—like those in the heart—talk to one another. So scientists at Harvard created the first truly hybrid robot animal. The coin-sized stingray has a gold skeleton covered in a stretchy polymer to which rat muscle cells are attached. Pulsing light makes the ray "swim." It could help us learn how to ultimately "see things you people wouldn't believe..."

It remains to be seen if China's straddling bus—which scoots over the top of cars, on tracks embedded in the pavement—is practical. But it's a bold idea for cities congested with traffic and pollution.

F

THYSSENKRUPP
MULTI ELEVATOR

Elevators That Go in Any Direction

Elevator shafts often take up half of a skyscraper's footprint, and the steel cables that carry them up and down limit how high the cars can travel. These constraints can be a major buzzkill for forward-thinking architects, who might want to design taller and wider. Enter MULTI, an elevator system that levitates—vertically, horizontally, and diagonally—atop tracks embedded with powerful magnets. Scheduled to begin testing in Germany early next year, MULTI will allow for arbitrarily taller, wider, and more creatively designed towers.

G

MIT + CALTECH
ADVANCED LIGO

A Microphone for the Universe

LIGO, or the Laser Interferometer Gravitational-Wave Observatory, first ran a decade ago to detect gravitational waves—ripples in space-time, some of which date to the Big Bang. This year, an upgraded system called Advanced LIGO, which is much more sensitive, confirmed one of Einstein's biggest predictions—on its first run. Observing these waves lets scientists plot the history of the universe and spot events like supernovas.

To beat the heat in the United Arab Emirates, this museum's galleries will be subterranean. Meanwhile, towers inspired by falcon wings will allow rising hot air to escape, while drawing cooler air into the structure.

H

MACK RIDES
PULSAR

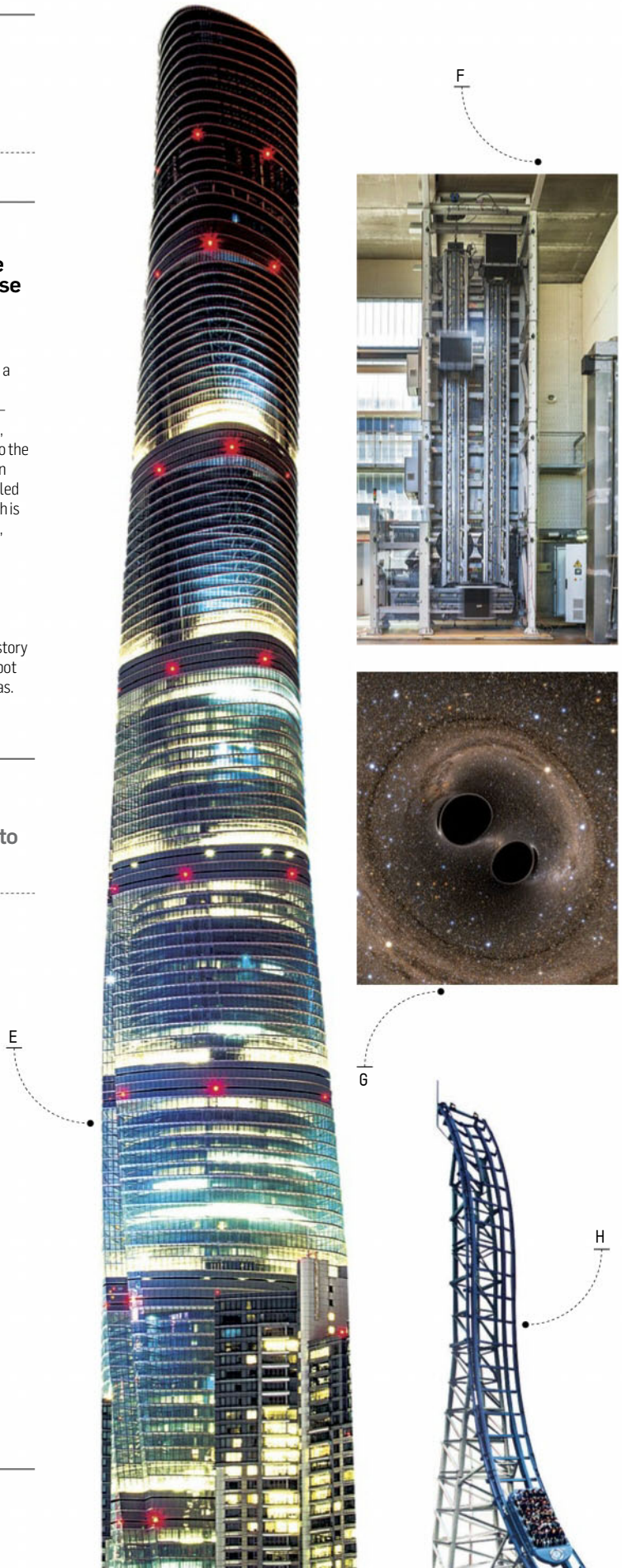
Next-Level Waterpark

Artificial log flumes in theme parks are so yesteryear. So, a German ride-design firm has brought the waterworks to a natural setting. They drained (then refilled) a lake to lay a foundation for a U-shaped roller coaster that rockets into the water at 100 kilometres per hour, creating a tsunami-like wave that drenches riders. Thrill-seekers swoop through the U twice before the force of the splash slows down the car. At least, hopefully.

M. LUDVIK
SKYSLIDE

Earthquake-Proof Glass

A slide that hovers 300 metres above Los Angeles might seem like mere novelty, but the process used to make the glass could lead to stronger, more energy-efficient buildings. Architects used code from NASA to analyse the design, then employed a new form of chemical strengthening to make glass that's as strong as steel. "We could create naturally lit structures with very low carbon footprints," says SkySlide engineer Michael Ludvik.



Do Not Fear Gene-Edited Food

NOT SINCE *ALICE IN WONDERLAND*'S hookah-smoking caterpillar gave us the call atop a psychedelic-looking mushroom has the lowly fungus so upstaged the action. At most dinner tables, mushrooms are ancillary characters. But this past spring, the food and agriculture worlds became obsessed with one mushroom in particular: the *Agaricus bisporus*, known as the white-button mushroom—that all-purpose fungus you jam by the fistful into a plastic bag at the market and abandon in the fridge, only to find it slimy and brown several days later. Science has now found a way to delay that browning, using the buzzy genome-editing tool, CRISPR, which can trigger changes in the DNA of plants, humans, and other animals with unprecedented precision and speed.

The name—Clustered Regularly Interspaced Short Palindromic Repeats—refers to a system that targets genetic code. The makers of the nonbrowning mushroom, at Pennsylvania State University, used the CRISPR enzyme Cas9, which can delete base pairs, changing a gene and altering its expression.

But that's not the part that got people talking. In April, the US Department of Agriculture said that it would not regulate the CRISPR-altered mushroom. To organic purists and eco-watchdogs, a genetically modified organism (GMO) had been given a green light to go to market without oversight: no warnings about what was in our food and no investigations into its environmental impact.

