

A LUNAR 'ARK' TO SAVE
US FROM EXTINCTION P22

THE BATTERY THAT
LASTS 25 YEARS P42

BUILD A BACKYARD
CHICKEN COOP P58

POPULAR MECHANICS



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OF THIS
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PLANE



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INSIDE THE PAINSTAKING,
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RESURRECTION OF A DE HAVILLAND
DH.98 MOSQUITO. P50

WE DRIVE A FORD F-150 IN THE USA

P90

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Raising chickens in your garden can be hugely rewarding. And if your chickens are happy and comfortable, it may also yield a lot of eggs. Turn to [page 58](#) for our step-by-step tutorial on how to build a classy backyard chicken coop.



ONE TRUCK TO RULE THEM ALL

EARLIER THIS YEAR, while we were putting this issue together, I was fortunate enough to travel to the United States. Some of the time was spent holidaying and travelling around, and the rest was devoted to the production of this magazine. (The ability to work remotely enabled me to carry on with my job from afar, with little interruption to our production cycle.)

While in the US, I received a Ford F-150 'truck' (*see below*) to review, fulfilling a years-long dream to drive and experience one of these colossal vehicles. We don't get this model of bakkie here in South Africa, and likely never will, so the folks at Ford USA generously gave me access to one of their media test vehicles during my visit, which we used for an extended road trip around the New England states.

You can read about my in-depth impressions of the Ford F-150 PowerBoost twin-turbo petrol hybrid on page 90, but, in short, it's a remarkable behemoth of a bakkie packed with impressive features. Coming from a country that's direly short on electricity, the ProPower Onboard system particularly impressed me; it effectively turns this truck into a powerful mobile electricity generator, with a variety of plug points for your connections. The power tailgate, too, is worthy of a review article on its own. It boasts slots for clamps, a marked-out ruler for field measurements at your worksite, as well as a fold-down step to help you access the (very) high load bed. I cannot wait to test the next-generation Ford Ranger that will be available in South Africa soon, as I'm confident many of the F-150's best features will be present.

It's certainly been a difficult and interesting year in South Africa, and, if you're able to take it, I wish you a relaxing end-of-year break to recuperate. Kick back with this issue, and enjoy the incredible cover story about the multi-year restoration of a wooden WWII aeroplane, along with many other fascinating reads.

And if you happen to do any interesting DIY projects around the house during December, be sure to share them with us in the new year.

Till 2023...

Mark

MARK SAMUEL
Editor



PHOTOGRAPHY: MARK SAMUEL

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 - CCTV Cameras (10W): 6.5 hrs
 - VoIP Phone (7W): 9.3 hrs



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 - CCTV Cameras (10W): 4.6 hrs
 - VoIP Phone (7W): 6.5 hrs



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GPS300



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1 x 3 Prong SA Plug Point**

- 300W Power Output
- Estimated Run Time (Single device connected):
 - Laptop (50W): 6 hrs
 - Lightbulb (11W): 27 hrs
 - Internet Router (12W): 25 hrs
 - 42" LED TV (100W): 3 hrs



GPS500

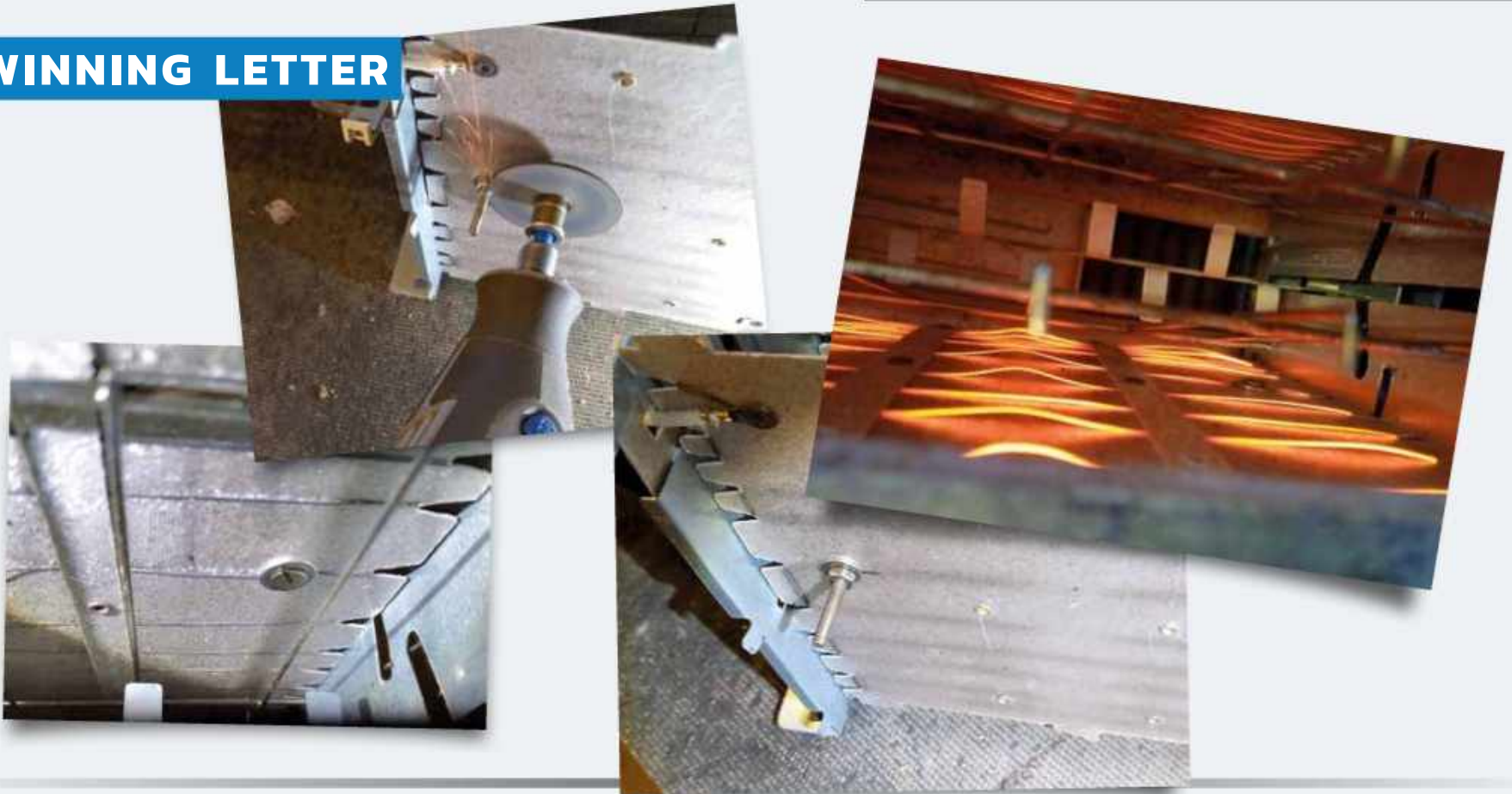


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 - Internet Router (12W): 43 hrs
 - 42" LED TV (100W): 5 hrs

WINNING LETTER



Toast-master

Our toaster's outer elements stopped working, resulting in it only toasting the inner surfaces of the bread. This meant that to get a proper piece of toast (a morning necessity), we had to turn the slices over and push them down again. As you can imagine, this was a rather labour-intensive and time-wasting process.

So, I set out to repair it myself. (Please note, I've worked with electrical systems my entire life,

so I have the knowledge to do this sort of work myself. I strongly advise only attempting electrical repairs yourself if you have the training, skills, tools and know-how to do it safely.)

I selected the following tools from my workshop for the project: Phillips and flat screwdrivers (medium and small); a small flat screwdriver (to fit into the oddly shaped three-slot screws used to discourage users from removing the base...); long-nose pliers; and a drill and a 3 mm bit.

Dismantling first entailed disconnecting the toaster from the electrical power supply, a crucial step! I did a lot of careful inspection of the toaster, and planning, as

I took the toaster apart, noting the location of each and every component. Taking close-up photos as you go can really help later when you're putting it all back together. I kept the parts from different assemblies grouped together, to make the reassembly process much easier.

Once 'inside', I found a break in the outer element circuit. The outer elements on both sides were connected in series, so the break rendered both sides inoperable.

Because soldering would melt at the toaster's usual operating temperatures, and welding these flimsy elements wasn't an option, I decided on a mechanical joint. I drilled a 3 mm hole precisely between the two

broken ends and joined them by placing an M3 stainless steel screw and nut and two flat washers over the broken ends. As the screw was a bit long and would've shorted out on the structure, I gently cut it with my Dremel.

After reassembly and ensuring that all earthing connections were connected and tight, I tested it and, voila, it worked!

EVAN STEPHENS

Congrats on a repair job well done, Evan! I've always enjoyed fixing things myself, rather than immediately heading out to buy a replacement. Hope you have many happy years ahead with this toaster making perfectly done toast!

– **Mark, Editor**

CONCRETE SOLUTION

I know that POP MECH has an interest in the concrete and construction industry. I also feel that the current drive towards reducing our carbon footprint is universally important. I'm writing in to share my opinion on ways to

reduce the carbon footprint in the construction industry.

I feel that the way that concrete structures are currently designed for durability (and even the way the design code is written) is opposed to achieving a reduction in the carbon footprint of a structure. The reason

for this is that the current design methodology for durability in concrete calls for minimum cement contents (more cement), an increase in cover (more concrete) and the use of specific SCMs (supplementary cementitious materials, such as fly ash and slag)

and aggregates, which sometimes have to be transported over large distances (which result in increases in prices and the use of more fossil fuel). It's true that concrete is a dominant factor in embodied carbon, but reinforcing

↓ WHAT'S ON YOUR MIND?

steel and structural steel has a minimum of 40 per cent higher carbon footprint than concrete. In addition, the conventional waterproofing measures are PVC- (plastic polymer), bitumen- (petroleum based hydrocarbon) and EPDM- (synthetic rubber) based, which have a much higher carbon footprint than integral crystalline waterproofing systems. These conventional systems also come at a higher cost, carry a shorter warranty time and require a more frequent maintenance schedule.

It's important to note that the embodied CFP (carbon footprint) of a building is the sum of: CFP of all construction materials; CFP of all construction operations; CFP of all maintenance operations; and CFP of demolishing operations and disposal of used materials.

Instead, by using a durable concrete mix with self-healing properties, the service life of a structure can be extended by 60 years and more. At the end of its service life, a building may either stay in service as is, or receive a new facade, monitoring and evaluation upgrades and be repurposed to serve a similar design life. As a result, the total embodied carbon footprint is either dramatically reduced or done away with entirely, effectively providing two structures with the CFP of a single structure. Moreover, the cement and concrete that is 'saved' becomes available for the construction of more infrastructure.

