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1 in 4 South Africans is affected by cancer.* That's 54 250 of you reading this magazine.

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*"One in four South Africans is affected by cancer through diagnosis of family, friends or self." Statistic provided by the Cancer Association of South Africa (CANSA).

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DOCTORS ON DEMAND

WE MAY BE THE LAST GENERATION to experience the well-thumbed magazines, rickety chairs and awkward tedium of the doctor's waiting room.

Within the next five years, Texas-based South African entrepreneur Clinton Phillips aims to eliminate the wait, the room and the army of front-of-house staff and, instead, use a cellphone app to connect medical care to a billion people across the globe. By the time you read this, the likes of the US Olympic squad will be using his Medici app to gain direct online access to their medical team. Think of it as a sort of Airbnb of medicine.

Medici styles itself as a global initiative to bring all the world's medical professionals on to a single, simple and mobile platform. You can read more about it on Page 56 as part of this month's feature on the role that artificial intelligence – virtual doctors! – is expected to play in future medical care. It's a prospect so intriguing that I felt moved, facts aside, to engage in a face-to-face chat (virtual, of course, via a Skype video call) to get Phillips's thinking on how tech is changing the doctor-patient relationship.

"We are incredibly excited about people in rural areas, unserved areas, who can now ask the simplest or most complex questions, that they are currently walking 60 kilometres to discuss with somebody whose qualifications they are not even sure of," he says.

Already established in the USA, he's been in talks with South African interests that range from banking and insurance to cellphone service providers. The goal is to have 30 million South Africans invited to Medici by January 2018. Using this country as a base, he plans to broaden the system out to sub-Saharan Africa. Big plans are in place for South America and India. The good news for developing countries: even basic latest-technology phones will work

Sometimes, though, throwing tech at a problem can aggravate things. Witness patients pouring out their hearts to a doctor sitting on the other side of a desk, practically ignoring them while staring fixedly at a computer monitor, busy ticking boxes or inputting information.

The answer lies, not in more personal contact, but oddly enough in *less*. In the US, he says, it's been found that as many as three out of four doctor's visits can be done virtually. That's three million people going to the doctor unnecessarily every day who could just as well use the SMS system, chat apps such as WhatsApp, or video calls.

Of course, this takes us into a legal minefield with liability heading the list of concerns. Fortunately, the Medici package involves insurance cover and comprehensive legal backing that developed out of asking such questions as, can doctors create a new relationship online, or do they have to go through an existing (physical) doctor? Can a doctor in the US consult across state lines? Across the world?

SA-born entrepreneur Clinton Phillips: take two of these apps and call me in the morning.

And what to do with the mountain of data that will be generated? We'll have access to our own medical libraries and histories, but to ensure good clinical care that data will need to be accessible to health professionals.

Still, there will be those eager to use the data to less noble ends. Spammers and telesales companies will be disappointed to hear, then, that there are no plans to monetise patient data. As yet, anyway. Security is taken seriously, too: "If our patrons lose their cellphone their data is protected. We have the head of mobile security of Amazon on our team."

Ultimately, Phillips says, "We want our patrons comfortable that their data is not being used for anything that is not ultimately for their benefit, for the greater good." We're in for interesting times.

Anthony

anthony@ramsaymedia.co.za

COMPETITION WINNERS Details online at *www.popularmechanics.co.za*

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Popular Mechanics

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LETTERS

WHAT'S ON YOUR MIND?

WINNING LETTER

WORDS THAT JAR

In the 1940s my Dad bought Popular Mechanics. Those magazines influenced my life. I still read them. Two things stand out.
1) Astonishingly, you find fascinating material to fill over a hundred pages month after month, and 2) You use words that mechanics love, which is what I want to talk about. If I may, I want to indicate some words that jar with mechanics and engineers.

Quite regardless of dictionaries, mechanics, like every trade and profession, have their words to communicate ideas and information quickly and efficiently. Journalists are national treasures, but being of a different profession their words can sometimes jar with the demographic they are shooting for. Ninety-nine per cent of the time Popular Mechanics gets it right.

But let's take the word "engine". On the factory floor and in workshops, engines are things that convert heat into motion: some examples are petrol engines, diesel engines, and steam engines.

On the other hand "motors", with the throw of a switch, run on electricity. This is an easy conversion: electricity into rotating motion. Much more difficult is the engine's job of converting heat into motion. In my trade a battery-driven-car has no engine, only motors: motors that drive it, wind its windows, and wipe its windscreen.

The mechanic's thinking can be illustrated by the concept of "prime-mover". Imagine we have two cars before us: one petrol, the other battery-driven. The petrol one has its own prime-mover, but not the battery one. Eskom, which charged its battery, is the prime-mover, the source of motion that created the electricity. Electricity itself being a motion – the motion of electrons.

Nobody tells his mechanic, "The car's mill is backfiring." Nobody tells their spouse, "The powertrain won't start." No manufacturer lists engine specs under "powerplant" specs.

As for the word "motor", totally acceptable misnomers do exist. Examples are:
Adjectives: motor car, motor bike, motor boat, motor show.
Noun: motorist.
Verb: motoring.

All of these are totally acceptable misnomers. But otherwise, to be even more agreeable with the mechanics that love Popular Mechanics please avoid using the jarring terms of powerplant, powertrain, powerstation, mill, and motor when discussing heat engines. The powerful word is "engine".

HARRY VORSTER
BY EMAIL

(We may disagree on terminology, but besides the witty tone of your contribution I find it hard to quibble with anyone who describes me and my colleagues as national treasures. – Editor.)

Write to us, engage us in debate and you could win a cool prize. Our winning letter earns a Makita Jig Saw Model JV0600K worth R2 499.
The jig saw is one of the must-have tools for every toolbox. This 650 W Makita top handle jig saw is compact, lightweight and achieves accurate cuts in a variety of materials (90 mm in wood and 10 mm in steel), with a variable speed control (500 to 3 100 strokes per minute) to match speed to application. Three orbital settings, providing optimum cutting action in wood, can be selected by simply turning a lever. The JV0600K has an aluminium base and bevels 0 to 45 degrees left and right. Plus, there's the convenience of toolless blade change. Supplied in a carry case, the JV0600K comes ready for action with a 2,5 m power supply cord, a hex wrench and a standard jig saw blade. To find out more about Makita power tools, visit www.*makita.co.za*

Send your letter to: Popular Mechanics, PO Box 180, Howard Place 7450, or e-mail *popular mechanics@ramsaymedia.co.za*
Please keep it short and to the point. Regrettably, prizes can be awarded only to South African residents.

SHOCKING POTENTIAL

In "Will it kill you?" (August 2017) you discuss the dangers of electrical outlets. What you fail to mention is that a human can be considered as something grounded. If a person were to touch the live terminal with a hand, chances are their feet would act as a grounding point and so would complete the circuit. Even thin-soled shoes offer little resistance to 220 V.

GAVIN BUCKLE
BY EMAIL

VIDEO ON DEMAND – MADE SIMPLE

Here's a challenge and a plea to all you inventive POPULAR MECHANICS readers.

My elderly mother has dementia and can no longer operate her DVD remote control. Given the lack of any decent programmes available on SABC, this means that her only form of entertainment is now gone. (We used to give her material to watch on a flash drive.) The more people I speak to regarding this problem, the more it becomes apparent that thousands of older folk are in the same boat.

What we thought of is using a Raspberry Pi linked to a TV that is permanently on AV1. This is where we need help, please! Is there anyone who would be interested in dumbing down an existing media player programme such as OSMC, or writing a new one, so that it just opens showing the file list of items to watch?

We are working on a simplified remote that has only a few buttons: on, select, play, pause and stop, so that it simplifies the process of selecting a file to watch.

Perhaps someone has already found a way around this problem. My husband and I would love to make contact with anyone interested in finding a solution. There are so many folk out there who could benefit from this.

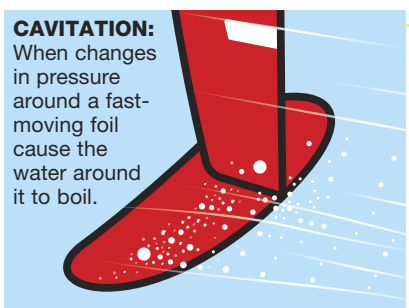
CAROL PIKE
PORT ELIZABETH

LET'S DO IT RIGHT

I have been reading POPULAR MECHANICS since the age of 12 – which was 70 years ago – and always thrill to the different technical articles. I still have copies dating back to the 1950s . Your August issue, relating the incredible "A Plane to the Stars" was truly informative and interesting.

Now I would like to challenge you on two fronts, as you like to be challenged. Firstly I believe POPULAR MECHANICS must do the math when referring to prices. South Africa is a Rand country and we really don't need prices shown in $. I know the original magazine is of American origin, but let's do it right.

Secondly, your sidebar on cavitation in article on Team Oracle US (July 2017), with the little picture of Oracle's blade, is misleading. The water does not boil and not in one's wildest imagination will steam arise from the blade at 50 knots through the water. I have been boating and racing power boats most of my life and cavitation has always been present with an incorrectly submerged propeller. All outboard motors are equipped with a cavitation plate, but the so-called boiling or steam is actually bubbles created when the propeller is incorrectly submerged and thus finds it has insuffient water to "grip" on resulting in it "slipping" and not thrusting at the solid water. This causes the bubbles.



After the Second World War, I obtained two Evinrude War Horses, which were 50/60 hp horizontally opposed (boxer-type) motors. Apparently American troops used these motors to push the huge steel landing craft on to the beaches. Using two-blade propellers, we had cavitation problems if the cavitation plate and propeller were not situated deep enough in the water to grip solid water at high speed.

Thank you for a good magazine.

GORDON BUTTO
BY EMAIL

(Regarding your first point: where possible we try to convert to South African units of measurement and currency, but sometimes it isn't feasible or logical and occasionally the troublesome item is contained in a direct quote, where a metric or South African equivalent would look odd coming from a US speaker. Using dollars can help in making clearer direct comparisons for, say, importing, when the varying exchange rate can confuse things.

On your second point, the writer used "boil" discriptively, not literally – Editor.)

SET SOME STANDARDS

Wouldn't it be nice if the full potential of installed green power could be used to produce hydrogen to be stored in standardised tanks to be used in standardised fuel cells? Fuel cells can be used to power virtually anything that needs electrical power.

The key is standardisation: a standard hydrogen from water unit or units, standard pumps to pump the hydrogen into standard tanks, standard fittings and couplings to fill standard fuel cells, to power standard invertors to power standard voltage equipment.

Imagine what efficiency could be reached per installed watt, and imagine the lower cost on this equipment if millions are manufactured.

STAN WOXHOLT
BALLITO

COULD CANCER ACTUALLY BE USEFUL?

Instead of trying to eliminate cancer (July 2017, cover story), we should be trying to manipulate it.

Here's something to think about: after more than 4 billion years of evolution, why are we still susceptible to cancer? Common sense suggests that all organisms should have evolved some sort of coping mechanism by now.

The only explanation is that cancer is actually something useful. After all, both cancer and the process of evolution are dependent on mutation. There are scientific journal papers that suggest that cancer is a cell's way of protecting itself, similar to a computer booting up in Safe Mode. The specialised cell reverts to its unspecialised state, thus protecting itself, in the process sacrificing the rest of the body.

But this leads to the conclusion that selfish cells will end up competing with the rest of the body. Research done on the evolution of cancer itself shows that some cancers have evolved defence mechanisms as though they were independent beings. What disturbs me is that a new species may be harbouring itself within our DNA.

So if we focus on manipulating cancer, we could turn the tables in our favour. It could assist in gene reprogramming, much like CRISPR gene editing. But it could also help us understand evolution, since cancer cells mutate within a period of months or days, as opposed to millions of years. The following equation says it all: Energy + Chaos Theory + Fractals + Mutation = Living Beings.

KRISHNA GOVENDER
TONGAAT

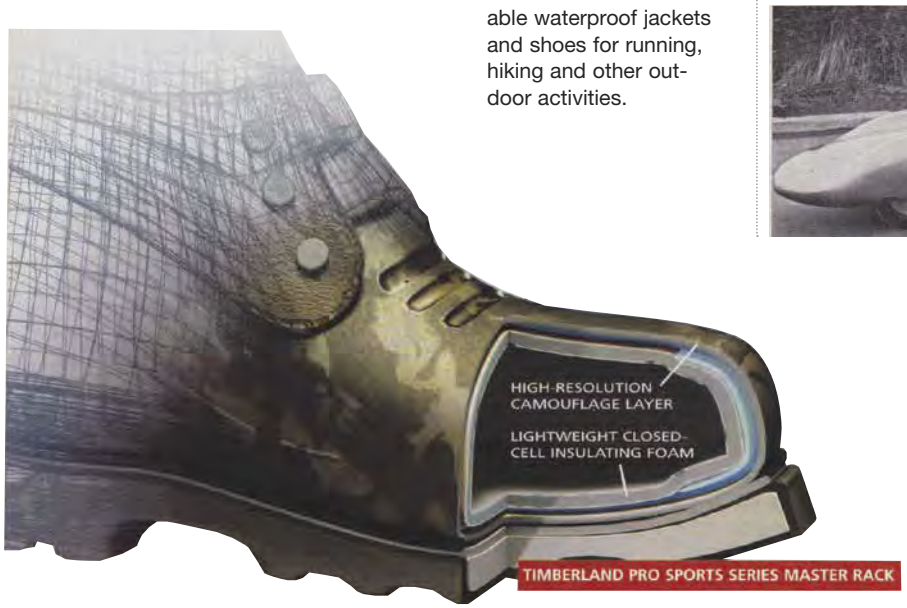
Time machine

1954 Unlike *Donkey Kong*, donkey ball really did involve asses, as well as people making asses of themselves. An odd mix of basketball and baseball, played on donkeys, donkey ball was a difficult game for both the players and animals. Originating in mining camps, it was used by miners to relax, but predictably most of their time was spent struggling to control their four-legged friends. A version of the sport is still played in some parts of the US, but has received criticism from animal rights groups.

Daredevils Play Donkey Ball

THERE IS a thrill per second in the familiar games of basketball and baseball when the players use such frisky and uncooperative means of transportation as the donkeys pictured on this page. The light-colored burro at the top of the page is appropriately named Atom Bomb. Donkey ball originated in mining camps years ago when the hard-working miners "relaxed" on Sunday afternoons by playing baseball on the backs of their faithful burros. Traveling donkey-ball troupes were popular in the 1930s, but today there are less than a dozen troupes left. They travel from town to town and recruit local daredevils to play the game, usually for charity benefits. Old-timers argue whether a donkey can be taught to respond to orders; most of them agree that he can't.

2004 Technology-driven clothing is far from a new thing. In this issue, we look at the best in lightweight rain jackets; back in '04, we examined the then-best fabrics for facing the elements as well. We took a look at breathable waterproof jackets and shoes for running, hiking and other outdoor activities.



2004 Boat-cars? Or car-boats? Either way, amphibious cars were the wave of 2004. The Aquada and the March Watercar were the first high-speed cars to transition from water travel to the road without missing a beat. The Dobbertin Hydrocar was a simpler water-only design that looked like a car, but worked like a boat. Neither managed anything like James Bond's Lotus Esprit in 1977's *The Spy Who Loved Me*, which not only had submarine capability, but boasted surface-to-air missiles, mines and torpedoes. Fortunately, this was all Hollywood fantasy.

1959 Meet the Zvedza, a cigar-shaped Russian racing car that stood a mere 70 centimetres high, forcing its driver to lie supine. Fitted with a tiny quarter-litre engine, it could reach 177 km/h. Speaking of tiny engines, in this issue we check out the evolution of the three-cylinder one-litre engine. **PM**

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zoom-zoom

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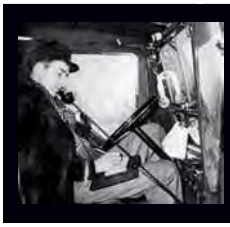
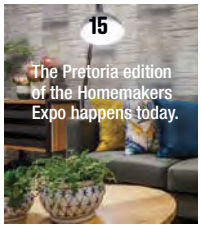
Calendar September

Get the most out of your month

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
 On 30 September 1906 (111 years ago), the world's first international balloon race began.			JOHANNESBURG BOAT SHOW Lifestyle Show		1 The Johannesburg Boat Show starts today.	2  In 1985, a US and French expedition located the wreckage of the *Titanic*, 73 years after the British luxury liner sank.
			6 OPEN BOOK CAPE TOWN The Open Book Festival takes place in Cape Town until the 10th.	South African BOOK FAIR 2017	8 Enjoy more reading at the South African Book Fair in Joburg today.	9 The African Bird Fair starts today. THE AFRICAN birdfair
 11 In 1946, the first mobile long-distance car-to-car telephone conversation took place between Houston and St. Louis.	12		13 In 1928, the first rail detector car was demonstrated in New York. 	14	15 The Pretoria edition of the Homemakers Expo happens today. 	16 GM In 1908, former carriage-maker William Crapo "Billy" Durant founded General Motors.
17	18 A new issue of POPULAR MECHANICS goes on sale today.	19 Aaaaaar! It's International Talk Like A Pirate Day. 		22 CAR FREE DAY! Put away your keys: today is World Car Free Day.		23 Getaway GAUTENG SHOW 2017 The Getaway Show comes to Johannesburg.
24 It is Cape Town's turn to experience the Coffee & Chocolate Expo.	25 On this day in 1974, scientists first reported that Freon gases released from aerosol spray cans were destroying the ozone layer.		27 In 1960, Europe's first "moving pavement", the travelator, opened at Bank station on the London Underground.		29 The Hermanus Whale Festival starts.	30 On this day in 1906, the world's first international balloon race began.

Future Park comes to South Africa for the first time this year. Brought to you by teamLab, the Future Park exhibition will showcase interactive digital technology at the V&A Waterfront's Watershed from 23 September to 31 January.

The exhibition has seen more than four million children across the world play in an ever-changing digital environment while they develop their fine motor skills. The exhibition's fun, interactive activities will captivate the imagination and introduce young ones to the wonders of technology by using scanners and sensors to make each child's colourful drawings come to life in a digital universe.

The Hermanus Whale Festival runs until 2 October and allows visitors a chance to enjoy the unique natural environment, watch the whales and revel in music, great food and other activities.

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FEATURES

Primary Blade Length : 6.6 cm
Closed Length: 8.9 cm
Weight: 42.5 g

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420HC Knife
Bottle Clip

FEATURES

Primary Blade Length : 6.6 cm
Closed Length: 8.9 cm
Weight: 42.5 g

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Can Opener
Bottle Opener
Corkscrew

FEATURES

Closed Length: 8.13 cm
Weight: 42.5 g
Aluminium Handle Scales

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2

COLUMBIA
GRAPHITE

TOOLS

420HC Knife
420HC Serrated Knife

FEATURES

Blade Length : 6.60 cm
Closed Length: 8.13 cm
Weight: 42.5 g
Aluminium Handle Scales

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BEAUTY IN THE AI OF THE BEHOLDER

Scientists have trained a computer to recognise beautiful scenery using "deep learning", an approach to artificial intelligence inspired by the architecture of the human brain.

WHAT IS IT ABOUT SCENIC SIGHTS that makes jaws drop, eyes open wide in astonishment and fingers prepare to tweet "awesome!!!!!"?

We're closing to finding that out after researchers at the Data Science Lab at Warwick Business School took more than 200 000 images of places in the UK that had been rated for their beauty on the website Scenic-or-Not and showed them to a deep learning model in an effort to find out what makes a scenic location beautiful.

The deep learning model processed all 200 000 images and labelled them with information on what was in the picture: 'valley', 'grass', 'no horizon' or 'open space'. Using these labels, the researchers were able to investigate which attributes of a scene led to higher scenic scores. The scientists then trained a new deep learning model to look at pictures and rate them itself.

They tested their model in London and it not only identified parks such as Hampstead Heath as beautiful, "but also built-up areas such as Big Ben and the Tower of London", says Chanuki Seresinhe, of the Data Science Lab at Warwick Business School. Seresinhe, along with WBS Data Science Lab directors Suzy Moat and Tobias Preis, used the MIT Places Convolutional Neural Network – a deep learning model – to analyse the images from Scenic-or-Not, which were rated by one and a half million people, and find what attributes, such as 'trees', 'mountain', 'hospital' and 'highway', corresponded to high and low scenic ratings.

Deep learning models are a particular kind of 'neural network' – simulated networks of neurons, like those in the human brain – and have driven recent dramatic advances in artificial intelligence tasks, such as facial recognition and speech recognition. Using the MIT Places deep learning model, the researchers found that fea-

ISTOCK PHOTO/MATTHEW LEES DIXON (MAIN IMAGE) ISTOCK PHOTO/TOMAS SEREDA (BIG BEN)

tures such as 'valley', 'coast', 'mountain' and 'trees' were associated with higher scenicness.

But it's not just natural beauty that matters. Some man-made elements also tended to improve scores, including historical architecture such as 'church', 'castle', 'tower' and 'cottage', as well as bridge-like structures such as 'viaduct' and 'aqueduct'. Interestingly, large areas of greenspace such as 'grass' and 'athletic field' led to lower ratings of scenicness rather than boosting scores.

"It appears that the old adage 'natural is beautiful' seems to be incomplete," she added. "Flat and uninteresting green spaces are not necessarily beautiful." Characterful buildings and stunning architectural features can improve the beauty of a scene. "I am fascinated by how deep learning can help us to develop a deeper insight into what human beings collectively might understand to be beautiful."

These findings are particularly interesting in the context of previous research, which showed that people who live in areas rated as more scenic report their health to be better said Dr Moat. "Our new results shine light on why a location being green might not be enough for it to be considered attractive. This distinction has clear relevance for planning decisions that aim to improve the well-being of local inhabitants."

The scientists then adapted the deep learning model to rate the scenicness of new locations, and tested it on more than 200 000 photographs of London that the model hadn't seen before. Professor Preis said it was fascinating to see that the model understood that bridges and historical architecture increased the perceived beauty of a scene, whereas grass and greenery were not necessarily scenic. "Our previous results make it clear that scientists and policymakers alike need measurements of environmental beauty, not just measurements of how green places are. Games like Scenic-or-Not can help us collect millions of ratings from humans, but having a model that can automatically tell us whether a place is beautiful or not opens up completely new horizons."

Their findings, 'Using Deep Learning to Quantify the Beauty of Outdoor Places' are published in *Royal Society Open Science*.

THE TEAM

Chanuki Seresinhe lived and studied digital media in the surroundings of the Silicon Valley during the commercial birth and boom of the World Wide Web. After more than eight years of running a digital design consultancy in London, she returned to university to pursue a PhD. Her research entails using big online datasets from such sources as Flickr and Twitter to understand how the aesthetics of the environment affect human well-being.

Associate professor of behavioural science and finance **Tobias Preis'** recent research has aimed to carry out large-scale experiments on complex social and economic systems by exploiting the volumes of data being generated by our interactions with technology. In 2010, Preis headed a research team that provided evidence that search engine query data and stock market fluctuations are correlated. He draws on an interdisciplinary background in physics, economics and computer science; is a prolific author; and advises government agencies as well as private companies on potential exploitation of online digital traces.

Suzy Moat, associate professor of behavioural science and co-director of the Data Science Lab, researches whether data on our use of the Internet, from sources such as Google, Wikipedia and Flickr, can help us measure and even predict human behaviour in the real world, from linking online behaviour to stock market moves to estimating crowd sizes. Widely featured in the media, she has also acted as an adviser to government and public bodies on the predictive capabilities of big data.

DO YOU (STILL) NEED A REAL CAMERA?

LYNSEY ADDARIO TAKES her camera to places where photographs matter. She took it to Afghanistan before September 11. She took it to Libya to document the 2011 revolution, and it got her captured by pro-Qaddafi forces, who held her hostage for six days. She takes it to South Sudan, to ISIS strongholds in Iraq, to the dark corners of the world where Syrian refugees hide. She has no formal training in photography, but she does have a Pulitzer Prize for her work at *The New York Times*, and she regularly reports for *National Geographic* and *Time*. The title of her excellent 2015 book answers the question people always ask about why she keeps carrying her camera into danger: *It's What I Do*. She thinks smartphone cameras are well and good, but she believes in carrying a dedicated camera, too. For when you want your photographs to matter.

"Unless I'm sneaking photos while I'm on assignment somewhere dangerous, I always use my camera's viewfinder. That removes me from the subject a little, and that distance allows me to analyse what I'm looking at. I always say: get tight, get closer. Don't just take a general shot of your subject from 200 feet away. Compose it. With a real camera, you understand that commitment. I was on assignment in Michigan, photographing a Bengali wedding. I post to Instagram when I'm out, so I shot a few nice frames with my phone. But the photos taken with may camera were richer – the sharpness, the colour saturation, the tone. A phone is handy. An f/1.4 lens and a big sensor is something different altogether. If you want to invest in photographing – even your everyday life – you need the right tool." – LYNSEY ADDARIO

FOUR CAMERAS POPULAR MECHANICS RECOMMENDS

FUJIFILM X-T20

For the intermediate to advanced amateur. You spend four figures for the durable body, sharp photos and Fujifilm's wide range of excellent lenses.

R15 000

SONY A6000

A perfect first camera. Lucid menus and dials make it easy for beginners to use, but customisation options and photo quality will last over the years as your skills improve.

ABOUT R7 000

CANON G9 X MARK II

Fits in a pocket, but its big sensor means richer images than any smartphone, particularly at night and indoors. Ideal if you want to be inconspicuous or travel light.

R6 595

LEICA M10

Priced for the serious photographer, because the vividness you get from Leica glass is unparallelled. No autofocus means you have to work, but it's rewarding to master. And the metal body elevates it to something rare in gadgetland: an heirloom.

R113 000

PHOTOGRAPH BY GREGORY REID

ME AND MY TECH

Popular Mechanics has hunted down some of South Africa's busiest and most successful people to find out what tech makes their lives better.
– LUMKA NOFEMELE

MAPS MAPONYANE is an actor, model, presenter and businessman. He does it all. He keeps his personal and professional life in order with the help of his Samsung S8 and S3 Gear smartwatch.

Samsung S8

Q What are some of the things that you do on your S8 that help you in your career?

A I do everything on it. It is super efficient. I can run multiple apps at once and it comes with a fast charger, so I have extended battery life. I can get a full charge in an hour. The S8 has high storage space, so I can download files and pictures for work and I can watch my videos or photos from shoots in the best quality.

How long have you had your S8?
Pretty much as soon as it came out, at the beginning of June.

Would you say that this is a must-have gadget for somebody in your line of work?
Definitely. If you are a really busy person, you need a device that speaks to every other device in your life. I can control everything from my washing machine to my watch through my phone.

Is there anything you don't enjoy about your S8?
Well, it makes me quiet anxious cause it has a great design and I'm in constant fear of dropping it.

What edge would you say your S8 has over other phones you've used in the past?
The device comes with Bixby vision. I just have to point my phone at an object and it gives me more information about that object or allows me to buy it online. I can also translate languages and complete tasks faster with Bixby.

< Samsung S8

Samsung Gear S3 >

Samsung Gear S3

How long have you had your Gear S3?
I upgraded from the S2 at the beginning of the year.

What do you mostly use your smartwatch for?
So many things. I especially use the maps feature, to track my runs and walks and to see where I am.

What did you think about wearables before getting your S3?
I collect watches, so it wasn't easy for me to change from a classic analogue watch to a smart watch, but now I can't take my S3 off. It is easy on the eye so I can wear it anytime like an ordinary watch.

How would you say your S3 has improved your life (personally and professionally)?
It has helped me be more efficient with my time. I can send quick replies to messages through my watch. I don't have to look at my phone, get distracted and end up looking at my phone for 20 minutes.

It vibrates on my wrist in the morning, giving me a pleasant wake-up and monitors my sleeping patterns.

THE CONFIDENT TRAVELLER

10 TOP TIPS
WHEN TRAVELLING WITH YOUR TECH

Adding technology to the long inventory for a holiday or business trip abroad can create unforeseen headaches. Here are eight tips from Mohamed El Aougri, sales director for Targus South Africa (plus two of ours), to make travelling with technology as simple as possible.

Check security protocols
Some countries have extremely tight security procedures and some might even ask you to switch on your laptop to search its contents, especially during periods of heightened terror threat. Allow enough time for this when you're planning to get to the airport, to make sure you don't miss your flight.

Keep documentation
Yes, some even ask for receipts. At the very least, you should have serial numbers for devices such as laptops. Most devices have these readily available on the casing or printed on the battery.

Go smaller
Laptops have hinged parts that need extra caution, but if you absolutely need to take one, make it the lightest one you have. If possible, carry fewer and smaller devices, preferably a tablet for business and a smartphone for leisure.

Take extra batteries
If your device has a removable battery, you can keep one charging while the other is in use. Make sure that your carrying case has spare capacity for batteries and chargers.

Use a power bank
A high capacity power bank will be quite large and bulky. This is unavoidable if you'll be spending extended periods in unelectrified zones and intend charging multiple devices for specific tasks. For brief trips, a small-capacity device for mobile phones should do just fine.

Carry a power adaptor
You don't want to be caught in a foreign country having to buy a new camera simply because they don't have the right plug for your charger. A universal power adaptor is useful, but familiarise yourself with requirements for plugs and voltage. A word of caution: ask the salesperson to help you test the device to make sure it works and converts the voltage properly as quality standards tend to vary.

Back up your info
With the recent spike in ransom-ware attacks, where cyber-criminals gain access to computers and demand money for the safe return of the files, regular backup is vital, even for home use. Using your computer on unfamiliar networks adds to this risk, and it's worth taking extra precautions. Back up all your data in the cloud or on an external storage device that is kept in a safe place, or both.

Appropriate carrying case
Your carrying case should have ample space for all the various accessories and cables you might need and it should be ergonomically designed to protect your shoulders and back. The ideal scenario is fewer, smaller devices in a slim carrying case that doesn't strain your arms, shoulders or back. For heavy tech users, the carrying case needs to be sturdy enough to protect the main device as well as the auxiliary equipment. Consider a backpack or a roller bag for extra comfort during the long walks through airports.

Cut cables
Stop your device cables from turning your bag into a weaver nest by sticking to common connection types. USB type-C, micro-USB and Lightning are the only ports that matter in portable electronics, if you only need those you'll be able to find suitable cables anywhere. Go for shorter lengths as far as possible, but have at least 1,5 metres for your laptop charger and one of your primary device (smartphone) charger.