The outcry from food warriors was swift: How had a genetically tweaked food evaded regulation?

It hadn't, exactly. "The USDA simply decided that, legally, the mushroom didn't fall within their regulatory system," says Greg Jaffe, the biotechnology director at the Center for Science in the Public Interest.

The USDA regulates genetically modified (GM) plants only for their potential to be "plant pests"—whether they can infect other crops. If there's that chance, it can require further testing and a permit before the crop is planted. A handful of modified GM plants have previously managed to escape regulation for various reasons. But the CRISPR process itself is what helped push the mushroom past the red tape. While most GM crops use bacteria or viruses to introduce new genes into a plant, CRISPR needed only a few snips to the genetic code. Since the CRISPR'ed mushroom contained no plant-pest DNA, the USDA decided it was out of their hands. (The Food and Drug Administration still may weigh in before the 'shroom goes to market.)

Still, consumers are wary. Ever since federal regulators approved GM seed crops 20 years ago, we've been a society torn—and often misinformed—over so-called Frankenfoods. The organic-food lobby and environmentalists vigilantly warn us about potentially harmful side effects to our health and to the planet. The issue has created a hothouse split between science and the public. A 2015 Pew Research survey found that more than 57 per cent of Americans believe GMOs are "generally unsafe." Meanwhile, 88 per cent of scientists surveyed say they are "generally safe."

But we've come a long way since the early days of GMO projects, when herbicide-resistant crops led to "superweeds" immune to chemical treatment. Such stories make us justifiably wary of playing God with our food. But nearly everything we eat is genetically modified. (See high school biology: Gregor Mendel). The real superweeds today have grown up around, and are choking, our legal-approval apparatus. Oversight has become part of the problem; our biotech regulatory framework is outdated and ill-equipped to deal with rapidly evolving tech. (The White House has promised to change that.)

The biggest mistake we can make, as a curious and concerned public, is to prematurely vilify CRISPR and the food it makes. We should instead push for informed, science-based evaluation. It could help improve the global food supply. The whole reason for this mushroom is that it resists bruising during harvest and browning in your fridge. That means you're more likely to eat it instead of tossing it. And CRISPR itself opens up a new world of food development, since it's cheap and easy to use, making it accessible to smaller labs and breaking Big Agriculture's GMO monopoly.

So let's not stall this science at a time when better, hardier, more efficiently grown food is a rising need. Gene editing requires funding and research—but it also requires public support to make it viable. There is great potential for smaller companies to make food that can nourish a growing population without harming the planet. Traditional bioengineering has a very high bar for entry. CRISPR lowers it: It democratises the technology so engineered plants are not just the domain of a handful of huge companies making feed crops, but can be done by one guy in a university lab with a great idea. PS

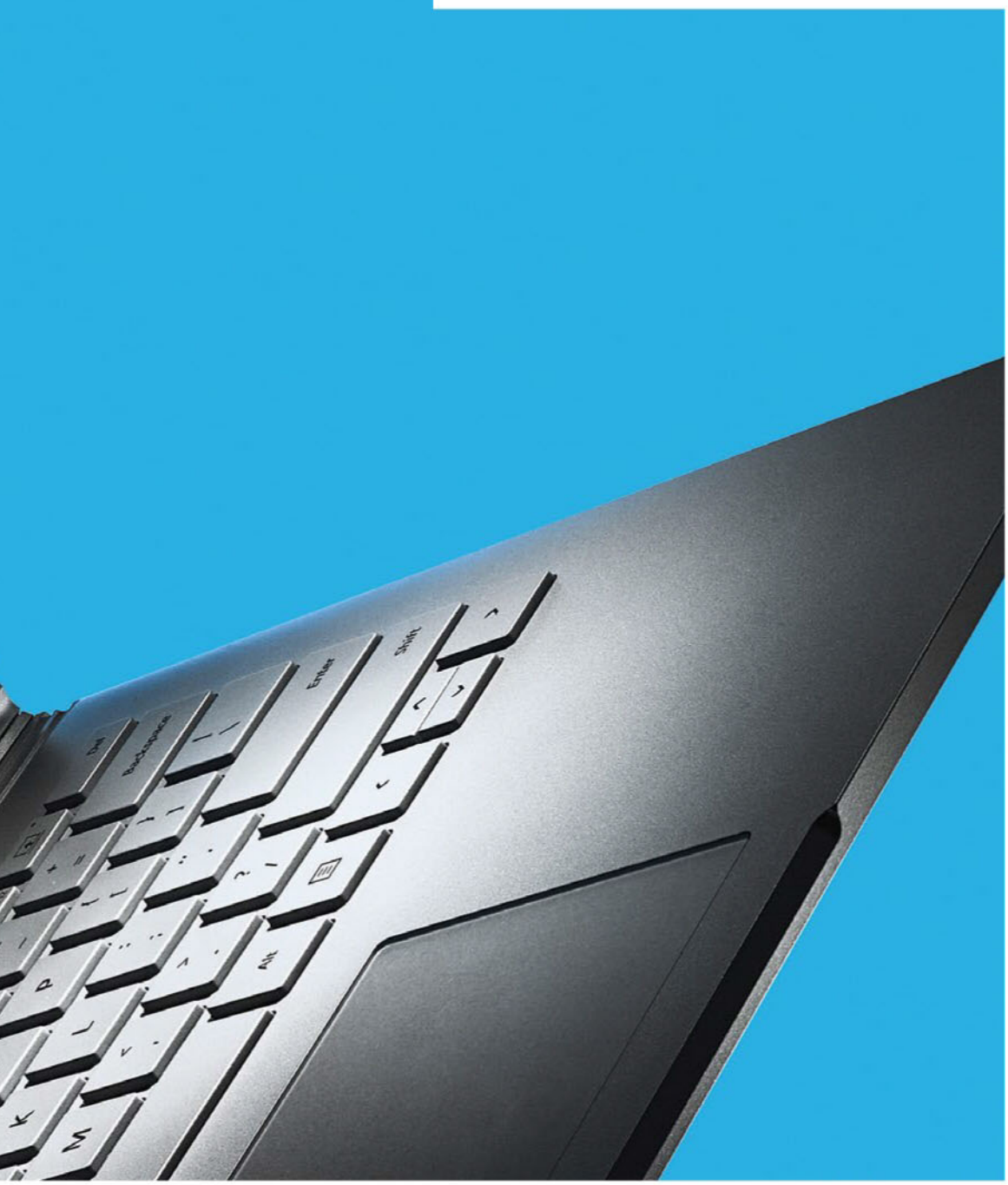
The biggest mistake we can make, as a curious and concerned public, is to vilify CRISPR and the food it makes. We should instead push for informed, science-based evaluation.

Illustration by MARCO GORAN ROMANO

By JEN SCHWARTZ


skype
Wir freuen uns auf 2016!
inda preciso fazer
inha resolução.