The International Concrete Repair Institute Committee 160 notes that the most effective sustainability strategy for concrete and masonry structures is to avoid the need

for repairs. This puts the responsibility to co-operate on the whole value chain on a construction project with:

- 1) Designers – to design infrastructure with all the factors contributing to CFP in mind, and to design structures that are easier and faster to build, using the latest technology available and with full, lifetime cost of ownership in mind;
- 2) Project managers – to plan the project with efficiency in mind (having fewer individual operations and reducing the number of people on site will lower the chances of things going wrong and result in fewer repairs);
- 3) Concrete technologists – to design concrete mixes that are able to self-heal, that negate the need for maintenance and repairs, but with less cement;
- 4) Contractors – to ensure infrastructure is constructed right, the first time.

The skills, technology and knowledge is available, but it's clear that the current philosophy of 'this is how it is done, because this is the way it has been done for years' will have to change.

Furthermore, I feel that the 'refusal' of structural concrete professionals to use the latest crystalline technology in concrete borders is irresponsible, and even gambling with clients' and very often tax payers' money.

JOHAN VAN WYK
(PENETRON AFRICA)

These are excellent points, Johan. It's imperative that every industry takes a very close look at its effect on our planet, and the construction industry specifically has scope to make easily achievable changes and significant improvements.
– **Mark, Editor**



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↓ THIS DAY IN HISTORY

NOVEMBER 2022

DECEMBER 2022

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1896: For the first time in its eight-year history, an image showing the bare breasts of a woman appears in <i>National Geographic</i> . 1	2	1921: US actor Charles Bronson is born. He died in 2003 at the age of 81. 3	4	1983: Five are killed in the <i>Byford Dolphin</i> diving bell accident. 5
6	1665: The first edition of <i>The London Gazette</i> , the world's oldest surviving journal, is published. 7	8	1953: Cambodia gains its independence from France. 9	10	1889: Washington becomes the 42nd state of the United States of America. 11	12
2015: Terrorist attacks in Paris leave 130 dead and more than 350 wounded. 13	14	1806: Zebulon Pike unsuccessfully attempts to summit a mountain in Colorado, a peak which now bears his name. 15	16	1942: Martin Scorsese is born. He goes on to become a famous film director, producer, screenwriter and actor. 17	18	1969: The 3rd and 4th humans walk on the Moon, during the Apollo 12 mission. 19
20	1995: A peace agreement known as the Dayton Accord is signed, ending the war in Bosnia and Herzegovina. 21	22	1972: The Soviets attempt the fourth (and final) launch of the N1 rocket. The project was suspended in 1974. 23	24	1981: Led by Colonel Mike Hoare, South African mercenaries attempt an unsuccessful coup in Seychelles. 25	26
1895: Alfred Nobel bequeaths his estate to establish the Nobel Prize. 27	28	2001: George Harrison, lead guitarist for the Beatles, dies of cancer at the age of 58. 29	30			
				1	1970: The US Environmental Protection Agency begins operating. 2	3
1969: American rapper, songwriter, producer, entrepreneur and philanthropist Jay-Z is born, in New York City. 4	5	1998: Zimbabwean-born golfer Nick Price beats Tiger Woods in the Nedbank Million Dollar Golf Tournament held at Sun City. 6	7	1953: US President Dwight D Eisenhower delivers his 'Atoms for Peace' speech to the UN General Assembly in New York City. 8	9	1954: In the name of research, Lt Col John Paul Stapp endures record-breaking acceleration and braking forces. 10
11	1915: US singer Frank Sinatra is born. 12	13	1798: David Wilkinson, of Rhode Island, USA, receives the first US patent for a nut and bolt cutting machine. 14	15	Day of Reconciliation 16	17
1944: The last major German offensive of WWII, dubbed the 'Battle of the Bulge', begins on the Western Front. 18	19	1996: Wes Craven's <i>Scream</i> , featuring Neve Campbell, David Arquette and Courtney Cox, is released in US cinemas. 20	21	1885: Ito Hirobumi, a samurai, is appointed as the first Prime Minister of Japan. 22	23	1952: The first flight of a Handley Page Victor takes place. 24
Christmas Day 25	Day of Goodwill 26	27	1954: Denzel Washington is born. He goes on to become one of the most acclaimed actors of his time. 28	29	1959: The USS <i>George Washington</i> , the United States' first operational ballistic missile submarine, is commissioned. 30	31

TEXT: MARK SAMUEL; PHOTOGRAPHY: JOSEF PAVLIK/CREATIVE COMMONS, NASA, US NAVY, PUBLIC DOMAIN

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1 NOVEMBER 1979

► Build PM's Tool Chest for Master Craftsmen

The cover of this issue showed a beautifully made tool chest, created from cherry wood. It was a duplicate, 'down to the last detail', of a tool box made by expert carpenter Patrick Murphy. Assembled with attractive dovetail joints, the multiple levels of the chest were purpose-built to accommodate all the tools a craftsman would need for their projects. Drawers in the lower sections left space for smaller tools, connectors, screws, plans and other odds and ends. Detailed plans, materials- and cutting lists and instructions followed on the ensuing pages.



2



3



5



4

2 DECEMBER 1978

► Wings: 75 Years of Powered Flight

In celebration of 75 years of flight, this multi-page feature explained not only the different types of wing designs for aircraft, but also took readers on a tour of discovery, explaining how aviation had changed and developed in the preceding three quarters of a century since the Wright brothers had flown their plane at Kitty Hawk.

3 NOVEMBER 1976

► World's Longest 'People' Tunnel

It was not yet finished, but when it ultimately *was*, the Seikan Tunnel in Japan became the world's longest tunnel to transport people (a feat that's subsequently been eclipsed). Measuring 53.85 km overall, with a 23.3 km portion under the seabed, this project represented an engineering accomplishment never achieved before.

4 DECEMBER 1968

► The Many Faces Watches Wear

Included within a bigger feature about timepieces, this layout detailed 11 different faces of watches commonly seen throughout the world. From 'parking-meter watch' to 'world travellers', to 'pilot's chronograph' and 'slide-rule watch', almost every design typically worn was shown. Of course, digital watches had not yet been invented.

5 NOVEMBER 1962

► PM's Toys of the Year

Toys have come a very long way since the early 1960s. This article described POP MECH's favourites, basing the selection on rugged testing by experts, and a 'very energetic children's panel'. The opening photo was somewhat creepy, showing a doll (containing a remote-control speaker) lying on its face, having survived a test fall 'from several feet above the ground'. **PM**

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
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↓ THE BIGGER PICTURE



ROYAL MARINES from the 4 Assault Squadron, which is part of the HMS *Albion's* Ships company, carry out cold-water wading and landing manoeuvres in Norway. Various vessels and vehicles are used in these highly demanding exercises, including Vikings, Beach Armoured Recovery vehicles (BARV), and six-ton logistical support vehicles (LSV). **PM**

PHOTOGRAPHY: PO PHOT SI ETHELL/© ROYAL NAVY/UK MINISTRY OF DEFENCE



A space odyssey

A Brief History of Black Holes sheds light on many of the mysteries and profound questions about our universe.

AT THIS VERY moment, Earth is moving at an incredible speed, spinning on its axis as it orbits the Sun. And in a galaxy of 100 billion stars – our galaxy called the Milky Way, to be specific – the Sun is, well, rather unremarkable. But in the centre of the Milky Way

sits a supermassive black hole that's approximately four million times heavier than the Sun. And, we're actually orbiting that too! So, what happens if we were to be swallowed up by this black hole? Aren't black holes like the Bermuda Triangle of space?

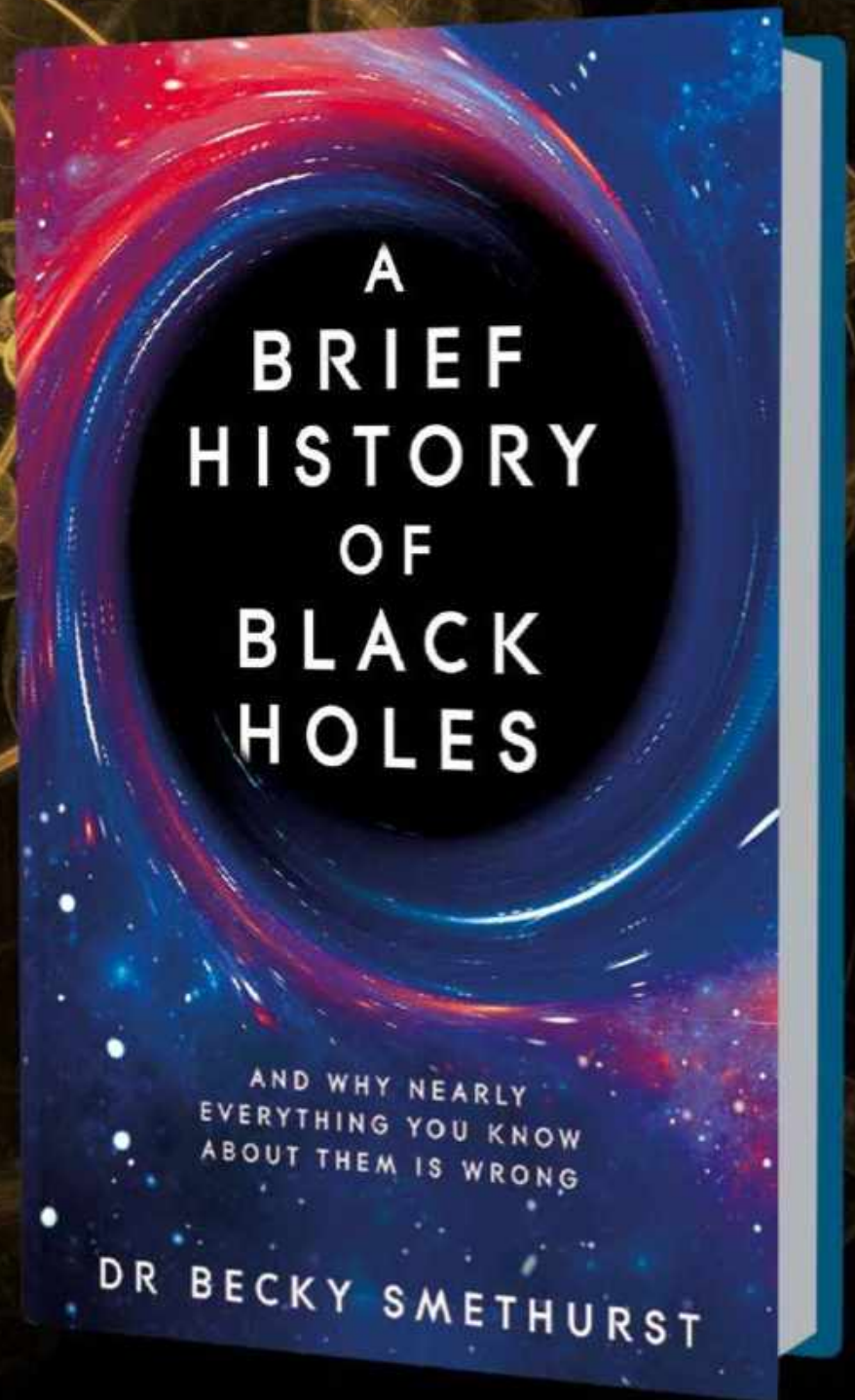
There are a lot of misconceptions and questions around black holes. Such as, they're not really black, nor do they 'suck' anything into them – in fact, it's incredibly rare for anything to make it into a black hole. And the right person to clarify all of this confusion is Dr Becky Smethurst, an award-winning astrophysicist and author of *A Brief History of Black Holes*. You might've even seen her speaking about space on YouTube or TikTok.