Designate a Wi-Fi device
Public Wi-Fi can be very helpful when travelling. If you can afford it, have a separate phone and email address to connect to unfamiliar hotspots. You can always tether your primary phone to it.

THE APES ARE COMING

And they're going to look more real than ever. The trees, too.

BY TIM GRIERSON

In the latest *Planet of the Apes* sequel, *War for the Planet of the Apes*, apes and humans battle for supremacy and the future of their species. Again. For the effects company responsible for the simian half of the battle, Weta Digital, the stakes felt nearly as high. "Every movie feels like a start-up," says visual effects supervisor Dan Lemmon, who was nominated for an Oscar for each of the first two *Apes* films in the current reboot series. Weta can't just use the same technology from the prior movies. It has to be better. This time, they'll even have to do it in the snow.

Snow that rests on an animal's fur has to look different from snow that's closer to the skin, where body heat causes the snow to start melting.

1 THE SNOW

Before Weta started on the film, director Matt Reeves gave the creative team a warning: there is going to be snow. "The biggest challenge with snow is interaction," says Marco Revelant, Weta's head of assets. Especially with the fur. "Falling snow sticks to fur, but if it's close to the skin it will start to melt. This in-between stage is a material and lighting challenge to get it to look totally believable." Creating the snow was a feat of collaboration. Modellers styled the fur and added snow to it. Coders wrote custom programs to make the snow look more realistic as it transfers to or from the apes' bodies. And the effects guys added the falling snow and footprints around them.

2 THE TREES

War features an epic battle that takes place in the forest. For this instalment, Weta built upon technology developed for another film, *The Jungle Book*. "On *Jungle Book,* we made probably a dozen trees, and then we started building the jungle from them," Lemmon says. "But we ran into the same problem that we've run into several times: you start to see the same tree over and over again. Plus, each tree might look correct, but the way that they relate to one another – the way the branches encroach upon another's canopy and the way that they cluster together and are arranged – those are all things that are difficult to replicate." The trick was to go micro, focusing on branches and leaf structures, rather than on overall trees, as the model for populating the apes' CGI woods.

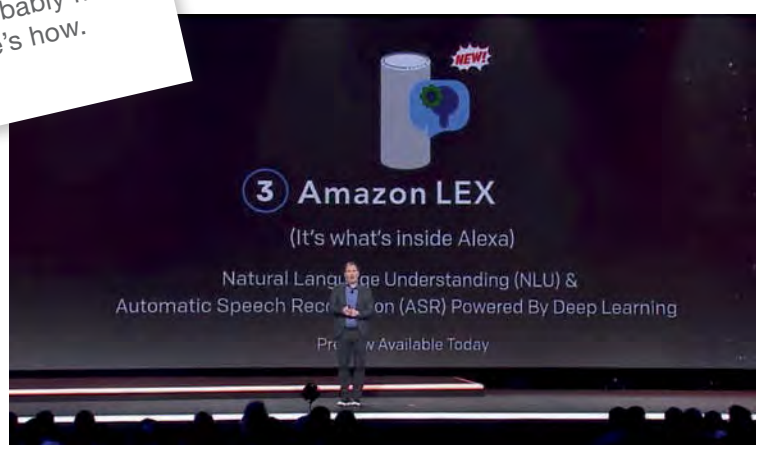
3 THE CHIMP

The leader of the apes, Caesar (pictured; played by Andy Serkis), is the most complex CGI character ever. "In this movie, Caesar is even more emotionally distraught," Lemmon says. "The facial expressions Andy was making were so evocative but also incredibly difficult to map back on the face of a chimpanzee." To accomplish it, Weta drew on cutting-edge video-game technology. "We adapted graphics cards to make our animation tools a lot more interactive and faster. The animators can try things out and iterate at a rate that's, in some cases, four or five times as fast as they were able to do on the last movie."

HOW AMAZON REALLY MAKES ITS MONEY

Most South Africans aren't aware that even though we don't have unfettered access to the global leader in online retail, you probably make use of Amazon every day. Here's how.

BY LINDSEY SCHUTTERS



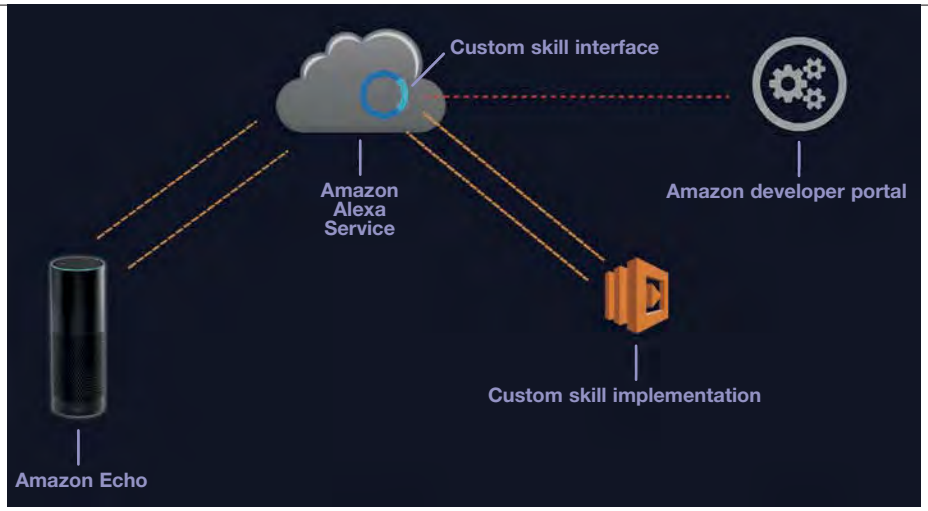
There are few futures as certain as the one that is dependent on cloud technology and built on powerful artificial intelligence. It just so happens that those are the markets that Amazon holds the lion's share of and is innovating in.

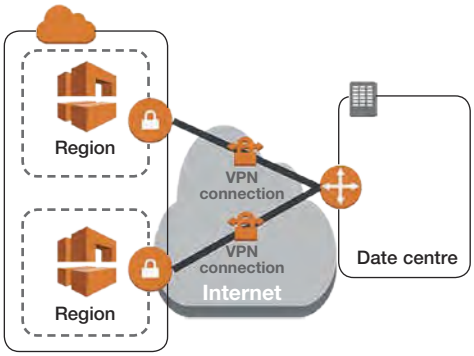
IN THE LAST WEEK OF FEBRUARY IN 2017, a significant part of the Internet broke. Amazon put out a press statement in the days following the outage, explaining how a team in the Amazon Simple Storage Service (S3) US-EAST-1 Region was debugging an issue and made a mistake in the command to take a small number of servers off one of the subsystems. The command took many more than intended off. Quora, Medium, Zendesk, Adobe cloud, Autodesk cloud, Citrix, Flipboard, Coursera, Mailchimp and even Strava can be counted among the astronomical number of affected services. Our sister publications have recently migrated their website image hosting to AWS; that went down, too. A solitary error in a single line of regularly used code sent ripples to the widest reaches of the Web.

Like spiders sensing the vibrations, social media pounced on the company's misfortune in hilarious fashion.

It's a Wednesday in July and I'm seated in a packed convention hall. Every CIO worth his bitcoin is present at the AWS (Amazon Web Services) Summit at the Century City Convention Centre in Cape Town. The lunch queue at the carnivore-friendly stations was at least 150 people long after half an hour of service. It's the type of event where, if a bomb had to explode in the concourse area between sessions, Apple would lose significant market share in South Africa.

A fellow journalist seated to my right disputes whether Amazon is really important enough in our market to warrant such an event. I ask him if he had ever shopped at Pick n Pay and explain how the retail chain uses AWS for large parts of its operations. His eyes blow his unimpressed





The secrets of AWS is creating services that customers ask for and then turning those into highly customisable tools for everyone.

Amazon CEO and founder Jeff Bezos (left) and VP Werner Vogels share impressive degrees in computer science, little wonder AWS is so dominant in the cloud.

bluff. He is quite surprised when the podium is brought out for the Cape's executive mayor, Patricia de Lille.

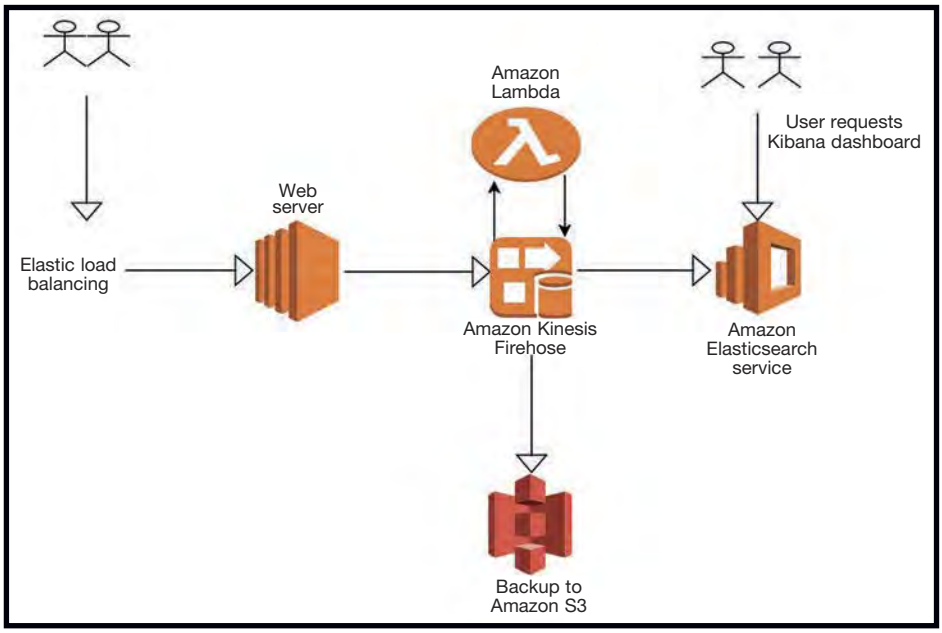
"As young people, you have the opportunity to shape and design your own future," says the mayor to the captive audience. She continues by thanking Amazon for hosting the summit in Cape Town, extending welcomes to the more important attendees. "You are at the right place, at the right time because you are in the Digital City of Cape Town. We have the most tech start-ups in the whole of the continent. One of our key transformational priorities in the city is we want to see technological progress. I always say to people that the world owes us nothing and we have to go out on our own to get things and find the best minds to help us govern our city."

She carries on explaining how cities are the drivers of change in this century and that they are affected by urbanisation and digital innovation. "Cape Town has grown more than 30 per cent in the past 10 years, but we need technological solutions to help us manage urbanisation. Our contribution to the economy is a R6 billion investment in infrastructure and hope that the private sector comes on-board to help further grow that investment. We have rolled out more than 800 km of fibre for broadband and, when this project is completed in 2021, we will have rolled out 1 300 km of fibre-optic cable. We have enough capacity in government and have connected our schools and libraries, but we also have extra capacity that we have been renting out to the private sector. By doing that we stimulated healthy competition."

Cape Town has also recently gone to market with its first Green Bonds, which were overscribed before the auction. The bonds are tied to projects and have been graded by Moody's and the Climate Change Institute with the city leading the country with AAA.ZA ratings. While the mayor was hopeful of achieving the billion Rand ambitions, she was quick to point out that those funds will be funnelled into infrastructure.

What does this have to do with Amazon Web Services? The city's digital innovation hub, Bandwidth Barn, hosts the Barclay's Rise incubator programme, which has named Cape Town the Rise capital for africa, taking its place as the fourth such capital in the world. Many of the start-ups coming out of Bandwidth Barn use AWS as their backbone.

Amazon is a services company and chief among those services is digital. The company's chief technology officer and vice president, Werner Vogels, strides out on stage to set the tone for the summit centrepiece: selling cloud services. While in the registration queue, I was privy to a brief conversation between what were



LIVING HIGH

A few innovations that keep AWS at the top of the pile

AWS Shield
An all-encompassing cloud security service that is available to all AWS customers. This alleviates the need for over the top security development for the hosted app or service.

Elastic GPUs
Need extra processing power? Amazon has the full spectrum of computing needs covered.

Lambda
Serverless computing that powers companies such as Netflix LexisNexis and Popular Mechanics parent publisher Hearst.

AWS Greengrass
A culmination of various web services products that is powering the connected future. This new product allows IoT manufacturers to start the development in the cloud and have access to infinite scale.

obviously former colleagues. The one who had since left the company to join Amazon remarked that the other would probably be fast-tracked into the summit because of his customer status. He was right. After a short word with one of the event staff, the man was ushered to an empty desk where a young lady stood waiting with his already fully prepared identification lanyard.

Amazon treats its clients like nobility. When you combine that client-centric attitude with relentless cloud computing innovation, you quickly realise exactly why Synergy Research found it to hold a mammoth 40 per cent of the cloud computing services market in the final quarter of 2016. That's more than its three closest rivals (Google, Microsoft and IBM) combined. With CenturyLink and Verizon exiting the cloud realm by selling off its data centres, it'll be little surprise if Jeff Bezos' brainchild closes in on half of the market by the end of the decade. Those ripples will be felt much further then.

"It's amazing that we've doubled the attendance from last year, but let's make sure that next year this conference centre is too small," says a characteristically upbeat Vogels of AWS's steadily expanding local footprint. He then speaks of how some SA companies were established on AWS since day one and that those experienced clients should spread their expertise with others.

In 2016, AWS launched more than 1 000 new and beta services, all in reaction to customer feedback and engagement. "We took a radically different approach to the way other major technology companies were bringing new software and services to market," Vogels says directly to the audience. "Basically, they would tell you how to develop your software. 'This is the platform, these are the tools you use and here's how you build it.' We believed that cloud was going to be such a revolutionary approach to software that we wouldn't be able to predict what platforms you will use or what type of systems you would like to build with. We've taken a toolbox approach where, instead of telling you how you should develop, we give you a toolbox with all sorts of very high-end, fancy tools in it so that you can make decisions about exactly how you want to build with what."

This forward-facing approach allows for Amazon's own tool developers to let their imaginations run wild and ensures that customer-use data is always flooding in with customisations also being led by customer requests. Data is the oil of the digital revolution and Amazon is in the data storage and refinement business. This is evidenced in the rapid development of its consumer-facing marquee product: the Amazon Echo. Alexa just got released as a native app on the HTC U11. Why is that significant? HTC made the Pixel for Google last year and had probably begun developing the U11 as a follow-up to that device. The Pixel debuted the Google Assistant, the Mountain View company's Alexa competitor.

Alexa is creeping into everything, with app and IoT makers commiting market suicide if there is no direct integration. Amazon is also feeding the customer interaction with Alexa into its algorithms to continuously evolve the platform to meet more complex, nuanced needs. All those customer interactions also feed into the voice-recognition underpinnings of the system: Lex. Amazon then packages Lex into and off-the-shelf product that developers can by to compliment cloud-based platforms with of the best voice artificial intelligence on the market. The company just happens to name its own iteration of Lex, Alexa.

If you thought that Amazon was just an online retailer, you were wrong. While there have been a couple of hardware missteps in the past with the Fire line of devices, now that the company is leveraging its greatest tool, it's the Kindle all over again. That success was so huge it became how we refer to an entire product category. Amazon is poised to be one of the dominant cloud computing company for decades to come. It's a position of strength that was built on being laser-focused on customers. There shouldn't really be a separation between AWS and Amazon, it's all just Amazon services. Well, until there's another coding mistake.

THE E-BIKE FOR EVERYONE

A bike is the fastest, and certainly most fun, way to get around any city. It's also the sweatiest. Enter the electric-assist bike, or e-bike, which gives you a boost while you pedal. The bikes have been slow to catch on in the US because they're expensive and often weigh more than 22 kg. Worse, the battery packs look more like industrial goiters than integrated components. The Volta, from Los Angeles based Pure Cycles, has none of these problems. The new e-bike, which on appearance alone looks fun to ride, weighs 18,6 kg, making it light enough to haul up and down stairs. The price tag ($2 500, available September) registers at least a grand lower than comparable rides. The space-saving 22-inch wheels are quick but sturdy. Instead of bulging from the frame, the battery is tucked inside the top tube; and an embedded GPS tracker records rides and alerts your phone if the bike is moved.

THE BEST LIGHTWEIGHT RAIN JACKETS

WHETHER YOU'RE FACING A DRIZZLE or a downpour, we at Popular Mechanics are acutely aware of the benefits of a quality waterproof and breathable jacket, so we took it upon ourselves to find the best rainwear for you.

A good rain jacket requires a few things: good seam sealing, a durable water repellent (DWR) coating, a secure adjustable hood, a high waterproof rating and breathability.

Not only does your rain jacket need to keep rain from getting through to your skin, it needs to move sweat back through to the outside world.

All waterproof rainwear has an added DWR finish. When a jacket's outer fabric is water repellent, precipitation literally beads up and rolls off.

Because even the most breathable rainwear can get overwhelmed during strenuous activity, almost all rainwear has pit zips (underarm vents) with some jackets going a step further, having mesh liners in torso pockets that can double up as additional vents.

Make sure to check for these factors before making a purchase and, while you're at it, check your jacket's waterproof rating.

A rating of 5 000 to 10 000 mm is suitable for most weather conditions and great for walking the dog or a jog in bad conditions, but is best worn under light rain and light pressure. For more extreme weather conditions, a jacket of 10 000 mm to 15 000 mm or above will offer the best protection. For heavy rain, snow or high-pressure conditions, a 20 000 mm rating is your best bet.

1 K-Way Merak Tri-lam Shell Jacket

This sleek and spacious black jacket is part of K-Way's expedition series and is made of 100 per cent nylon.

With a 20 000 mm waterproof rating, this jacket can brave most of the elements.

The hood is articulated and adjustable for volume and visor control. Fitted shoulder reinforcements protect the fabric from scuffing caused by backpack straps. Your backpack's shoulder straps are kept in place by a non-slip feature and pit zips have been added for ventilation. The hem and cuffs are adjustable to keep the cold air out and the seams are taped for added waterproofness.

The jacket also has a secondary internal baffle to redirect any water that may enter through the front zip.

2 K-Way Kilimanjaro Shell Jacket

Also 100 per cent nylon, this berry-coloured jacket for women has three layers of protection from the elements: a high-performance membrane bonded to a tough outer material and a robust inner mesh. With a 15 000 mm rating and water-repellent zips, you are certain to remain completely dry no matter where your road takes you.

The Kilimanjaro Shell has an engineered arm articulation at the elbow point and the usual extras of underarm pit zips for added ventilation integrated, an adjustable hood with a reinforced visor and adjustable hem and cuffs. The bright colour, paired with the reflective logos, helps make you visible in low light.

3 Asics packable jacket

Keep your head protected with the adjustable hood, and your lower back covered with the slightly longer hem. Plus, keep the air flowing with vent panels.

Slip it off quickly when mid run with the easy grab zip and stand out at the finish line with the all-over bright print design.

Ultralight, non-bulky fabric makes this jacket easy to pack with the pocket doubling up as a storage pouch.

4 K-Way Race Shell Jacket

This bright blue stretch jacket is 88 per cent polyester and 12 per cent spandex with a 10 000 mm waterproof rating.

The design features laser cut back mesh vents as well as hidden underarm vents. Using just one hand, the hem and hood is adjustable and features a soft polyester inner visor for comfort and moisture control. The hood folds down into a mock collar with a Velcro tab to secure it. The front chest pocket is completely laser cut, with reflective logos.

5 K-Way Bonnie Rain Jacket

Bonnie is 100 per cent nylon and finished with a water-repellent and a waterproof polyurethane coating. It's lined with mesh for added vapour permeability and features two hand warmer pockets, an internal zip pocket and a secure internal chest pocket. The jacket is completely packable into the hood and has an 8 000 mm waterproof rating.

ALL MINE

Crypto currency is the smart money of the present; here's how to make more of it.

Before you rush out to put your gaming rig to work, there's one thing you need to know: mining on your graphics card isn't very profitable anymore. That said, there's still some money to be made. So let's make it.

Q Can anyone with an internet connection mine crypto currency?

A Yes. Most crypto currencies are built on the blockchain and mining is the process of adding blocks to the chain. Well, technically validating blocks.

What are blocks and please explain why they appear in a chain?

Blockchain is a software-based transactional ledger that exists in a peer-to-peer distributed network. For this example we'll use bitcoin. Any bitcoin transaction is added as a block to the blockchain and is immediately viewable by any computer that is associated with that blockchain. Miners do the work of capturing the transaction data, adding it to the chain and encrypting it with a hash. That's the secret sauce of the entire process because the next block added to the chain uses the preceding block's hash for verification. If a hacker wanted to then tamper with the system, that person would need to have control over more than half of the computers associated with that blockchain to have the chance of altering the hash encryption code. Altering that hash would also change the data contained inside the block, so the hacker would also need to decrypt the hash as well.

Okay, so why does bitcoin pay for this encryption?

Because it takes processing power and consumes energy. When you're mining you are contributing your electricity that drives your machine and crunches the numbers to capture the transaction. You then get rewarded for your efforts with a fraction of a currency. No-one owns the blockchain, making it a truly democratic system.

And I can do this with the gaming PC I already own?

Yes. Kind of. You'll be competing against purpose-built server farms in China. Because only one new block can be added to the chain every 10 minutes and hashes are ridiculously hard to generate, the more hashes you can process per second, the better. GPUs have become less efficient at processing hashes compared to proprietary application-specific integrated circuts (ASIC) which are designed for specific currencies. You'll need to join a mining pool which electronically voltrons your rig to a network of rigs to maximise processing power.

Your perfect mining rig **MSI GE72MVR Apache Pro**

We were a bit harsh on the previous model, but this unit comes with a VR-ready Nvidia GeForce GTX1070 graphics card, backed by up to 64 GB of DDR4 RAM and seventh generation Intel Core i7 CPU. We actually didn't have a game that this machine couldn't cope with and it all looked superb on that 120 Hz 17,3-inch screen. Because the GTX1070 is capped at 151 W, your power consumption won't be too hectic when mining with this machine during non-playing periods. The card is capable of around 20 MH/s (million/mega hashes per second) and MSI's CoolBoost 4 system should keep things nice and temperate with three heat pipes dedicated to the GPU.
R38 000, *msi.com*

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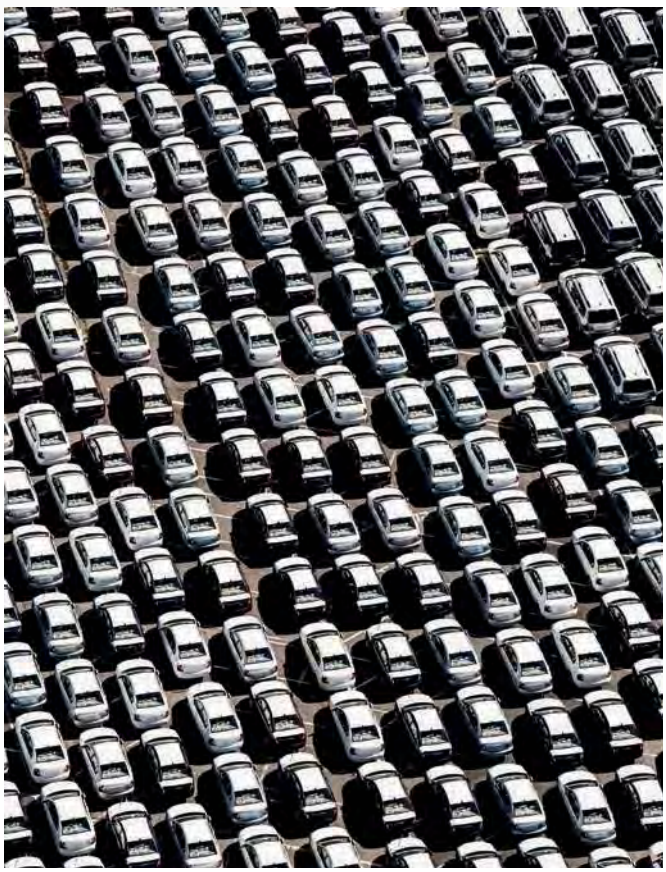
BIG QUESTIONS. ANSWERS YOU CAN'T FIND ON THE INTERNET.

AT BIG CAR COMPANIES' HEADQUARTERS, DOES EVERY EMPLOYEE DRIVE THAT CAR?



GETTY

PRETTY MUCH. Though some carmakers surveyed did their best to evince a magnanimous spirit towards those woefully misguided employees who might elect to drive a competitive vehicle, one gets the sense that, generally, American auto-workers are, ahem, strongly encouraged to cruise the streets propelled by the hand that signs their paychecks.

Of course, many autoworkers gladly drive the house brand out of loyalty. General Motors plant communications manager Mary Ann Brown said that after 40 years, she has "blue blood". "I am extremely loyal to my company. They're the ones who pay me. I tell people, 'What is someone going to think if they come to your house and they find a non-GM vehicle in your driveway? What does that tell them? That even though you work there you don't think their vehicles are worth purchasing?'"

There's also a sense of pride that comes into play; how many people, after all, can say that they personally built the engine in their car? "We have a lot of Silverados and Sierras in the parking lot," Brown says. "Then people can say, 'Yep, the Side Three that's in the engine, I helped build it.' I have a middle-aged woman building Corvette engines. She went out and bought an absolutely beautiful Corvette. She's having a blast with it." We'll bet she is.

Manufacturers generally make it easy, too, offering workers attractive discounts and lease deals. Former Chrysler engineer David Tracy fondly recalls the corporate lease programme: "It includes maintenance and insurance so you don't have to worry about tyres or oil changes or things like that."

That's the carrot. Here's the stick: in some cases, employees who stray from the brand they build are banished to special, less convenient parking lots; a sort of automotive Siberia. Presumably these subversives have plenty of time to contemplate the error of their ways as they trudge to and from their posts through those long Michigan winters.

Fiat Chrysler is perhaps the most rigid, explicitly earmarking 80 per cent of employee parking at corporate HQ for those driving company-made cars, and reportedly slapping parking boots on interlopers who poach proprietary spaces. "We buy what we build and we support our company," says FCA spokeswoman Jennifer Herman. "The competitive parking policy is an outward expression of these principles."

Similarly, at certain plants, Ford reserves "premium" parking exclusively for company-made vehicles. Some manufacturers do profess to be more flexible: Japanese carmakers such as Honda and Toyota say they couldn't care less what you drive or where you park it, so long as you show up for work. Even so, we suspect ambitious workers will consider appearances and choose their cars carefully.

Do you have unusual questions about the world and how it works and why stuff happens? This is the place to ask them. Don't be afraid. Nobody will laugh at you here. Email *popularmechanics@ramsaymedia.co.za* Questions will be selected based on quality or at our whim.

ASK ROY

POPULAR MECHANICS' SENIOR HOME EDITOR SOLVES YOUR MOST PRESSING PROBLEMS.

BY ROY BERENDSOHN

Q Can I drill holes with an impact driver?

A Yes, you can use an impact driver. The important thing is the drill bit. You can make small holes in light-gauge steel and soft wood with an impact driver using a standard hex-shank drill bit, but if you want to make holes larger than about 5 mm in heavy steel, hardwood, or pressure-treated lumber, you need a bit rated specifically for an impact driver. Otherwise it will either snap or detach from its hex shank.

Q My central air-conditioning system doesn't seem to be moving much air. What's the problem?

A Of the things that can contribute to lack of air movement, some are simple enough for you to check. For others, you'll need a contractor.

If the system seems to have slowly and gradually lost air movement, that could be a dirty evaporator coil or air filter. It takes a lot of neglect and a lot of airborne dirt to cause an air-blocking build-up, but it can happen. For example, if your home went through a long phase of remodelling and the contractors didn't do much to keep flying dust under control, that could be the cause. Have a look at the filter and, if you know where to find it, check the evaporator coil, too. Another source of slow loss of air movement is a fan that's not operating properly. Normally fans and blowers either work or they don't, but one that runs intermittently or is turning slowly (and perhaps even overheating) could cause the problem.

If the problem occurs suddenly, it could be the ducts. A flex duct (essentially, a large insulated hose) that has detached or been pinched could suddenly prevent air flow. A quick look in the attic is all it takes to spot this. Similarly, if a duct-cleaning company didn't send its A-team, they might have damaged the system or knocked loose a piece of rigid insulation inside a steel duct. This would have the same result.

If the problem appeared soon after having a new system installed, you need to get the contractor back. The problem might be obvious, like a closed damper, or it might take some sophisticated pressure testing to reveal whether there is improper duct sizing or an air filter that's just too restrictive.

Q Every summer, moles wreck my yard. What do I do?

A

Moles burrow after insects in the ground, but eliminating their food source isn't the best approach. You'll end up killing near-surface insects and larvae, some of which – earthworms, for instance – are beneficial. Plus, you'll cause the moles to dig deeper. It's not a bad idea to selectively apply an insecticide to kill turf-destroying insects such as grubs. But it won't do much to solve the mole problem.

Now, killing near-surface insects and driving the moles deeper does have advantages. You will no longer see mole tunnels and the critters won't kill off big chunks of your lawn by chewing through grass roots. But as soon as the ground thaws and the near-surface insect population increases, they'll be back. The ugly truth is that traps work best. Just know that killing one or two isn't enough to eliminate the problem. Chances are you'll need to work through the summer and into the fall when they start their deep tunnelling. You kill enough of them, you'll have peace, at least for a while.

A PHOTOGRAPH BY TODD MCLELLAN

DISASSEMBLY REPORT

WRISTWATCH

MODEL:
SHINOLA
THE RUNWELL
SPORT CHRONO
48MM

PRODUCED:
DETROIT, MICHIGAN

TIME TO DISASSEMBLE:
89 MINUTES,
0 SECONDS

NUMBER OF PARTS:
136

NOTES: Sure, Shinola's movements use Swiss parts. If you want a good timekeeper, you get the parts from Switzerland. But the folks doing the hard part – assembling the tiny pieces into a watch – are all-American. Even Olivier de Boel, Shinola's factory manager, who explained to us in exacting detail how the watch works, was in awe of the keen eyesight and steady hands required to build one of the company's timepieces. And with the exception of dispensing lubricating oil and checking for imperfections, the craftsmen do the work without magnification. Which is more than we can say for the picture at right.