SOFT-WARE

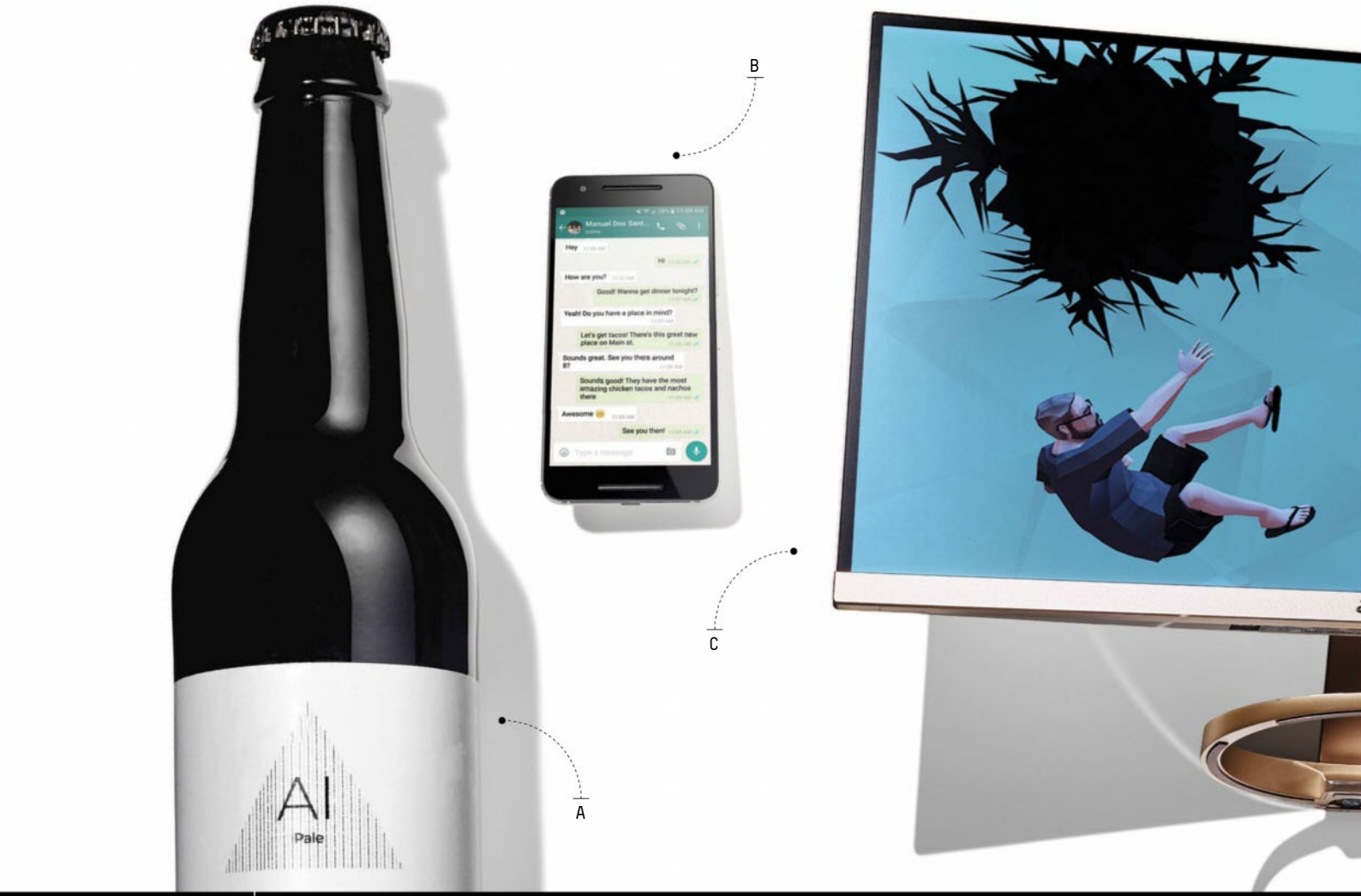


MICROSOFT SKYPE TRANSLATOR

The End of the Language Barrier

The Internet connected us all—but what good is that if we can't understand each other? Skype's artificial-intelligence-based Translator is our digital Tower of Babel. It lets us talk to anyone, anywhere, regardless of mother tongue. Made available on Windows in late 2015, Translator uses layers of machine-learning algorithms. When a user speaks, the AI, drawing on millions of speech examples, analyses the words and transcribes them into text. The text is then scrubbed of "ums" and word repetitions, and run through a translator. The AI is self-learning; the more it "hears" a regional accent or slang, the smarter it gets and the better it functions. Callers can receive audio in eight languages and see transcripts in more than 50. Can you hear us now?

By DAVE GERSHGORN + LINDSEY KRATOCHWILL • Photograph by SAM KAPLAN



SOFTWARE

GOOGLE
DAYDREAM LABS

Creating VR in VR

Daydream Labs lets developers animate and build virtual reality not on a flat computer screen, but for the first time inside VR itself. They can interact, socialise, offer feedback, and use hand controllers as their virtual creations rise up around them.

A

INTELLIGENTX BREWING COMPANY

The First AI Brewmaster

Humans have brewed beer for millennia. Intelligentx Brewing Company thinks artificial intelligence should take a shot. Its machine-learning algorithm reads beer recipes like any other brewmaster. But it also learns from you. After drinking one of the brewery's four beer styles, you tell a bot on Facebook Messenger what you like, don't like, or want more of, and the AI uses your comments to brew the next batch. More data, better brew.

B

WHATSAPP
ENCRYPTION

One Billion Safer People

In April 2016, more than one billion cellphone users gained the ability to outsmart the NSA or any third-party snoop when Open Whisper Systems released its WhatsApp end-to-end encryption protocols. Made for voice calls and texting (including photos, videos, and files), users verify their communication is encrypted by either scanning a machine-readable QR code or comparing a 60-digit code with their fellow security-savvy interlocutor.