Her book is a fantastic read, covering everything from why the stars shine, to the theory of gravity, and what, exactly, it takes to create a black hole. There's also valuable information about black holes burping, dark matter, ultra-massive black holes, Hawking radiation, and quantum mechanics. All in all there's certainly a lot to suck you in (unlike black holes, of course). **PM**

SPAGHETTIFICATION

Yes, this is a real astrophysical term. It's a phenomenon caused by black holes.

According to Smethurst, 'The gravity around a black hole is so strong that if you fell towards it headfirst, the gravity would be so much stronger at your head than at your feet that you would get stretched out like Elastigirl from *The Incredibles*.' It would result in you looking more like a piece of spaghetti than a human being – a long chain of atoms stretching all the way down to the centre of the black hole.

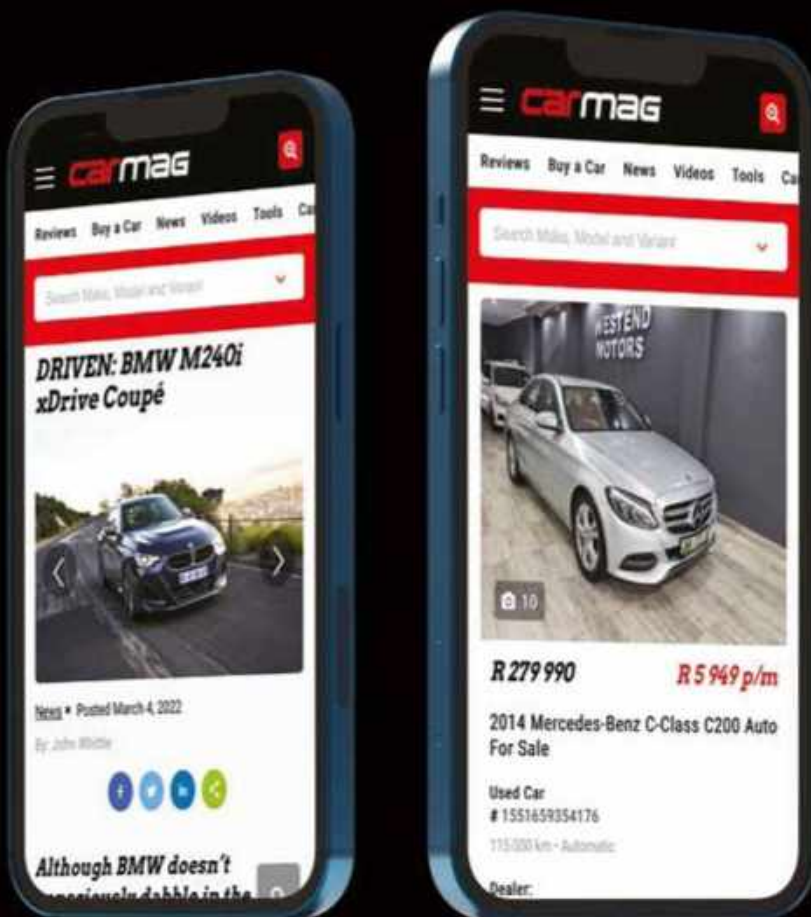


A Brief History of Black Holes by Dr Becky Smethurst (Pan Macmillan) is now available online, and wherever good books are sold.



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Charbay master distiller Marko Karakasevic started brewing beer, then realised he could use it to make whisky.



The genius of distilling beer into whisky

IN MARCH 2019, BOTTLE LOGIC BREWING, A CULT maker of imperial stouts based out of Anaheim, California, visited Interboro Spirits & Ale in Brooklyn, New York. The plan was to brew a collaboration beer, but the Californians took interest in the copper pot still lurking in one corner of the brewery. ‘They said, “Sure, let’s make a beer, but more importantly, let’s make a whisky”,’ says Jesse Ferguson, Interboro’s co-founder, brewer, and distiller.

This wouldn’t require much extra work. To produce whisky or beer, you start by mashing grains: taking barley, corn, and the like, combining it with water, and then heating the mixture. Then things typically diverge. For beer, you add hops and yeast; for traditional whisky, you add yeast and, once fermented into distiller’s wash, you distil it.

While Interboro recognised the efficiency of adding a distillery to a brewery, some distilleries now also take the step of brewing or sourcing full-flavoured beer. The results are whiskies with unusually complex flavours.

The distilling of craft beer is not exactly new. It was spawned by 13th-generation master distiller Marko Karakasevic, whose family’s Charbay Distillery has been producing brandy in northern California since 1983. When he joined Charbay in 1995, he was itching to produce whisky. Wanting to differentiate his first release from the big brands that were using the typical corn, rye, and malted barley mash bills, he took inspiration from the local microbreweries that were revolutionising the once-bland beer industry. He and his dad took 20 000 gallons (75 708 litres) of a Czech pilsner from a micro-brewery, then spent three-and-a-half weeks double-distilling on a copper alembic pot still, around the clock, to turn it into 1 000 gallons (3 785 litres) of Charbay Whiskey.

‘I was quite happy with what occurred,’ Karakasevic says. ‘Anything that was alcohol-soluble, distilled over.’ Meaning, the essential oils in ingredients such as hops were carried with the vaporised alcohol from the pot still to the condenser. Karakasevic figures the flavours of the pilsner became 10 times more intensified, with aromas of pine and weed and a palate breadly and a bit spicy. ‘All the top notes from those crazy hops from Germany and Washington state – but no lingering bitterness – were now concentrated and gave the whisky more flavour and character,’ he says. And he found that distillation preserved hops’ aroma and flavour indefinitely, unlike in beers, where it degrades in a matter of months.

Karakasevic had inadvertently created a style of whisky – ‘hop flavoured whisky,’ according to US labelling standards – uniquely his own. Eventually, Karakasevic decided to distil Bear Republic’s Racer 5 IPA, sourcing a 6 000-gallon (22 712 litre) tanker truck full of it. The resultant Charbay R5 would become a unique cult hit with its mix of floral, dank, spicy, and citrusy notes.

‘To me, it’s the ultimate form of making whisky,’ Karakasevic says. And a lot pricier, too. He figures it costs him \$5 a gallon (3.785 litres) to distil craft beer, whereas distiller’s wash – which, while potable, would be like drinking flat, bland beer – costs less than a dollar to distil. ‘But it’s a lot more flavourful, bottom-line.’

Eventually, Karakasevic’s thinking would inspire a raft of distilleries. Launched in 2004 as House Spirits, Portland, Oregon’s Westward Whiskey has always fermented its mash with ale yeast, which is more flavourful than the typical distiller’s yeast. In 2016, Westward collaborated with BridgePort Brewing Co, pot-distilling a clone of their Kingpin Double Red Ale recipe. Two Malts Whiskey, as it was dubbed, was released in mid-2021, with herbal and zesty notes typical of a rye, along with a coffee and cocoa palate akin to a dark beer.

Elsewhere, Foundry Distilling Co in West Des Moines, Iowa, has set up the Brewer-Distiller Alliance, working with acclaimed craft breweries to turn some of their most famous beers into whisky. So far, they’ve released six whiskies distilled from a stylistically diverse group of beer, including Boulevard Unfiltered Wheat Ale, Surly Furious IPA, Left Hand Milk Stout, and Arrogant Bastard Ale.

‘The most exciting thing is how much of the beer character comes through,’ Foundry Distilling owner Scott Bush says. ‘It is really cool for folks to try the whisky along with the beer and realise that both started their lives as the same liquid.’

As for Interboro, when it came time to brew their beer and impromptu whisky collaboration, Ferguson decided to employ an old English technique called parti-gyle – essentially making multiple beers out of one mash. They first collected what is known as the first runnings – undiluted wort that (by this recipe) could be fermented to a 12 per cent-alcohol imperial stout. After that, Ferguson flushed the grains with hot water to collect 900 more gallons (3 406 litres) of the weaker second runnings, which could be fermented into an unhopped eight per cent beer he and Bottle Logic distilled.



3 BOTTLES FROM THE US TO TRY

CHARBAY R5 | 49.5% ABV

Now in its fifth bottling, Bear Republic Racer 5, a 7 per cent IPA, is double-distilled into R5. The nose is extremely bright and aromatic, piney and dank with hints of lemon zest. The palate leans more towards chocolate.

INTERBORO STRAIGHT MALT WHISKEY | 50% ABV

The first whiskey release from the five-year-old Brooklyn outfit, this is a blend of two barrels aged for three years in first-use American oak before spending their final year in barrels that had previously held Woodford Reserve Double Oaked bourbon. The result is a heavier

char flavour than a typical Scottish single malt, with notes of dark cherry, vanilla, and caramel.

ARROGANT BASTARD WHISKEY | 48.5% ABV

The Escondido, California, brewery produces their typical Arrogant Bastard wort (unfermented beer) and transports it to Foundry Distilling, where a distiller’s yeast is pitched to start fermentation, before it is column-distilled. Aged for 26 months in undersized, 114 litre new charred American oak barrels, it offers bright notes of citrus zest with hints of herbal tea, though the youth of the whiskey is evident by its graininess.

A few months later, the stout, Fuel for Fractions, was released. It offered rich notes of figs, cocoa, and coffee. A couple of years from now, a four-year-old malt whisky with the exact same mash bill (and, in theory, a similar but more concentrated flavour profile) will also be released.