THE QUARTZ

The movement – the parts of the watch that produce its measurements of time – is constructed like a round metal sandwich. The **main plate (13)** is the bottom piece of bread. The fillings are the power system, the processor and the gear train that turns the watch's hands. **Bridges (18)** are like the intermediate piece of bread in a double-decker: metal plates that properly space the parts and provide protection and rigidity. The top piece of bread is the **dial support (12)**, which circumscribes the date rings, the uppermost portion of the movement.

The Runwell has a quartz movement, in which the ticking is regulated by a quartz crystal that is integrated with a microchip in the **electronic module (16)**. Quartz is piezoelectric: electricity causes it to vibrate. When current from the **battery (2)** is sent through the crystal, it vibrates at 32 768 Hz. From this the microchip derives an electric signal that pulses once every second.

THE CURRENT TIME

The electric pulses are directed towards a **coil (3)** to generate a magnetic field. The coil is linked to a **stator (23)** through which a **rotor (14)** protrudes. The magnetic field causes it to rotate 180 degrees every second. In effect, this creates an electric motor whose engine speed is measured, not in revolutions per minute, but seconds.

The gear that links the motor to the readout on the **dial (4)** is called the **cannon pinion (8)**; the gears that correspond to specific units of time are called, unsurprisingly, the **second wheel (5)**, **minute wheel (22)**, and **hour wheel (27)**. The watch's **hands (1)** mount to the gears with a press-fit system: posts on the underside of the hands seat in cylinders centred on the gears. The system is lubricated with small amounts of oil in little red compartments called **jewels (17)** because they used to be made of hard precious stones that would resist wear. Today, they're smooth, synthetic ruby.

The time is set manually by pulling the **crown (9)** on the end of the **setting stem (10)** to the second of its two positions. In this position, its **setting lever (15)** engages the minute wheel, so that as the crown is rotated, the minute and hour hands turn. (The cannon pinion acts as a clutch so the motor doesn't fight the wearer as they set the time.)

THE DATE

The date function is linked to the timekeeping gear train, and is set by pulling the crown to its first position. Whereas some watches use a single date ring numbered from one to 31, the Runwell uses two rings, the **units indicator (19)** and the **tens indicator (20)**. The tens indicator is positioned on top and has **windows (21)** that show the units digit, unless it is the 20th, 30th, or 31st day of the month.

THE CHRONOGRAPH

There are three more small electric motors regulated by the quartz's vibrations, all for the chronograph: one for its tenths-of-a-second hand, located on the **six o'clock subdial (25)**; another for minutes and hours, located on the **nine o'clock subdial (26)**; and one for the large second hand. If the chronograph is not being used, none of these motors receives electricity. But if the wearer presses the **top button (6)** on the **case (24)**, its **spring (7)** activates a circuit that delivers power to the motors and the hands turn. When the **bottom button (11)** is pressed to reset the chronograph, the microchip delivers enough pulses to return all the hands to the 12 o'clock position. – *Kevin Dupzyk* **PM**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GREAT NEW STUFF

NINTENDO SNES CLASSIC EDITION

The Nintendo Switch may have fulfilled our "play anywhere" dreams, but the company wasn't done with pleasing the inner child. With the Nintendo Classic the hottest stocking stuffer for Christmas 2016, of course we would see the Super Nintendo this year. The original was the first console with shoulder buttons on the controllers and be compatible with an external Super FX chip (included in the cartridge of games that needed extra graphics processing). This one doesn't take cartridges because all the games are stored inside. One of those games is *Star Fox 2*, which until the release of this console was considered to be a myth. Alongside it are 21 games including the original *Super Mario Kart*, *Mega Man X*, *Street Fighter II Turbo*, *The Legend of Zelda: A Link to the Past*, *Yoshi's Island* and *F-Zero*. We're a bit sad that neither *Killer Instinct* with its groundbreaking mirror graphics and combos, nor the genisis of all role-playing games (RPG) *Chrono Trigger* were deemed worthy of this console, but it's still a solid line-up. The only question that can stop us from buying is whether we can wait for the surely inevitable N64 Classic next year.

AVAILABLE FOR PRE-ORDER, *NINTENDO.COM*

ATARIBOX

On the other side of the retro game revival is the Atari offering that brings four USB ports, ethernet and and SD card reader to your TV. The company is promising new titles as well as compatibility with Atari 2600 games like *Pong* and *Ms. Pac Man*. The device's port array smacks of multimedia entertainment hub, though.

VISIT *ATARIBOX.COM* FOR MORE

BOULDER 1160

Matching the M900A for continuous 300 Watt per channel output, this stereo power amplifier takes a more connected approach to delivering sweet tunes. Plug in your ethernet cable and turn this into the backbone of your music delivery system.

$28 000, *BOULDERAMP.COM*

UNDER ARMOUR THREADBORNE FORTIS 3

Nike seem to have sewn up the lightweight and supportive running shoe market with its FlyKnit innovations, but Under Armour is challenging the crown. The breathable, fully-woven upper has been meticulously engineered, layer by layer to ensure a natural fit for maximum comfort.

R2 360, *UNDERARMOUR.CO.ZA*

PORSCHE DESIGN 911 SPEAKER

In typical porsche Design fashion the company has converted the original exhaust pipe from the 911 GT3 into a Bluetooth speaker. Expect 24 hours of playtime and 60 Watts of performance from this twin-pipe wonder. Hell, there's even NFC for fast pairing.

500 EURO, *PORSCHE-DESIGN.COM*

MCINTOSH MA900

Combining preamp and amp into one device is old hat. Now add in 10 analogue connections which are divided into 2 balanced and 6 unbalanced inputs, and moving coil and moving magnet connectors for your turntable. There's also digital inputs (2 coax, 2 optical, USB and MCT). Standard McIntosh innovations are on board like Power Guard and Home Theatr PassThru. This may be the most complete integrated amp on the market.

RTBA, *MCINTOSHLABS.COM*

BOSSA MOONRAKER SOUND SYSTEM

Two separate bi-amplified wireless speakers is what you need to achieve authentically wide sound-stage. Sure, you can lug in coax or optical cables if you want, or even analogue audio. Either way, this will upgrade your home audio to levels rarely heard.

$2 400, *BOSSASOUND.COM*

ASUS ROG ZEPHYRUS GX501

The world's slimmest gaming laptop measures in at 18 mm at the thickest part of its side profile. Inside is an Nvidia Geforce GTX 1080 graphics card and your choice of seventh-generation Intel Core processor. Traditional gaming touches like RGB keyboard lighting and super-fast NVMe SSD storage are not forgotten from this package. Be warned though: just like smartphone RAM is different from laptop RAM, this iteration of the GTX 1080 won't perform the same as its desktop equivalent.

$7 000, *ASUS.COM*

SILCA CENTENNIAL HX-ONE ESSENTIAL KIT

Care for your high-tech mountain bike with an old-world style hex key set. Silca have been making bike tools for 100 years and have put out this walnut-cased set of 8 hex keys, coated in a grippy red polymer. In the box is a magnetic adaptor and the 6 most-used Torx sizes, 2 flat and 2 Phillips head drivers.

$185, *SILCA.CC*

MSI GT83VR TITAN SLI

Want even more power? How about two GTX 1080s in SLI for unmatched laptop graphics. You'll need a large lap though, because you're staring at an 18,4-inch IPS display and typing on a mechanical keyboard with Cherry MX Silver switches. MSI didn't manage to crowbar an optical drive into it, but there are 4 USB 3.0 ports, an SD card slot and USB type-C/Thunderbolt 3 connectivity.

RTBA, *MSI.COM*

DEWALT DEMO HAMMER

Designed for remodelling homes, this claw hammer is also a Red Dot Award winner. Timber frames and dry walls fear every swing and strike. While it won't find its natural work in SA, it will look great in the toolbox.

R750, *DEWALT.COM*

CANON SELPHY

Also for pictures, but this one lives at home for even higher quality prints. This unit does have on impressive party trick, though: you can print your own ID photos. Never have to queue at the stall outside the traffic department again, or run around when applying for a visa.

FROM R900, *CANON.CO.ZA*

HP SPROCKET

Print photos directly from your iOS or Android smartphone with this pocket-size device. We love the convenience and quality, but hate that there's now another device that requires charging, ink and proprietary 3x2 paper.

R2 000, *HPSHOP.CO.ZA*

BROTHER DCP-T500W

Print, scan or copy, and top up your ink by squirting ink directly into the cartridges. Yes, you read correct. This printer is all about saving you cash while still delivering Brother's outstanding wireless printing and scanning functionality.

R3 000, *BROTHER.CO.ZA*

CASIO PRO TREK WSD-F20

This year's Casio Android Wear smartwatch comes with the latest software (2.0) and Casio's interface layered on top, but also adds in on-device GPS for total off-grid reliability. If you want a truly outdoor rugged smartwatch, you don't have many other options. Trust us.

$500, *WSD.CASIO.COM*

PM

PM TESTED

QUANTIFY YOURSELF

TWO ACTIVITY TRACKERS THAT ARE GREAT FOR EVERY DAY CARRY AND WORK WELL IN A CROSSFIT BOX.

▸▸ **WEARABLE FATIGUE.** It's a thing. Especially at the pace that some of these companies put out new devices. At this stage, until the new wave of these products hit with all new tracking metrics, it is sound advice to stick with the one you already have. Except when a new release comes with the exact sensor that you're holding off on the Apple Watch for. Like Garmin bringing in stress monitoring to what is essentially its third-from-the-bottom product. That's the next big thing, checking how you respond to your environment throughout the day.

There's a South African start-up underpinning that kind of innovation, it's called LifeQ and the COO Dr Riaan Conradie has some interesting objectives. TomTom originally used the company's homebaked optical heart rate sensor, the LifeLens, on the original Spark and Runner 2 cardio watches. At this stage, LifeQ was heavily invested in trying to match big players like Philips in the game of reading blood pulsing. It has since refined its approach and tackled more nuanced data crunching. Instead of developing the tools to gather the information, now it builds the algorithm that analyses the data and work closely with the manufacturers to ensure the correct parts are being installed.

While we don't have it on record, we're pretty sure that's what's happening with the Vivosmart 3. The heart rate monitoring hardware is from Firstbeat and the stress detection software is done by LifeQ. It will be interesting to see what else lies in store for wearables, especially with Fitbit having acquired Pebble, but we'll wait and see. For now, these are the smartest buys on the market. - *Lindsey Schutters*

Garmin Vivosmart 3

What is it? The Vivo range denotes general activity tracking. Last year's Vivosmart HR+ was our pick for best fitness tracker for most people with a winning combination of accurate step counting, good heart rate monitor, smartphone notifications and a built-in GPS tracker. This model ditches the GPS (although we expect it on a plus variant later this year) and slims down the package to discreetly pass as just an armband.

What's good about it? It's really slim and the new heart rate monitor seems a bit more accurate. Those new optics also allow for all-day stress tracking. It's swimproof and the battery will last at least 5 days.

What's bad about it? Garmin removed the larger, always-on screen and replaced it with an LCD with sometimes finicky touch interface.

Verdict A decent third act for the Vivosmart range, but one best left to its own devices when it comes to general movement tracking. Garmin's MoveIQ algorithm is good at auto-recognising running type sports. The addition of strength training as a mode is great, especially the fairly accurate rep counting. We would love to see some kind of GPS since its direct competitor, Fitbit Charge 2, at least uses connected satellite tracking, but this remains the benchmark for the category. The Connect mobile app has come a long way and is almost on par with Fitbit.

R3 000, *garminonline.co.za*

TomTom Touch Cardio

What is it? A pared-down rehash of a failed concept that does save the Dutch tracking masters' face. Last year's TomTom Touch debuted bioimpedence body composition readings that weren't well thought out. We like it, but it may have been too complex for the average consumer. This time around, TomTom stripped out the clutter and present a more focused approach.

What's good about it? TomTom will always be aggressive on price and the Touch is no different. You'll struggle to get quality optical heart rate monitoring from a reputable brand that syncs with all the major digital platforms at this price anywhere else.

What's bad about it? Not as powerful in terms of data gathering as the Garmin and the app, although far better than it has ever been, is some way behind Fitbit.

Verdict It's stylish and discreet, goes about business of activity tracking pretty well, but there's no stand-out feature that will draw in the crowds. Charging via micro-USB is a masterstroke because proprietary cables are a special hell to prescribe to people who paid money for your product. I cannot count the number of times I've been away from home without the right cable that charges the fitness tracker on my arm.

R1 500, *tomtomshop.co.za* **PM**

One of Desktop Metal's 3D printers makes a part out of a steel alloy, demonstrating its ability to churn out complex structures.

THE MACHINE THAT COULD FINALLY CHANGE MANUFACTURING

BY DAVID ROTMAN
MIT TECHNOLOGY REVIEW

For all the hype around 3D printing, it's done little to transform the way things are made. Now a startup called Desktop Metal thinks it's cracked the code on how to print metal parts practically and affordably.

It's less than two months before his company's initial product launch, and CEO Ric Fulop is excitedly showing off rows of stripped-down 3D printers, several bulky microwave furnaces and assorted small metal objects on a table for display. Behind a closed door, a team of industrial designers sit around a shared work desk, each facing a large screen. The wall behind them is papered with various possible looks for the start-up's ambitious products: 3D printers that can fabricate metal parts cheaply and quickly enough to make the technology practical for widespread use in product design and manufacturing.

The company, Desktop Metal, has raised around R1,3 billion from leading venture capital firms and the venture units of such companies as General Electric, BMW and Alphabet. The founders include four prominent MIT professors, including the head of the school's department of materials science and Emanuel Sachs, who filed one of the original patents on 3D printing in 1989. Still, despite all the money and expertise, there's no guarantee the company will succeed in its goal of reinventing how we make metal parts, and thus transforming much of manufacturing.

As Fulop moves about the large, open workspace, his excitement and enthusiasm seem tempered by anxiety. The final commercial printers are not yet ready. Employees are busy tinkering with the machines, and fabricated test objects are scattered about. Progress is being made, but it's also obvious that the clock is ticking. In a corner near the front door and entrance area, the floor is empty and taped off; soon the space needs to be filled with a mock-up of the company's planned booth for an upcoming trade show.

CAST PART | 3D PRINTED

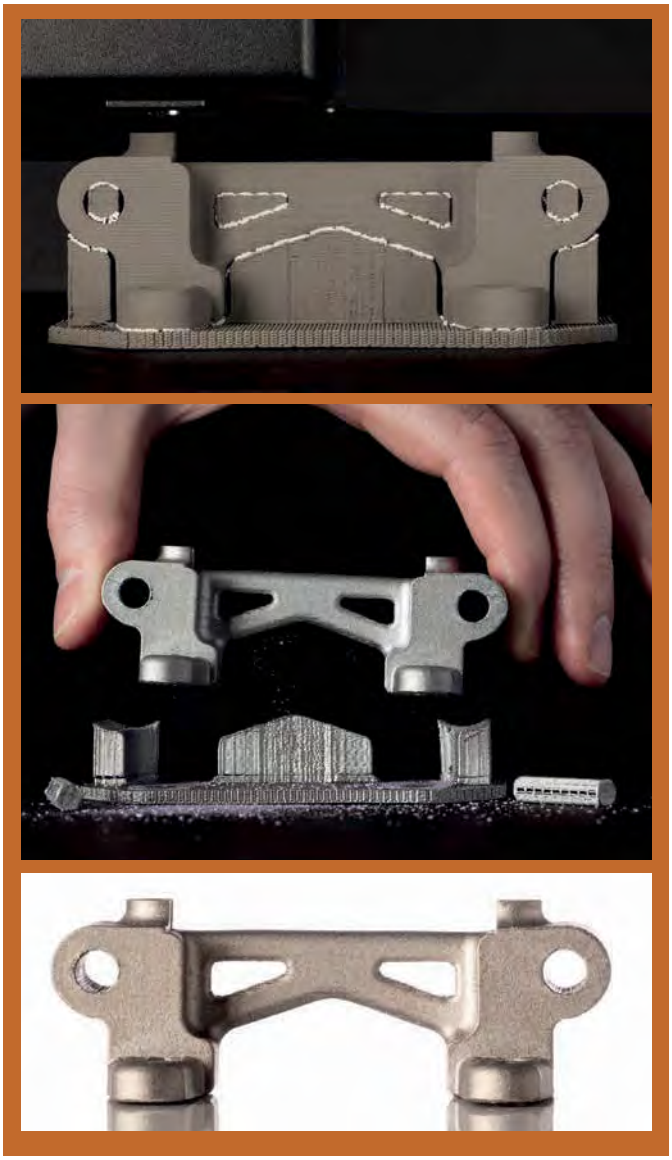
Though it is possible to 3D-print metals, doing so is difficult and pricey.

If it succeeds, Desktop Metal will help solve a daunting challenge that has eluded developers of 3D printing for more than three decades, severely limiting the technology's impact. Indeed, despite considerable fanfare and evangelical enthusiasts, 3D printing has, in many ways, been a disappointment.

Hobbyists and self-proclaimed makers can use relatively inexpensive 3D printers to make wonderfully complex and ingenious shapes out of plastics. Some designers and engineers have found those machines useful in mocking up potential products, but printing polymer parts has found little use on the production floor in anything but a few specialised products, such as customised hearing aids and dental implants.

Though it is possible to 3D-print metals, doing so is difficult and pricey. Advanced manufacturing companies such as GE are using very expensive machines with specialised high-power lasers to make a few high-value parts. But printing metals is limited to companies with millions to spend on the equipment, facilities to power the lasers, and highly trained technicians to run it all. And there is still no readily available option for those who want to print various iterations of a metal part during the process of product design and development.

The shortcomings of 3D printing mean the vision that has long excited its advocates remains elusive. They would like to create a digital design, print out prototypes that they could test and refine and then use the digital file of the optimised version to create a commercial product or part out of the same material whenever they hit "make" on a 3D printer. Having an affordable



Right: Close-up image of printed part showing proprietary separable supports layer. Proprietary separable supports make it possible to remove support structures by hand. Above: Desktop Metal printed the bolt and wing nut separately to demonstrate that it can fabricate parts with tight tolerances.

and fast way to print metal parts would be an important step in making this vision a reality.

It would give designers more freedom, allowing them to create and test parts and devices with complex shapes that can't be made easily with any other production method; say, an intricate aluminium lattice or a metal object with internal cavities. It could eventually enable engineers and materials scientists to create parts with new functions and properties by depositing various combinations of materials. For example, printing out a magnetic metal next to a non-magnetic one. Beyond that, it would redefine the economics of mass production, because the cost of printing something would be the same regardless of how many items were produced. That would change how manufacturers think about the size of factories, the need for backup inventory (why keep many parts in stock if you can simply and quickly print one out?) and the process of tailoring manufacturing to specialised products.

This is why there has been a race to turn 3D printing into a new way to produce parts. Long-time suppliers of 3D printers, including Stratasys and 3D Systems, are introducing increasingly advanced machines that are fast enough for manufacturers to use. Last year, HP introduced a line of 3D printers that the company says will allow manufacturers to prototype and make products with nylon, a widely used thermoplastic. Last year GE spent more than R10 billion on a pair of European companies specialising in 3D-printing of metal parts.

But the real competition for Desktop Metal is probably not from the growing number of companies in 3D printing. For one thing, the 3D printers from HP, Stratasys (an investor in Desktop Metal), and 3D Systems mainly use various types of plastics, not the range of metals Fulop's company wants to use in its printers. GE's high-end machines overlap little with Desktop Metal's market ambitions. Instead, the real competitors for Desktop Metal are more likely to be established metal-processing technologies. Those include automated machining techniques, such as the method used to make the ultra-thin aluminium back casing of iPhones, and a rapidly growing practice called metal injection moulding, a common way to mass-produce metal products.

In other words, rather than merely trying to outdo other 3D printers, Desktop Metal will have the tough task of converting manufacturers away from production methods that are at the heart of their businesses. The very existence of this large, established market is what makes the prospect so intriguing. Making metal parts, says Fulop, is a trillion-dollar industry. Even if 3D printing wins only a small portion of it, he adds, it could still represent a multibillion-dollar opportunity.

Too hot to print

Look around. Metals are everywhere. But whereas 3D printing has been widely used in making plastics, the technology's use in making metal parts has been narrowly confined, says Chris Schuh, head of materials science and engineering at MIT and cofounder of Desktop Metal. "Metal processing is more of an art. It's a very challenging space."

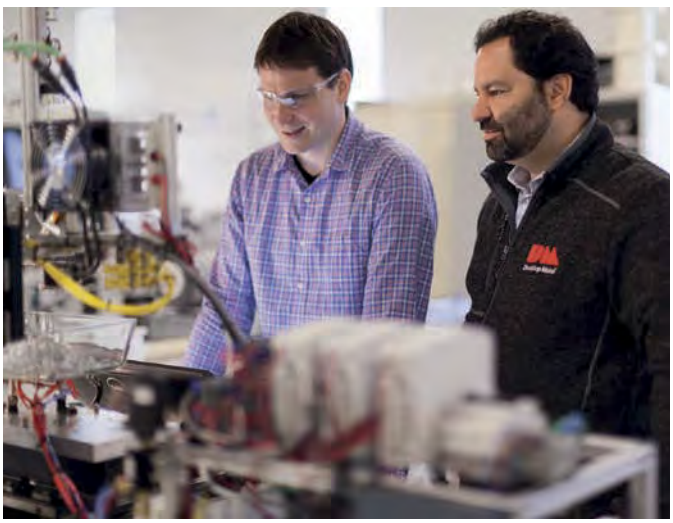
Making metal objects using 3D printing is difficult for several reasons. Most obvious is the high temperature required for processing metals. The most common way to print plastics involves heating polymers and squirting the material out the printer nozzle; the plastic then quickly hardens into the desired shape. The pro-

This steel propeller has just been printed. Between the propeller's blades and the metal support is a thin line of ceramic, which will turn to sand during the sintering process, allowing the finished part to be easily separated from the support.

The propeller after processing provides an example of a high-performance part that can be made with 3D printing. Engineers can use the method to prototype and optimise different designs.

One of the key advantages of 3D printing is its ability to make complex structures, including internal lattices in a metal part. Such structures could be used to make lighter and stronger parts.

A hydraulic manifold is processed inside a microwave furnace, which uses temperatures up to 1 400° to sinter the steel part. Such a part is too complex to make with conventional methods.



Above: The DM Studio System is the world's first affordable, office-friendly metal 3D printing system. Right: CEO Ric Fulop (right) and materials research scientist Uwe Bauer in Desktop Metal's R&D lab.

cess is simple enough to be used in 3D printers that sell for around R15 000. But building a 3D printer that directly extrudes metals is not practical, given that aluminium melts at 660°, high-carbon steel at 1 370° and titanium at 1 668°. Metal parts also have to go through several high-temperature processes to ensure the expected strength and other mechanical properties.

To make a 3D printer fast enough to be used in manufacturing metal objects, Desktop Metal turned to a technology that dates back to the late 1980s. That's when a team of MIT engineers led by company co-founder Sachs filed a patent for "three-dimensional printing techniques". It described a process of putting down a thin layer of metal powder and then using ink-jet printing to deposit a liquid that selectively binds the powder together. The process, which is repeated for hundreds or thousands of layers to define a metal part, can make ones with nearly unlimited geometric complexity. In the most common application of the technology, the binder acts like a glue. However, it can also be used to locally deposit different materials in different locations.

The MIT researchers knew their printing method could be used to make metal and ceramic parts, says Sachs. They also knew it was too slow to be practical, and the metal powders required for the process were far too expensive at the time. Sachs turned to other research interests, including an effort to improve the manufacturing of photovoltaics. In the ensuing decades, 3D printing took off and captured the imagination of many product designers. Most famously, a cheap and easy-to-use 3D printer from MakerBot was introduced in 2009, appealing to many self-styled inventors and tinkerers. But these affordable printers bumped up against the reality that they were limited to using a few cheap plastics. What's more, though the machines can print complex shapes, the final product often isn't as good as a plastic part made with conventional technology.

Meanwhile, researchers at industrial manufacturers such as GE were busy advancing laser-based technologies invented in the late 1980s for printing metals. These machines use lasers or, in some cases, high-power electron beams, to draw shapes in a layer of metal powder by melting the material. They repeat the process to build up a three-dimensional object out of the fused powders. The technique is impressive in its capabilities, but it's slow and expensive. It is worthwhile only for extremely high-value parts that are too complex to make using other methods. Notably, GE's new jet engine uses a series of sophisticated 3D-printed fuel nozzles; they are lighter and far more durable because intricate cooling channels have been built into them.

The founders of Desktop Metal decided that, to make 3D metal printing more widely accessible, they would need to sell two different types of machines: a relatively inexpensive desktop model, suitable for designers and engineers fabricating prototypes, and one that is fast and large enough for manufacturers. Luckily, several innovations have finally made Sachs's original invention practical for mass production, including the development of very high-speed inkjet printing for depositing the binder. Successively printing about 1 500 layers, each 50 micrometres thick and deposited in a few seconds, the production-scale printer can build

Desktop Metal's Studio System includes a fully automated, office-friendly sintering furnace with fast cycle times and a peak temperature of 1 400°, allowing for the sintering of a wide variety of materials.

It could also inspire manufacturers to change their logistics and production strategies.

up an 8 000-cubic-centimetre part in an hour. That's about 100 times faster than a laser-based 3D printer can make metal parts.

For its prototyping machine, Desktop Metal adopted a method from plastic-based 3D printing. Instead of a softened polymer though, it uses metal powders mixed with a flowable polymer binder. The formulation is extruded, using the printed binder to clump the metal powder into the intended shapes.

However, whether the part is printed with the prototyping machine or the production model, the resulting object (part plastic binder and part metal) lacks the strength of a metal one. So it goes into a specially designed microwave oven for sintering, a process of using heat to make the material more dense, producing a part with the desired properties. In a series of carefully calibrated steps during the sintering process, the polymer is burned off, and then the metal is fused together at a temperature well below its melting point.

The sales pitch

According to the promises of its enthusiasts, 3D printing will reduce the need for industrial manufacturers and empower local artisan producers. The reality is likely to be far different, but nonetheless profound. Many sectors of industrial production increasingly use automation and advanced software; 3D printing enhances this ongoing move to digital manufacturing. In some ways, it is not unlike an automated machining process that works off a digital file to create a metal part. What's different about 3D printing is that it offers ways to make far more complex objects and removes many of the constraints that the production process puts on designers and engineers.

It could also inspire manufacturers to change their logistics and production strategies. For relatively small quantities of goods, 3D printing could be cheaper, since it eliminates the costs associated with the tooling, casting and moulds required to churn out most metal and plastic objects. The time and money needed to set all that up is one reason why mass production is often required if a manufacturer is going to make money. Without that incentive to commit to mass-scale production, factories could shift production schedules and be more responsive to demand, moving even closer to just-in-time manufacturing. John Hart, a professor of mechanical engineering at MIT and co-founder of Desktop Metal, calls it customised mass production. Rather than having large facilities make a huge number of identical parts that have to be shipped across the world and warehoused, manufacturers might maintain scattered factories that make a diverse set of products, ramping up production as needed. "The implications in a decade or two are probably beyond our imagination," Hart says. "I don't really think we know what we will do with these technologies."

For now, the challenge for Desktop Metal is to get its equipment in the hands of designers and engineers who are responsible for their companies' next generation of products. Towards the end of 2016, Fulop was preparing to showcase the company's initial product, the prototyping machine, at a trade show in Pittsburgh in early May. (The production 3D printer is scheduled to be available next year.) His task would be to convince attendees that spending the equivalent of R1,5 million on Desktop Metal's prototyping printer and sintering furnace is essential for the future of their companies.

It is a sales job that Fulop is well suited for. He has started more than a half-dozen companies, beginning with one that imported computer hardware and software that he founded when he was 16 and still living in his native Venezuela. He is probably best known for founding A123 Systems, a battery company that was one of the highest-flying start-ups in the late 2000s, culminating with a roughly R5 billion IPO in 2009. The company was based on a novel lithium-ion technology developed by Yet-Ming Chiang, an MIT professor who is also a cofounder of Desktop Metal. Like their current 3D-printing startup, A123 hoped to apply materials science expertise to revolutionise a huge market.

Though A123 enjoyed rapid growth and a highly successful IPO, the company declared bankruptcy in 2012 (Fulop left in 2010). Ask Fulop the lesson from A123 and he says simply: "Batteries are a low-margin market." Indeed, A123 struggled to compete in an increasingly crowded battery business; it didn't offer a radical enough performance improvement over established lithium-ion batteries to immediately win over a fledging hybrid-vehicles market.

The challenges faced by Desktop Metal will be very different. A huge market for metal parts already exists. And the start-up believes its technology will, at least in the short run, have few direct competitors. Chiang points to the start-up's "really rich" patent portfolio. "It's not just the materials; it's the techniques, it's the [sintering] furnace," he says. "The harder the technology is, the higher the barrier to entry you build if you're successful."

In his office, Chiang has a wooden box containing a half-dozen swords, on loan from the Museum of Fine Arts in Boston, that were made in the 1970s using traditional Japanese techniques. Chiang uses the swords in teaching. The lesson: how the craftsmen used the secrets of metallurgy to turn iron ore into the final product: an ultra-sharp, slightly curved steel sword. Showing off the swords, Chiang points to some of their details, explaining the tricks their makers used, such as the quenching method used to create an extremely hard edge and a softer body. Back at his desk, his attention again on Desktop Metal, he's equally enthusiastic as he describes the metal objects recently printed by the company and on display at its facilities. What's exciting is "the idea that you can really make these parts", Chiang says. "A few hours, and here's a part that you couldn't even make before."

It won't replace such century-old production techniques as forging and metal casting, but 3D printing could create new possibilities in manufacturing. And, just maybe, reimagine the art of metallurgy.

PM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Olympic Games

The *ways* of the FUTURE

If you want to see what the future will look like – bar WWIII – then you need look no further than the Tokyo 2020 Olympic Games. For Japan, much more than the world's most revered sporting spectacle, the Games will be an opportunity to showcase Japanese sci-tech mastery of advanced global emerging technologies you probably thought was still a long way off. A village of helper-robots? Hydrogen-powered buildings? Self-driving taxis? AI security? Instant translation tech? Algae-fuelled airlines? Turns out, the ways of the future is right around the corner.