C

NUMINOUS GAMES
THAT DRAGON,CANCER

A Game That Will Break Your Heart

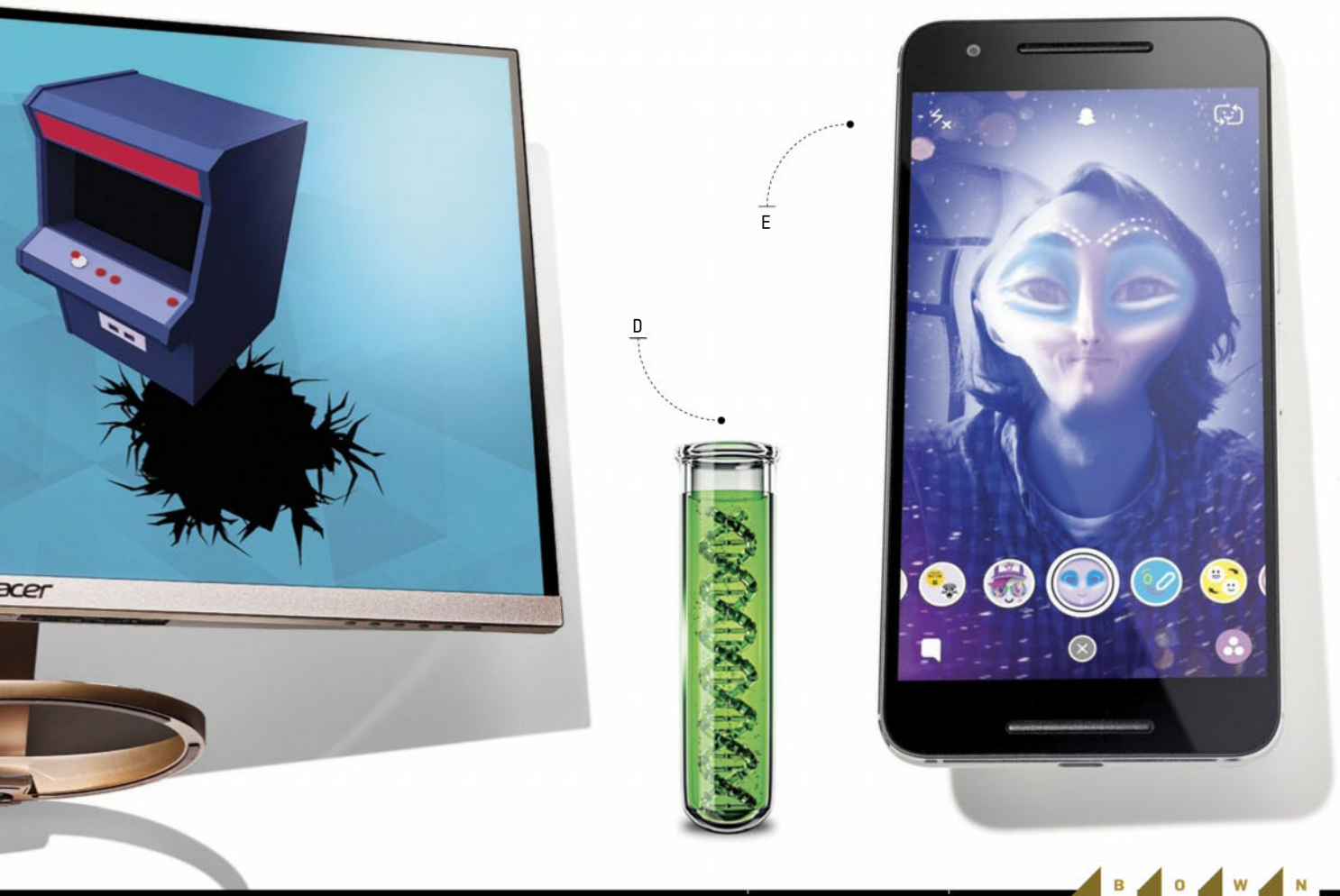
When game developer Ryan Green's son, Joel, was diagnosed with brain cancer at 12 months, Green turned to his medium to work through it. The result is a soul-twisting video game that lets players experience the ups and downs the Greens went through during Joel's four-year battle—the challenge of comforting a child in pain, the joy of storytime, and the grief of dealing with his death. "My favorite moments are the moments where you can be with Joel," says Green. "To play with him, hear him breathe, or hear him laugh, those moments I like the most."

D

UNIV. OF WASHINGTON
DNA STORAGE

The Densest Of Data

Instead of server farms, the entire Internet may run out of a bunch of vats fully of organic goo - and take up less space. That's what researchers at Microsoft and the University of Washington proved in July, when they encoded 200 megabytes of digital files into the building blocks of DNA—breaking the previous 20-MB record. They did it using a type of enzyme called polymerase, which makes copies of DNA in a programmable way and allows any part of the DNA string to be read.



E

SNAPCHAT
LENSES

AR's Big Moment

Augmented reality's most universale seizure of the zeitgeist in 2016 wasn't through the monster-catching caper of Pokémon Go. It was Snapchat's Lenses—object recognition and real-time special effects that let you change your on-screen eye colour, superimpose faces, wear animal "masks," and place scenes around an image. So many memes! How we LOLed...

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MA/608

Manual

A DIY Retro Arcade Cabinet

Powered by Raspberry Pi, the Picade is a Kickstarter success story, and geek chic too

by ANTHONY FORDHAM

THE INEXPENSIVE Raspberry Pi, now in its third iteration, is a $60 computer capable of running Linux - and it has pretty good graphics performance too. That got Raspberry Pi project makers Pimoroni thinking: combine a Pi with a bit of carpentry and some old-school arcade controls and it should be possible to create a self-contained retro games machine.

The result is this: the Picade! Sized just right to fit on but not dominate the average desk, it combines an 8-inch 800x600 LCD display with some controls and a Pi 3 loaded with a special OS called RetroPie. What does it give you? Hours of old-school fun.

The genius core of this project isn't actually the Raspberry Pi itself - it's the **Picade board.** This Arduino-compatible PCB includes a 3W stereo amplifier and connections for volume buttons and a typical set of arcade controls. Joystick and buttons are wired directly to the Picade board, and the board itself connects to the Pi via USB and acts like a keyboard. Users can configure what each button and joystick axis does via software.

Because the board includes an amp and speaker connectors, it makes getting sound out of an arcade project much easier. Simply connect the Picade board's 3.5mm audio-in to the Raspberry Pi's audio-out, easy!

Pimoroni sells the Picade as a kit, but you do need to be somewhat familiar with these kinds of projects to put it together. Instructions are not included in the box, but there is a sheet that directs you to some handy YouTube videos. Here's how we did it.

PICADE CABINET

Cost: $290 for kit, $115 for Raspberry Pi
Time: 3-4 hours
Difficulty: 4
www.pimoroni.com

PI NOT INCLUDED

Because the Raspberry Pi keeps getting updated, Pimoroni doesn't include one in the kit. You can grab a barebones Pi for $65, but a $125 kit will include an HDMI cable, power adapter and an SD card preloaded with a program that makes it easy to install Raspbian. raspberryp-ishop.com.au

WANT A BIG, BIG SCREEN?

If an 8-inch display sounds too titchy for you, there is a cut down version of the Picade which packs everything into the bottom section with the controls. Simply plug into power and an HDMI port on a TV or PC display, and you'll be up and retro gaming in no time. It cost $215. www.pimoroni.com

HOW TO BUILD IT

1. We found it easier to configure the Raspberry Pi BEFORE we started building. Install a Linux distribution like Raspbian, then install RetroPie. (The Pi plugs in to a normal keyboard and mouse and any HDMI monitor.)
2. Insert the line "hdmi_force_hotplug=1" into /boot/config.txt to ensure the Pi will be able to use the Picade's display.
3. Construct the cabinet using the pre-cut MDF panels and bolts (tip: the bolt heads face outwards). Take extra care with the rear door which has tricky hinges.
4. Press the buttons into the controller board until they click, and mount the joystick with the included bolts. Mount the speakers to the sides of the cabinet.
5. Wire the controls to the Picade board using the wiring diagram at learn.pimoroni.com (everything is colour-coded and the Picade board has little symbols to help you out.) Don't forget the speakers!
6. Mount the display using the included bracket and secure it into the cabinet.
7. Attach the Raspberry Pi to the pre-drilled mounting holes inside the cabinet and plug everything in. The display needs to be plugged in to power as well as HDMI. The Picade board only needs USB.
8. Power everything up! If you've configured the Pi correctly, an interface called EmulationStation should appear. You can load game "roms" via USB and configure them using the joystick and buttons. However, attaching a small keyboard to one of the spare USB ports on the Pi will make the process much easier.
9. From here it will take a LOT of tinkering and configuration adjustments to get every retro game running smoothly, but of course that's half the fun!