‘In terms of technology, nothing we’re doing is new,’ Ferguson says. ‘From what I’ve heard, the oldest distilleries were all originally breweries too.’ And yet, in this day and age, what he’s doing certainly feels innovative, giving us flavours never before experienced in whisky. **PM**

Scientists are planning to build Noah's Ark on the Moon

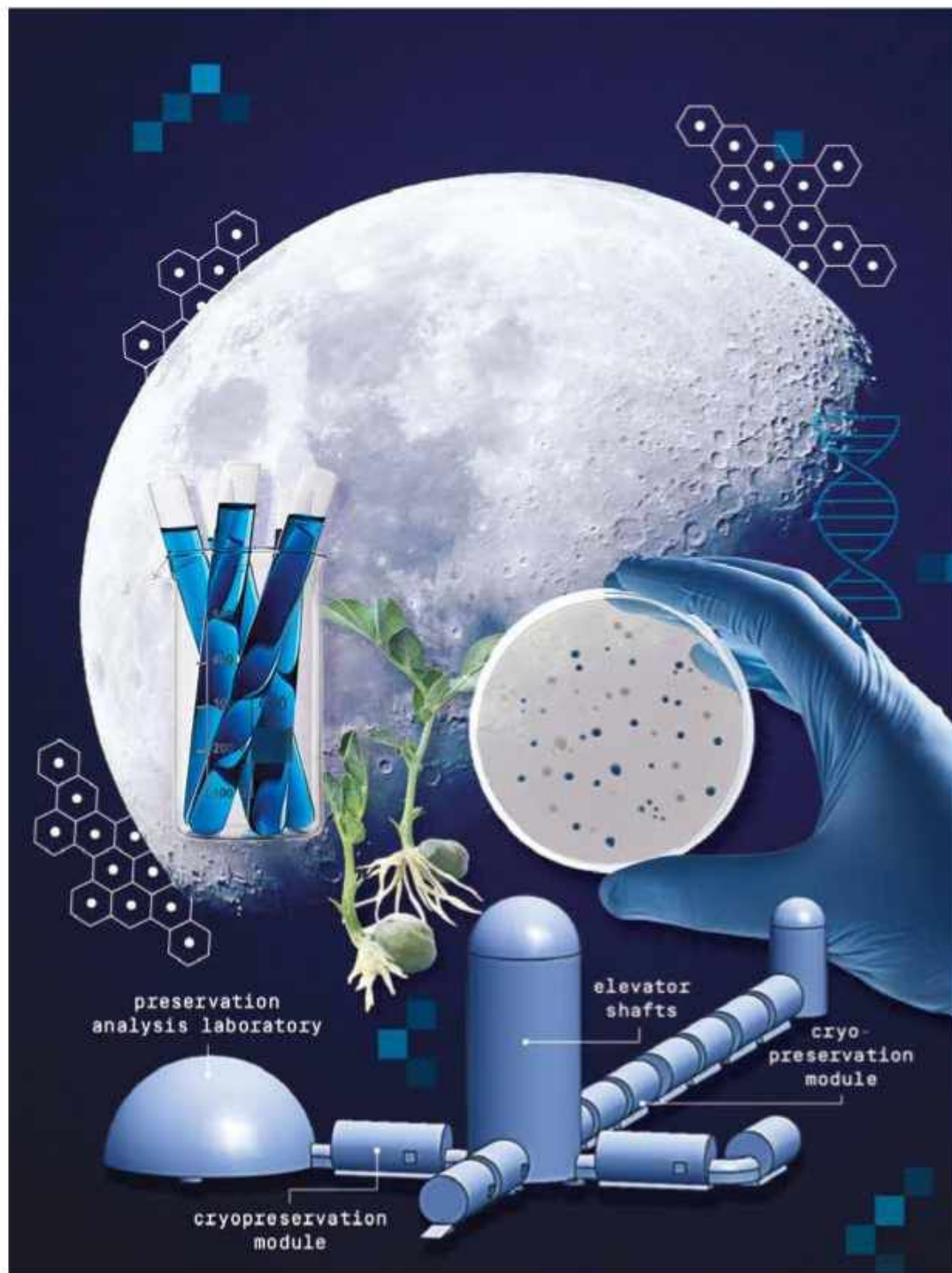
A TEAM AT THE UNIVERSITY OF ARIZONA is proposing a concept that just might save us from extinction: a 21st-century version of Noah's Ark on the Moon. This ark wouldn't contain two of every animal, but rather a repository of cryogenically frozen reproductive cells from 6.7 million species on our planet.

Consider it a global insurance policy, says Jekan Thanga, PhD, an assistant professor at the University of Arizona's Department of Aerospace and Mechanical Engineering, and the project's mastermind. 'As a human civilisation, we're in a fragile state,' he says. And such a shelter could come to fruition in the next three decades, he adds.

The Svalbard Global Seed Vault in Norway, an Earth-bound version of the lunar ark, opened in 2008 and currently contains more than 1 million crop seed samples, including staples such as rice, wheat, and barley. It's a somewhat appropriate analogue for the lunar ark, but storing 6.7 million gametes, spores, and seeds isn't the same on the Moon as it is on Earth; there are the added challenges of microgravity, radiation levels roughly 200 times those on Earth, and wildly fluctuating temperatures.

With that in mind, Thanga's team plans to install the lunar ark inside the Moon's extensive network of over 200 lava tubes just beneath its rocky surface. These tunnel-like structures are an ideal home because they insulate the facility from harsh conditions in much the same way that Svalbard's storage facility, built deep inside a mountain, provides protection from the elements here on Earth.

The team wants to first send a mission called SphereX (not to be confused with NASA's Earth-orbiting SPHEREx



In the event that an asteroid threatens our planet, the lunar ark might be our best bet at maintaining life on Earth.

mission) to explore the lunar lava tubes and collect lunar regolith (loose rock and dirt). A team of robots would deploy from a nearby lander, hop or fly into the tubes, and then form a relay, transferring images and data back to the lander. SphereX could teach researchers about the lava tubes' layout, temperature, and geological makeup, to guide the design process for what would be the first structure built on the Moon.

'What we envision is taking one of the existing pits – just the opening into the lava tube – and installing an elevator

shaft,' Thanga says. From there, the elevator shafts would function as the entry and exit to a series of 32 cryo-preservation modules. These upright cylinders, stacked in 16 rows, would preserve the reproductive cells. Robots or astronauts would be able to check samples in petri dishes in and out, 'like a library,' Thanga says.

The storage modules would need cryogenic coolers to maintain the cells at the right temperatures: -180°C for reproductive cells, and -195°C for stem cells. And they would require a spinning apparatus that uses centrifugal force to keep the freezers in motion and prevent the cells from clumping together and building up cold spots. 'The setup would be similar to a carousel shelving unit with music CDs packed into a circle,' Thanga says.

Meanwhile, robots connected to a magnetic strip (to simulate Earth's gravity) could remove the samples from their modules and transport them to an analysis lab, periodically checking to see if the seeds and sex cells are stable.

There's evidence to suggest that the samples would remain viable despite the radiation and microgravity. In 2010, researchers at the Slovak Academy of Sciences found that flax plants could grow in radioactive soil near the Chernobyl nuclear power plant with minimal changes to the plant's proteins. And in June 2021, scientists in Japan produced 168 healthy mice offspring from sperm cells that had been in storage aboard the International Space Station (ISS) for nearly six years.

Thanga says that private companies such as SpaceX and Blue Origin, which continue to drive down the cost of space launches, further bolster the likelihood of

▶ *THE LUNAR ARK SOUNDS LIKE A SETTING FOR A SCI-FI NOVEL, BUT THANGA SAYS THE POSSIBILITY FOR SUCH A SHELTER IS VERY REAL AND COULD COME TO FRUITION IN THE NEXT THREE DECADES.*

establishing a lunar ark. With some back-of-the-envelope calculations, Thanga estimates it would take 250 rocket launches to carry 50 specimens each of the 6.7 million species his team wants to preserve on the lunar ark. To put that into context, it took 40 launches to build out the ISS, the most expensive structure ever created.

Thanga's team is currently planning an experiment that will send two cryopreservation pouches into space. Each will contain 500 samples from one animal species – 50 individual samples are the bare minimum to prevent inbreeding in the short-term, while 500 individuals are required to prevent genetic drift. Ideally, the system will demonstrate successful cryopreservation for five to seven days in-orbit before returning to Earth to see if the samples survived. **PM**

PHOTO ILLUSTRATION: CREATED BY ALYSE MARKEL USING GETTY IMAGES AND COURTESY ARIZONA STATE UNIVERSITY (BUILDING DIAGRAM); RIGHT-HAND PAGE: UNIVERSAL HISTORY ARCHIVE/UNIVERSAL IMAGES GROUP VIA GETTY IMAGES



MOON CONSTRUCTION 101

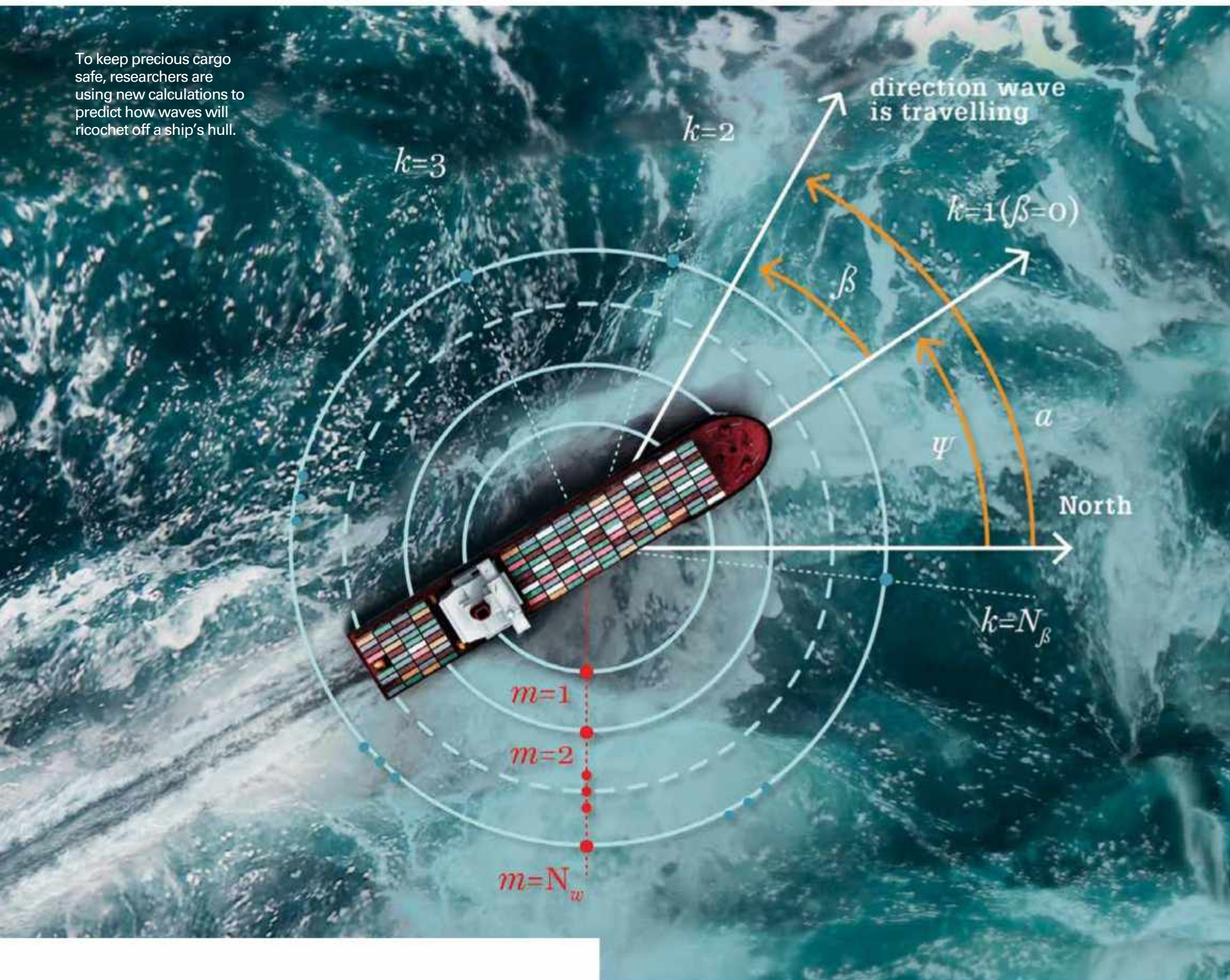
Building out the lunar ark will be an expensive endeavour, considering it costs about \$700 to put a 0.45 kg payload into Earth's orbit, according to NASA. That's why scientists want to avoid

lugging cement into space; instead looking for ways to use moon rocks, says Sven G Bilén, PhD, professor of engineering design, electrical engineering, and aerospace engineering at Pennsylvania State University.