BY FANIE VAN ROOYEN


AI security
Algae biofuel
Self-driving taxis

The *ways* of the FUTURE

When it was announced on 26 May 1959, only 14 years after the atomic bombs dropped on Hiroshima and Nagasaki, that Tokyo would play host to the 1964 Olympic Games, it signified a new dawn for the country of the rising sun.

Still recovering from the massive blow they were dealt in World War II, the Japanese saw it as a chance to return to the global stage with confidence and show the world what they are capable of. They wasted no time in doing just that. According to *The Wall Street Journal*, the then-poor Japan spent the equivalent of its entire national budget on an unprecedented building programme that transformed the city's infrastructure. It paid off.

Thanks to Syncom 3, the world's first geostationary communication satellite, the 1964 Olympic Games were the first to be telecast internationally without the need for tapes to be flown overseas (as was done until 1960). It also introduced the world to the now-famous Shinkansen bullet train service between Osaka and Tokyo, which began operating nine days before the Games kicked off. Tokyo Haneda Airport was modernised and highways, expressways and subway lines were built. The 1964 Games, the first to be hosted in Asia, were a huge success for Japan as the rising sun soared to a new zenith.

Fast-forward about 50 years and Japan is still recovering from a global recession, not to mention a devastating earthquake and tsunami in 2011. The country is eager to repeat the successes, the technological show of force and the economic rise that resulted from the 1964 Games.

The Tokyo 2020 Organising Committee has stated, according to Newsweek.com, that the 2020 Games is not just a sports festival, but also a chance to showcase innovative scientific technologies.

Eiji Uda, chief technology and innovation officer of the Organising Comittee, confirms this. He says that there are plans to deploy various new tech innovations, such as hydrogen-powered vehicles, discrete high-tech security solutions, multilingual translation devices and enhanced sports-related data technologies and devices, among others.

"We are also working on innovations for the visualisation of sport, such as virtual reality and 3D visual technology, and smartphone applications, to enhance the spectator experience and make it more interactive. The use of these technologies will make sport more engaging and will ultimately lead to more people taking up sport and adopting more active lifestyles, which will result in significant savings in medical costs of some trillion Japanese yen," says Uda.

All in all, according to a study of the Tokyo Metropolitan Government, the Tokyo 2020 Games will bring economic benefits totalling R3,8 trillion and their positive impact is expected to continue for a decade after the Games, he says. "Moreover, we hope that the Tokyo 2020 Games will provide a forum showcasing a diverse range of technological innovations by Japanese and overseas companies that will amaze the world, and will act as a catalyst for innovation across the sports industry and beyond."

The Organising Comittee has said in a statement that the 2020 Games are expected to leave Japanese society a number of positive legacies.

"Sporting facilities that will be newly built or improved, as well as enhanced security systems, technology, transportation infrastructure, and medical care, will continue to benefit Japanese society long after the Games. Most importantly, it will provide a host of intangible but real benefits, through bringing the entire nation together, renewing Japan's reputation as a cultural, technological and creative destination internationally, demonstrating Japan's recovery from the 2011 earthquake and tsunami and inspiring young people to achieve their personal best."

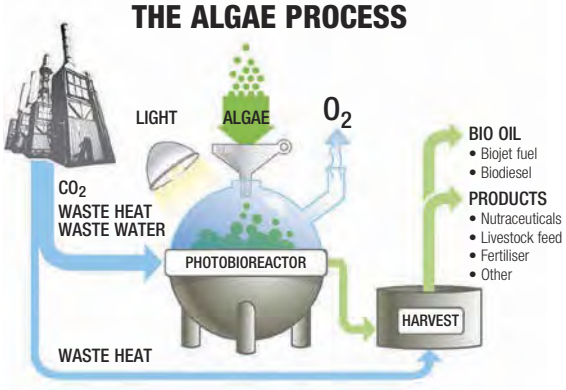
At the time of going to print, the projected budget for the Tokyo 2020 Organising Committee itself stands at R62 billion. The budget for "other entities", namely related infrastructure and technology projects, stands at a staggering R136 billion to R160 billion.

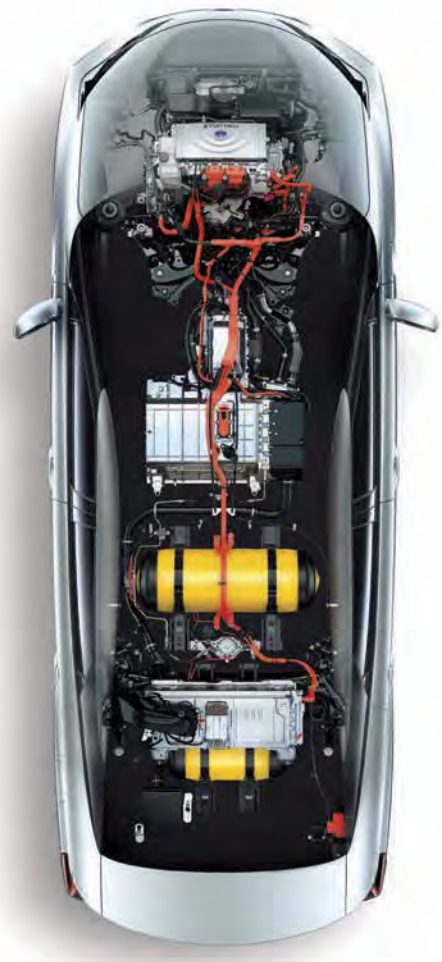
So what can sports enthusiasts, athletes and tech-lovers look forward to in 2020? Although some of the tech projects are still being kept a little hush-hush, we've compiled a rundown of some of the expected innovations.

ALGAE-FUELLED AIRLINERS AND HYDROGEN-FUELLED CARS, BUSES AND BUILDINGS

THE INITIATIVES for Next Generation Aviation Fuels (INAF), a consortium of 46 organisations including Boeing, All Nippon Airways, Japan Airlines, Nippon Cargo Airlines, the Japanese Government and the University of Tokyo, in 2015 unveiled a five-year road map to develop sustainable algae-based aviation biofuel. This fuel is expected to be able to reduce carbon dioxide emissions from aircraft by 50 to 80 per cent as a way to reduce aviation's environmental footprint ahead of 2020 (prnewswire.com). Furthermore, the Japanese Government has repeatedly stated its intentions to create the world's first "hydrogen society" by 2020. The Tokyo Metropolitan Government is actively promoting the use of hydrogen as an energy source, including the creation of a 40 billion Yen (R4,7 billion) fund for setting up 35 hydrogen refuelling stations and other infrastructure. The entire Olympic athletes' village will reportedly be hydrogen-powered with a giant pipeline that will pump hydrogen directly into buildings. Authorities are also working closely with Toyota and Honda to reach the aim of having 6 000 fuel cell cars and 100 fuel cell buses operating in Tokyo by 2020 (with the Toyota Mirai and Honda Clarity vehicles). Tokyo Governor Yoichi Masuzoe has said, "The 1964 Tokyo Olympics left the Shinkansen high-speed train system as its legacy. The upcoming Olympics will leave a hydrogen society as its legacy."

THE ALGAE PROCESS



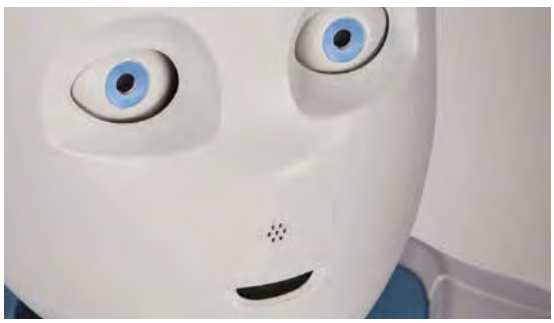


ISTOCKPHOTO/SKY2014

ARTIFICIAL METEOR SHOWERS

IT HAS BEEN WIDELY rumoured that the Japanese technology start-up ALE (*star-ale.com*), an "outer space entertainment company", will be tasked to help wow the Tokyo 2020 Opening Ceremony crowd with its in-development Sky Canvas technology aimed at creating artificial shooting star spectacles in the night sky. Basically, a microsatellite will be launched, 80 kilometres above Earth, that will then travel about one-third of a full orbit before dispensing small pellets designed to burn up brightly in the atmosphere to create a magnificent celestial show below. According to the *Japan Times* ALE, founded by astronomer Lena Okajima, is working closely with several Japanese universities on getting the chemical composition of the pellets – which remains a closely guarded secret – just right.

The *ways* of the FUTURE

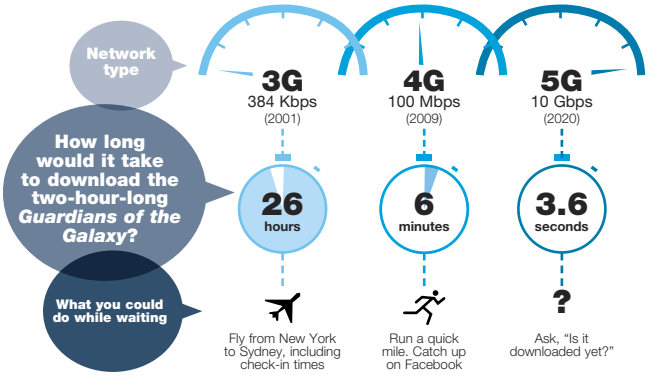


A VILLAGE OF ROBOTS

ACCORDING TO the *Japan Bullet*, the 2020 Olympics will be used to "give visitors a sense of a futuristic society where humans are waited on hand and foot by robots". A committee of the Japanese science and technology ministry has plans for a robotic village to be set up in Tokyo's Odaiba district, next to the athletes' village, to house a variety of robots. These automated helpmates will be able to provide directions, information and translation services for foreign visitors. Also on the cards are robotic personal transport devices to assist the elderly and the disabled. The idea is to create a space where helpful, polite robots can assist humans regardless of age, race, nationality or disabilities in the compassionate spirit of Japanese culture.

5G WIRELESS INTERNET

THE LARGEST MOBILE operator in Japan, NTT Docomo, is hard at work in collaboration with Nokia to develop a future 5G wireless mobile network to be used at the Tokyo Olympic Games. NTT Docomo and Nokia last year achieved the world's first wireless real-time transmission of 8K video, deploying a 5G radio access technology system. In that trial, 8K video of 48 Gbps – four times greater than 4K video – was compressed into signals ranging from 145 Mbps to 85 Mbps and successfully transmitted without delay. Other recent achievements include ultra-high-speed data transmission in excess of a whopping 2 Gbps at the Roppongi Hills high-rise complex in Tokyo, the company has reported.



SELF DRIVING TAXIS

THE JAPANESE INTERNET gaming giant DeNA, in collaboration with robotics firm ZMP, has set up Robot Taxi Inc. (*robottaxi.com*) and is currently testing its self-driving taxis (retrofitted Toyota Estimas) in Tokyo with the aim of fully deploying the service in time to ferry athletes and tourists around during the 2020 Games. Furthermore, Toyota and Nissan are reportedly also working on a self-driving network of cars and buses specifically to cater for the Tokyo Games. A joint automotive venture (including Mitsubishi) last year began with the creation of a high-definition 3D map of the city to be used by self-driving vehicles, according to *asia.nikkei.com*.

INSTANT LANGUAGE TRANSLATION DEVICES AND APPS

LANGUAGE CAN BE a big barrier when all the nations of the world descend on one city, but great efforts are being made to ensure that this will no longer be a problem by 2020. The government-funded National Institute of Information and Communications Technology (NICT) has created an instant translation app called VoiceTra, which currently covers about 30 languages, including even Urdu and Dzongkha. For speech, it is "already good enough to make understandable 90 per cent of what you want to say in English, Korean, Chinese and Japanese, when using short sentences", according to the *Japan Times*. In the private sector, tech giant Panasonic is working on a palm-sized pendant-type portable device worn around the neck that will instantly translate Japanese into various languages for the thousands of foreign athletes and spectators. Currently it supports English, Korean, Chinese and Thai, but many more will be added before 2020, according to the company's website.

Megaphone translator

NEXT GEN AI SECURITY TECH

PANASONIC IS ALSO, according to *Newsweek.com*, developing a "total surveillance system" that can integrate tens of thousands of fixed and mobile cameras and sensors for advanced situational awareness. The 360° fish-eye lens surveillance cameras will be combined with image-processing software and built-in directional microphones to accurately recognise (and even translate) voices and noises in a specific area. This will enhance counter-terrorism, while complying with privacy legislation. Separately, a system utilising artificial intelligence to analyse images from high-definition surveillance cameras and cameras fitted on security guards is being developed to identify suspicious individuals or activities. "We are having AI learn the movements of thieves, pickpockets and people carrying knives as well as people around them," Kunio Hoshiba, an official of Sohgo Security Services, commonly known as ALSOK, is quoted as saying.

8K TV BROADCASTS AND VR

OF COURSE, Japan wants the world to witness its high-tech futuristic society in as much detail as possible and that means 8K live broadcasts. Sharp Electronics is already selling 8K TV sets and the Japanese state television network NHK plans to beam the Tokyo 2020 Olympic Games in ultra-vivid 8K: that's 7 680 x 4 320 pixels, about 16 times as many pixels as most full HD televisions are capable of. So those consumers who will be able to afford 8K-ready TVs will have something to brag about, come the Games. With virtual reality (VR) headsets set to be widely available by 2020, the Organising Committee has further expressed interest in exploring various ways that VR technology can be used to view the Olympics. For instance, they might be used to allow spectators to feel what it is like to participate in certain sports, such as wheelchair baseball. However VR will be used, it is sure to add a fresh, interactive first-person element to what is clearly set to become an unprecedented global spectacle that will provide a tantalising peep into a more advanced, more sustainable, more accessible, and more fun, future.

SUPERSPEED MAGLEV TRAINS

THE JAPANESE RAILWAY company JR Central is currently expanding its superfast Maglev (magnetic levitation) trains network and hopes to complete a new 100 km passenger line between Kofu and Tokyo in time for the 2020 Games. Although Maglev trains have been around for a while, the Japanese Maglev is the fastest. In 2015, it broke its own record by attaining a maximum speed of 603 km/h. **PM**

WITH A LITTLE HELP FROM AI FRIENDS

Would you trust a robot doctor?

BY KAYT SUKEL, NEW SCIENTIST (TNS)

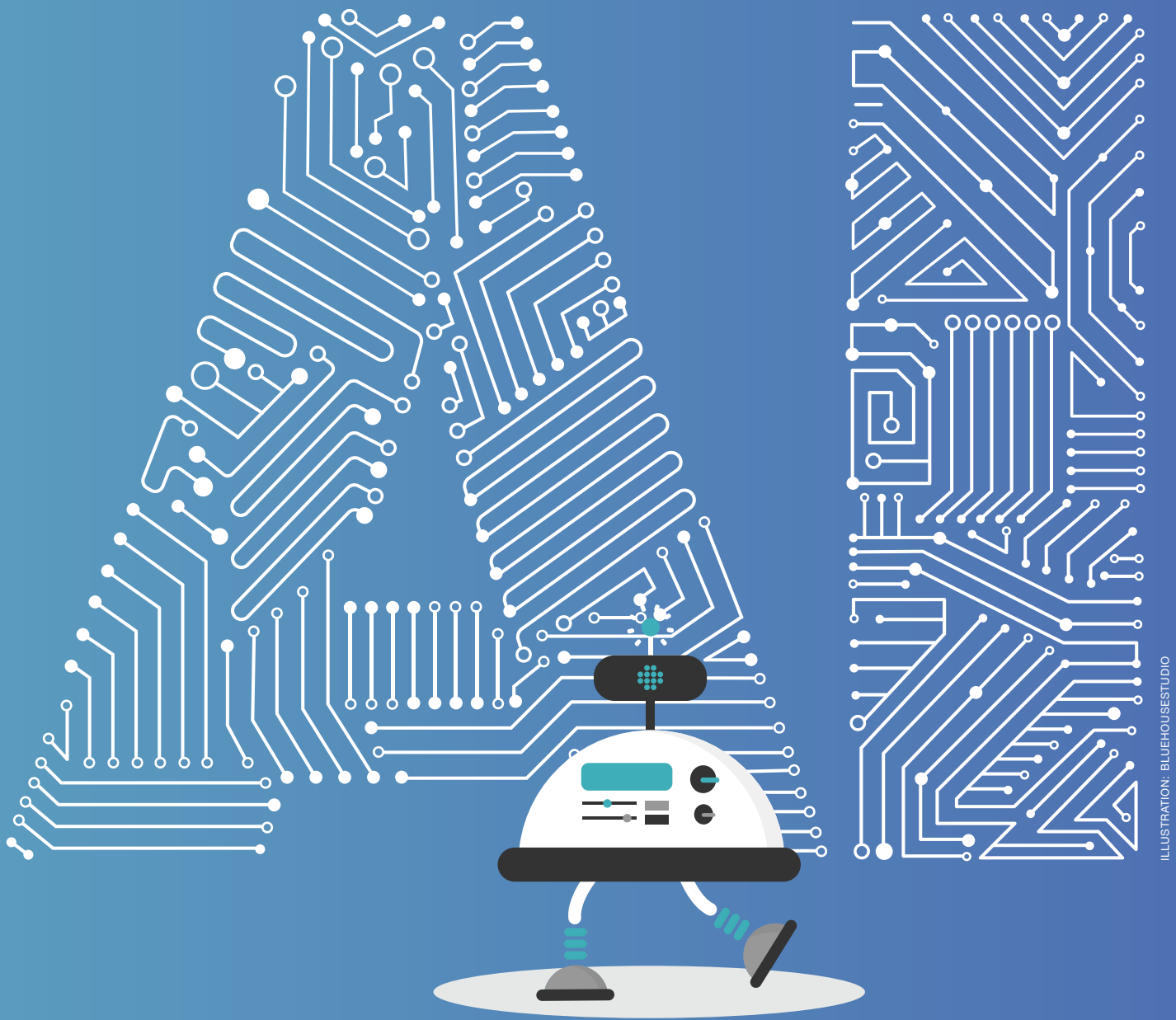


ILLUSTRATION: BLUEHOUSESTUDIO

THE DOCTOR'S EYES FLIT from your face to her notes. "How long would you say that's been going on?" You think back: a few weeks, maybe longer? She marks it down. "Is it worse at certain times of day?" Tough to say: it comes and goes. She asks more questions before prodding you, listening to your heart, shining a light in your eyes.

Minutes later, you have a diagnosis and a prescription. Only later do you remember that fall you had last month. Should you have mentioned it? Oops.

One in 10 medical diagnoses is wrong, according to the US Institute of Medicine. In primary care, one in 20 patients will get a wrong diagnosis. Such errors contribute to as many as 80 000 unnecessary deaths each year in the US alone.

These are worrying figures, driven by the complex nature of diagnosis, which can encompass incomplete information from patients, missed handoffs between care providers, biases that cloud doctors' judgement, overworked staff, overbooked systems, and more. The process is riddled with opportunities for human error. This is why many want to use the constant and unflappable power of artificial intelligence to achieve more accurate diagnosis, prompt care and greater efficiency.

AI-driven diagnostic apps are already available. And it's not just Silicon Valley types swapping clinic visits for diagnosis via smartphone. The UK National Health Service (NHS) is trialling an AI-assisted app to see if it performs better than the existing telephone triage line. In the US and mainland Europe, health insurers and national healthcare providers are hopeful AI-based medical apps will improve care. But is the hype around medical AI all it's cracked up to be? Would you trust your care to a robot?

A GLOSSARY OF AI SPEAK

ARTIFICIAL INTELLIGENCE
Applying computers to tasks that normally require human-level intelligence, like reasoning, decision-making, problem-solving and learning

BIG DATA
The huge data sets that can be analysed by computers and algorithms to reveal patterns, trends and associations

MACHINE LEARNING
The capacity of an algorithm to learn from new information and modify its processing as a result, without being explicitly programmed to do so

NEURAL NETWORK
An algorithm used in deep learning that imitates the activity of layers of neurons in the brain, filtering data through tiers of virtual brain cells

DEEP LEARNING
The "black box" of AI. Unsupervised neural networks that create their own processing constraints as they learn from vast troves of training data.

For decades, researchers have been honing artificial intelligence, including deep-learning algorithms, which are designed to learn without being fed rules or constraints (see "A glossary of AI speak"). "These would take in hundreds or even thousands of symptoms and then would learn to diagnose various diseases," says Pedro Domingos, a computer scientist at the University of Washington and author of *The Master Algorithm: How the quest for the ultimate learning machine will remake our world*. "By training these systems with the data from a medical database of patient records for, say, diabetes or lung cancer, or any other condition, you can push a button and literally get something that will diagnose things more accurately than human doctors can."

Outperforming doctors

That's not just hype. When Sebastian Thrun and his team at Stanford University in California trained a deep-learning neural network using more than 100 000 images of skin problems, ranging from cancer to insect bites, then tested it on 14 000 new images, the system correctly diagnosed melanomas more often than seasoned dermatologists. Deep-learning networks have also outperformed doctors at diagnosing diabetic retinopathy, a complication of diabetes that damages blood vessels in the eye. Other AI tools can identify cancers from CAT scans or MRIs, or even predict from data about general health which people may have a heart attack.

But should we trust their successes? What are these systems seeing that highly trained doctors aren't? It's not a question that can always be answered. While some deep-learning tools are designed to spit out the rules they come up with, Thrun's, for instance, was a "black box": it's unknown what features it homed in on.

With some studies suggesting that patients may be more open with therapists when talking to them via a compuer screen, is it time to consider removing the human altogether?

That makes some nervous, with reason. Consider the experience of Joshua Denny, a medical informatics specialist at Vanderbilt University in Tennessee. He recently developed a machine-learning tool to identify cases of colon cancer from patients' electronic health records, but soon learnt that it was latching on to the wrong information. "It was performing excellently," he says. Unfortunately, it was picking up on the fact that all of the patients with confirmed cases had been sent to a particular clinic, not clues from their actual medical data. "There's always the risk that a black box model can learn features that you won't expect and won't be stable over time," he says.

While acknowledging potential pitfalls, Thrun is circumspect about the nature of the black box approach. "If your doctor looks at your skin and says, 'I think this is a melanoma,' you aren't going to stop him and say, 'What are the rules you are using to determine this?'" he says. "No, you are going to have a biopsy and then, most likely, get treatment. We shouldn't distrust these rules just because we can't say exactly what they are."

Garbage in, garbage out

Still, Thrun concedes that deep-learning tools are only as good as the data they are trained on. Thanks to the rise of electronic medical records, we finally have big enough data sets to do this training, but there are major logistical hurdles to overcome. The wide range of healthcare IT systems can mean that their records vary just enough to skew any algorithm trying to process them. That means up to 90 per cent of the effort in designing these AI tools is spent simply cleaning up the data, Thrun says. Kyung Sung, a radiologist at the University of California, Los Angeles, agrees. It took his team more than five years to clean up a set of prostate cancer images for his AI, which aims to better identify aggressive tumours. "Unfortunately, the fact that we now have all these images available doesn't always mean that they will be useful," Sung says.

It's even possible that an emerging or evolving disease might skew the results, which is something developers have to look out for. For example, the creators of diagnostic app Ada trained it on vast troves of medical files, and it now refines its results with data from users. To avoid the AI picking up on the wrong things and warping the outcomes, human-supervised and unsupervised learning are both used to fine-tune the algorithms, says Claire Novorol, the company's chief medical officer. "We use multiple experienced doctors as well as other technical feedback loops," she says.

Humans keep the AI in check, but there will be times when they shouldn't. "If there are presentations not currently known by experts or in the literature, humans may not be the best ones to catch that," says Novorol. "Those trends will be patterned in the

"Sharing health data should be a civic duty. Only those who opt in should benefit. We can create a tool for human therapists that makes them superhuman"

data and, ultimately, patient outcomes; and the algorithms can help us identify those patterns and use them in a predictive way."

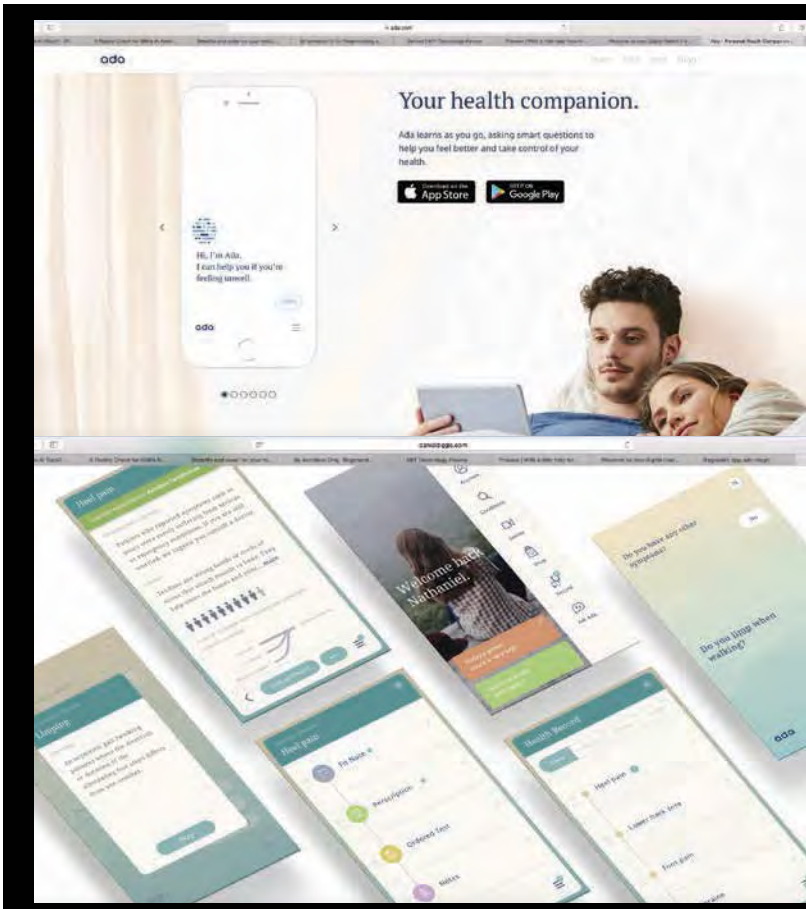
Today, deep-learning diagnostic tools are not used in hospitals except in research studies, but many think they will be within five years. By then, they will be able to do far more than diagnosis, says Eric Horvitz, a medical AI researcher at Micro-soft. "The hard part is managing diseases, figuring out therapies over time and tracking progress," Horvitz says. New, more detailed algorithms should help doctors better understand how conditions progress. "Diabetes, arthritis, hypertension, asthma and other chronic diseases; these are the expensive, challenging cases. These are where most of the healthcare costs come in. Machine learning may offer us new opportunities to better manage them."

Horvitz is not alone in his optimism. Valentin Tablan, principal scientist at Ieso Digital Health, sees potential for AI to revolutionise mental healthcare. Ieso provides cognitive behavioural therapy online for NHS patients and has treated more than 10 000 people to date, keeping digital records of every exchange. The company wants to mine that immense data set to help understand what really works. "Machines are very good at helping find the elements that are very important and can really help patients get better," Tablan says.

With some studies suggesting that patients may be more open with therapists when talking to them via a computer screen, is it time to consider removing the human altogether? Tablan scoffs at the idea. "AI doesn't have the capabilities to work at that kind of level yet. But by building models based on these data sets, we can create a tool for human therapists to use that makes them superhuman therapists."

That's a recurring theme: the rise of the superhuman doctor. By equipping medical professionals with enhanced abilities, AI is poised to change the very delivery of healthcare, says Isaac Kohane, head of biomedical informatics at Harvard Medical School. At present, doctors have to manage mounds of paperwork and digital form-filling while trying to stay on top of the emerging research to keep their knowledge current. If AI could ease some of this burden, that would free them to focus more time on patients, to take detailed histories, to listen.

Ultimately, it may even reshape what it means to train as a doctor. Denny says medical education will need to include data science and may shift away from rote learning to focus on problem-solving, critical thinking and how to best deal with



The medical app Ada has been developed for "informative purposes" to help people better understand their health. In the UK, Ada Doctor Chat provides connectivity with a network of doctors: users can ask questions, upload photos and include information using text.

the probabilistic outcomes that so many AI systems produce.

As medical AI matures, Thrun believes it will replace many roles in dermatology, radiology and pathology; those that mainly involve repetitively reviewing images. At the same time, there will be growth in other areas, such as specialised surgery.

It could also change what it means to be a family doctor, says Kohane. "They will be able to offer their patients specialty care, like imaging and dermatology procedures right in their office, with expert-level performance and then refer the patient to a specialist if and only if a truly actionable finding comes up." That could mean a more holistic approach, and not having to split care between half a dozen doctors. "That would be a great thing both for the doctor and the patient."

There are a few significant obstacles to jump first. To start: how to provide the massive data sets that AI systems need, while protecting patient privacy. The advent of electronic medical records has also ushered in stringent regulations, such as the HITECH Act in

"AI doesn't have the capabilities to work at that kind of level yet. But by building models based on these data sets, we can create a tool for human therapists to use that makes them superhuman therapists."

the US and the Data Protection Act in the UK. Last year, New Scientist discovered that the NHS had shared patient data with Google DeepMind, a deal the UK Information Commissioner's Office just found "failed to comply with data protection law". The irony is, for medical AI to truly take off, even more rapid and wider sharing of data may be necessary. That might require new legislation. "Current laws don't really cover the kind of sharing scenarios we need to make these systems work," Denny says.

Who is in charge?

Domingos agrees that the legal framework will need to change, and stresses that any policies must require informed consent. But he also argues that sharing your health data should be seen as a civic duty, and that only those who opt in should reap any benefits. "If someone won't allow their data to be used, then they shouldn't have access to the better treatments that result," he says.

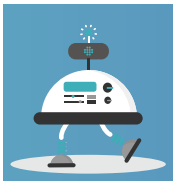
Even as the debate over privacy flares up, there's still the matter of liability. Malpractice laws are complex and vary from place to place, so it's unclear how they might need to change to accommodate AI. Kohane isn't worried, though. He points out that doctors already use machines to make a diagnosis; software that helps them identify tumours in MRI scans or abnormalities in echocardiograms, for example. "If a doctor is in the loop, the legal and ethical stuff is not going to be that challenging," he says. Ultimately, it's the doctor's responsibility. If AI and doctor disagree, a supervising physician or committee could break the tie.