Making Carbon Fibre Count

Why NZ engineer Simon Brown is using next-gen materials to improve last-gen tech

AS THE VINYL RENAISSANCE CONTINUES and presses struggle to keep up with a surprising new demand for LPs, smaller manufacturers are tapping into a market that hasn't existed since at least the early 1990s.

Simon Brown of Design Build Listen decided to focus on one particular aspect of vinyl playback: the tonearm. "I saw all these little turntable companies popping up, but they all had to buy their tonearms from Jelco or Rega or Pro-Ject. Which means they were effectively buying from their competition!"

Turntables today are broadly split into mass-market products from the afore-mentioned brands, which come ready-to-play, and boutique systems where the user must choose turntable, tonearm and cartridge themselves.

"A tonearm's job is basically to manage vibration," says Brown. As the stylus picks up information in the record's groove and the cartridge converts it to an electrical signal, Brown says vibrations can propagate back and forth along the tonearm and (at least on very high-end equipment) degrade the sound.

"Others have used carbon fibre in the past, mainly as a way to save weight. I'm using it to strengthen the arm and dampen resonances," Brown says. Indeed, the most striking thing about his Wand+ tonearm is the thickness of the main tube. He says it has about four times the diameter of a typical tonearm.

"The basic tonearm design is a cartridge on one end, a tube and then a counterweight hanging off the other," Brown says. "My idea was to concentrate as much mass as possible into one big lump and only have small adjustment options."

The other unusual design element in the Wand+ is that it sits on a so-called "unipivot", where it rotates freely on a spindle, instead of using a gimbal with separate horizontal and vertical bearings.

"Whether a unipivot design is better or worse is quite political," says Brown. "Some people hate it, but I chose it initially as a way of keepings costs down, though it didn't quite work out that way in the end..."

The Wand+ comes in different lengths, with the majority of systems likely to use a 9.5-inch (241mm) model, which costs $1499. DBL also has a new Master-series Wand (pictured) for people who prefer turntables that cost as much as a decent car. Pricing isn't set yet, but it will cost about twice as much as the Wand+. PS

by Anthony Fordham

3D PRINTED? YOU MEAN LASTER SINTERED!

Because this is 2016, naturally there's a 3D-printed element in the Wand+. The mount that holds the cartridge is made from laser-sintered titanium, which means it's built by fusing powder with a laser rather than cutting it out from a larger block of metal. Brown says this allows him to make a stronger, lighter but more complex mount, at a lower price. For more details, visit: designbuildlisten.com

THE WAND+ TONEARM
PRICE: $1499
WEB: www.addictedtoaudio.com.au

Prototype Your Project... With A Mobile?

by Anthony Fordham

GOOGLE'S PROJECT ARA MAY HAVE ENDED without a phone to show for it, but the idea of a modular phone isn't dead. Motorola's Moto Z supports Mods - clip on backs for the phone that add, for instance, a high-end Hasselblad camera or JBL speaker, or even a little projector (we'll take a closer look at these next issue).

Prepackaged Mods are fun, but where this platform gets really interesting is with the Moto Mods Development Kit. Consisting of a reference Mod back (which provides power and connections), a perforated circuit board and a protective cover, the MDK allows tinkerers and builders to make their own Moto Mods.

What can you make? What can't you make! Motorola provides some example "personality cards" (see left) that clip into the reference Mod and show what's possible. The company also highlights the available HAT (Hardware Attached on Top) board which creates connectivity with Raspberry Pi addons.

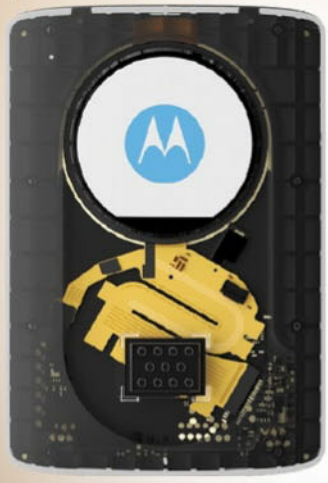
HATs are inexpensive, and include everything from LCD displays to buttons and various different sensors. Having HAT compatibility makes the Moto MDK much more flexible.

Of course this system still requires a Moto Z phone, unlike the open nature of Raspberry Pi or Arduino, so it will be interesting to see if the MDK spawns a new maker movement... or ends up being just another smartphone gimmick.

MULTIPLE PERSONALITIES

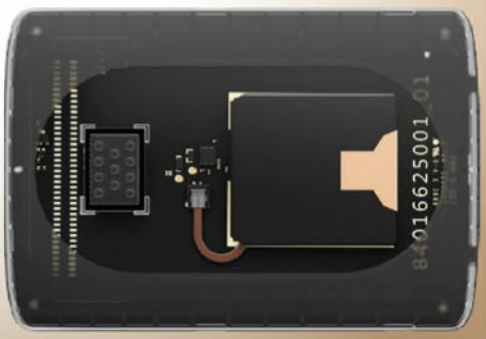
These Personality Boards are example MDK Mods that show what's possible.

DISPLAY adds a second LCD display to show notifications or whatever else the developer wants. This round display is from the Moto 360 smartwatch.



TEMPERATURE SENSOR Uses a basic thermistor to detect ambient temperature, but the point of this card is to show how custom sensors can be implemented.

AUDIO Adds a better-quality class D amplifier and automatically reroutes the phone's audio output with no need for an app.



BATTERY A simple Mod that expands the phone's battery for extra run time, but also shows how a battery can power a Mod without the phone.

November 1986

Early Adventures in Smartcard Technology

by
ANTHONY
FORDHAM

YOU CAN EASILY IDENTIFY which decade of the 20th century any Popular Science back issue comes from, not necessarily by the design and certainly not by reading the cover date (pfft, who would do THAT). No, you can always tell by whatever technology the issue is obsessed about.