'The regolith that's on the Moon is a very, very challenging regolith to work with, because it's essentially these tiny little razor

blades, they're very jagged and sharp, they've never had a geological process to form them,' says Bilén, who is not involved in the lunar ark project. So, building this kind of complex would likely require an entire moon-rock mining operation, as well as a processing centre where operators could melt the rocks down into a flowable cement.

To keep precious cargo safe, researchers are using new calculations to predict how waves will ricochet off a ship's hull.



The maths that can help cargo ships see into the future

CARGO SHIPS LOST MORE THAN 3 000 CONTAINERS IN 2020, and several thousand more in 2021, according to the World Shipping Council. For comparison, the council estimated an average annual loss of 779 containers between 2017 and 2019. The damage is inconvenient for you, but can also disrupt entire supply chains.

A team from the Norwegian University of Science and Technology (NTNU) might have a solution to these maritime woes. Using a few simple calculations, researchers can predict the height and direction of incoming waves without relying on expensive, and occasionally unreliable, wave radar equipment on the vessel itself. Currently the team is testing their method on stationary ship models. But one day, it could help captains avoid disaster.

'If we know the waves, then we know everything we want,' says Zhengru Ren, postdoctoral fellow at NTNU. Waves hold crucial information about ocean variables, such as the swell height and depth, which provide valuable insight to sea captains. In March 2021, Ren and company published a paper in the journal *Marine Structures* detailing their new wave-analysis approach.

It involves a concept called the 'wave buoy analogy', which relies on a ship's size, shape, and motion responses to the water to understand the overall sea state (including wave direction, height, and frequency). This all hinges on the scientists' ability to treat ships like buoys. The flotation markers sit on the ocean's surface, moving in tandem with the sea itself – rising and falling with a wave's peaks and troughs – so, the buoy's movement (or the ship, in this case) is a proxy for the ocean's movement.

Ren's team has added in a new factor: the ship's often asymmetrical geometry. The team can add that data into its pre-sail calculations, called 'response amplitude operators' (RAOs). Ren says captains can easily plug those into a simple algebraic equation, along with a vessel's motion, then use regression-based methods to solve for the wave spectrum. That's a measurement detailing the sequence of waves in the sea, helping captains see into the ocean's future behaviour.

'We can do one linear equation, like in high school algebra,' says Ren. 'It's $y = ax$. For this, the "x" is the wave spectrum. The "a" depends on RAO. And "y" is the vessel motion.' It's a case of simple division to solve for the wave spectrum.

The wave-buoy analogy has existed since the 1980s, but Ren and colleagues found that the estimation technique wasn't very precise. To solve this problem, they needed to smooth out the data with a concept called a Bézier surface, which is made up of Bézier curves (see sidebar). These parametric curves smoothly connect points on a plane, much like the arc of a thrown baseball. Previous estimation methods relied on just three points to cover the peaks and valleys of an entire curve (here, the wave spectrum), but Ren's method can use as many points as necessary. 'The more nodes we consider, the more smooth the estimates will be,' he says.

In this way, the team could more accurately predict wave parameters, such as height. As long as a captain knows their ship's geometric specs, they can make these RAO calculations safely on land, as the ship is being designed or purchased, says Ren.

His tech will take the form of a software package like WAMIT or ShipX (which captains already use to calculate

RENAULT'S SLEEK CURVES

While working for the French automaker Renault in 1968, Pierre Bézier unveiled his 'UNISURF' system for Computer Aided Drafting (CAD), which made it possible to use computers in designing the sleek, curved bodies of Peugeots and Renaults. Specifically, UNISURF allowed users to intuitively manoeuvre the curves in

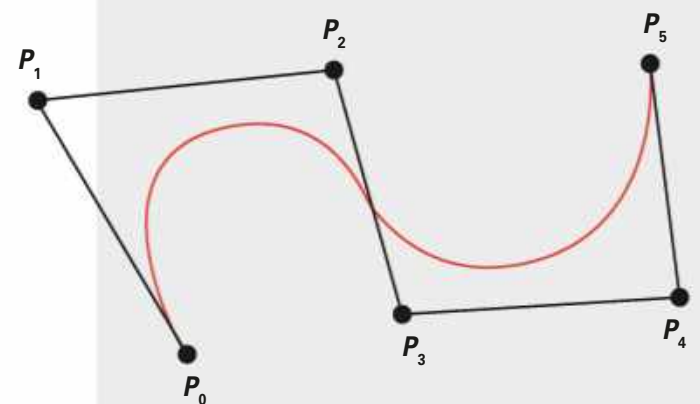


Figure 1

a car's design by manipulating a number of control points, called nodes, to shape the parts (see Fig 1). Notice that some nodes sit outside the curve itself, with the exception of the first and

last points. Today, these Bézier curves are used to smooth out everything from new typefaces, to computer-generated illustrations with a simple click-and-drag motion. – Courtney Linder

RAOs). It's not ready to hit the seas yet, but Ren estimates it will debut within the next decade.

Because Ren's team is still testing out the software on stationary ship models, for instance, the technology may be better suited to stationary vessels – like floating wind farms – in the short term. It's yet to be seen whether Ren's method really will work on moving ships, explains Ulrik Dam Nielsen, an associate professor of marine technology at NTNU who was not involved in the work. 'The research is truly novel but whether – or how – the method will work in practice with *real* data and for ships having forward speed still remains unclear,' he says.

For his part, Ren is confident that the new method could elevate the sacred connection between a captain, their ship, and the sea.

'The field of marine technology is moving towards digitalisation,' he says. 'One hundred years ago, captains had no information about the sea state; they could only trust their eyes and experience... This [new] information can just help the captain make better decisions.' **PM**

Autonomous drones have attacked humans. This is a turning point



IMAGINE A FEW YEARS FROM NOW, US SUPPLY troops have just wrapped up a field exercise in Poland, showing solidarity with the country in the face of sabre-rattling from nearby Russia. As the sun sets, GIs rest next to their trucks, knowing the Russian 18th Guards Motor Rifle Division is encamped just a few kilometres away.

The soldiers hear a faint buzzing in the distance and see a dark cloud crossing the horizon. Suddenly, a solitary scout drone swoops low over the Americans – it's seen them. Like a predator catching the scent of prey, the cloud stops dead in its tracks, then rushes towards the soldiers with astonishing speed. Following programming orders, each of the 60 drones scans the ground below and picks its

STM's Kargu rotary wing attack drones use their electronic brains to detect and strike targets.

target, while AI ensures no two drones aim for the same vehicle. The drones arm their explosive payloads just as the first bursts of gunfire begin lancing out from the American position.

Sometime around March 2020, this long-standing trope of science fiction – autonomous attack drones eliminating human beings on the futuristic battlefield – crossed over into science fact. That's when, during the Second Libyan Civil War, the interim Libyan government attacked forces from the rival Haftar Affiliated Forces (HAF) with Turkish-made Kargu-2 ('Hawk 2') drones, marking the first reported time autonomous hunter killer drones targeted human beings in a conflict, according to a United Nations report.

Unmanned combat aerial vehicles, loitering munitions, and the Kargu-2 'hunted down and remotely engaged' HAF logistics convoys and retreating fighters, the UN report found. The autonomous drones were programmed to attack targets 'without requiring data connectivity between the operator and munition', meaning they located and attacked HAF forces independent of any kind of pilot or control scheme.

The Kargu-2 is a quadcopter drone developed by STM, a Turkish defence contractor. The drone features sensors and an electronic brain, and is designed to carry a weapons payload. In marketing materials, STM explicitly says Kargu-2 is capable of carrying out an autonomous attack.

Here's how it works: The drone operator loads a set of target co-ordinates into the Kargu-2's software. The drone then takes off and travels to the co-ordinates, searching for objects on the ground that fit the profile of preferred targets. Once the drone identifies a target, it swoops down on the target at high speed and detonates an on-board explosive package, with an effect similar to that of a shotgun blast.

'The first use of autonomous weapons in war won't be heralded with a giant fireball in the sky,' says Zachary Kallenborn, an official US Army 'Mad Scientist' and national security consultant. 'It may just look like an ordinary drone. The event illustrates a key challenge in any

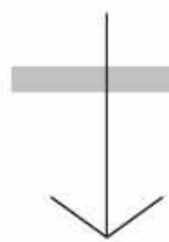
attempt to regulate or ban autonomous weapons: How can we be sure they were even used?"

One major difference between a remotely controlled attack drone and an autonomous drone is the software, which might be difficult to obtain from scattered bits of plastic for forensic analysis.

The US Army is working on autonomous drones, including the Bell Textron M5 medium robotic combat vehicle. The M5 is an uncrewed, 10-ton tracked armoured vehicle that looks like a miniature tank and has a top speed of 65 km/h. It features a 30 mm XM813 chain gun and is designed to operate alone or as a wingman to M1A2 Abrams tanks and M2 Bradley infantry fighting vehicles.

The key difference between the US Army's drones and the Kargu-2, however, is that the army insists on a 'human in the loop'. The drone might search for targets autonomously, but it can only open fire once a human operator gives permission. This allows the operator to call off an attack if the drone has mistaken a civilian for a soldier.

Some events in the history of humankind, such as the 1945 atomic bomb test at the Alamogordo Bombing Range in New Mexico, are so profound, they serve as a divider between one social, economic, or military era and another. The events in Libya may similarly divide the time when humans had full control of weapons and a time when machines make their own decisions to kill. **PM**



THE EVOLUTION OF MILITARY DRONES



CURTISS N2C-2 FLEDGLING

In 1938, an unpiloted US Navy Curtiss N2C-2 Fledgling dive-bombed the battleship USS *Utah*. A human operator observed the N2C-2 from a distance and steered it using radio signals.