Stand-alone AI systems would require further consideration, however. "That is indeed terra incognita and something we'll have to figure out as we go along," Kohane says. Liability may ultimately switch from the physician to the manufacturer, as with self-driving cars. "Volvo has said they will assume liability for their self-driving cars. For the kind of AI machines you might find in your corner pharmacy, the company that made that machine is going to have to assume liability for its range of parameters," says Denny. As for what happens if that AI gets it wrong, "it's something we need to really think carefully about", he says. "To my knowledge, the malpractice industry hasn't yet thought about this kind of thing. But it's time that we do."

Once these thorny issues have been worked through, the question is whether stand-alone AIs will ultimately replace doctors. Not likely, says Denny. By streamlining diagnosis, they will make it easier to access credible medical advice no matter where you live and will assist with a lot of routine care. "These systems will allow physicians to reduce their mental load, to pay more attention to each patient, to prioritise which patients need critical care right now; to be more efficient overall," says Denny. "It's going to be a win for everyone."

Doctors won't be cut out of the picture, because their empathic relationship with the patient is an essential part of care, says Vimla Patel, a cognitive psychologist and specialist in biomedical informatics at the New York Academy of Medicine. AI can augment clinicians' abilities, but can't do all the heavy lifting. "When things get complex, and medicine often is complex, you need human reasoning to make decisions," she says. "Computers, no matter how sophisticated, cannot replace that."

Kayt Sukel is a writer based in Houston, Texas.



MEDICAL INNOVATION'S DIGITAL FUTURE

FOSTERING INNOVATION in medical care while at the same time ensuring proper regulation of new devices being developed in the digital age will be crucial.

As part of a broad initiative, the US Food and Drug Administration is developing a new Digital Health Innovation Plan that is focused on fostering innovation at the intersection of medicine and digital health technology, according to Scott Gottlieb, MD, Commissioner of the FDA.

"This plan will include a novel, post-market approach to how we intend to regulate these digital medical devices," Gottlieb wrote in a contribution to *FDA Voice*.

Quoting a 2016 estimate that 165 000 health-related apps were available for Apple or Android smartphones, Gottlieb said it had been forecast that such apps would be downloaded 1,7 billion times by 2017. "From mobile apps and fitness trackers to clinical decision support software, innovative digital technologies have the power to transform health care in important ways, he added.

Examples included:

- Empowering consumers to make more and better decisions every day about their own health, monitor and manage chronic health conditions, or connect with medical professionals, using consumer-directed apps and other technologies to help people live healthier lifestyles through fitness, nutrition, and wellness monitoring.
- Enabling better and more efficient clinical practice and decision-making through decision-support software and technologies to assist in making diagnoses and developing treatment options; managing, storing, and sharing health records; and managing schedules and workflow.
- Helping to address public health crises, such as the opioid epidemic that is devastating many American communities. In fact, FDA conducted a prize competition to encourage the development of a mobile app to help connect opioid users experiencing an overdose with nearby carriers of the prescription drug naloxone for emergency treatment.

While needing to be forward-leaning in making sure that they had implemented the right policies and regulatory tools, the FDA needed to communicate its stance in a clear-cut and unambiguous way, he continued, to avoid discouraging innovators.

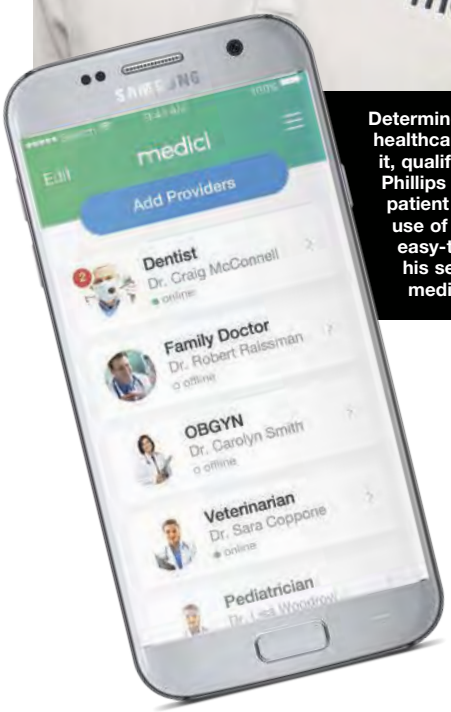
The US Congress had already taken a major step to advance these goals in the 21st Century Cures Act, Gottlieb explained. Expanding on policies advanced by the FDA, the Act revised the organisation's governing statute to, among other things, make clear that certain digital health technologies – such as clinical administrative support software and mobile apps that are intended only for maintaining or encouraging a healthy lifestyle – generally fall outside the scope of FDA regulation. "Such technologies tend to pose low risk to patients but can provide great value to the health care system," he added.

Going forward, the FDA would provide guidance to clarify its position on products that contain multiple software functions, where some fall outside the scope of FDA regulation, but others do not, he said. In addition, FDA will provide new guidance on other technologies that, although not addressed in the 21st Century Cures Act, present low enough risks that FDA does not intend to subject them to certain pre-market regulatory requirements.

"In addition to these efforts, we are also announcing… a new initiative that FDA is undertaking. This fall, as part of a comprehensive approach to the regulation of digital health tools and in collaboration with our customers, FDA will pilot an entirely new approach toward regulating this technology. This will be the cornerstone to a more efficient, risk-based regulatory framework for overseeing these medical technologies."

Among the significant components of the overall broad plan would be the leveraging of real-world data gathered through the National Evaluation System for health Technology (NEST). NEST will be a federated virtual system for evidence generation composed of strategic alliances among data sources including registries, electronic health records, payer claims, and other sources. The initial version of a fully operational system is expected by the end of 2019.

THE LOCAL CONNECTION



Determined to change the healthcare industry as we know it, qualified chiropractor Clinton Phillips revolutionises doctor-patient consultations with the use of a recently launched, easy-to-use app: Medici, his second successful medical platform.

A new spin on the doctor-patient relationship.

South Africans certainly aren't being left behind in the rush to bring disruptive technologies to the traditional interaction between patient and medical caregiver.

Two of the most recent additions to the interactive options available are **Medici** and **Signsupport for Pharmacy**.

DOCTOR, DOCTOR

South African-born Clinton Phillips completed his studies at the University of Johannesburg before moving to the US, where after establishing a chiropractic practice he launched his first health tech endeavour, 2nd.MD. His idea was to offer patients fast and reliable answers to medical queries at the touch of a button, without having to travel or spend time sourcing information from sought-after top medical specialists around the world.

Phillips drew inspiration from personal tragedy: his daughter, Gabi, suffered a stroke at birth. Doctors said she would never walk or talk again. Desperate to find accessible alternative medical advice, Phillips and his wife searched high and low for a paediatric neurologist, a timeous and exhausting process. "The challenges we faced trying to access top doctors was extremely disheartening, it astounded me that we could easily buy stocks in Tokyo or a book in a foreign language and have it couriered to you the next day, but to simply talk to a physician on the phone was just not possible," explains Phillips.

This first-hand experience inspired the entrepreneur to establish a more realistic means of obtaining information from highly qualified medical specialists. Thus 2nd.MD was born, bridging the gap through innovative technology to help millions worldwide.

Gabi's story has a happy ending. Fully recovered, she is enrolled in regular schooling and like any ordinary seven-year-old loves nothing more than to run, sing and play with her pets.

Medici was officially launched in the United States at the South by Southwest Festival in March 2017 after nine months of testing in beta phase, followed by a successful launch to the SA market in May, 2017. The app allows users quick and efficient one-on-one contact with their own trusted healthcare providers, conveniently on their mobile device. Patients can consult with multiple doctors on the app, from GP to paediatrician, from dentist to gynaecologist, psychologist, even their vet, and more.

"I have stayed very close to the innovations of South African

Associate professor in computer science at the University of the Western Cape, Bill Tucker (left) and team members developed an app for mobile phones, Signsupport for Pharmacy, to help Deaf people break the sign language barrier to communicate about their medication.

healthcare. You can never get SA out of your heart, which is why it was next on my list of countries to infiltrate," says Phillips. "Medici was crystallised when I saw a friend WhatsApp his doctor for his daughter and I realised the challenges the US faced were very similar to the needs of SA and Africa. Transforming SA healthcare is tremendously exciting. Healthcare will get better, cheaper and more enjoyable."

SPEAKING FOR THE DEAF

There's deaf, which means suffering hearing loss. Then there's Deaf, with a capital D: people who primarily use sign language as their mother tongue and as their identity.

When most people go to the pharmacy to collect their medication, they are able to talk to the pharmacist, ask questions about their medication and read the printed directions on the product label. For many Deaf people, that's simply not possible. Many are functionally illiterate and know only sign language, according to Professor Bill Tucker, associate professor in computer science at the University of the Western Cape.

So, unable to discuss their needs with the pharmacist, disadvantaged Deaf people tend to merely collect their medicines and rely on their families to advise them on how to take them.

Seeking a solution that would allow Deaf people to access information about their prescribed medication independently, Tucker, postdoctoral students Prang Nat Chininthorn and Andre Henney as well as several colleagues developed an answer. Their app for mobile phones provides Deaf people with the information they need about their medication or illness in sign language. The app, a video application dubbed 'SignSupport for Pharmacy', was developed in consultation with Deaf people as well as pharmaceutical and other experts.

Pre-recorded videos, which cater for a range of medical needs, are loaded on phones and can be accessed via the app. The apps can be accessed on mid-range phones costing about R1 300.

"We aim it at the lowest-end phone that has a front-facing camera so, when Deaf people have questions, they can connect to a remote interpreter to clarify information. Once they are on the phone, it does not cost the end user anything. That's key for us as we are dealing with disadvantaged people," says Henney. Tucker says the team worked with hospital pharmacies because Deaf people were most likely to use those.

One of the problems the team had to overcome was that there were many variations of South African sign language. People in different communities have developed their own sign languages, much like the different dialects of English developed.

However, Chininthorn says, "Even though there are multiple dialects there's enough commonality among Deaf people. It is possible for good signers to sign in a way that more people can understand, for instance in a video."

The team had an industrial design engineer work with Deaf people to get their input, and a PhD student in pharmacy who made sure everything adhered to proper pharmacy protocols. All this work was handerd to computer scientists, who coded the mobile app. Having worked with the Deaf community since 2001 and on the app since 2010, the team feels the app is ready for the marketplace, but this has been hampered by a lack of funding and support.

According to the researchers, DeafSA estimated that in 2006 there were about 600 000 Deaf South Africans. Despite this huge market, getting the government to buy into the concept has been difficult.

"We have had meetings with the government, which went well, but then nothing happened. What we need is to form an organisation that will take ownership of this project. This needs to be commercialised, even if for free, which is how I would like to see it," says Tucker.

The app is as not intended for all people with hearing loss, but for a specific segment of that community.

"Deaf – with an upper case 'D' – denotes people who primarily use sign language as their mother tongue and as their identity. Cultural ethnic identity is attached to your language," says Tucker.

"With a lower case 'd', 'deaf' people are usually older people who suffer from hearing loss but can communicate as they have been reading, writing, speaking and hearing all their lives. So they are more likely to be able to lip read, talk and use a hearing aid.

"Our target audience is 'Deaf' people, for whom SA sign language is their sense of identity and community. For instance, children of Deaf parents might be able to hear, but their first language is sign language. They would also call themselves Deaf even though they can hear, as that is the language they use." **PM**

– Sources: Medici and UWC.

THE *MOST* EFFECTIVE WORKOUT IN THE WORLD*

*Combination of functional movements that are frequently used in HIIT workout routines like those used in CrossFit **Journal of Sports Science & Medicine, ResearchGate, Mayo Clinic

WE PORED OVER THE RESEARCH THEN POUNDED, DANCED, GRINDED, CYCLED, RAN, LIFTED, FOUGHT AND BURPEED OUR WAY TO WHAT SCIENCE DESCRIBES AS THE BEST RETURN ON YOUR SWEAT INVESTMENT.**

BY LINDSEY SCHUTTERS

ALL PICS RETHA FERGUSON

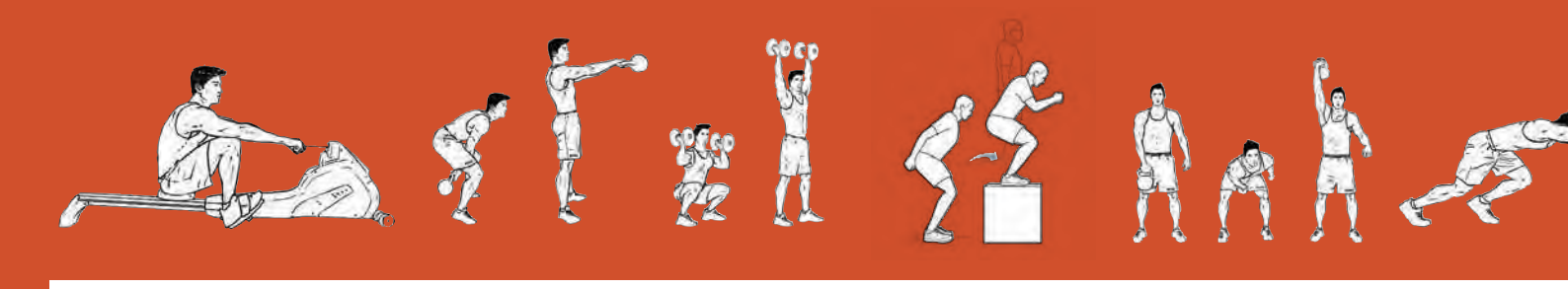
THE ANSWER, if you were looking for an easy one, is CrossFit. Technically speaking it's a seemingly randomised mix of high intensity interval training (HIIT), resistance training, continuous moderate intensity exercise (CMIET) and sport-specific training. You basically want to adjust your training to being very functional in a gym environment and then schedule in some dedicated sessions for your chosen sport, like a long run or hitting the mountain-bike trails on the weekend.

Whereas there is a ton of research around what the best exercise is, most studies and hypotheses circled back to two existing bodies of work. The first is a 2014 study conducted by exercise and sport science department at Western State Colorado University in the US. Researchers set out to compare the effectiveness of CMIET alone and CMIET with one day of HIIT per week. The 29 adults were randomised into three groups and returned after 12 weeks of close supervision with a 10,1 per cent increase in $V0_2$ max among the group with the one day of HIIT training in their routine. The straight CMIET group saw an increase of only 3,9 per cent and the sedentary crew a reduction of 5,7 per cent.

The other study comes courtesy of Germany's Martin Luther University's Department of Sport Science, which in 2012 prepared two groups of recreational runners over 12 weeks for a half marathon. One group trained using two endurance run sessions (totalling 150 minutes) on a weekend and the other four 30-minute HIIT sessions and one 30-minute endurance run, with workouts happening after office hours. Members of the HIIT group saw significant gains in oxygen intake ($V0_2$ peak) over the other group, but all 34 athletes finished the half marathon with little performance increase over previous times.

Although you can fit in HIIT sessions virtually anywhere, no other organisation has coded it into its DNA like the CrossFit brand. The organisation is based on a fitness regimen developed by Gregg Glassman, who defines fitness as "increased work capacity across broad time and modal domains". It's the "work capacity" bit that sticks out the most. That serves as a call-out to an idea of fitness that isn't about looking good in a bikini or how many lines there are in your sixpack. CrossFit capability is proven by how many reps of the workout you could achieve in the allotted time, how fast you could do the prescribed workout or how much weight you could lift for a given movement.

These principles and the ability they have to inspire legions of acolytes to strive to achieve ever-increasing outcomes was prime breeding ground for the organisation's marquee event: the CrossFit Games. At the games, the organisers crown the fittest on Earth. It's a bold claim, but easy to make when your sport is literally people working out. The fittest on Earth for 2017 were crowned as this story landed at the printers, but there would be no surprises to see Mathew Fraser and Katrin Davidsdottir reclaim their respective titles.



THE WORKOUT

Functional training movements are intended to prepare your body to face the actual movement patterns and exertions you will encounter in daily life. Humans have evolved to be proficient at running, jumping, climbing, walking, lifting, carrying, throwing and pulling. It doesn't take a particularly large leap in logic to then match any physical training to those movement patterns.

The contributing doctors, physicians and specialists at Mayo Clinic have built a trusted brand of peer-reviewed science. Those experts have distilled the basic exercise programme needs to at least 150 minutes of moderate aerobic activity or 75 minutes of vigorous aerobic activity per week, along with strength training exercises at least twice a week. These guidelines have been adopted globally by government health departments and have numerous studies backing it up.

But that's just a start. Popular Mechanics has taken this guide and matched it to functional movements that offer the biggest returns on investment and will bring about the greatest physiological changes. The important thing to understand is that if it gets you breathing faster and gets your heart rate up, it's an aerobic exercise and will help to improve how efficiently your body works with oxygen. Oxygen is the fuel that keeps the whole machine running; you want to tune and maximise every breath.

Do these moves, but don't be shy to play around with others, in any combination of two or more for 20 minutes a day or 30 minutes five days a week at a high intensity and you'll have all your bases covered from a fitness standpoint.

ROW

WHY: You're using your entire body to crank out strokes, it's a powerful aerobic trainer.
HOW: Keep your back straight, brace your core and drive with your legs. Pull the handle to your chest once when you're at the end of your leg drive. Return to start position and repeat. Legs, arms, arms, legs – that's one stroke.

KETTLE BELL SWING

WHY: It may sound counter-intuitive, but this is the standing equivalent of using the rowing machine.
HOW: Feet shoulder-width apart, holding the kettle bell by the handle in both hands so it can swing under your crotch area. Then bend knees, drive bum back while keeping your back straight and then use your hips and buttocks to propel the kettle bell forward. Your shoulders and arms are there to carry the momentum and swing the kettle bell and steady it directly above your head. That's one. Let it swing down for the next repetition.

THRUSTER/SQUAT THRUST

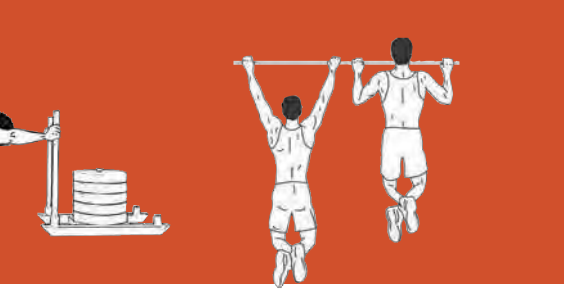
WHY: The squat is a foundational movement in human kinetics; you should be doing it every time you work out. A thruster combines the squat with an overhead press, bringing core stability and co-ordination into play.
HOW: With a bar bell or an equal weight in each hand resting on your chest/shoulders, squat down until your hips break parallel with your knees (remember to send your knees tracking over your pinky toes) and stand back up, driving the weight to full arm extension above your head with knees and hips fully extended as well. That's one.

BOX JUMP

WHY: Building explosive power in your legs is a whole body exercise. Jumping is the ultimate explosive move.
HOW: Stand in front of a stable obect that can easily hold more than your weight. In one move propel your body upwards and forwards so that you land with both feet on the object at the same time. Stand up straight with knees and hips fully extended. That's one.

SINGLE ARM SNATCH

WHY: You want symmetry in your strength and movements as well as explosive power. This builds both of those.
HOW: With the dumbbell or kettle bell on the floor, squat down and grab it in one hand.



Keeping your back straight, brace your core and buttocks and move the object from the floor to overhead in a singlular explosive movement.

PRO TIP: Use your leg drive, hip thrust and a shrug of the shoulder – in that order – to move the weight from the floor, while trying to keep it as close to your body as possible.

SLED PUSH

WHY: Because the most effective workout move is you versus a heavy object that you have to move across a distance. Think ploughmen and dead car batteries.

HOW: Approach the sled, concentrate on keeping your back straight, walk with your heels hitting the ground first and drive it forward.

PULL-UP

WHY: It's the only way you can do a pulling motion outside of climbing a rope, and that's exponentially more difficult.

HOW: Hang on to a horizontal bar that can support you weight. Pull yourself up until your chin passes the bar. Lower yourself down and repeat.

Coach's corner

We sought out CrossFit-certified Level 2 coach and SA weightlifting champion AJ Visser for help with these moves. Visser is a long-time CrossFit athlete who has competed as part of a team at the CrossFit Games Meridian Regionals and is the owner of CrossFit Brackengate, which is situated in Bracken Gate Business Park next door to the mammoth new Shoprite/Checkers warehouse in Cape Town.

PM: *What draws you to CrossFit?*

VISSER: "I love the fact that CrossFit is a group environment where you're motivated by the person next to you and I also love the idea that it's possible for anyone to do. You can be the fittest person or come straight off the couch and you can do a workout, as long as you scale it to suit your abilities."

How do you manage athletes of various capabilities in a group class?

"I believe it's very important to spend time with each and every athlete to learn what they can and can't do and what their goals are. It's difficult if you have bigger classes or run many classes to, as a head coach, make it to every class, but it's important at least for the first few weeks when someone joins to spend time with them. Then you have to translate that to the other coaches."

How important is it for an athlete to know themselves?

"That's very important. It's easier to manage a more mature crowd because they'll make better decisions and, crucially, take guidance very well. It can be difficult to coach more enthusiastic athletes who are focused on what others are doing and want to progress too quickly. In that initial period when we're spending time with newer athletes, it's important to be strict about teaching them the correct way to move and slowly ramping up the weight so that they are doing it safely before trying to push themselves."

What's your coaching philosophy?

"I like to listen to my athletes and support them in whatever their goals are, but the results I look for are beyond weightloss or body image. The best for me is when a client comes to me and tells me how he hit a mountain-bike trail on the weekend and could ride longer or faster. We're preparing people for life when they come into the gym. CrossFit must help you be better at everything. Yes, you'll lose weight and look better, but you must be better. **PM**

UPGRADE

TO THE DEPTHS

PUTTING DIVERS TO THE TEST IN THE WORLD'S DEEPEST MAN-MADE POOL.

AT THE FOOT OF A HILL in Montegrotto Terme in Padova, Italy, along a leafy countryside road stands an unassuming white building that houses the world's deepest swimming pool.

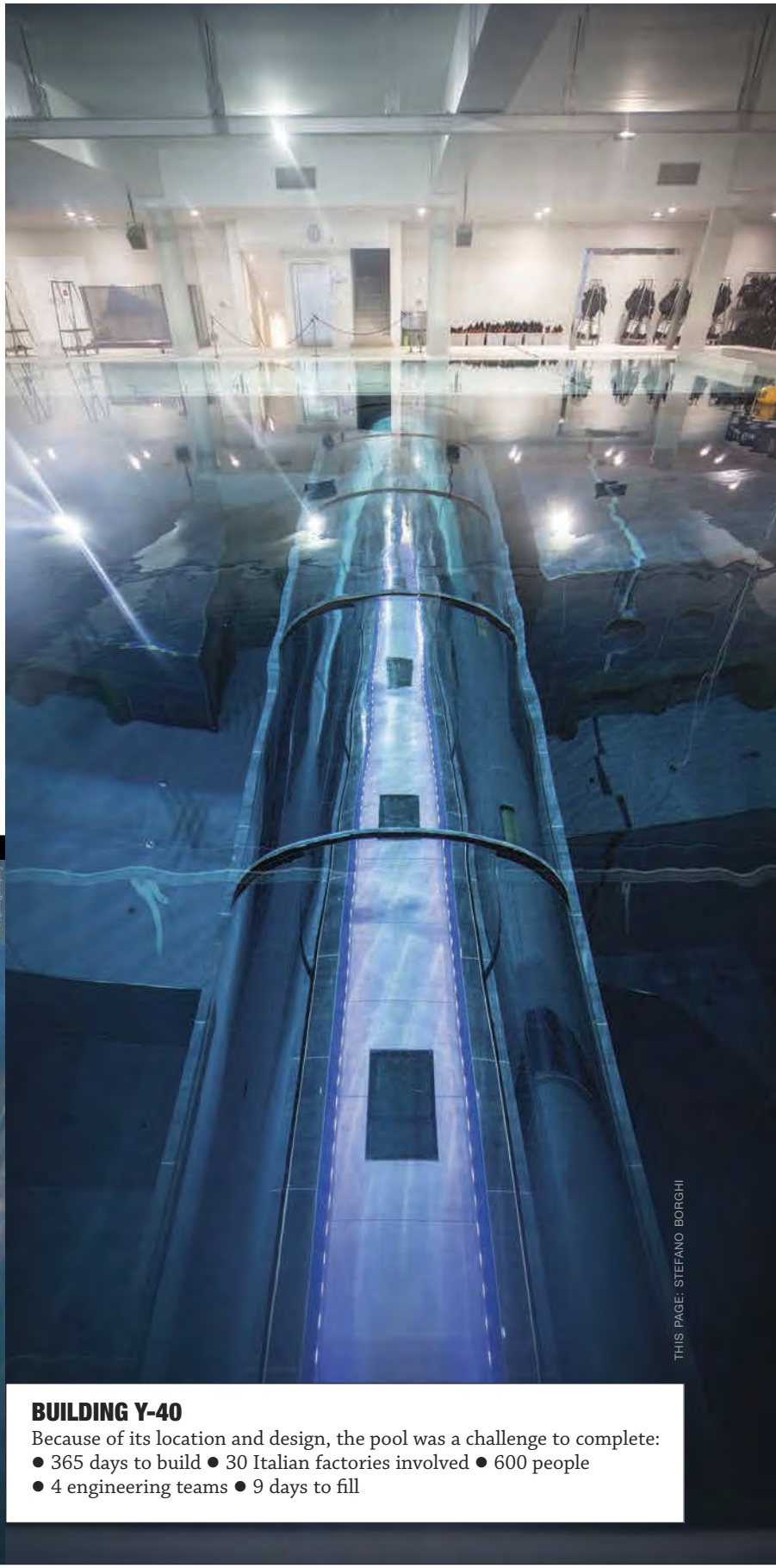
Here in the countryside just outside of the city of Padua and an hour's drive from the coast, divers gather from across the globe and companies come to test gear.

Y-40 was designed by architect and hotel-owner Emanuele Boaretto and pays tribute to Italy's 82-year-old freediving history. The centre specialises in training both freedivers and scuba divers.

Freediving is a form of unassisted diving that relies on a diver's ability to hold their breath. This style of diving has been used by fishermen and ship repairers for millennia.

After a build that lasted a year, the centre was inaugurated on 5 June 2014. On the same day *Guinness World Records* crowned it the "Deepest Swimming Pool for Diving".

Included in the pool's unique design is a 13-metre



THIS PAGE: STEFANO BORGHI

BUILDING Y-40

Because of its location and design, the pool was a challenge to complete:
● 365 days to build ● 30 Italian factories involved ● 600 people
● 4 engineering teams ● 9 days to fill

viewing tunnel and windows installed for visitors. This would prove to be especially popular when kids want to watch mermaids practise (below). In the top 10 metres a variety of caves and platforms are installed to train divers.

Since its opening, the centre has seen more than 100 000 visitors each year, with many South African divers making the pilgrimage, too.

According to the operating company, about 1 000 diving certifications are earned here annually, making Y-40 one of the largest diving centres in the world.

Y-40

BY THE NUMBERS

DEPTH:
42,15 metres (equal to a 14-storey building)

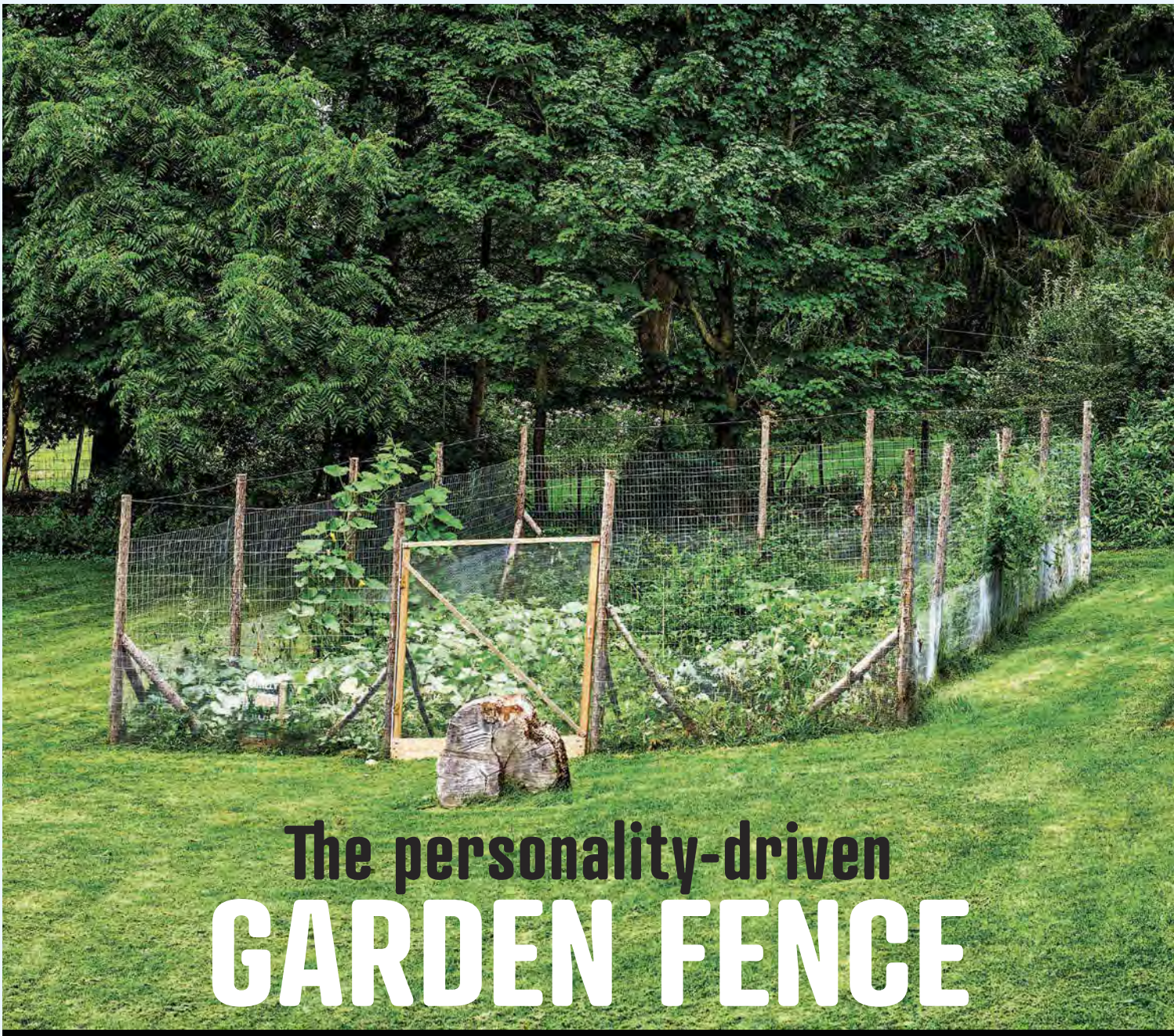
TEMPERATURE:
32°-34°

VOLUME:
4 300 cubic metres

VIEWING TUNNEL:
13 metres

SURFACE AREA:
21 x 18 metres

Platforms @
-1,3 m, -5 m, -6 m ,-8 m, -10 m, -12 m, -25 m, -42,15 m.