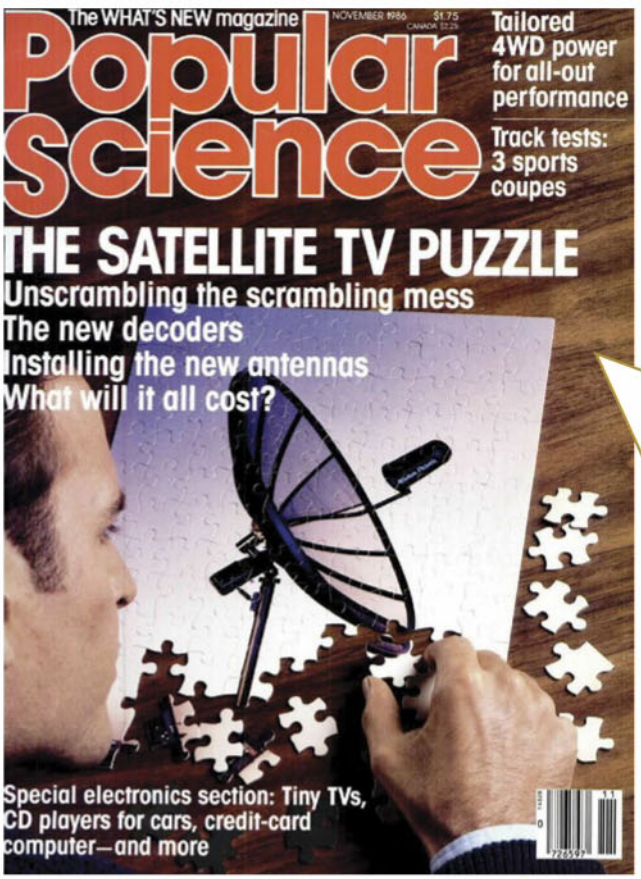
Pre-war, it's crazy machines. During the war it's about how US machines will WIN. In the 50s, it's planes, trains and automobiles. The 60s is all Modern Conveniences (ovens, vacuums, moon rockets). The 70s and 80s? It's cover-to-cover ELECTRONICS.

By November 1983, rumours of the Apple Macintosh were flying, you could buy a home computer that actually did stuff, and there was a growing sense that computers - even moreso than our beloved electronic gadgets - were going to be a big part of the future. And they were going to be really, really small.

Meanwhile, also because it was the 1980s, America was falling in love with the concept of credit. With a single plastic card, you could buy things before you earned the money to pay for them, and worry about servicing the crippling debt later! No more putting on a suit and grovelling in front of a bank manager just to get a cheque. Or rather, check.

But those of us old enough to actually remember the 1980s will also remember that credit cards were kind of a hassle. First, retailers had to use a sort of carbon-copy machine, or else take card details manually. The magnetic strip came along soon enough, but people waking up to the kind of damage a rogue credit card could do wanted more security than a scrawled signature (which no one checked anyway).

Today of course we have EMV. Created by Europay, MasterCard and Visa (thus the acronym), these "Chip and PIN" cards are scanned by a device and the payment is authorised. Various systems and standards keep the process, hopefully, secure. What's more, using a PIN is safer than a signature.

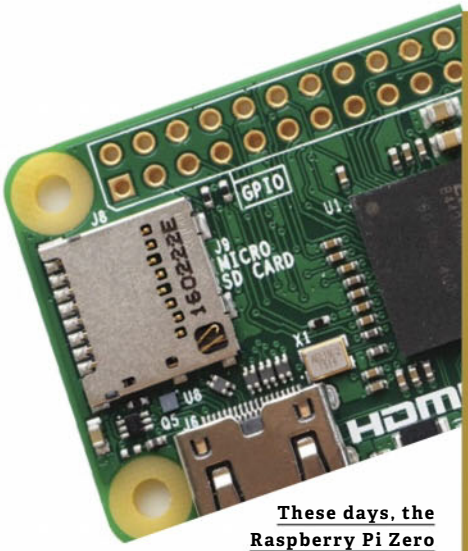


Satellite TV! The ultimate in entertainment! Again, the 1980s was all about the transition from pure electronics to computerised gadgets. Satellite TV somehow encapsulates this era perfectly, freeing neighborhoods (sic) from cables but also needing a computer descrambler. This issue also includes a "special electronics section" which shows off... gasp... CD players for cars!

The everything card

By G. BERTON LATAMORE

Photo By Burt Plokin



These days, the Raspberry Pi Zero is actually smaller than a credit card

This tech and standard didn't arrive overnight, of course.

In our November 1986 edition - 30 years ago to the month - we looked at the Ulticard, which took the ultimately unnecessary step of building an entire computer into a credit card.

However, what's interesting about this article isn't the funny 80s-tastic Ulticard but rather contributing editor G Berton Latamore's prediction for its use.

We saw the Ulticard as going far beyond credit card functionality and doing everything, from acting as a fitness coach to letting you pay for things like parking meters and train rides...

...which is of course pretty much what a smartphone does today. The Ulticard offered multi-layered security to protect your finances, but we're also seeing this being implemented in the various "Pay" NFC functions from (so far) Apple, Android and Samsung.

In 2016 the truly-tech-savvy tap their phone against the card reader to pay for a packet of chips. As for credit-card sized computers... well of course these exist in the form of hobbyist boards like the Raspberry Pi Zero. But nowadays having a computer with credit-card-sized bulk is a bit... well it's a bit old fashioned isn't it? Our smartwatches would be pretty unwieldy if they had to be as big as credit cards. PS

This is a prototype," says SmartCard International president Arlen Richard Lessin, obviously pleased at the plastic card he hands me. "The final version will be no thicker than a regular credit card and will fit into a bank automated teller machine."

I'm sitting in the office of SmartCard International in New York, holding the world's smallest computer in one hand. It's the size of a credit card but twice as thick. It has a two-line LCD screen, a tiny battery for power, and a 10-key alphanumeric keyboard that resembles those on push-button telephones. This is Ulticard, a rigid piece of plastic that could be the first in a new generation of supersmart cards that help you in a variety of ways - from losing weight to saving your life... Also, it may be your next Visa card.

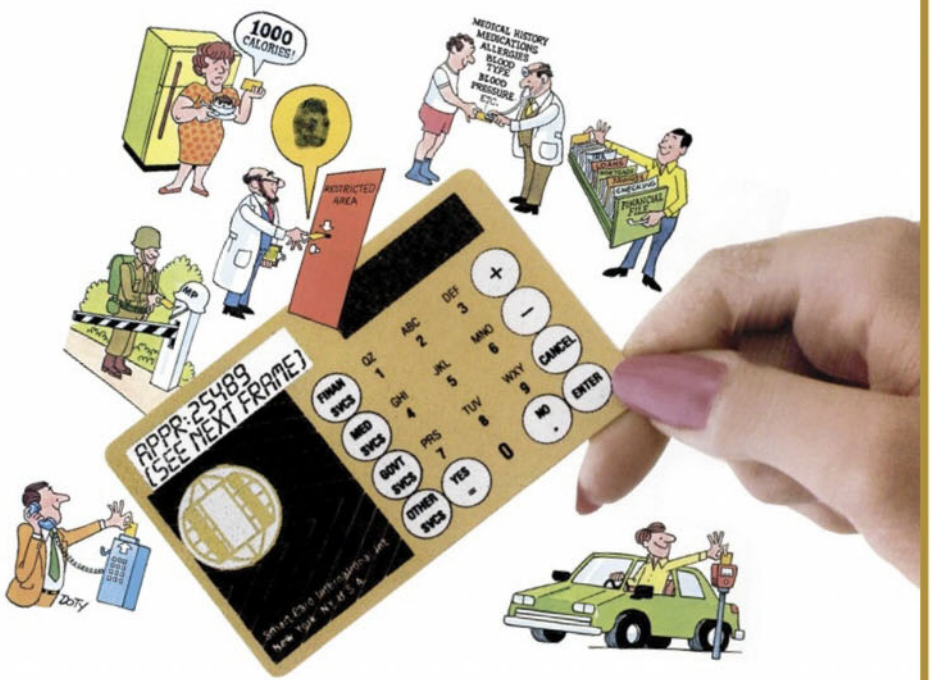
Ulticard was developed from the French smart card [PS July '83], and was created in a short six months after Visa and SmartCard International announced plans for it.