MQ-1 PREDATOR

In 2001, a Predator drone successfully launched a Hellfire anti-tank missile for the first time. Because they can stay aloft for 24 hours at a time, Predators have helped the US military search for, identify, track, and ultimately destroy targets.



SEA HUNTER

In 2019, Sea Hunter became the first sea drone to make the trip from California to Hawaii autonomously. Larger sea drones equipped with dozens of Mk 41 missile silos will soon sail alongside manned warships, increasing their firepower.

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The performance wheel has been reinvented

LIGHTER WHEELS ARE FASTER WHEELS. And after decades of incremental advancements in wheel-casting and forging technology, additive manufacturing (3D printing) is primed to transform how little performance wheels can weigh and what the wheels look like.

An early example of what we can expect was produced in 2019 by wheel-building boutique HRE in collaboration with GE Additive, GE's 3D printing subsidiary. Their HRE3D+ wheels mated printed titanium components with a carbon-fibre barrel. The 20" × 9" front and 21" × 12.5" rear wheels weighed just 7.2 and 8.6 kg respectively. For high-end wheels of the same size, this saves roughly 0.45 kg in the front and 0.9 kg in the rear.

Traditional wheels are manufactured using cast or forged aluminium alloys. These existing processes are cost-effective but suffer from material inefficiencies where extra meat is left on the wheels to give the manufacturer margin for error in meeting strength standards.

Casting's standard process, gravity casting, is the simplest and cheapest: molten aluminium is poured into a mould and left to cure. Because the aluminium casting process suffers from porosity – which creates weak points – the wheels require more material and designs are limited to large, simple elements.

Forged wheels are lighter and stiffer (and more expensive) than their cast counterparts. The most common method is machine forging, which involves tempering a block of billet aluminium to add strength, then CNC-machining it into a wheel.

HRE's concept wheels used GE's electron beam melting (EBM) technology to print five interlocking individual components that formed the face of the wheel. The EBM process uses a 3 kW electron beam to solidify layers of metal powder into potentially complex 3D shapes at temperatures in excess of 982°C. The remaining powder can then be vacuumed away and recycled.

The final part requires minimal finishing work thanks to a beam diameter of 140 microns – one micron is equal to 0.001 mm. Unlike traditional gravity casting's porosity, these machines can achieve nearly 100 per cent material density.

While additive manufacturing offers an excellent opportunity to disrupt the performance wheel industry, it necessitates vastly different design requirements than forged and cast wheels.

'Step one in learning to design for additive is forgetting everything you know about everything else,' says Josh Mook, chief engineer and innovation leader at GE Additive. Mook stresses that EBM technology pushes the boundaries

Advantages of additive under the bonnet

GE has been working with manufacturers like Cummins to showcase the performance and efficiency advantages of 3D-printed drivetrain parts, such as pistons. The stronger, lighter pistons can be actuated faster while using less fuel.

Like wheels, pistons are traditionally produced through casting or forging, and suffer material inefficiencies – in this case, unnecessary material where the

rod connects to the piston. Additive manufacturing allows for much greater control in these tight areas.

Another advantage of additive manufacturing is that these performance gains can be achieved without the added cost of tooling. Eliminating this expense could even allow small tuning shops to print pistons and other complex engine components without the need to outsource manufacturing.

The face of the HRE3D+ wheels was built using five interlocking 3D-printed sections.

of what's required from a material science standpoint. Despite HRE using a robust Ti-6Al-4V titanium alloy, the complicated geometries of the HRE wheels required additional support structures to suppress thermal distortion during the printing process. These scaffolds, which get removed during the finishing process, prevent the hot 3D-printed metals from sagging during manufacturing.

But how will lighter wheels make your car faster? This all has to do with the unsprung mass of an automobile, the components that aren't supported by the suspension system – wheels, hubs, brake discs, callipers, brake lines, and tyres. While these components only make up around 10 per cent of the overall weight, they have an outsized effect on how your car drives.

As unsprung mass decreases, so does the workload on the suspension system. In bumpy situations, this allows the tyre to remain in contact with the road for longer, leading to more traction. Lower unsprung mass also means lower rotational inertia, which allows for better acceleration and shorter braking distances.

While additive technology has yet to be seen in most production vehicles, GE Additive is currently developing a more scalable and affordable additive manufacturing solution to fill this gap.

HRE has no plans to sell these wheels at the moment, but doesn't doubt that these types of wheels will see production at some point. The technologies behind casting and forging wheels have essentially plateaued, but additive manufacturing is just beginning to unlock a higher level of performance in the automotive industry. **PM**



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The right work boots are boots for life

FIFTY YEARS AGO MY PARENTS GAVE ME an oversized pair of moccasin-toe work boots for my 12th birthday. The earthy aroma of fresh leather that came wafting out of their box is still with me. They were good quality, US-built (of course), and were large enough for me to grow into. That one pair took me from childhood through buying my first truck, construction jobs, college, and into full-fledged adulthood. When, after more than a decade, they became outright disgusting, I used them as the boot of last resort for painting and driveway sealing. Once, lacking a pair of rubber boots, I even wore them while pouring the concrete slab for a crawl space. I just waded in and hoped for the best. The boots were fine; a thorough cleaning with a garden hose washed off the concrete.

Calling them work boots doesn't give them enough credit. Aside from wearing them on the job or in the garden, I – and everyone I grew up with – also wore them hiking, camping, hunting, fishing, wrenching on jalopies. Later in life, I turned to work boots when my kids were young. In that era, they were more like 'father boots', the footwear I wore on countless miles of nature trails, slogging up and down sledding hills with one of my kids on my shoulders, stumbling around corn mazes, and selecting a Christmas tree to cut down. In those days I probably wore work boots as much as I wore sneakers.



BACK TO LIFE /

▲ My current boots with 13 years of wear (left), and after being refurbished (right).

If you want one piece of advice for buying boots that you can grow old with: find a pair that looks like it would have been perfectly at home on someone's feet 80 years ago. After nearly half a century of wearing work boots, I've given up on advanced designs, insulation, waterproofing, fancy stitching, and any features claiming to produce comfort. A traditional leather work boot can be easily dried out and cleaned, and even resoled or rebuilt.

My Thorogood boots (*above*) are a perfect example. I don't know how many projects and tool tests for this magazine I've done while wearing those boots over the last 13 years but it's a lot. I recently sent them out to a shoe refurbisher called NuShoe for a complete overhaul. They came back astonishingly clean, given what I'd put them through, with even the 'tobacco' stain restored. It was good to take those boots out of their box, unwrap them, and admire the workmanship in their original construction and in their rebuilding. It was enough to make me feel like a 12-year-old kid again. **PM**

ROY BERENDSOHN IS A SENIOR TEST EDITOR AND HAS WORKED AT POPULAR MECHANICS SINCE 1986.



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GEAR & GADGETS

Must-have hardware for humans on the go

THULE AION CARRY-ON SPINNER

If an airline has ever lost your checked luggage, and you've experienced the dread of bags not arriving on the carousel after a long-haul flight, you'll understand the importance of good carry-on baggage options.

When it comes to choosing a carry-on case, finding that balance between sturdy and durable (but also lightweight), is key. You want to pack in as much as you can, including a few changes of clothes, your toiletries, snacks, and your electronic devices, and still remain under the relevant weight- and size limits.

Thule's Aion collection, made from a 100 per cent recycled canvas fabric that's highly durable and water-resistant, is a rugged yet attractive solution. The 35-litre 3.2 kg Aion Carry-on Spinner has four wheels, but the rear set is oversized, for navigating bumpy terrain. The V-tubing telescoping handle has several height settings, so there's no hunching over while you're in transit and on the move.

The polycarbonate back panel creates a durable exoskeleton, absorbing the types of impacts you might typically encounter while travelling. The large zippered front pocket is a good spot to stash your jacket, or laptop, and there's another tiny exterior pocket for on-the-go items such as a wallet and keys. A TPU-lined removable compression cube is included inside, ideal as a day bag or to keep dirty laundry separate, and when cinched in place it keeps packed items nice and secure.

Available in two colours – Nutria or Black – the Aion Carry-on Spinner meets all of the practical requirements, and looks very good while doing it.

RRP R7 999
thulestore.co.za



KREG 90° POCKET-HOLE DRIVER

This ingenious little tool from Kreg turns any drill into a 90° driver, enabling you to drive screws in awkward-to-reach places. The magnetic tip of the 3" square-drive bit keeps the screws in place, because there's nothing worse than dropping a screw at the most inopportune time when trying to assemble a woodworking project. Conveniently, the attachment works with all hex shank bits, meaning it's suited to many other applications aside from just pocket-hole-screw work.

Kreg has designed it to be held easily in one hand, allowing you to control your drill with the other. It's impact-rated too, so using it with your impact driver won't present any problems.

RRP R617
vermontsales.co.za





LEDLENSER KIDS' HEADLAMPS AND LANTERNS

Those with little ones will know how they love to mimic the things that mommy and daddy or older siblings do. And, during these frustrating times of load-shedding, that mimicking behaviour probably extends to wanting to wear a headlamp around the house at night too.

Ledlenser has created a marvellous range of headlamps and lanterns, themed specifically with children in mind. Whether it's the dinosaur- or rainbow-decorated model, your kids are sure to love one (or a few) of these highly useful Kid Led 2 headlamps or Kidcamp 6 lanterns. Eskom woes aside, in a far more practical and adventurous sense, camping trips will be a lot more exciting for the younger ones when they have their very own battery-operated lights.

The headlamps have an IPX4 water-resistance rating, so they're protected from splashes, and deliver up to 40 lumens of light on 'power' mode. There's also a 'low' and 'blink' mode. The lanterns have a lumen rating of 60 on 'power' mode, and flash white, red, green and blue when using the 'blink' function. Rather cleverly, they can be set to switch off automatically after 20 minutes.

RRP R265 (Kid Led 2 Headlamp)

RRP R390 (Kidcamp 6 Lantern)

awesometools.co.za

HUAWEI MATEBOOK D14

The MateBook D15 is Huawei's all-new 15.6" laptop. It has a sleek metallic finish, and measures only 16.9 mm at its thickest point. It's lightweight but feature-heavy, and capable of performing complex tasks thanks to its quad-core, eight-thread Intel processor and high-speed solid-state drive. It's an absolute workhorse, but at the same time, a truly beautifully designed machine.

It includes all of those little details we love, such as its fingerprint sensor built into the power button and a retractable camera in the keyboard. If you're a Huawei fan, you'll definitely appreciate the MateBook D15's multi-screen, multi-device collaborative capabilities. Just imagine accessing your entire phone or tablet via a laptop screen? And that includes drag-and-drop, content-sharing functionality. Connecting seamlessly to all of your devices using Huawei's Harmony OS might not sound like a stand-out feature, but once you experience how fluid it is, opting for a laptop such as this is a no-brainer. We also particularly enjoyed using the D15's SmartCharge, which provides up to two hours of battery life after just 15 minutes on charge, or in 30 minutes, more than half the D15's battery capacity will be powered up.