PHOTOGRAPHS BY COREY OLSEN

The personality-driven GARDEN FENCE

It's just to keep scavengers out, sure, but it's also a large, permanent, highly visible lawn ornament. Make it how you want it.

BY RYAN D'AGOSTINO

THERE ARE STRONGER fences out there. Fences more precise in their dimensions, more uniform in their materials. Fences that took less time to build because they were planned out ahead of time, or even bought as an E-Z prefab kit. Mine I kind of made up as I went along.

We needed the fence because we have deer. Many deer. Also foxes, bobcats, coyotes, the occasional river rat, chipmunks, squirrels, and something that makes tracks we haven't been able to identify. I don't know how many of these animals enjoy eating vegetables, but enough that the fence was mandatory.

This is ostensibly a how-to article about fencing in your backyard vegetable garden, but even if you were to follow these steps by the number, your fence would turn out different. As it should. It's your yard, and your fence, and I learnt while building this one that a fence can have personality. My yard, for example, has about a 30-degree slope in the area where my wife wanted the garden, and I wanted the fence to move with the slope. That's one way our fence developed its particular personality. But don't build this fence. Build your fence.

Fig. 1

INSTRUCTIONS

1 TILL THE PLOT

In the preceding autumn I tilled two parallel strips into the grass, each 12 metres by three metres – these would be the planting beds. I left a two-metre runway of grass between them, which provides both a place to walk without stepping on the vegetables and a barrier against erosion (because it's on a slope).

I didn't peel away the sod before tilling, I just tilled the grass right into itself. This is not the best way to do it, because it encourages the grass to regrow. But for one thing, I used aggressive machinery: a Kubota BX25D-1 tractor with a 1,25-metre power take-off tiller. Each tine clawed 15 centimetres of loamy soil with every revolution, and there were six tines in total. I dragged that thing over both 12-metre plots at least ten times.

Again, this was in the autumn, so the grass didn't pop right back up anyway. We covered all the dirt with a layer of hay, then it snowed all winter, and by spring the grass seemed to have been put in its place.

2 DIG THE POSTHOLES

I intended to buy 100 mm square cedar posts – I don't like pressure-treated wood – but then a friend told me about these beautiful, three-metre, bark-on cedar poles at a local lumberyard. I liked the natural look so I sprang for them.

I rented a two-man General brand auger with a Honda engine from my reliable local supplier. The other man was my neighbour Andy, and we spent most of a Saturday wrestling the corkscrew through very good but very rocky soil. We started with the two holes that would mark either side of the garden gate and worked our way around from there, digging each hole at least three-quarters of a metre deep. You have to go at least that deep, especially if you're not planning to anchor the posts in concrete, which I wasn't. Some holes, in truth, were less than that because we hit enormous rocks and gave up.

3 SET THE POSTS

The drill: throw a shovelful of gravel in the bottom of each hole. Set the bottom of the post on the gravel


Fig. 2

(for drainage). Fill the hole, alternating a few centimetres of soil with a few centimetres of gravel, topping off with a layer of sand, which my father told me keeps insects away. (Even with cedar, you can't be too careful.) Don't worry if some of the posts wiggle a little. Eventually they will draw strength from each other.

I halved the remaining four poles on a 45-degree angle with a chainsaw and used them as braces on the four corner poles [**Fig. 3**], fastening the braces to the poles using four-inch GRK #8 construction screws.

Then I realised the gateposts should have braces, too, because they would be under stress every time someone opened or closed the gate. I had no more cool cedar poles. So I picked through the brush pile that had grown behind my barn and found some good branches.

4 WRAP THEM

Now for the part that makes the fence useful: one hundred feet of 14-gauge galvanised steel mesh, fastened using 20-millimetre poultry-fence staples and a low course of poultry netting to keep out small rodents.

First we dug a 30-centimetre-deep trench to bury the steel mesh. Some varmints burrow deeper than that, but it was getting hot, so that's as deep as we dug.

Once we stapled the beginning of the mesh roll to one of the gateposts, two guys (me and my father) pulled


Fig. 3


Fig. 4


Fig. 5

the roll taut while a third guy (my brother Mike) madly hammered staples into the next post. Whenever Mike hammered his thumb, we'd switch. Afterward, you can tighten the wire to fit by kinking it with a set of linesman pliers [**Fig. 1**]. Complete the fence by stapling up the poultry netting.

5 LEVEL THE TOPS

Because our holes were all different depths (remember the rocks), our posts were different heights. They had to be even. The only question was: what did even mean? The ground sloped. Should the posts make up for that; that is, should the lower posts be taller so the tops were all on plane? Or should they be the same height, so they sloped with the hill? I chose the latter. No need for a tabletop top.

On this day, Andy was back, and with my Sawzall he buzzed them all at about two and three-quarter metres. We saved the nubby tops for some future use, which still has not been determined.

6 RUN A WIRE

A strong deer can jump two and a half metres from a dead standstill, so we ran a single 16-gauge galvanised steel wire around the tops of the posts, simply wrapping once and stretching it to the next one [**Fig. 4**]. At the last post, I wasn't sure how to finish, so I just wrapped it around ten times and it hasn't budged.

7 MAKE A GATE

You need a top, bottom, and two sides, plus hinges [**Fig. 5**] and some poultry netting. Some boards left over from a barn-door repair became the bottom and the sides. The top was scrap. I bolted the four edges together and added a diagonal for strength. My door is a parallelogram, because of the slope, and so far it's worked fine [**Fig. 2**]. I never added a latch, so we just kick a river rock back and forth to keep it shut or open.

No animal of any kind has been spotted in the garden, ever. **PM**

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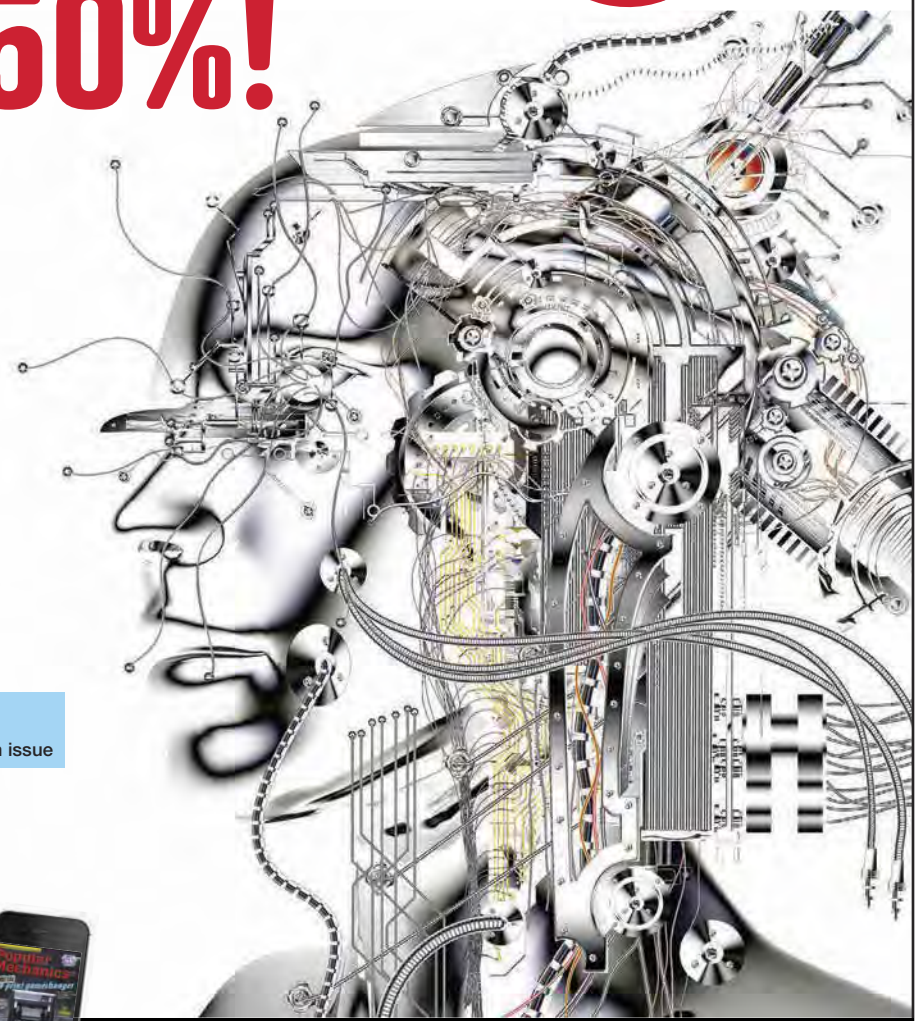

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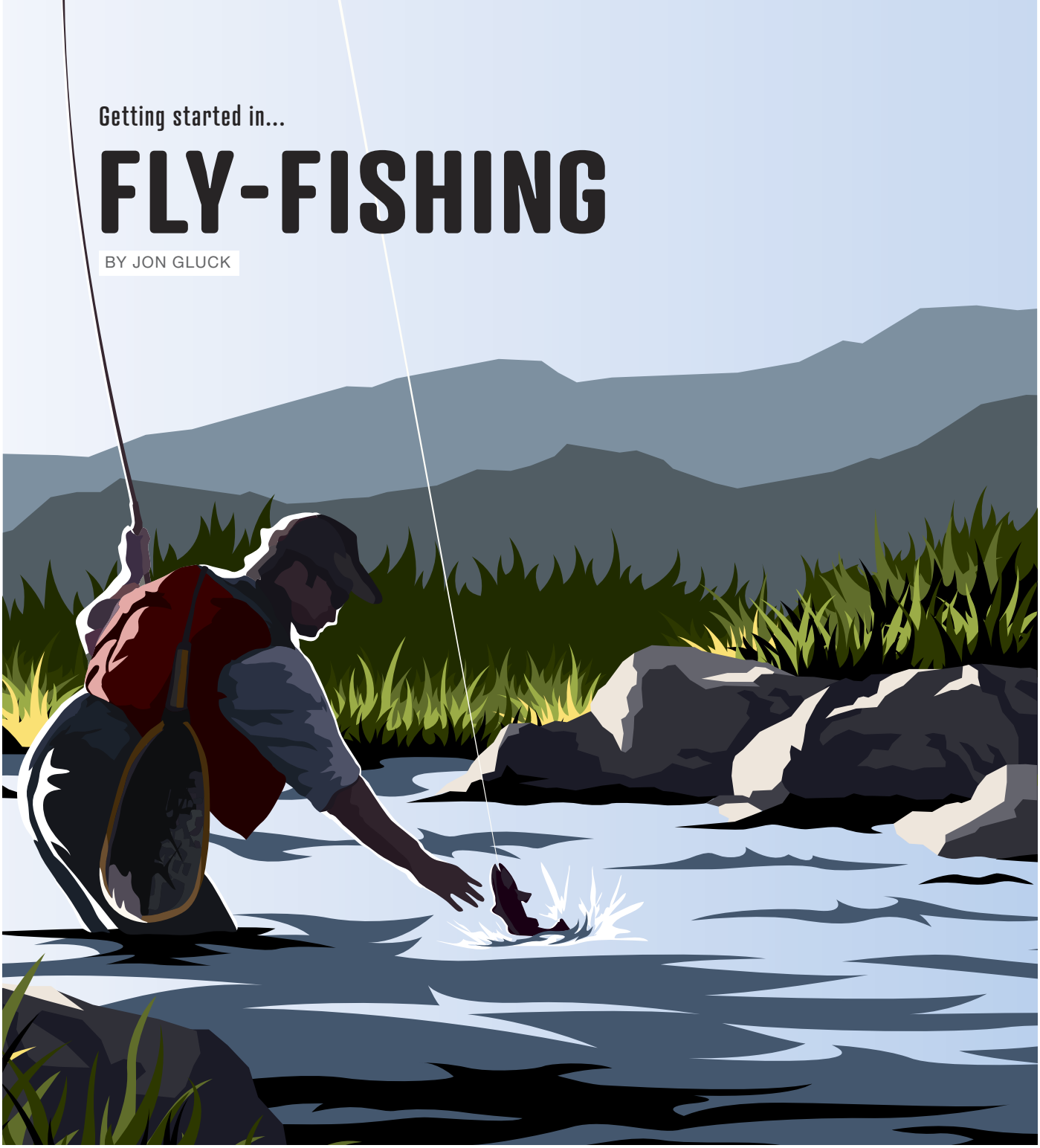
Getting started in...

FLY-FISHING

BY JON GLUCK



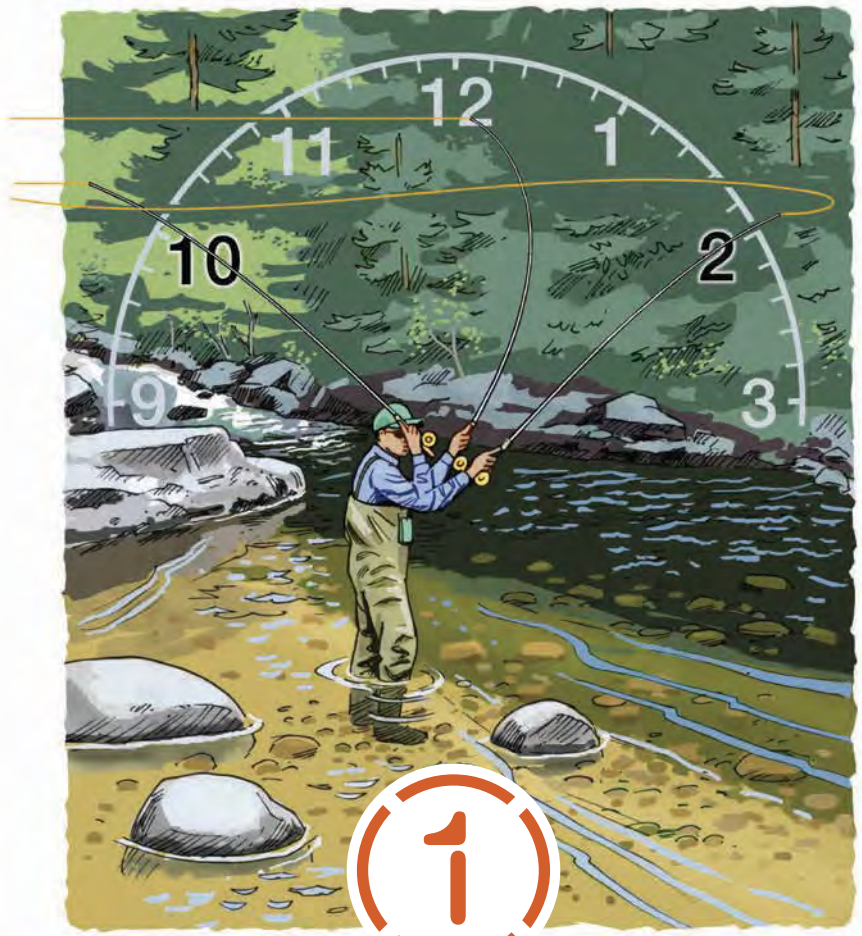
ISTOCKPHOTO/TSEYBOLD

THE FISH WAS HOLDING maybe a dozen metres upstream, rising every 30 seconds to feed. When small fish eat flies that way, they make little splashes as they break the surface. Big fish push the water in slow, silent ripples. I saw ripples.

I had already cast to this particular target twice, but my fly landed wide the first time and a couple of metres short the second. On my third attempt, I managed to put the thing a few centimetres from my quarry's nose and... he took it. He ran, and I played him for a minute or two before bringing him alongside the boat. Fifty centimetres is a benchmark of size for a German brown trout, one of the sport's most prized species. This fella was easily over that. After I netted him, I asked my friend Tim to hold him for a moment so I could position myself for a picture. We were on the South Fork of the Snake River in Idaho, just across the Wyoming border from Jackson Hole. The Tetons stood in the distance, still snowcapped in late July. The sun shone, the water sparkled and the cooler was full. I had just landed the largest, most beautiful trout I had caught in my life, and I was about to log photographic evidence so I could brag to all the world, as one does, about outsmarting a lower-order vertebrate. And then, when I took the net back from Tim, my trophy was gone.

That's when I saw the hole in the net.

I have never felt so happy and so heartbroken in such rapid succession. That's why I fly-fish. It's life, in all its joy and pain, distilled and intensified. With beer.



1

CASTING TIPS

Fly-fishing is essentially the art of putting a fake fly in front of a fish in hopes he'll mistake it for the real thing and eat it. That all begins with the cast. Here, casting champion and Texas Gulf Coast fly-fishing guide Rick Hartman explains the basics.

MAKE LIKE A METRONOME

The casting stroke "is an art that is performed on a four-count rhythm between ten and two o'clock", wrote Norman Maclean in *A River Runs Through It*, arguably fly-fishing's most beloved text. Live that advice. "The biggest mistakes I see people make are to cast too fast or with too big a stroke," says Hartman. Imagine you're trying to toss a tin can off the end of your rod. "Keep everything tight and easy."

BE SMOOTH

The key to generating distance is to stop the rod – abruptly – at ten o'clock and two o'clock. "That's what generates power and shoots the line with maximum speed," Hartman says. Some guides teach anglers to think of hammering a nail into a wall, but Hartman says that often leads them to stop their rod too soon, robbing their cast of oomph. "Just make a nice, smooth stroke forward," he says, "then stop."

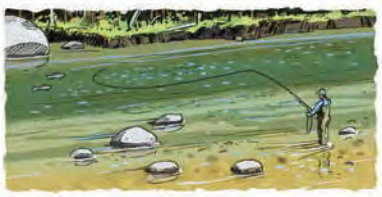
BEWARE THE FLYING ELBOW

Another common error is to cast with your arm too far from your body. Tuck a newspaper under your arm to practise, Hartman advises. "All that flailing your arm around is a waste of energy. Your casts will be weak and you'll tire out faster."

2

WHERE TO LOOK

Like anything that breathes, fish are hardwired for survival. They look for hangouts that provide (a) protection, (b) food, or (c) rest. Rob Ceccarini, fishing manager at Orvis in Manhattan, suggests the best places to try your luck.



WHERE WATER TURNS FROM GREEN TO DARK GREEN

Indicates a drop-off in water depth, which provides safety and a steady "pour-over" of natural flies.

JUST DOWNSTREAM OF BOULDERS AND ROCKS

Fish can hold in the relatively slow water without having to work too hard, but can easily dart into the main current for food.

IN POOLS THAT RECIRCULATE UPSTREAM

Fish (and flies) seem to like to ride the gentle, backwards currents.

BENEATH UNDERCUT BANKS

The trifecta: overhead protection from predators; cool, dark conditions; and terrestrial insects falling into the water.

ILLUSTRATIONS BY STEVE SANFORD

3 ESSENTIAL GEAR

Many lodges will be glad to lend you a rod and reel on your first visit. When you decide to take up the sport, these are the key pieces of equipment.

1 / SAGE 2200 FLY REEL
The large-arbor size lets anglers retrieve line fast. (From R1 800)

2 / CABELA'S RUBBER LANDING NET
The wide mouth makes for easy scooping. (About R400)

3 / SIMMS FREESTONE WADERS
Comfy, practically puncture-proof, and the right pockets for holding stuff. (R5 600)

4 / SMITH GUIDE'S CHOICE POLARISED SUNGLASSES
Essential for reducing glare and spotting fish underwater. (About R2 000)

5 / WINSTON BORON III PLUS ROD
A balance of light and strong from one of the sport's most venerated makers. ($855)

6 / STANLEY CLASSIC WATER BOTTLE
Hot stuff stays insanely hot, cold stuff stays insanely cold. (from about R700)

7 / CABELA'S ADAMS PARACHUTE DRY FLY
A versatile mayfly pattern that belongs in every angler's box. (R24 a pack of 3)

8 / ORVIS CAMO BALL CAP
Solid sun protection and retro style. ($25)

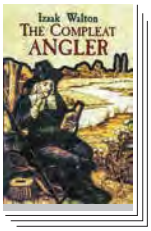
A FEW PLACES TO GET STARTED

SMALBLAAR RIVER, DU TOIT'S KLOOF, WESTERN CAPE
If you've ever driven the N1 out of Cape Town to Worcester, you know this tranquil river just on the other side of the Huguenot Tunnel. There are six different fishing beats starting from the hotel just off the highway.

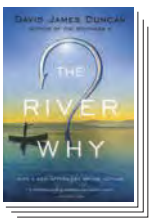
CRYSTAL WATERS, UNDERBERG, KWA-ZULU NATAL
Stocked regularly at the end of summer from the trout hatchery on the premises, overnight visitors are limited to one fish per day. Fish the rivers flowing into the dam or from a paddle boat in the dam, your choice.

GROENVLEI FLY-FISHING, BELFAST, MPUMALANGA
Described as the jewel of the trout triangle, the farm loves to boast about the quality of its fish, with good reason. Five dams more than cater for various fishing levels and dams are sustainably stocked from Katrinarust next door.

THE THREE BEST FLY-FISHING BOOKS



The Compleat Angler
Published in 1653, Izaak Walton's treatise on fly-fishing and its pleasures is widely viewed as the sport's urtext.



The River Why
Set in the Pacific Northwest, David James Duncan's novel is a fishing yarn, love story, paean to the natural world, and tale of self-discovery all beautifully knitted into one.

A River Runs Through It
Norman Maclean's elegiac memoir is equally brilliant on angling, family, and loss. The film version made Montana fly-fishing (and Brad Pitt) famous.

DIY Divas

WALL FLOWERS

Use plywood to make planter boxes mounted on a French cleat system that allows you to easily remove the planter boxes when necessary.

WE ASKED OUR FRIENDS the DIY Divas for another easy project. They suggested the French cleat. It's a great way to hang heavy items and decorate your home. For planter boxes, where a French cleat mounting is used, you can easily lift the boxes off the hanger to water or replace the plants.

Why French?

It could be because the French influence spread far and wide in earlier years. Or as one source suggests, it could be because of the term used for cutting food into thin strips. Nobody seems to know for sure.

What makes the cleat particularly useful – whether you speak French or not – is that it provides a customisable system for organising storage. And it's adjustable, simply by swapping storage containers (or, as in this cases, planter boxes) around.

MATERIALS

- 1 of 32 x 67 x 1800 mm pine – French cleats/mounting plank (1 200 mm long)
- 3 of 16 x 150 x 150 mm plywood – sides and back
- 1 of 16 x 166 x 182 mm plywood – front
- 1 of 16 x 182 x 182 mm plywood – back
- 3,5 x 30 mm screws
- Exterior wood glue
- Cup hooks [2]
- Rust-Oleum LeakSeal

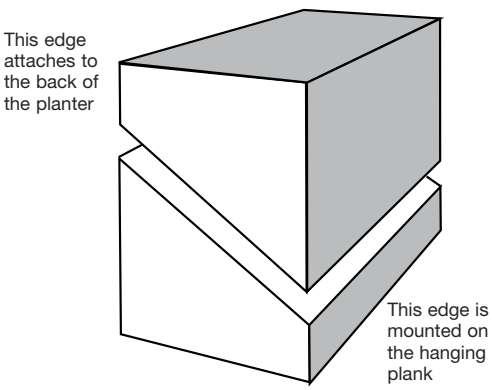
Optional: Rust-Oleum Ultimate Wood Stain

TOOLS

- Drill/Driver plus assorted bits
- Mitre saw or table saw – or mitre box and backsaw
- Quick clamps
- Tape measure and pencil

CONSTRUCTION

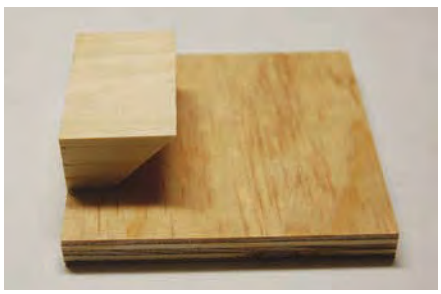
1 The integral part of this system is the French cleat, and to make a French cleat you need to use a compound mitre saw. The compound angle is 45 degrees.



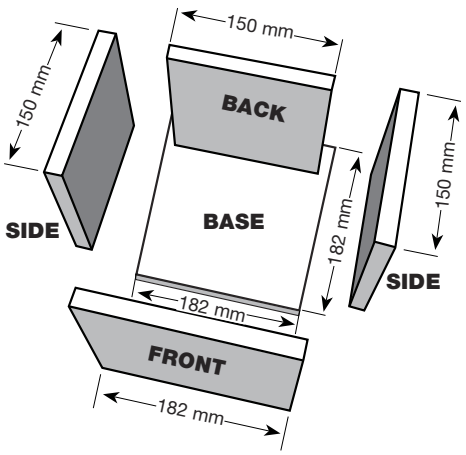
GOOD TO KNOW:

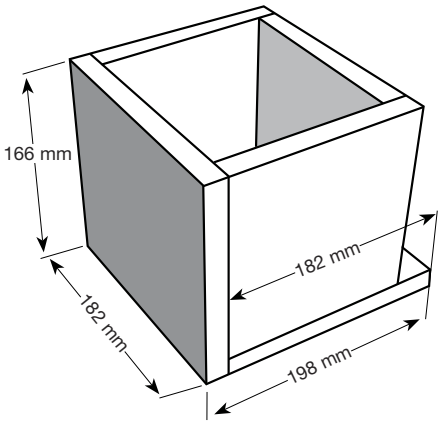
- You could use a mitre box and backsaw, but be prepared to put in some effort to cut the angles using this method.
- Cut the four French cleats from a long, single plank, so that you are always working well away from the blade.

The French cleats are cut from a length of pine. First, cut a 45-degree mitre and then cut a straight. Repeat this until you have four French cleats. The cleats are approximately 64 mm long, but you can make them longer; the most important part is that they fit together to create the hanging system.

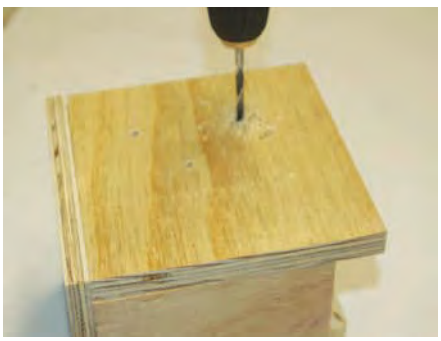


2 Use wood glue and 30 mm screws to attach one half of the French cleat to the box back.





3 Assemble the boxes by gluing the sides, front and back onto the base. Clamp and leave overnight.



4 Drill 4 mm holes through the base to allow water to flow through.

5 Along the 1200 mm long mounting plank, make a mark at 20mm, 346 mm, 672 mm and 998 mm. Of the four cleats you need to attach to the plank, take two and pair them up to mark the position for mounting the bottom half of the cleat to the plank. Using the previous marks as a guide, place the pair on the board and mark the bottom of the cleat to indicate where to attach.

6 Secure the bottom cleat on the plank with 30mm screws – drive through the back of the mounting plank.

7 If you want the planter boxes to last longer, you need to offer some protection from water. The original project pictured here used two coats of Rust-Oleum LeakSeal inside the boxes. This flexible rubber coating repels water, and although not completely waterproof, the boxes will last far longer than if left untreated.

8 To hang the planter boxes on a wall, add a couple of cup hooks at the top of the plank, on the sides. The finished project will be quite heavy once the plants are potted up; the two hooks should be enough to hold everything.

FINISHING

Finish off the planter boxes with Rust-Oleum Ultimate Wood Stain in rustic sage. You can stain, seal or paint the boxes in your desired finish, or simply let them age naturally. Rust-Oleum also offers a Soft-Touch Polyurethane and Ultimate Spar Varnish that can be applied over the wood stain.

Compiled by **ANTHONY DOMAN** *(anthony@ramsaymedia.co.za)*

DRIVING

THREE SPIRIT

TRIPLES AIN'T WHAT THEY USED TO BE. AND YET THEY ARE. BY ANTHONY DOMAN

One thousand is, more or less, the number of kilometres in the return trip from our Cape Town home to Knysna. One thousand is, more or less, the meaning of the 1.0 – as in one litre, a thousand ccs – designation of the Volkswagen Golf 1.0 TSI Bluemotion I'm driving. And an almost unbelievably low one thousand is where the rev counter needle is pointing as we comfortably keep up with freeway traffic.

So this is what a three-cylinder one-litre engine feels after 30-something years in development.

Main picture: Refuelling (us, that is, not the Golf) in Swellendam. Right: Boot's big enough… just… for our road trip.

Shift down, step on the gas and there's a throaty growl that you just have to love. Especially when it was the original analogue-era soundtrack to a young family's first tentative steps up the Garden Route. In a little yellow Daihatsu Charade, still squeaky with newness. Three of us, three cylinders and a thousand cubic centimetres, more or less.

We trekked there and back countless times over the years. But circumstances change, people move on and memories and traditions fade. We went elsewhere. We grew up.

It's a good thing that I'm not big on coincidences, but while I was mulling over our Knysna travel plan, I got to thinking about those early days. Just then, Volkswagen launched a new Golf range that included a new model with three cylinders. With a thousand cubic centimetres. Yet, with as much power as the original Golf GTI of 1976. And Newton metres to burn.

I tried to avoid mentioning words like "destiny" in what I hoped was a measured email to VW's public affairs boss Matt Gennrich, outlining my thinking. I did mention nostalgia, though, which he seemed to like the sound of.