"Ulticard is the first self-contained credit authorization system," says Lessin. "Even more, it's an automated wallet with a pocket reminder thrown in." Ulticard can hold the complete records of at least two accounts - either credit accounts such as Visa and MasterCard or debit accounts like an electronic checkbook. Also, it can store addresses, appointments, or even life-saving health data. And the final version, which Visa will ultimately call Super Card, will have a currency-conversion program and contain a magnetic stripe so it can act as any normal charge card.

Like the traditional smart card, Ulticard's memory is divided into three sections, each with a different security level. "The first level is open, accessible to anyone who turns the card on," says Lessin. This might contain health information or your name and address in case the card is lost...

"To use the card to make a Visa purchase, you must unlock the memory by entering your PIN [personal identification number]," Lessin tells me. "You can then check your account balance to make sure you have enough to make the purchase." You need not show your balance to the clerk, however. Once you've activated the card, you enter the amount of the purchase. "The card records it, deducts it from the balance, and displays an authorization code, which the clerk copies onto the charge slip," Lessin explains...

...It's not yet clear which of the various technologies that are being developed will ultimately become the standard for credit cards. "But if nothing else," says Lessin, "it is clear that the thirty-year-old standard credit card is in need of replacing."



The Gyrobus

Who wouldn't want to commute while sitting on a two-tonne disc spinning at 900km/h?

by ANTHONY FORDHAM

CONSIDER THE THANKLESS task of the mid-20th-century town planner. You must, especially in Europe, design your city such that hundreds of thousands of people can move around it every day, but of course there is no money to do this. Budgets are tight. Fancy overhead electric wires down every street for the trams? Maybe in *Western* Europe... wait, this was a problem in Switzerland? And the Swiss came up with an insane solution?

Indeed, while the rest of Europe was going up in flames, during the 1940s the Swiss somehow had enough time and money to develop the Gyrobus. Unlike a typical electric tram, the Gyrobus could not depend on a network of overhead electric wires. And since this was the 1940s, the concept of lithium-ion batteries or hydrogen fuel cells or even LPG was beyond the wildest dreams of science fiction authors.

Come Back DJ

So Swiss technology group Oerlikon decided to store energy in a flywheel instead. Basically, at certain points on the bus route, the bus would raise three booms to contact a charging pole. Electricity from the pole would power an AC induction motor which in turn would spin up the flywheel to incredible speeds, thus storing energy.

When it pulled away from the charger, electrical systems in the Gyrobus would switch the AC motor to operate as a generator, bleeding off momentum from the flywheel to create an electric current. This current ran the engine and brakes.

For bus-work it was... okay. The Gyrobus could trundle along at 50km/h for six kilometres or so before the flywheel needed another spin. On flat routes, this was fine. On

routes where drivers would take short-cuts across rough terrain, not so much.

Your Record Is Scratched

The real problem with the Gyrobus was that everything about it was *so extreme*.

To give the bus even halfway decent range, the flywheel had to weigh over three tonnes. And it had to be spun up to 3000rpm, at an effective energy cost of 3.4 kilowatt hours per kilometre.

And at 3000rpm, it meant the outer edge flywheel itself was spinning at a truly insane 900km/h. There are no reports of a flywheel ever escaping containment, but if it had the results would have been... look, catastrophic seems barely strong-enough a word. Just imagine three tonnes of *anything* shooting across a crowded street at 900km/h remains after doing a bunch of complicated angular-momentum calculations we're not paid enough to bother with.

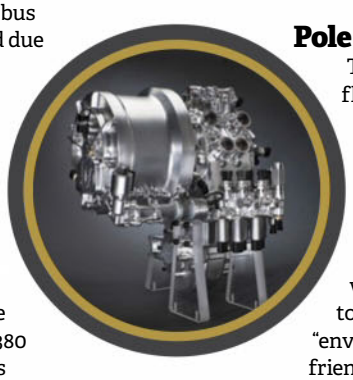
More weirdly, the spinning flywheel was big enough to have a gyroscopic effect on the bus. When the driver tried to go around a corner, the flywheel would make the bus try to keep going straight ahead. Apparently the gyroscopic forces were relatively easy to overcome, but the sensation was disturbing to say the least. Then there's the psychology of sitting on top of a three tonne disc spinning at 900km/h...

Bill Shock

Ironically though for a technology created to save money, the Gyrobus ultimately failed due to cost. Because bus operators wanted a fast recharge - three minutes was considered too long - the charge voltage had to be increased from 380 to 500 volts. This gave the system that 3.4 kWh/km consumption figure which, take it from us, is bad.

Beyond Switzerland, the Gyrobus system saw deployment in Kinshasa in what was then the Belgian Congo, and in Ghent, Belgium. Historical accounts are not kind: the buses were criticised for being so heavy they damaged the roads, and they were considered unreliable in the way experimental V1.0 tech always seems to be.

Anyway, trams won the war of light commuter vehicles, and then they too eventually died out in a post-war world of cheap petrol. But the flywheel system was destined to live again in a very different place: the Kinetic Energy Recovery Systems on race cars.



Volvo's KERS provided a 55kW boost to a petrol engine

Pole Position

There are a few flywheel KERS (including one called Flybrid which is our kind of wordplay), and most were created to meet the new "environmentally friendly" rules in Formula One. Far from running the entire car, they recover kinetic energy into batteries or a (much smaller) flywheel.

These days we have amazing synthetic lubricants and seals capable of holding a vacuum, and there's little change that a 5kg flywheel capable of a 60kW boost is going to escape containment and cut a swathe through the pits.

Indeed, between 2010 and 2014 there was talk of building a larger Flybrid system to power a whole car, and much was made of the way that lithium-ion battery systems were too heavy and expensive to provide the 40kWh a car needs to be useful for the daily commute.