RRP R11 999

consumer.huawei.com/za



LOGITECH LIFT VERTICAL ERGONOMIC MOUSE

This is a vertical mouse. Yes, you read that right. The Lift from Logitech is a mouse unlike any other we've got our hands (or hand) on before.

First up, it's surprisingly comfortable. The unique shape, textured grip and smaller size make it a pleasure to hold. It's light, soft, and your hand is propped in an upright position as you use it, which, from an ergonomic standpoint, takes strain away from your wrist, arm and upper body... and your fingers are positioned in a more natural posture. Logitech calls this a 'handshake position', which sounds kind of novel but it's really about anatomical proficiency and comfort.

Because this mouse is from Logitech, there's far more to the Lift than just clicking, scrolling, and gliding. It comes with customisable buttons and two easy connection methods – via Bluetooth, or using a Logi Bolt USB receiver. Inside, you'll find a single AA battery that keeps the mouse powered for up to two years.

It's important to mention that the clicking is almost silent. The Lift's scroll wheel is fast, precise, and like the main buttons, whisper-quiet. Perhaps its only downfall for some is that it's on the small side (something our reviewer appreciated), so if you need a bigger mouse for large hands, Logitech's MX Vertical might be a better fit.

RRP R1 185
firstshop.co.za



OLFA CTR SK-16 SAFETY KNIFE

The SK-16 safety cutter from Olfa is designed to cater to all of your professional and hobbyist cutting- and unpacking needs, easily slicing through thicker materials such as carpeting, rubber sheets, double-walled cartons, stretch-film and plastic.

Its clever design limits users' exposure to the cutting edge, as the blades are safely positioned between two plastic guards. Not only does this feature make it safer to use, but it helps to avoid damaging goods inside boxes when cutting through tape and packaging. The enhanced metal tip on the back of the handle is a more efficient way of slicing through packaging tape.

Changing the blades is extremely simple, but it won't need to happen too often, as they're made from ultra-hard stainless steel. Activate the blade release from either side of the handle to detach the dull blades. Then it's just a case of clipping in the replacement. The handle is ergonomically designed for comfort, and made from chemical-resistant resin.

RRP R202
vermontsales.co.za



MSI

STEALTH 15M B12UE LAPTOP

IF YOU'RE ON THE HUNT for a laptop that will meet all of your needs, at school or university, work, or when high-speed gaming, look no further than MSI's Stealth 15M. At 1.8 kg and 17 mm, it's one of the lightest and thinnest powerful gaming laptops in the world, boasting specs and features to take your leisure time to the next level.

MSI's new logo, designed with glowing texture and rainbow colours which change at different angles, is emblazoned on the top. The keyboard is backlit in pink, orange and blue in three distinct zones, inspired by street art and graffiti.

But it's inside where the magic (and high-paced processing speed) happens. Depending on the spec level you go for, it takes up to a 12th Gen Intel Core i7 CPU. There are two slots for RAM, and this can be maxed out at whopping 64 GB. There's a NVIDIA GeForce RTX 3060 graphics card, which delivers solid performance for gamers without breaking the bank. The 144 Hz refresh rate of the 15.6" IPS-level display (1920 x 1080p) is well suited to fast-moving content. Using the HDMI and USB Type-C ports, up to three monitors can be added to expand the display space.

The Cooler Boost 5 technology, incorporating four pipes and two fans, ensures optimum performance even under extreme gaming conditions.

RRP from R35 999

computermania.co.za





TECNO SPARK 8C

Designed with creators and budding entrepreneurs in mind, the Spark 8C boasts an array of features which make it a desirable yet budget-friendly smartphone option.

First, it looks really good, available in a range of eye-catching colours including Turquoise, Magnet Black, Iris Purple, and Diamond Grey. At 6.6" the screen is large and user-friendly, and it has a respectable 90 Hz refresh rate.

The 13 MP main camera has dual lenses (with dual flash), with the ability to capture wide-angle shots with a zoom equivalent to 27 mm. The 8 MP front lens with flash will handle all your selfie-shot and video-call needs.

With its 5 000 mAh long-lasting battery, you'll easily remain powered up all day (and beyond, depending on your usage).

The on-board Memory Fusion technology extends the standard 4 GB of RAM up to an impressive 7 GB, resulting in impressive operating speeds. Internal memory is a substantial 128 GB. Dual SIM slots let you operate with two phone numbers, particularly useful if you're running a business or travelling abroad and need an overseas cell number.

RRP R2 999

tecno-mobile.com, hi-online.co.za

D-TECH BEAM AND BOX LEVELS

So many projects around the home, garage or office – such as installing shelves or flooring, hanging artwork on the walls, or fitting security gates or burglar bars – require things to be perfectly level or vertical. That's where the services of D-Tech's range of industrial beam- and traditional box levels come in. Available in a variety of sizes, from 400 mm right through to 1 200 mm, all with an accuracy of 0.5 mm, you're almost sure to find a D-Tech product to suit your needs.

The spirit levels are made from durable industrial-grade plastic set in a black or yellow powder-coated aluminium frame, while shock-protection on the corners helps them stand up to bumps or drops. Bubbles enable you to check horizontal or vertical angles, and some models have a third bubble for 45° angles.

The leak-free design of the vials will ensure the D-Tech range of levels serve you, trouble-free, for many years.

RRP from R178 – R545

vermontsales.co.za



ASUS PROART STUDIOBOOK

This is a high-end, powerful machine that's been created with professionals such as 3D designers, architects, videographers, graphic designers and industrial engineers in mind, the sort of people who demand premium performance from their devices. When you work in these creative fields, lag is your worst enemy, especially when you're pushing to meet an unmissable deadline.

The machine we tested featured an 11th Gen Core i7-11800H 2.30 GHz processor and 32 GB of RAM, but these machines can accommodate up to an Intel Xeon W-11955M or Intel Core i9 11900H processor with 8 cores and 16 threads. Performance is optimised for software dedicated to stats and big data, CAD and modelling, video editing and image manipulation.

The OLED display delivers precise colours and superior response times, while the graphics processing power is provided by up to a NVIDIA RTX A5000 GPU.

With a storage system capacity of up to 4 TB in the form of an ultra-fast SSD, data-read speeds of 7 000 MB/s can be achieved.

Cooling is facilitated by ASUS's IceCool Pro system. It uses 102 aerofoil blades which carry out their work efficiently, quietly and optimally. Six heat pipes and seven intelligent sensors ensure peak cooling performance at all times.

The three-button touchpad and associated ASUS dial offer precision control, especially when panning, rotating or orbiting a 3D design.

With multiple ports, including two USB 3.2 Gen 2 Type-C sockets and the latest HDMI 2.1, you'll never be short of swift connections.

RRP from R29 999 – R39 999

za.store.asus.com



XIAOMI MI ELECTRIC SCOOTER 3

Keen to cut back on petrol costs? Perhaps what you need is a zippy electric ride such as Xiaomi's Mi Electric Scooter 3.

Battery-powered and (for the most part) maintenance free, a scooter is a great eco-friendly option for shorter commutes. In the box you'll find everything you need to get up and going: there's a power adapter, Allen key, extended nozzle adapter, screws, a spare tyre, and a user manual. The whole set-up is self-explanatory and connecting the scooter to the Mi Home app via Bluetooth is a breeze.

The scooter can travel around 30 km on a single charge. If the battery hits empty, it'll take five and a half hours to fully recharge. There is, however, a sleep mode that automatically activates to save battery life. In the centre of the handlebars is a bright LCD and a single button that you use to turn the light on and off and toggle between the three power modes: 'pedestrian', with a max speed of 5 km/h; 'standard' (or eco), with a top speed of 20 km/h; and 'sports' mode, which unleashes all of the power the scooter can muster ... which is really just 25 km/h.

Weighing 13 kg, the scooter is relatively easy to carry around. It feels solidly built and the mechanism that enables the scooter to fold is pretty savvy. Included are excellent safety features such as a bright headlight and tail light, as well as two brakes. While you won't win any races, this nimble commuter scooter gets a double thumbs-up from us.

RRP R10 999

syntech.co.za; goelectric.co.za



SAMSUNG GALAXY Z FOLD4

It feels like just yesterday that Samsung surprised everyone with a foldable smartphone, and now, already in its fourth iteration, the Galaxy Z Fold4 is almost perfect. It's a bit on the heavy side, and perhaps a touch narrow if you're not used to it, but don't let that deter you – the Fold4 is easily one of the most covetable devices out there.

Folded, you can use it like you would any other smartphone, but when opened up it becomes a streaming dream with tablet-like multitasking functionality. The beautiful 7.6" Infinity Flex Display supports HDR+ and there's even a front-facing camera camouflaged under that big screen (which now supports Samsung's S Pen stylus). This is a Samsung smartphone, after all, so you already know that the Z Fold4's rear camera line-up is as premium as it gets. The 50-megapixel wide-angle camera and 30x space zoom are very impressive and we particularly liked using the main screen as the viewfinder.

More than anything, the Z Fold4 feels durable – there's a new and improved hinge mechanism and it's (finally!) waterproof. This is, by far, the best foldable device created by the tech giant.

RRP R36 999

samsung.com/za

LG

TONE FREE FP8 TRUE WIRELESS EARBUDS

In a world of countless wireless earbud brands, it's becoming increasingly difficult to choose which one to go for. LG's TONE Free FP8s are fast becoming our everyday go-to option. The concha-shaped design makes them super comfy to wear for longer periods, and you'll certainly be wearing them a lot because the battery life is that good. You get 24 hours of playtime on a single charge – 10 hours of continuous listening and another 14 hours if you pop them back in the charging case.

And let's elaborate a bit on that case... Not only does it offer fast-charging capabilities, but, using UV light, its UVnano technology eliminates 99.9 per cent of harmful germs in only a few minutes. And that's great, because after a lot of usage, earbuds are not very hygienic at all.

If you like to wear your earbuds while exercising, you'll be pleased to hear that this pair boasts an IPX4 rating, so they're both sweat- and splash resistant.

And what about the sound quality? Let's just say that LG has won numerous awards for the overall audio experience, enhanced active noise cancellation, and customisable, ambient listening features of the TONE Free FP8 earbuds. It's almost like having a high-end speaker system shrunk down to fit inside your ear.

RRP R2 999

lg.com/za/uv-earbuds





ACER CHROMEBOOK SPIN 514

Do you remember when chromebooks were a thing? If the Chromebook Spin 514 from Acer has taught us anything, it's that this more affordable, more portable category of computing is here to stay.