Meanwhile, devastating fires engulfed Knysna. Thousands were displaced. Miraculously, our pre-booked accommodation survived. The annual Oyster Festival was going ahead. So was the run.

And so in mid-July, we were back on the familiar road, though this time with unfamiliar intent. Our goal: to get our runner daughter Toni to tick the Knysna half-marathon box. Her parents had made the pilgrimage more than once in the past. Now we planned to line up at the forest startline as before with our long-suffering running buddies. This time, with two members of the next generation to receive the torch.

Above: Charred remains of once lush foliage outside our holiday flat overlooking Brenton-on-Sea.

Now, as I said, I'm not big on coincidences.

Non-coincidence #1: on the morning of our departure, I collected the VW Golf 1.0 TSI and turned into Roeland Street to head up De Waal Drive, skirting Devil's Peak. Rewind to 1984: we exit Alfa Supreme (Alfa Romeo's South African subsidiary assembled the high-roofed five-door Charade locally from '83 to '85), turn up Roeland Street head on to De Waal Drive to take our first three-cylinder one-litre for a test drive.

In the end, it came down to a choice between a Citi Golf (non-coincidence #2) and the Charade. The VW was trumped by the Daihatsu's R7 440 price and trade-in offer. Or maybe it was trumped by the lingering memory of the briefly

A little over three decades apart, father and daughter take a break to tread the sands of Wilderness Beach.

Golf GTI of 1976 produced 81 kW – the same as the frugal, Bluemotion-equipped Golf 1.0 TSI of 2017.

exciting, but terminally troubled second-hand VW Golf 1 GTS (non-coincidence #3) that led us to bite the bullet and decide to buy new.

The Charade's normally aspirated single-carb 993 cm³ engine produced a meagre 44 kW, not enough to outrun the equally wheezy Renault 5. Gentle inclines or a south-easter headwind meant a downshift into third to keep up a decent pace.

We loved it. Even when in later life it rusted. When it took to starting reluctantly though, at just 700 kg sopping wet, push-starting was a one-man job, given a slight downhill. The switch-like controls were slick and smooth and it was amazingly economical. Even when my wife drove it. Around town, I could get 5,5 litres/100 km when I wasn't paying attention and 5 litres/100 when I was.

July 2017, somewhere near Rivierson-derend: I disengage from my reverie and look down at the Golf 1.0 TSI's average fuel consumption readout: 5,5, and we're hauling, er, ass. Okey dokey. Things change. Speaking of change, one thing I looked forward to on the Golf was having, at least, a decent boot. Hmmm. I should have realised a daughter's size bears no relation to the dimensions and quantity of her luggage. Still, fully laden we could comfortably fit four adults, when needed, to get to the Knysna festival ground.

Speaking of which: "Oh look," I said, pointing at the banner announcing the 34th running of the marathon. The birthday girl stared back blankly. "It's as old as you are today." The weak smile suggested that non-coincidence #4 was a bit of a stretch.

Over the course of our four-day stay, we shuttle several times to and from our spot high on the hill where we can see Brenton-on-Sea out the front window and the Kynsna lagoon out the back; clearly visible, now that there's only twisted, blackened brush as far as the eye can see. The hill is steep and twisty. The Golf's one-litre three-cylinder tells me it's happy to stay in sixth gear. Fifth feels better. Fourth even better. But not really necessary.

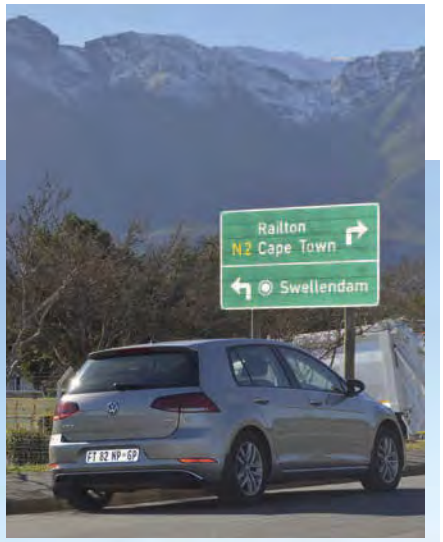
So when we refuel our 50-litre tank for the return trip, 590 km on the odo seems like a pretty good deal.

There are times in the VW you think, I need some more bottom end. When it feels strong, but not like it wants to spring forward. And the gearshift indicator says, hey! Change up! (Sometimes I don't believe it.) Still, you can change down one or even two gears. There's six to choose from and you can wind up the engine. It's okay with that.

Homeward bound, somewhere between Heidelberg and Swellendam on a dozy Monday afternoon: with our fellow travellers bunched up in the rear view mirror, we creep up on a train of slower traffic. In the near distance, I can see the road splitting to create an uphill overtaking lane. I keep it around one and a half thousand revs in 6th, just ambling along at 100 or so kays (one and a half! In Top!). As the train ahead shifts to the left, I think about accelerating. Just enough of a thought to increase my right big toe's pressure on the pedal ever so slightly. The Golf maintains its speed, almost imperceptibly at first and then with gathering intensity. The rev counter nudges up a fraction. On the left, the cars are slipping backwards. Behind us, our fellow travellers hold station. It's not hard to keep up with a one-litre car when you've got three times the engine capacity and double the cylinders. I glance down. We've gained 20 km/h without breaking a sweat. And we're still picking up speed.

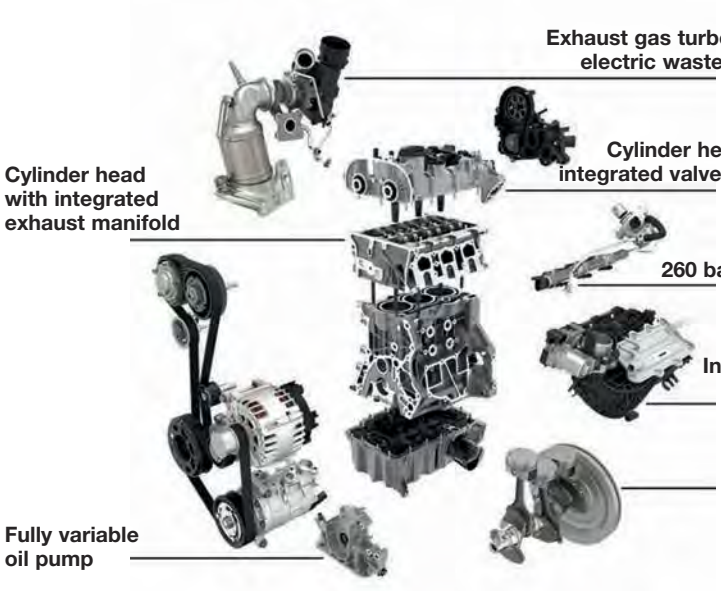
"Try doing *that* in a Charade," I say to no one in particular.

Below: Hillside above Knysna bears fire's scars; challenging hill road is no match for the 1.0 turbo. Right: Midwinter snow blankets the Langeberg on the homeward leg.



1 000 CM THREE, THEN AND NOW

	Then	Now
ENGINE	3-cylinder petrol	3-cylinder petrol
DISPLACEMENT	993 cm³	999 cm³
VALVES PER CYLINDER	2	4
FUEL SUPPLY	Carburettor	Direct injection, turbo
MAX POWER	44 kW	81 kW at 5 000 r/min
MAX TORQUE	81 N.m	200 N.m (2 000 – 3 500 r/min)
MAX SPEED	140 km/h	196 km/h
FUEL CONSUMPTION	5,5 L/100 km	5,5 L/100 km
PRICE	R7 440	R304 200



3 vs 4

Three seems to be the magic number when downsizing is the motivation. These days, you can get your three in seriously high-tech flavours: Volkswagen's TSI and Ford EcoBoost are familiar names that play in this arena.

There are some obvious advantages over a four-cylinder in a compact car. Like one less cylinder, though the apparent flipside of that is a quarter less power. But not quite: three cylinders mean fewer moving parts and less power lost to friction. The three is lighter, hence more efficient for a given size. Smaller size could help optimise drivetrain packaging. Less material equals lower cost.

To bring us back down to earth, the three has drawbacks, too.

In the four-cylinder four-stroke cycle – intake, compression, combustion, exhaust – one cylinder is always on the power stroke. Four power strokes in a full 360-degree rotation of the flywheel equals one every 90 degrees. Contrast that with a three-cylinder's three power strokes, which mean one every 120 degrees (360 divided by 3). That half-cycle delay between power strokes translates to less smoothness, particularly at low engine revs. Fortunately at higher revs, flywheel momentum helps the three settle into better balance and smooth running, which you will need, because it needs to rev higher to make more power. Get your three to breathe easier (using two exhaust and two inlet valves per cylinder) and more forcefully (through turbocharging) and it's possible to achieve the power gains you need, without having to rev the engine too high.

A consequence of the typical 120-degree crank angle of a triple is good reciprocating-mass balance, though there's in-line rocking caused by asymmetrical piston velocities. A balance shaft can help smooth things out.

Inline threes have been used in capacities as small as Suzuki's 543. Smart's 799 diesel triple is currently the smallest and Volkswagen's 1,2 the biggest in regular production for cars.

Big bangers in the commercial world include three-cylinder versions of the Detroit Diesel Series 71 two-stroke diesels and the unique Rootes Group Commer TS3: the "Commer Knocker". Used on now defunct Commer trucks from the mid-'50s until the late '60s, the unique Knocker was a surprisingly powerful supercharged two-stroke 3,25-litre diesel with three cylinders, each containing two opposed cylinders.

Above: Volkswagen's three-cylinder power unit has been used in models such as the Polo, Up! and now in the Golf. Left: Internals of the 85 kW version as used in the Golf Sportsvan.

THE NEW, IMPROVED HYDROGEN CAR!

Driving Toyota's and Honda's next-gen fuel-cells.

A simple chemical reaction between hydrogen and oxygen generates energy, which can be used to power a car, producing only water, not exhaust fumes." That was US president George W Bush in 2003, proposing R15 billion to research fuel-cell automobiles. Six years later, president Obama killed that funding, nudging the hydrogen car onto the list of technology that was, and always would be, about ten years away. Meanwhile, over in Japan, Toyota and Honda have been at work, spending millions in R&D to make the new hydrogen-powered Mirai and Clarity. It's more reasonable than it sounds. Fuel-cell cars are as appealing now as they were a decade and a half ago. It's still the only way to get zero-emissions driving with petrol convenience; pull up to the pump, wait five minutes, and be on your way. But with fewer than 40 public hydrogen pumps in the United States, the only Mirai and Clarity customers there will be coastal and in big cities. At least for now. We drove the Mirai in Los Angeles and the Clarity in New York, two places promising to build more hydrogen stations in the next two years, to assess both cars' present-day drivability.

HONDA CLARITY

The sensible crossover-hatchback roofline, the upright driving posture, seating for five adults. It all makes you think: your Uber is now arriving. Yes, a driver could press the Clarity's Sport mode button and have fun with the on-ramps. The steering and especially the brakes feel as natural as any of Honda's excellent OPEC-powered models. But at 1 800-plus kilograms and with a zero-to-100 we'd estimate near double digits, you don't get petrol thrills.

The Clarity comes in one trim option that's loaded with tech such as lane-departure warning and automatic braking. Wrapped in suede made from recycled plastic, the digital dash has a ball that shrinks and expands, coaching you towards efficient driving. As long as performance isn't a priority, all that adds up to a hell of a lot of civility for the price, which is a loss-leader low. You can't buy a Clarity. Honda says MSRP would hit near three-quarters of a bar. You lease it for about R40k down and R5k a month. Along with the car, Honda gives you a R195 000 credit card to spend on hydrogen fill-ups, and 21 days of petroleum-car rentals for longer trips. And Californians get a R65 000 rebate, and a carpool lane sticker. Pick up a few weekend driving shifts and going fuel-cell is cheaper than an iPhone upgrade. – ALEXANDER GEORGE

Base price: **R5 000 per month (lease only)**
Range: **588 kilometres**

The rear hydrogen tanks are covered in carbon fibre and aluminium to protect against punctures.

TOYOTA MIRAI

Driving north out of Los Angeles, I notice the battery gauge tick down a few bars and experience the familiar twinge of range anxiety. Then, the battery display pulls a stunt I've never seen in an electric car, climbing back up to near full. The car charged itself. So cool.

What really happened is that the Mirai's fuel cells sent over some electricity to top off the nickel-metal-hydride battery that powers the 114 kW drive motor. Range concerns alleviated, I gun the little Toyota toward an off-ramp, its fuel cells ramping up with a sound that's like someone mowing a lawn two blocks away. Acceleration is reminiscent of a small diesel with excellent torque, good fun once you know how to use it. But the Mirai is a modest set-up. Toyota is already demonstrating the high-power possibilities with a heavy-duty truck. The twin fuel cells in that sucker make 500 kilowatts and 1 800 N.m of torque. Imagine that in a Camry.

A few dozen kilometres later, I look in the rearview mirror to see... another Mirai. Is that a glimpse into the future? Fuel cells obviously work. Yet, the question is the same now as it was a decade ago, before the EV takeover, whether something just over the horizon might work even better.

– EZRA DYER

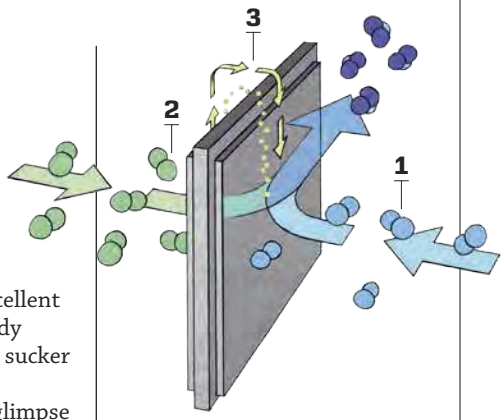
Base price: **R5 000 per month (lease only)**
Range: **588 kilometres**

The fuel cell is under the hood, and the 245-volt battery sits beneath the seats, for a low centre of gravity.

WHERE WILL YOU FILL UP?

This is a significant problem. In the US, most of the 35 hydrogen stations dot the area around San Francisco and Los Angeles, with just two (marked in green) on the East Coast. But unlike earlier fuel-cell cars, the Mirai and the Clarity work in cold winters, which is why Massachusetts, Connecticut, and New York say they'll collectively add 12 more stations (blue) to the Northeast by 2019.

DIAGRAM AND MAP BY JOE MCKENDRY



HOW A FUEL CELL WORKS

Think of it as chemistry that charges an electric vehicle's battery.

1 Hydrogen from the car's tanks and oxygen from outside meet at the fuel cells, a thin membrane separating the two elements.

2 The hydrogen is attracted to the oxygen on the other side, but only the hydrogen's proton, not its electron, can pass through to meet the oxygen.

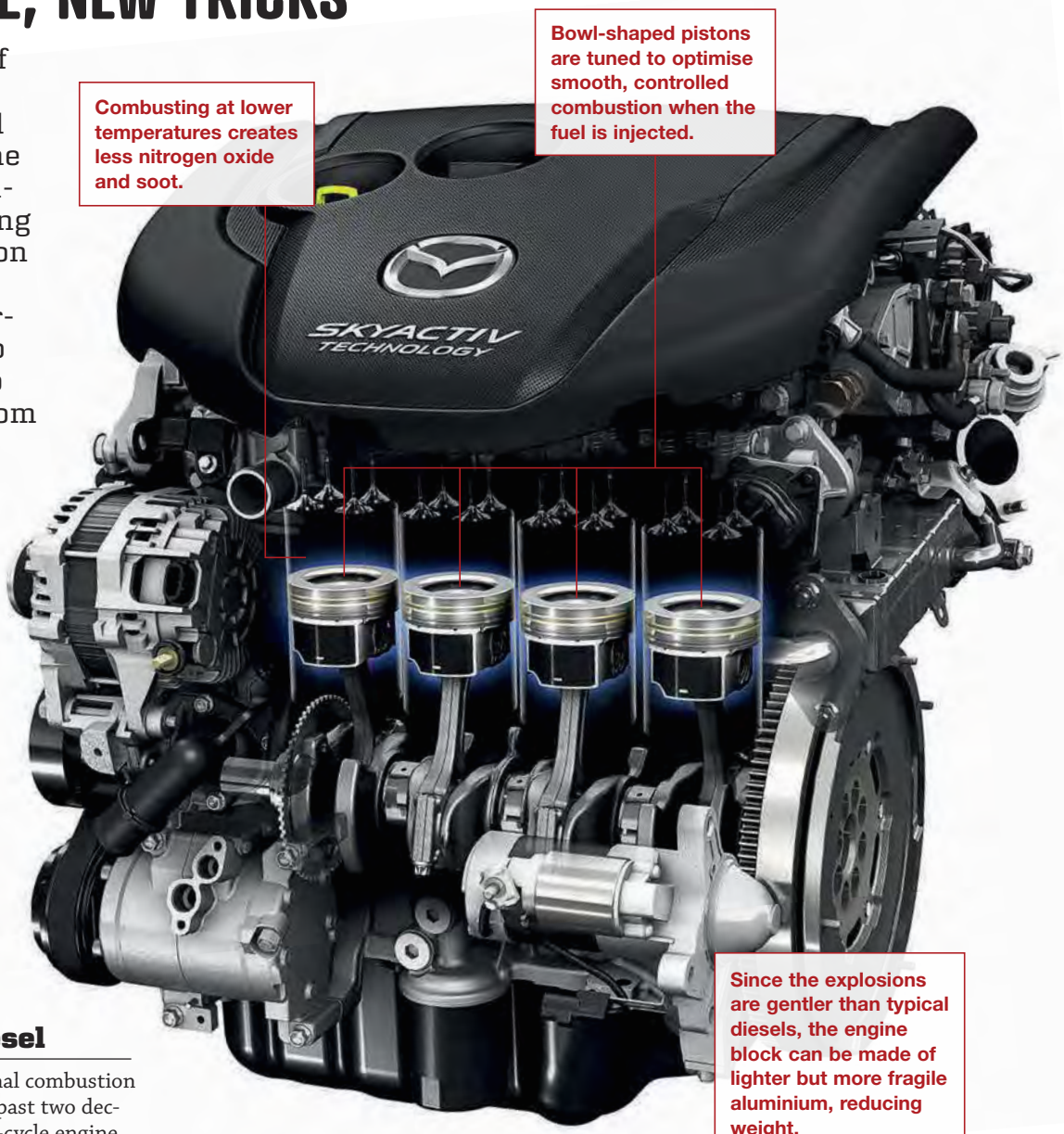
3 Unable to pass, the electron goes up and around the membrane, which produces electricity to charge the battery that drives the motor.

The main difference between a hydrogen pump and your local BP is the signage that reminds you not to touch the metal parts of the nozzle. They get cold, and you'd look silly with your hand frozen to a hydrogen hose.

OLD ENGINE, NEW TRICKS

After 100 years of refinement, you'd think the internal combustion engine was out of innovation, coasting along until electrification takes over. But these manufacturers are coming up with new ways to get more miles from petroleum.

BY EZRA DYER



The precision diesel

Nobody tinkers with internal combustion like Mazda does. Over the past two decades, it's produced a Miller-cycle engine, rotaries, and a tiny 1,8-litre V6. Now, it's made a 2,0-litre four-cylinder diesel that runs so clean it doesn't even require an exhaust after-treatment. Unlike the German TDIs, it comes by that distinction through technical innovation rather than devious software.

With a low compression ratio – 14,4 to 1 – the fuel–air mixture ignites when the piston is at top dead centre rather than on its way back down, maximising the energy achieved by each combustion event. That ratio allows for explosions at lower temperatures, creating less nitrogen oxide and soot, that is, pollution. The combustions are also less violent, so Mazda can make the engine block out of aluminium and slim down the reciprocating parts, dropping weight and improving responsiveness. To control the explosions, especially when the engine is cold, multi-hole piezo-electric fuel injectors deliver up to nine separate injections per combustion, ensuring a precise fuel–air mixture. "You can even smooth out the clatters that you associate with diesel," says Dave Coleman, a Mazda development engineer. "We can set up combustion events at frequencies that cancel each other out, like active noise cancellation."

The twin-turbo Skyactiv-D will be available in the CX-5 as the top-of-the-line engine, both the most powerful and the most fuel-efficient option.

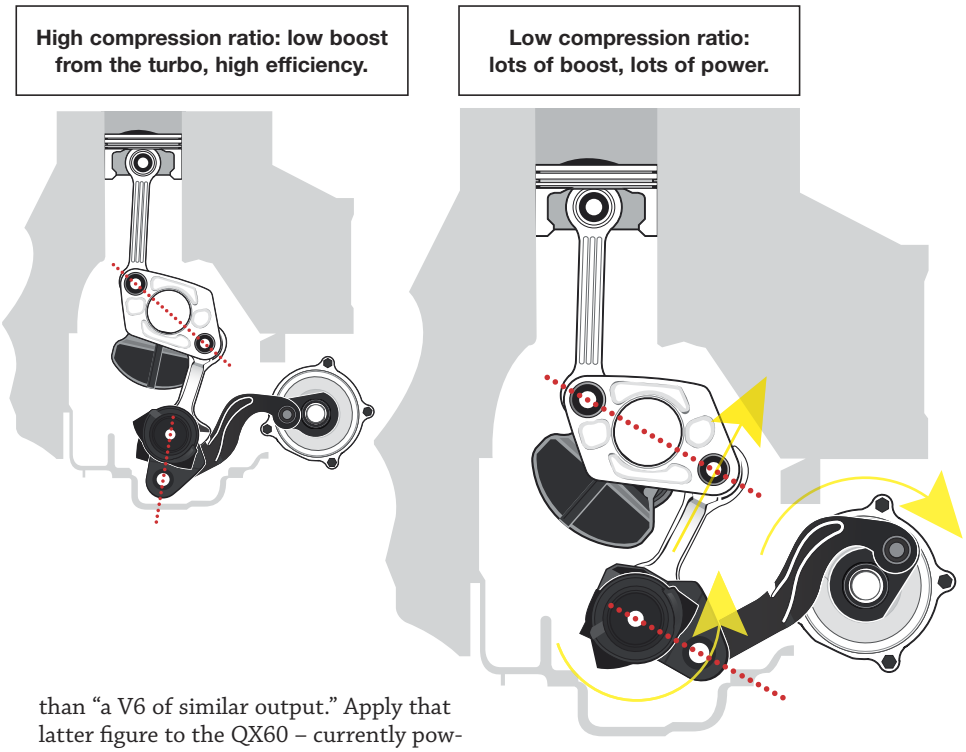
COMPRESSION RATIO: The space in the combustion chamber when the piston is all the way down versus all the way up.

The 20-year turbo

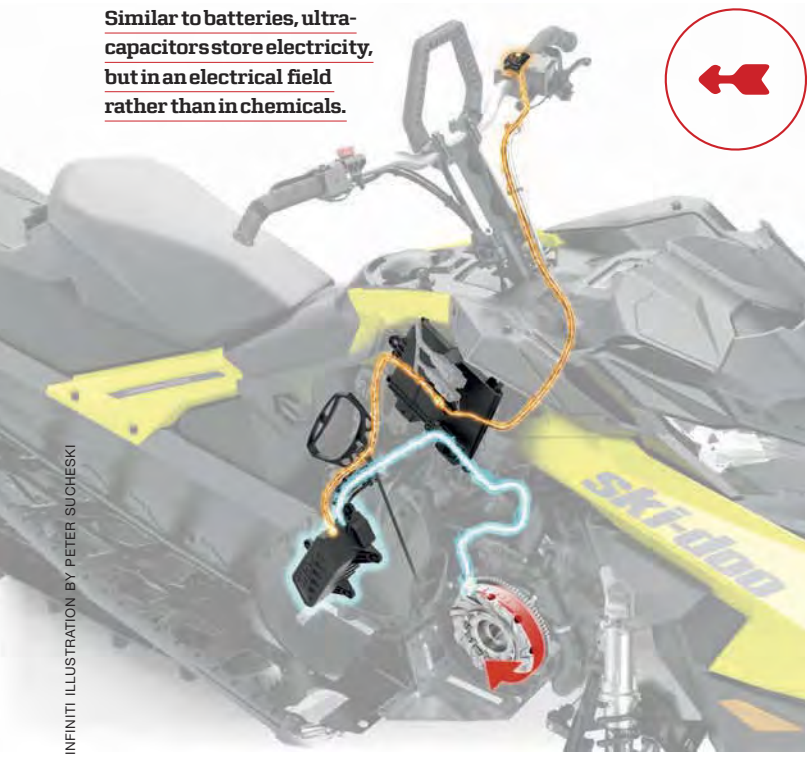
In every piston engine, the compression ratio is fixed. Choose either a high ratio for efficiency, or a low ratio for more power and turbo boost. Infiniti's VC-Turbo, however, can do both.

A reduction gear connected to an external electric motor powers the mechanism between the connecting rod and the crankshaft, allowing the engine to adjust piston height on the fly. It can change the compression ratio from 8 to 1 (big power, lots of turbo boost) to 14 to 1 (low boost, high efficiency). Infiniti invented the system in 1998, but it's taken till now to perfect it for production. With three times as many bearings as a conventional engine, durability was a concern, so Infiniti logged the equivalent of three million kilometres in the lab.

Final road testing is happening right now, and when the engine goes into production next year, Infiniti predicts it'll make 200 kilowatts and 390 N.m of torque with 27 per cent greater efficiency than "a V6 of similar output." Apply that latter figure to the QX60 – currently powered by a 3,5-litre V6 – and you'd have a big three-row crossover that gets 7 L/100 km highway. Variable compression took two decades, but those numbers make it look like it'll be worth the wait.



The mechanism between the connecting rod and the crankshaft allows the engine to adjust piston height.



Similar to batteries, ultracapacitors store electricity, but in an electrical field rather than in chemicals.

INFINITI ILLUSTRATION BY PETER SUCHESKI

The two-stroke saviour

Two-stroke engines seem like a bygone technology, conjuring buzzy, pollution-spewing '80s dirt bikes and, these days, mostly just chainsaws. But BRP, which owns brands like Ski-Doo, Sea-Doo, and Can-Am, is still developing these engines for outboard boat motors and snowmobiles because the two-stroke is still unbeatable for simplicity and power-to-weight ratio. The new SHOT system, a $600 option on new snowmobiles, improves the latter by saving about 9 kilograms. People spend 20 or 30 thousand rand in carbon-fibre parts to save that much weight, says Frederic Desjardins, engineering project manager for Ski-Doo.

Here's how it works: instead of a typical battery and electric starter, SHOT uses a small electric generator called a magneto and an ultracapacitor; it functions like a battery, but outputs more energy at the expense of long-term charge storage. The rider pull-starts the engine at the beginning of the day, and a magneto attached to the flywheel charges the capacitors. From that point on, the rider can kill the engine and restart it within a half hour. The capacitors hold a charge for up to two hours, but the probability of a successful restart drops as the clock keeps ticking.

The system works only with two-strokes, but Desjardins predicts that it could spread as two-strokes themselves make a comeback. "I think they're going to have a resurgence, particularly in dirt bikes," he says. Of their 124 kW engine, which weighs 43 kg, he says: "There's nothing else like that."

THE R900 INTERIOR REVIVAL

Interior work gets expensive in a hurry. Restoring all that upholstery, carpet and trim can rival the cost of an engine rebuild – or a trip to the operating theatre – by the time you're done. Which is why spare parts stores are filled with products promising to bring new-car look (and smell) back to your cruddy cabin on the cheap. So, with a modest budget, I decided to see how far back I could turn back the clock on my 1993 SUV's shabby interior.

BY EZRA DYER

STEP 1
Cover the seats:
Stingray Seat Covers
(About R450)

STEP 2
Clean the rugs:
Turtle Wax Power Out GL Interior (R135)

STEP 3
Shine the trim:
Griot's Garage Interior Cleaner
(About R170)

STEP 4
De-funk the whole thing:
Turtle Wax Power Out Odor-X (R125)

→ The seats look like they tried to break up a fight between two rabid wolverines, too far gone for any leather spray to save. Time for seat covers. Options included Hawaiian motifs, wetsuit neoprene, or that old standby of retired academics given to wearing tweedy garments and hats, sheepskin. Cabbies: you're on to something with those acupressure beads. Aiming to match the factory interior rather than make a statement, I bought a pair of tweedy-tasteful equivalents. Turns out, this is one of the best bang-for-the-buck upgrades you can make. Mine will shroud the Bronco's upholstery until I find a pair of decent seat replacements.

→ The first owner must've smoked a pack a day through the grunge era, sold the car to someone who spilled a bottle of Powerade while worrying about Y2K, and the guy I bought it from apparently left the vehicle parked outside in the rain with the roof off. Wait, that was me. Whatever the case, you have options. Some cleaners of this kind come with a removable plastic brush to massage the foam into the carpet. Somehow, these actually lift dirt out of the fibres and the foam is capable of devouring stains you thought were permanent. The carpets don't look new, but the Power Out took about 15 years off their perceived age.

→ "Perfect for use on your vehicle's vinyl, cloth, headliner, and leather," reads the bottle . "Also excellent around your garage, shop, and home." Not exactly. It left the upholstered door panels looking like a wet cat, and no amount could budge a discoloration on the dash, perhaps a melted lollipop circa 2004. Unlike other cleaners that just coat surfaces with shiny oil, Griot's seemed to actually clean the trim, but it didn't match the grime-busting horsepower of more caustic agents I've used. Best bet for South Africans: Turtle ICE Total Interior Clean (R160).

→ The interior cleaned and the seats looking presentable, there was just one final step: aromatherapy, administered by spray bottle. With Odor-X, Turtle Wax purports to replicate the alluring off-gasing of new plastics and upholstery, the scent we call New-Car Smell. In practice, the smell is closer to a mildly floral air freshener. Which isn't bad. But if you want new-car smell, you're going to need to spend a lot more than R125. In general, unless your car reeks like a chewing tobacco fan's spittoon, you can skip this step. I got more of my money's worth from the visual and tactile improvements that other products provided.

PHOTOGRAPHS BY JEREMY LANGE

AN ALL-AMERICAN STREET RACE

Some of the world's best bikes are made in America – and ridden by Eddie Van Halen.

BY DAVID CURCURITO

The Arch KRGT-1 has a massive 2 032-cm³ 91 kW V-twin engine.