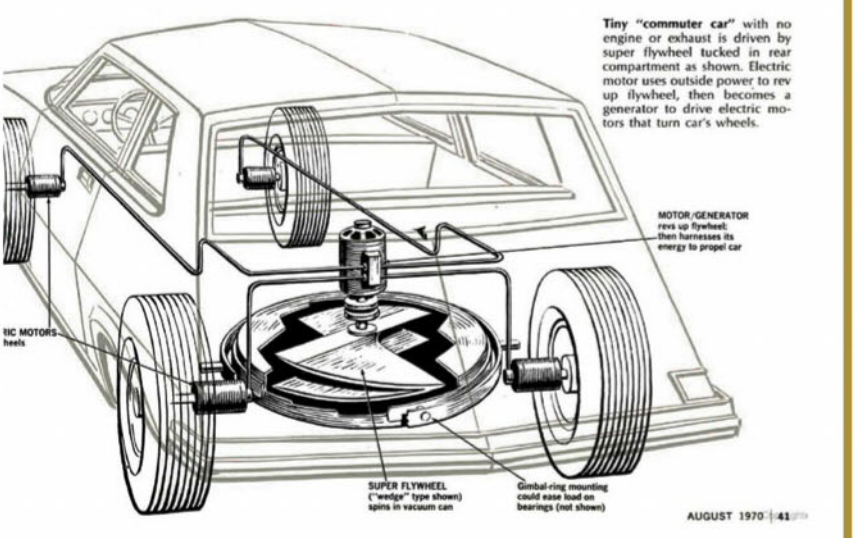
Of course nobody counted on Tesla making a real go of it with the Model S. The cheapest version has a 60kWh battery system, and the top model 100kWh. Technology has beaten the naysayers, in this case. The Model S can carry around so much electricity, there's enough for the silly Ludicrous Mode and sub-four-second 0-100km/h sprints to impress hipster Silicon Valley types.

Volvo did some work implementing a Flybrid system into an S60 sedan, where it would provide a 55kW helping-hand to a 200kW five-cylinder petrol engine. That was in 2014. Today it must be tempting for all car manufacturers to just buy a bunch of Li-Ion batteries and hide them under the boot.

Flywheel-powered cars have a lovely steampunk feel to them, but like so many alternate energy systems, the negatives outweigh the positives. They have a role to play in certain KERS implementations, but you have to wonder if it's only some engineers' irrational hatred of electric cars that keeps flywheel research going... PS

IN 1970, WE BACKED FLYWHEEL, BIG TIME

This rather doubtful-looking diagram comes from our August 1970 issue, where the awesomely-named Alden P Armagnac waxed lyrical about the potential benefits of a flywheel system that could propel a 450kg car to 100km/h in just 15 seconds! It's not like this flywheel would have to be stupid-huge like in the Gyrobus, either. Just 750mm in diameter and weighing only 100kg. Of course, it would have to spin at 23,700rpm. And that means an outer-edge speed of 3218km/h or, as military pilots would put it, Mach 2.6. I wonder what it would have SOUNDED like?



Labrats

STORY BY ***Subject Zero***

The Greatest Show On Earth*

The asterisk doesn't mean anything, it's just supposed to make you suspicious...

BY NOW IT SHOULD COME as no surprise that I don't really do trade shows. Why would I? My "job" isn't to promote these people's products and innovations, just subject myself to them. Fill out the form, tick the box that best describes the burning sensation, get my $125 and move on.

There are always exceptions, of course. For instance, the Personal Fitness Cybernetics And Gluten Free Robotic Kitchen Appliances Expo 2016 really, really wanted a bunch of "reputable" scientific test subjects up on stage to demonstrate a whole range of products to potential retailers. My agent (and ex-union headkicker) K[c]urt Blockade had negotiated an hourly rate of $17.50 which was good, but also persuaded my sort-of-not-really girlfriend Atalanta to come along too, which was even better.

Due to an issue with an expired bus ticket, a stormwater drain and my front door key, I arrived two hours late, by which point the riot had set in.

Later, I found out that someone had brought in some gluten or something, or someone had been unable to adequately certify that a Thermomix-rip-off called a GlutenBuster could actually remove gluten from something glutinous, and then there was a disagreement which devolved into an altercation, and pretty soon people were throwing punches. The Personal Fitness Cybernetics side of the exhibition space stayed out of it until a virus got onto the free Wi-Fi somehow and all the training robots went nuts and were catching people and forcing them to do push-ups and run on treadmills and so forth.

I found Atalanta over by the coffee cart. She was looking at the unattended machine longingly and I assumed that, as an itinerant scientific test subject like myself, she had no money.

"Hey," I said a little shakily. "Is that a ProntoShunt 4000? I used to wrangle one of those back in my barista days..."

Atlanta looked at me with absolutely unconcealed contempt. "You were a barista?" she said, which were the first words she'd spoken to me in over four months. "Why aren't you still a barista?"

"Long story," I said, as I climbed up into the empty coffee cart and started spinning the familiar dials and pulling the familiar levers. I looked out over the exhibition space and saw a squad of fitness machines stomping determinedly toward the coffee cart, probably to tell us coffee was bad and we had to do a bunch of push-ups.

"Um," I said. "Maybe you'd better get into the cart with me and we can lock it or something."

Atalanta looked around, made a teeth-sucking sound, and then slowly and unconcernedly climbed into the cart and shut the door, just as a spandex-wrapped manipulator claw tried to grab her by the elbow and drag her off to a fate worse than not having to do any exercise.

We sat there, on milk crates, facing each other but not looking each other in the eye. The ProntoShunt 4000 steamed and gurgled somewhere up above my right ear. After a moment, the coffee cart started rocking back and forth - not super-violently. After all, these fitness bots wanted to help us, not hurt us. Outside, the sounds of the gluten-sparked riot created a background of almost-soothing white noise and occasional crashes.

"Uh..." I said. Atalanta picked at the milk crate. She looked perfectly glum. She'd dyed her hair black again. She sighed and looked at her wrist where a band of very slightly paler skin indicated she'd once worn a watch.

"What happened to your watch?" I asked brightly, pointing at her wrist. Atlanta frowned.

"I got rid of it," she said, frowning at her wrist. "Because of a virus."

"A virus?! Your smartwatch caught a virus? Like, an Android virus?"

"No, *it* gave *me* a virus. And it wasn't a smartwatch." She paused, but then didn't say anything else, but instead stared at the ProtoShunt 4000 which was starting to gurgle more urgently and produce a kind of electrical burning smell.

Suddenly my agent C[k]urt Blockade hurled himself over the counter into the coffee cart, bounced off the back wall and hit the floor with a thud that shook the whole thing on its flimsy collapsible struts.

"Damn!" he cried, sounding all pumped up and excited. His good eye rolled. "This is the greatest show on Earth! I've never been able to punch so many coeliacs in one go before!" He grinned and hurled himself over the counter again and was gone.

I turned to Atalanta and opened my mouth, but at that moment the ProntoShunt 4000 executive coffee management system exploded.

Luckily for us, the titanium-weave watertank shaped the detonation such that all we had to do was duck: shrapnel, steam, frothy milk, and coffee grounds erupted out in a flat trajectory in all directions, neatly demolishing all the fitness bots.

It was the best date Atalanta and I had ever been on. PS

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