The three of us line up at a red light on Ventura Boulevard in Los Angeles. Eddie Van Halen is on my right and Heath Cofran of Alpinestars on my left. We rev our engines hard, the giant V-twins beneath us shaking our skulls while we wait for the light to go green. *Blaaaaahhhhh!!!!!!* Eddie flies off the line so fast I'm surprised the helmet doesn't pop off his head. Heath is right with him, tucked forward so his front tyre stays on the tar. I'm white-knuckled and cranking on the throttle. My heart pounds and I'm giggling because the power doesn't slow until we stop at the next light. I manage to pull off a controlled skid behind them before offering a thumbs-up and a smile.

With massive power and the riding position of a high-performance cruiser, the handling and response of a super-sport, and a completely different look that comes with being hand-built in America, these bikes don't come cheap. Heath and I are on KRGT-1s (about R1 million) from Arch, a company started by Keanu Reeves – who's actually a big motorhead – and master builder Gard Hollinger. "I had this Harley-Davidson Dyna that I was looking to customise and what I was doing was horrible," Keanu told me. "I wanted a sissy bar and Hollinger looked at me and said, 'I don't make sissy bars, but why don't you come inside and see what we do here?'" With Hollinger's guidance, Keanu built what would become the KRGT-1 and the two men launched Arch. Eddie, whom I've known for a little while now, is on the strange and beautiful Confederate Wraith B120 (R1,2 million) one of only 50 ever built. Confederate was founded in 1991 in Baton Rouge, Louisiana, by Matt Chambers. After Hurricane Katrina destroyed his New Orleans facility in 2005, he moved to Birmingham, Alabama, where the Wraith was the first of many bespoke bikes to roll out of the new facility. Van Halen is riding serial No. 1.

If the Silver Surfer gave up surfing, he'd ride the bike I'm on. It's chrome, with a big 20-litre solid polished-aluminium fuel tank. Heath's Arch has a red-and-white-paint scheme and gold forks, and a completely different riding position. Even though these are production bikes with more than 200 hand-assembled parts, each one is customised specifically for its owner. I clunk the six-speed gearbox into first and rev the engine until it vibrates my teeth. Green light. If you think Eddie is fast on the guitar, he rides even faster. The Wraith set the world land speed record in its class at just shy of 268 km/h in 2008 and Eddie seems as if he's trying to beat that now. "The whole thing is carbon fibre, including the winged backbone frame, wheels and backward-looking forks," he says. "The rest is aircraft-grade billet aluminium, so it's nimble, manoeuvrable and very, very fast." The pedestrians he roars past must think something from the future just arrived or that a fighter jet flew over their heads.

Heath leads us to a great restaurant called Gasolina Café, where we sit drinking iced teas with these beautiful, expensive machines parked in front of us. It's hard not to think about how much love, passion and engineering goes into every bike. Even if you never have the chance to ride one, it's good to know that people are always pushing the limits of what's possible.

Eddie realises the owner of the restaurant speaks Dutch and strikes up a conversation in his native language. He emigrated from Holland when he was a kid, and look how far he's come. America really is great.

PHOTOGRAPH BY JOHNNY TERGO

FORD RANGER 2,2 TDCI XLT AUTO DC 4X2

CITY SLICKER

This is South Africa, where the bakkie is king. Our reigning monarch is currently the Ranger, which unseated the Hilux after years of trial and error. Actually, Ford did such a great job with the Ranger T6 that its competitors are only now catching up with offerings that bring the same level of car-like refinement. Just as the chasing pack closed in, the Blue Oval brought in a facelift, updated some software and expanded the range with a couple of new options categories. One of those categories is the XLT trim level for the more frugal four-cylinder turbodiesel.

Whereas the up-spec 2,2 does gain a lot of creature comforts (leather upholstery, reverse camera with park assist), our test unit was disappointingly fitted with the CarPlay- and Android Auto-lacking SYNC 2 infotainment system. There's also no non-slip lining in the load bay and the drivetrain tops out at 4x2. That's honestly the only criticisms I have against this car and it's fair to say that Ford SA purposely omitted some of those features to not cannibalise its 3,2 line-up.

Who is this bakkie for? People who only occasionally leave the urban jungle. If you've always fancied a double cab and have zero intention of venturing into the bush or climbing a mountain, smart money would buy this car. Why? That 2,2-litre Duratorq motor's 110 kW and 375 N.m are more than enough for effortless highway cruising and won't bankrupt you idling away in the peak hour maelstrom.

In our testing we returned fuel consumption of 9,2 litres/100 km. The load bay and rear suspension were also more than capable of accommodating 200 thick pieces of damp bluegum firewood, although the fitted soft tonneau cover was very difficult to peel back.

As a family hauler, the new Ranger had already proven its chops with other model derivatives I'd taken home. My brood does, however, sway towards the loftier bakkie and mid-size SUV segments. Our combination of Cape winelands gravel and rutted B-roads will show up overly hard suspension set-ups, but this car got full marks for comfort and ease of access for a preschooler and a toddler.

Though R492 900 seems a bit steep for a non-4x4 double cab, that's what these things cost now. This is one of the best you'll get as a lifestyle vehicle.

– LINDSEY SCHUTTERS

IN BRIEF

DRIVER AIDS ABS, EBD, brake assist, G-Vectoring, adaptive headlights, lane departure warning, Smart City Brake Support, driver attention alert, blind-spot monitoring.

ENGINE	inline 4
CAPACITY	2.0
TRANSMISSION	6A
POWER	115 kW
TORQUE	204 N.m
PRICE	R380 600

MAZDA CX-3 INDIVIDUAL PLUS AUTO

URBANE URBANITE

Compact crossovers are an odd species. Though not big or capable enough to be taken seriously as true all-terrain vehicles, they lure disenchanted hatchback buyers hankering for bulk, a more commanding driving position and something just plain different. Join the queue.

Mazda's CX-3 ticks all the aforementioned boxes. But besides that, it also has a zippy, growly yet refined powertrain and sharp handling that makes it a fun car to drive around town.

A kind of smaller clone of its bigger CX-5 stablemate, it leans more towards the car-oriented end of the crossover spectrum. It's got some of the crossover look – though less so than some competitors – that is intended to resonate with its owner's presumably outdoors, active lifestyle.

From the driver's seat, The CX-3 does seem to have more in common with Mazda's passenger car line, which is after all what it's based on. It sits a modest 160 mm or so off the ground and overall doesn't have quite the purpose-built look and feel of a family crossover, which might ordinarily have features such as roof rails.

If bothered by the thought of moving from small-car comfort and convenience to a cabin designed more around utilitarian practicality, fear not: the CX-3 will feel entirely familiar and car-driver-friendly. The interior presents a refined ambience with leather/cloth trim and sensibly laid out controls.

Front accommodation is ample, but taller passengers might feel a little short-changed at the rear, considering the way the roofline slopes downwards. Given the vehicle's perceived role, perhaps some more stowage space would have been a good thing, especially in the boot.

Although some vehicles in this price bracket – and that includes crossovers – are turning towards downsized engines using turbocharging, the normally aspirated Skyaktiv direct injection 2,0-litre petrol engine relies on the adage that there's no substitute for cubic inches. As a result, a smooth flow of torque is available across a wide band for easy low-speed lugging. Fuel economy is actually not bad, considering.

The "learning" auto box seems quicker than most to respond to one's driving style. So, if you suddenly start throwing the CX-3 about, it's quick to respond by downshifting more eagerly and holding on to a lower gear for longer to provide engine braking as you enter a bend.

Part of the driver aid suite, by the way, is G-Vectoring, which uses the engine's torque to maintain optimum body position and thereby improve handling. A side-benefit of this is said to be reduced driver fatigue because you don't have to keep tweaking the steering.

Ride is controlled and verging on firm, without being harsh, on its 18-inch alloy wheels. As a result the driver can feel quite confident about picking up the pace when necessary. The electrically assisted steering is light yet precise, with sufficient feedback from the wheels to keep driver involvement levels high.

Our colleagues at CAR were moved to describe the whole experience as engaging and I'd be inclined to agree.

The Individual Plus model tested here is one of the more recent additions to the CX-3 range. As the flagship model, it comes with a comprehensive standard specification that includes Sat-Nav, stability control, brake support, blind spot and lane departure warning and infotainment system with touchscreen interface.

I can't see the CX-3 being bought primarily for treks to out-of-the way campsites or extended jaunts on farm tracks, but in fairness it's aimed at a more urban lifestyle. There, attributes such as sleek styling, wieldy drivability, ease of access and refined interior and ride add up to a crossover with sporty intentions that is much more in tune with urban warriors. – ANTHONY DOMAN

1 2 3

BMW 4 SERIES

Things began easing into perspective when I glanced into the rear-view mirror and saw the 3 Series behind us being passed by the noticeably wider, lower-slung and more assertive face of one of our 4 Series convoy. What seemingly started out as an idea for a more rational approach to a 3 Series coupé has morphed into a full-on product line with its own coupe, Gran Coupé and convertible versions. This is not surprising, given similar shifts by rival premium sports sedans, to placate buyers hungry for a more individual look that doesn't go completely over the top. Tech highlights include LED lighting front and rear, optional Professional navigation (whose interface has large convenient tile-style control pads) and optional Multifunctional Instrument Display. Crisper new lines and revised suspension are two of the new 4's significant changes. Those athletic lines are matched by equally athletic performance and handling, as we were quick to discover on some of this country's finest driving roads in Mpumalanga (potholes excepted, of course). The Coupé and Gran Coupé now come with a stiffer suspension set-up that's said to deliver sportier handling without any loss of ride comfort – notably, regardless of the load. Three petrol engines ranging in output from 135 kW in the 420i up to 240 kW in the 440i are available. The 140 kW 420d gets around 4,2 litres/100 km.

Price: from R605 000

LAND ROVER DISCOVERY

They're calling it the best family SUV in the world. Let's get one thing out of the way from the get-go: the boxy look of its predecessors may have been ditched in favour of more aerodynamic and, yes, trendy lines in keeping with the Discovery Sport model below and the Range Rover above, but the uncompromising off-road ability remains. Yet on-road, the new Discovery is so refined that you begin to wonder how the flagship Range Rover will top this when it's due for replacement. Versatility and modern tech are hallmarks of the interior design. Significantly, there's a seven-seat option and, having shared the third row of seats with a colleague, I can vouch for the set-up being surprisingly comfortable and spacious. There's as much as 2 500 litres of luggage space, up to nine USB ports, six 12-volt charging points, an in-car 3G Wi-Fi hotspot for up to eight devices and world-first first remote Intelligent Seat Fold tech that you can operate from your smartphone. Drivetrain upgrades include All-Terrain Progress Control (ATPC), a kind of crawl-speed cruise control – all you need do is steer – that makes it practically unstoppable. Trademark design features, like the stepped roofline and stadium seating, are still there. And a nifty fold-down powered "inner tailgate" panel that can hold up to 300 kg substitutes for the previous split tailgate. Engines are six-cylinder petrol or diesel with 8-speed automatic gearbox.

Price: from R980 000

RENAULT DUSTER EDC

Pricing, capability and practicality have helped drive budget-conscious adventurers towards the Duster, which has become quite the hit in the compact SUV market. To date all models have been manual-shift, but in response, to quote Renault's words, "customer needs", it's spiced up the proven SUV recipe with an Efficient Dual Clutch (EDC) transmission, as happened earlier with the more upmarket Kadjar. Smart move. The auto seems well suited to the 1,5 turbodiesel engine it's matched with. Our Gauteng test route kept us mostly on tar, but a detour on gravel indicated that the EDC Duster is a package well suited to its likely users' lifestyles. Only the flagship Duster gets a full 4x4 drivetrain, so the EDC is available only in 4x2. The Duster EDC's 6-speed automatic gearbox uses two clutches under electronic control, with one clutch always in readiness for a change while the other engages. That's a recipe for optimised efficiency, Renault says, with the comfort of an automatic, the responsiveness of a manual and fuel efficiency. In combination with the punchy 80 kW/250 N.m 1.5 dCi, expected fuel consumption is 4,8 litres/100km, and CO_2 emissions 126 g/km. ABS, Emergency Brake Assist and Driver and Passenger Airbags (front +side) come standard in the Duster Model range, with ESP with traction control on the 4x2 EDC. The vehicle comes in Dynamique specification; metallic paint is a R2 500 option.

Price R 299 900. **PM**

car DIGITAL DEALER CONFERENCE

THE car DIGITAL DEALER CONFERENCE IN ASSOCIATION WITH INNOVATION GROUP

With new technology continuing to shape the future direction of the motor industry, it is more critical than ever to stay ahead of the trends that will change the way South African dealerships operate. Vehicle buyers now turn to the Internet and mobile devices to guide them through their purchasing decisions, by way of search, online reviews, social media, and user-friendly experiences. This behaviour requires dealerships to adopt cutting–edge technologies and digital strategies to maintain their competitive advantage.

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2] Breaking bad: Identifying poor digital habits and the tools to fix them

CRAYG HITZEROTH: MANAGING DIRECTOR OF AD DYNAMO TWITTER'S PARTNER IN AFRICA

Panel

CLAIRE COBBLEDICK: MARKETING MANAGER OF GUMTREE SA

Panel

NIKKI HARDING: VERTICAL LEAD AUTOMOTIVE - FACEBOOK SUB-SAHARAN AFRICA

Panel

Unlocking and leveraging the value of social, best practice and key measurements to engage car buyers

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3 600 MILES
and a dream

The author flew his Cessna from Massachusetts to Houston and back because he wants to be an astronaut. And somehow the trip made perfect sense.

BY BEN URMSTON

BRAKES – HOLD. Fuel selector – Both tanks. Mixture – Full rich. Carburettor heat – Off. Circuit breakers – In. Primer – Three pumps. Throttle – Open quarter-inch. Battery master/alternator switch – On. Beacon – On. Propeller area – "Clear!" Ignition – Start.

As I finished the checklist and turned the key, Freddy's engine roared to life and I smiled as I got ready to begin my takeoff. My destination, six flights over three days away, is Houston. I am flying to Houston because, when I was five years old, my kindergarten teacher, Mrs Ackley, told the class that before we could go outside for recess each of us had to whisper in her ear what we wanted to be when we grew up.

"Astronaut", I said, then ran out to the swings.

Junior year of high school: the concert band (I played the trumpet) took a trip to Washington, DC. We got to tour some museums, and I chose the Smithsonian National Air and Space Museum, where they were showing an Imax movie called *Destiny In Space*. I walked out a different person.

I remembered Mrs Ackley that day.

A commercial flight would have got me to Houston faster, cheaper and on time. But it seemed less in the spirit of the thing. A few months earlier, I had submitted my astronaut application to NASA along with 18 300 others. NASA will take only eight to fourteen of us. It was spring break at Berkshire School in western Massachusetts, where I work as a physics and astronomy teacher, so this might be my only chance to visit while my application is being processed. If I'm going to visit NASA only once, I want it to be an adventure.

My whole life – I'm 39 now – I've lived in pursuit of becoming an astronaut. I have a degree in aerospace engineering and have been a sailing, backpacking, and canoeing instructor at the National Outdoor Leadership School (NOLS) for a decade. I spent

two seasons as an antenna rigger and two seasons as an alternative-energy specialist in Antarctica, which is about as close as you can get to space on dry land.

My uncle got me into aviation as a kid. He'd take my brothers and me on little trips in his Cessna 172K Skyhawk (a single-engine, high-wing four-seater) known officially as N7202G and unofficially as Freddy. I had to sit in the back seat because I wasn't the oldest brother. Years later, while I worked in an aircraft maintenance hangar over two summers during university, I took lessons in Freddy and got my pilot's licence.

Recently, I took ownership of Freddy. I sit in the front seat now. I took out the other three so I can sleep in the plane. I've never crawled into a hotel bed and thought: I love this!

I have so many questions. What does a spacecraft smell like? How does it feel to wake up on the International Space Station when everyone is asleep? One evening on the trip to Houston, while I was resting in the plane with the cool evening air coming through the open cargo door, I looked up at the sky and thought, I was just up there. That might sound banal, but it's the way you feel sometimes as a pilot. You notice a cloud and think, I know what that's like: how the air feels, how it will behave. Sometimes I imagine what it would be like to have that same feeling about the moon. To look up on a full-moon night and think: remember when I was up there?

I fly for about three hours at a time, then stop to refuel, stretch, check the weather, and plan the next flight. I flew 1 561 nautical miles, burned 128 gallons of fuel, which cost me $500, and spent 16 hours in the air en route to Houston. I stopped in Delaware, Tennessee, and Mississippi once apiece, and North Carolina twice. I landed at small, untowered airports along the way, the kind of airports where I didn't have to tell them I was coming ahead of time, just called on the radio when I was about ten miles out.

When an air-traffic controller told me to switch frequencies to "Houston approach", I knew I was close. Another controller asked a pilot what Mach number he was flying at. I knew I had finally arrived to Houston's Ellington Field when the control tower said, "N7202G, you'll be number two following the F-16, cleared to land." My local runway in Great Barrington, Massachusetts, is about twenty-six-hundred feet long on a good day.

Ellington's, by contrast, is nine thousand.

Before the trip to Houston, Freddy's carburettor heat knob cable needed a repair so that ice wouldn't form on the carburettor in flight.

I was commander, pilot, navigator, meteorologist, logistician, and cook. My return mission: get home before Tuesday's 8 am physics class.

OUTSIDE THE WENDY'S across the street from Johnson Space Centre I met Rex Walheim, a veteran of three shuttle flights and chief of the Exploration Branch at NASA. He's a clean-cut guy, fit and sharp. I met him because astronaut crews these days often take a NOLS course in the wilderness to solidify their teamwork before they travel to space. A NOLS instructor friend of mine who had worked one of Rex's courses put us in touch.

I picked up my badge and Walheim led me into the Neutral Buoyancy Lab, a 31-by-62-metre pool where astronauts practise space walks among silver and white mock ISS modules positioned well below the surface. This must be one of the biggest and coolest pools in the world. The huge room smelled of chlorine. It was as quiet as a space walk. The suited man floating in the pool – astronaut Reid Wiseman, who spent six months on the space station in 2014 – couldn't possibly hear anything but the soft huffs of his own breath.

Wiseman had been underwater for about six hours, said Walheim, who was explaining the training that goes on in the buoyancy lab in a way that was meant not to overwhelm me with the insane level of detail with which astronauts understand their craft. As Reid was hoisted out of the pool, he pointed at me and gave me a big thumbs-up, much like he would if he were returning from a successful space walk.

We took a few pictures with Wiseman in his dripping spacesuit, then headed to the Space Vehicle Mock-up Facility. I visited on my own the day before and stood behind the glass on the second level with a hundred other curious tourists. Now I was on the ground looking at the equipment in close-up. We climbed inside the orbiter mock-up. NASA reconfigures it for every new flight, but because Walheim was on the last space shuttle flight, it was still set up for his mission. He showed me where he slept, where he kept his clothes, where his food was stored. For a few moments it felt like I was in space, a rookie being shown around.

Walheim let me sit in the commander's seat while we talked through what it was like to launch. I could have stayed there all day, imagining pressing the buttons and controlling the spacecraft. The parts and pieces becoming an extension of the mind. My mind controlling my body, which controls the machine, like I was the aircraft's brain. Imagine being the brain of a thing like this.

On the way out, we stopped by the Astronaut Selection Office. Walheim showed me a room where veteran astronauts interview

astronaut hopefuls. “We try to keep it low-key, though we know it’s not from the applicant’s perspective,” he said.

This very room was where I would sit for an interview. I felt like I might throw up.

WHEN I GOT BACK TO FREDDY, I had a little sense of relief. I was no longer the observer. For this voyage, I was the commander, pilot, navigator, meteorologist, logistician, and cook. If I couldn’t yet take to the stars as an astronaut, I was eager to get back into the skies as an aeronaut. My return mission was to get home before Tuesday’s 8am physics class.

There’s a high-pressure system to my south and a low-pressure system to my north. I ride the resulting atmospheric conveyor belt back towards New England. With a 45-knot tailwind I could make it home from Texas in one day, but so close to home, the task nearly completed, I can’t seem to let it end.

The airport lounge is locked at the quiet Pennsylvania airport, so after tying down Freddy for the evening I eat a dinner of crackers, cheese, and hummus in the cockpit. Even after eight hours of flying, sitting there makes me smile. The gauges, the dials, the switches… my own little spacecraft. I stay up late, writing in my journal, filling out my logbook, getting everything shipshape. Then I sleep in my sleeping bag in the back, the cargo door open to the night.

In 1998, while spending a month volunteering at the Christa McAuliffe *Challenger* Centre in Framingham, Massachusetts, I was introduced to astronaut Al Sacco, who flew as a payload specialist on a space shuttle mission in 1995. He gave me a piece of advice I’ve never forgotten: “Don’t bank your whole life on becoming an astronaut, because statistically, it’s not going to happen. I’ve seen people work their whole lives towards it and then, when it doesn’t happen, they’re devastated. You have to love what you do even if it never happens.”

Left: The Mississippi-to-Kentucky leg, coming home.

Above: An astronaut, Reid Wiseman, and Urmston, who dreams of becoming one, in NASA’s Neutral Buoyancy Lab.

Whether I am one step closer to becoming a real astronaut, I don’t know. But I do know that the trip to Houston was unforgettable. The space programme has led me to Antarctica, to the skies and seas and mountains. Now it has led me to Houston to meet real astronauts. Even if I never get to interview in that room Walheim showed me, NASA has enriched my life enough. It keeps me steady every time I do maintenance on a boat, on Freddy, or my car; every time I have to work to find the answer to a question; and every time I encounter a gnarly situation in the sky. Other people might grumble about squeezing into a tight, awkward place, but all I can think is training for space, training for space, training for space.

One day, it might even be true.

Ben Urmston was not selected in NASA’s latest astronaut selection round. He is still flying. Follow his adventures at *bylandseaandsky.blogspot.com*

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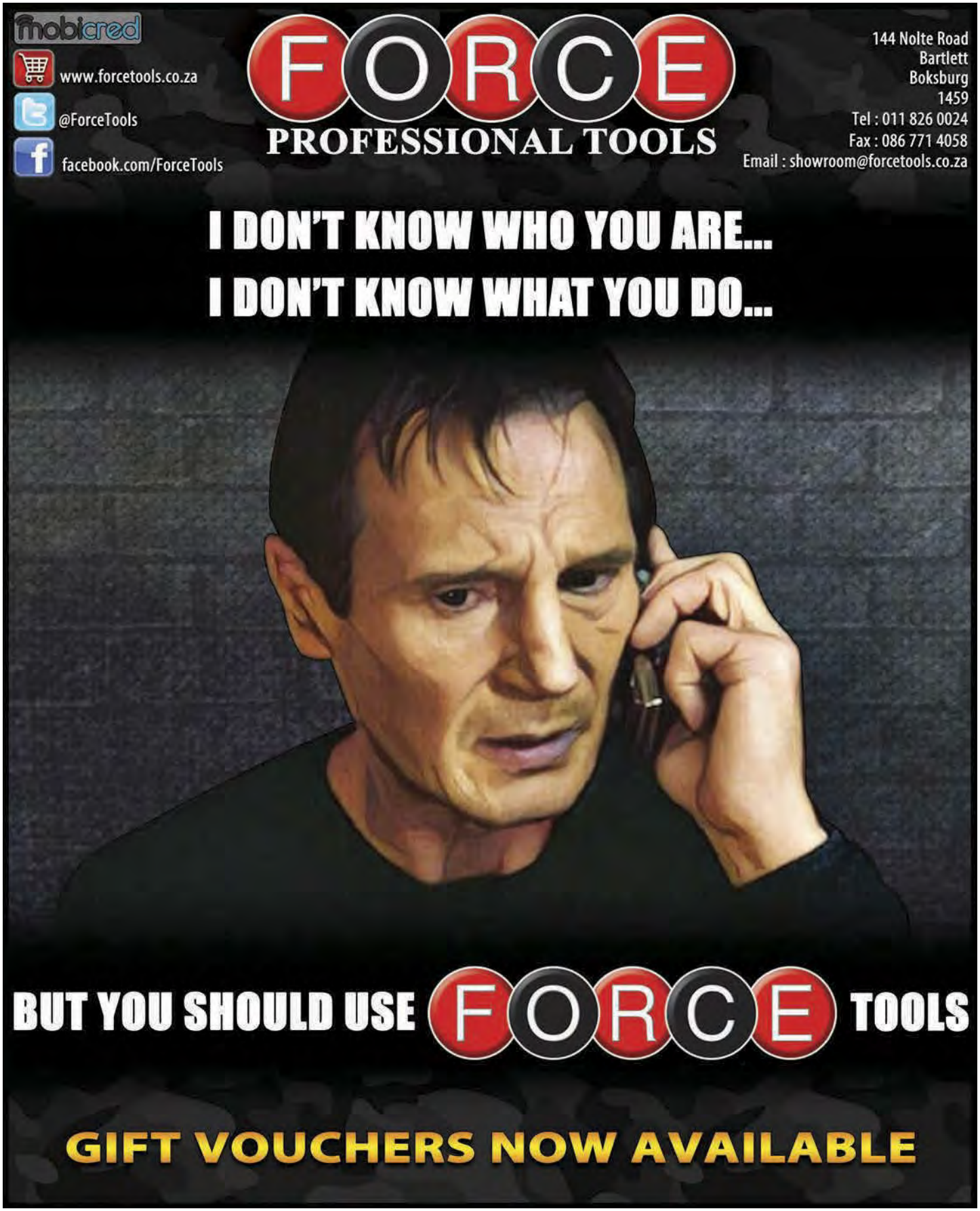

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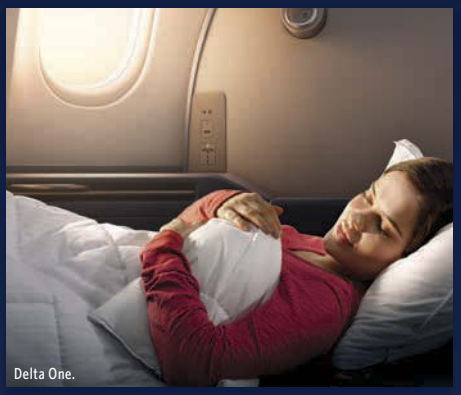

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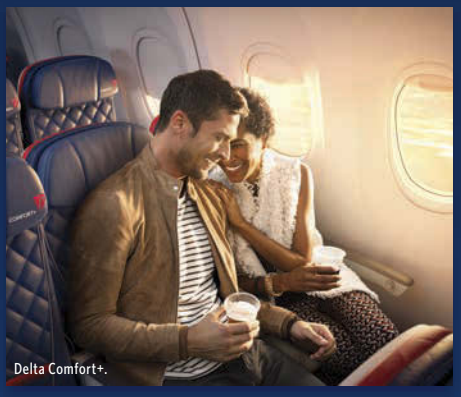

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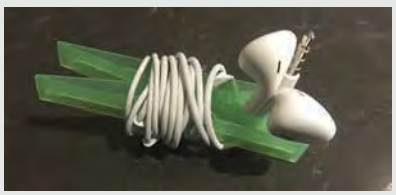

PEG YOUR CABLES

As an avid gadget freak, the ensuing spaghetti of gadget charging cables and earphones drives me insane. Especially when you need a specific one in a hurry.

I thought of this cheap option instead of purchasing any "cable storage solutions". Works a treat.

DR ANTHONY ALLWOOD
SOMERSET WEST

SAVE THE BACKWASH

I thought your readers may be interested in my tip to save swimming pool water when backwashing. This is particularly pertinent now, given the drought and low dam levels in the Cape. Above is a picture of the siphon in operation.

I installed a 220-litre plastic water storage tank next to my pool (costing about R850) and connected my backwash pipe at the top and backwash and rinse until the tank is full, checking visually from the top.

I also connected a length of hosepipe to a metal rod with cable ties so that its end is about 12 cm from the end of the rod. The rod with the pipe attached is inserted into the top of the tank in an existing hole in the lid so that the pipe remains 12 cm from the bottom. This ensures that only clean water is returned to the pool. I wait about three days until the dirty water becomes quite clear, with the brown dust settling on the bottom of the tank (about 1-2 cm maximum per backwash).

Lastly, I siphon the clear water back into the pool (which takes about an hour) and the siphon is commenced by holding the already inserted hose pipe over the running pool pump outlet which expels all air back into the tank and commences the siphon. Occasionally I clean out all the sediment from a drain at the bottom of the tank (about once a month).

After a trial of about three months, I can detect no adverse effects on my pool water.

BILL MCIVER
JOHANNESBURG

LUBE LOGIC

Here's a quick, easy way to lubricate a control cable (Bowden cable). With one end of the cable released, take a balloon and put a teaspoon of thin oil in it. Ensure that the ferrule of the cable is a few millimetres from the outer housing and tie the neck of the balloon around both the inner and outer with soft wire or a cable tie. Squeeze the balloon gently, and, hey presto, watch the oil ooze out of the other end! Mission accomplished.

GRANVILLE KILLIN
LAKESIDE

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MasterLock Excell Laminated Padlock. The tough 45 mm wide laminated steel body is surrounded by weather-resistant stainless steel and zinc, with a Tough-Cut boron-carbide 51 mm long and 8 mm diameter octagonal shackle. The 4-pin cylinder prevents picking and the dual locking ball bearings resist prying and hammering. (With limited lifetime warranty.)

MasterLock Excell Solid Steel Combination Padlock. A strong, reliable 56 mm wide zinc body houses a 38 mm octagonal Tough-Cut boron-carbide shackle 9 mm in diameter. The resettable combination includes pick- and pry-resistant roller pin cylinder, weatherproof hinged dial cover and shackle seal, and reinforced body bumper. (With limited lifetime warranty.)

MasterLock Spin Dial Combination Lock. This 3-digit combination padlock features BlockGuard Anti-Shim technology, hardened steel shackle and double-reinforced stainless steel casing; it fits lockers with a padlock eye of at least 7 mm diameter.

Send your tips to:
PM Do It Your Way, Box 180, Howard Place 7450, or e-mail *popularmechanics@ramsaymedia.co.za*. Please include your name, address and contact number. Regrettably, only South African residents are eligible for the prize. Prizes not claimed within 60 days will be forfeited.

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