The clamshell Chromebook Spin 514 is thin and light and comes with a full HD 1080p 14" touchscreen that looks bigger than it is thanks to narrow bezels and a 78 per cent screen-to-body ratio. As with other computers in Acer's Spin series, the Spin 514 is convertible. You can easily switch it up according to how you want to work, rotating the screen for convenience or collaboration. Perfect for on-the-go work, the Spin 514 has all the ports you'll need as well as decent upward-firing speakers located next to a large, backlit keyboard and large Gorilla Glass trackpad.

It's also more than capable of handling everyday workloads. It performs like a champ, and that's because inside is 8 GB of RAM and AMD's Ryzen 3 dual-core processor. You also get a built-in HD webcam, Bluetooth 5, WiFi 6, and battery life of around 15 hours, which is more than sufficient. While the device's box does say that it has 'military grade' durability, we opted against drop-testing it to make sure.

RRP from R13 999

shopacer.co.za/chromebook

K-WAY MERCURIUS SMALL

South Africans have grown to love Cape Union Mart and K-Way products for many reasons, and the top-of-range Mercurius 'Small' gives you one more to add to the list.

If you're planning on taking only carry-on luggage with you on your flight, this 31-litre polypropylene hard-shell case is a safe, sturdy and good-looking option. Measuring 55 x 23 x 37 cm, and weighing 3.2 kg, it swallows up and protects your treasured belongings and still easily fits in the plane's overhead stowage compartments.

It has an integrated three-digit TSA-approved locking clamp, as well as two additional clamps – on the top and bottom – to prevent the case from popping open on its own. The four wheels, together with the telescoping handle, give it 360° manoeuvrability, so the bag won't hinder you during hurried transits through the airport. There are two packing compartments inside (the main body space, and one in the lid), as well as a zipped mesh pocket.

This is the smallest case in K-Way's Mercurius luggage range, so you can invest in the 60- and 109-litre hard-shells, with the same look, feel and functionality, to complete the set.

RRP R1 499

capeunionmart.co.za





THE HOLY GRAIL OF

BATTER

EVES

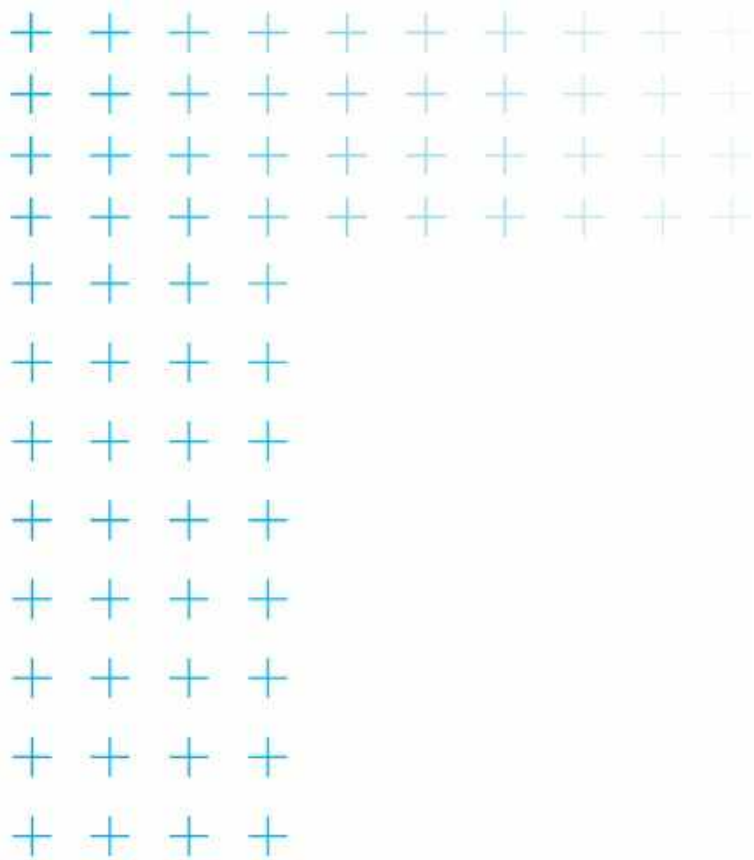
Solid-
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—
BY CAROLINE DELBERT

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THE DRY ROOM AT SOLID POWER'S

Louisville, Colorado, facility is abrasively bright, and yet the low, encompassing hum of the fans and chillers is oddly soothing. It's here in the humidity- and contaminant-free production area where Solid Power produced their first full-size solid-state lithium-metal battery cells. The cells, a shining silver contrast to their surroundings, were a moonshot.

The technology, in theory, sounded too good to be true: a 10× jump in power (or 10× drop in size) from traditional lithium-ion cells. Solid Power was aiming for more modest gains in its first prototypes, but could still see an 80 per cent improvement in the near future.

Then, on 7 August 2021, three engineers donned protective Tyvek 'bunny suits', entered the dry room, and drew voltage from the largest prototype lithium-metal battery to date.

Josh Buettner-Garrett, Solid Power's chief technology officer, monitored from his office. He felt confident, but a little apprehensive: 'We knew we could make something that looked like a battery cell, but there was still a chance we'd have a brick.'

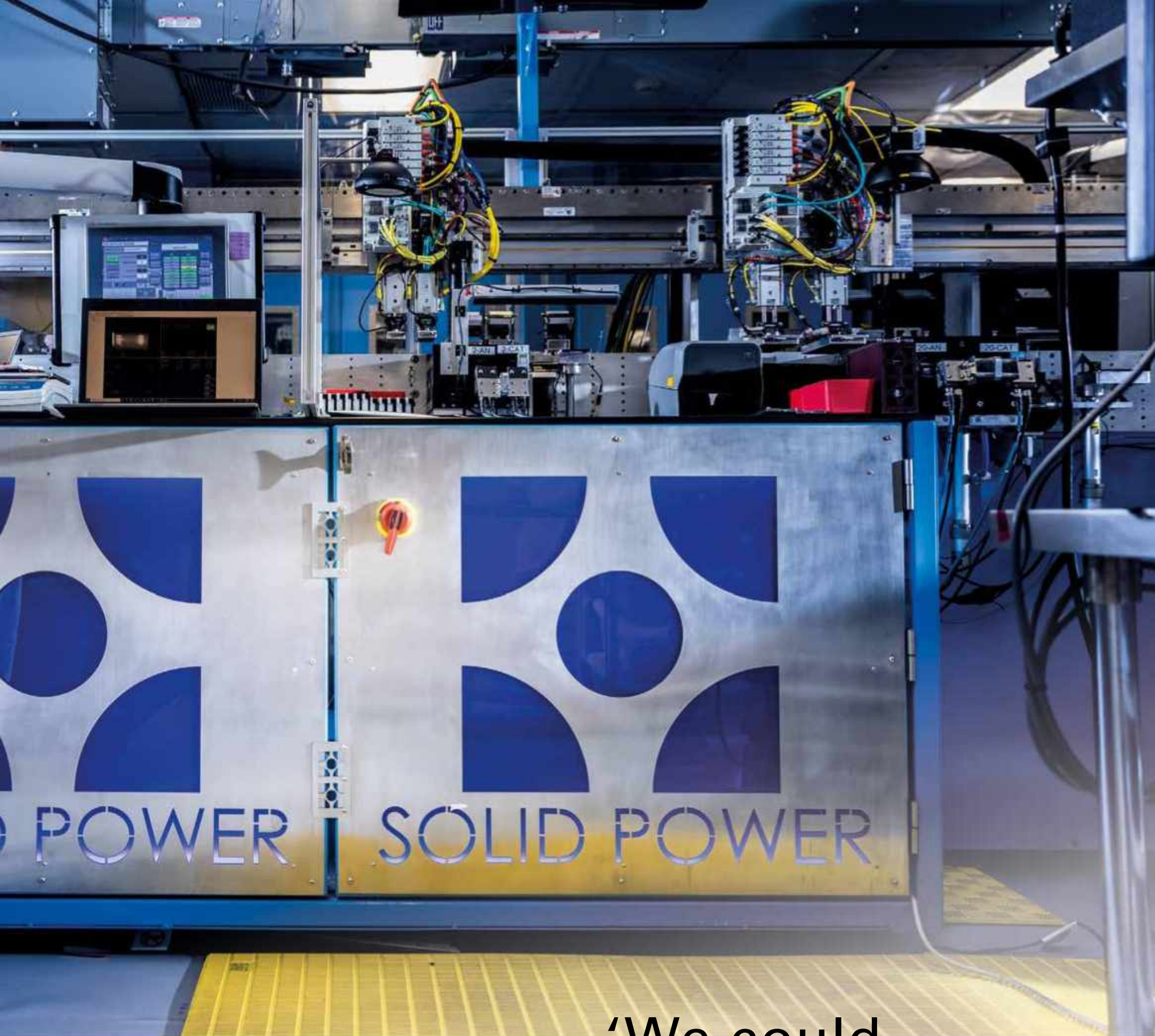


THE LITHIUM-ION battery that Solid Power hopes to make obsolete is already a modern marvel that earned its key researchers a Nobel Prize. And the preceding lithium-iodine cells of the 1970s lasted years longer than existing alkaline-based AA, AAA, or D batteries, thanks to the material's unmatched energy density. They were, for example, an



immediate boon for pacemaker patients, who could now rely on a battery for 10 years instead of two. But lithium's greatest impact on batteries came with the rechargeable lithium-ion batteries in the 1990s for portable electronics and electric cars.

Lithium has been the focus of battery research for decades because it's an excellent conductor. Like its fellow alkali metals on the far left of the periodic table, lithium has a single outer electron that it easily gives up, says Jeff Sakamoto, PhD, a mechanical engineering professor at the University of Michigan who specialises in solid-state battery research. 'That creates a really high voltage,' he explains. And compared with other alkalis, such as potassium or sodium, lithium has the smallest ion size – and third-



PHOTOGRAPHY: COURTESY SOLID POWER (THIS PAGE AND PREVIOUS SPREAD)

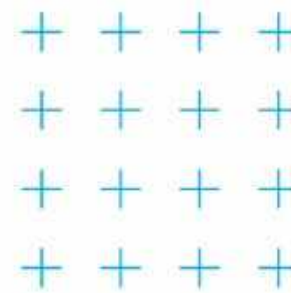
▲
Two Solid Power engineers huddle at the cell stacker machine.

lowest atomic weight on the periodic table – meaning more electrons and charge for a given battery size. The energy density of lithium-ion cells is as much as four times greater than that of the nickel-cadmium batteries they’ve largely replaced.

Current lithium-ion batteries use a liquid electrolyte where ions flow back and forth between the anode and cathode, recharging and discharging electrons. The cathode (positive electrode) is a lithium compound, and the anode (negative electrode) – which determines total storage – is made of graphite. This material is plentiful, conducts well, and is easy to work with. However, lithium metal’s capacity is 10 times that of graphite.

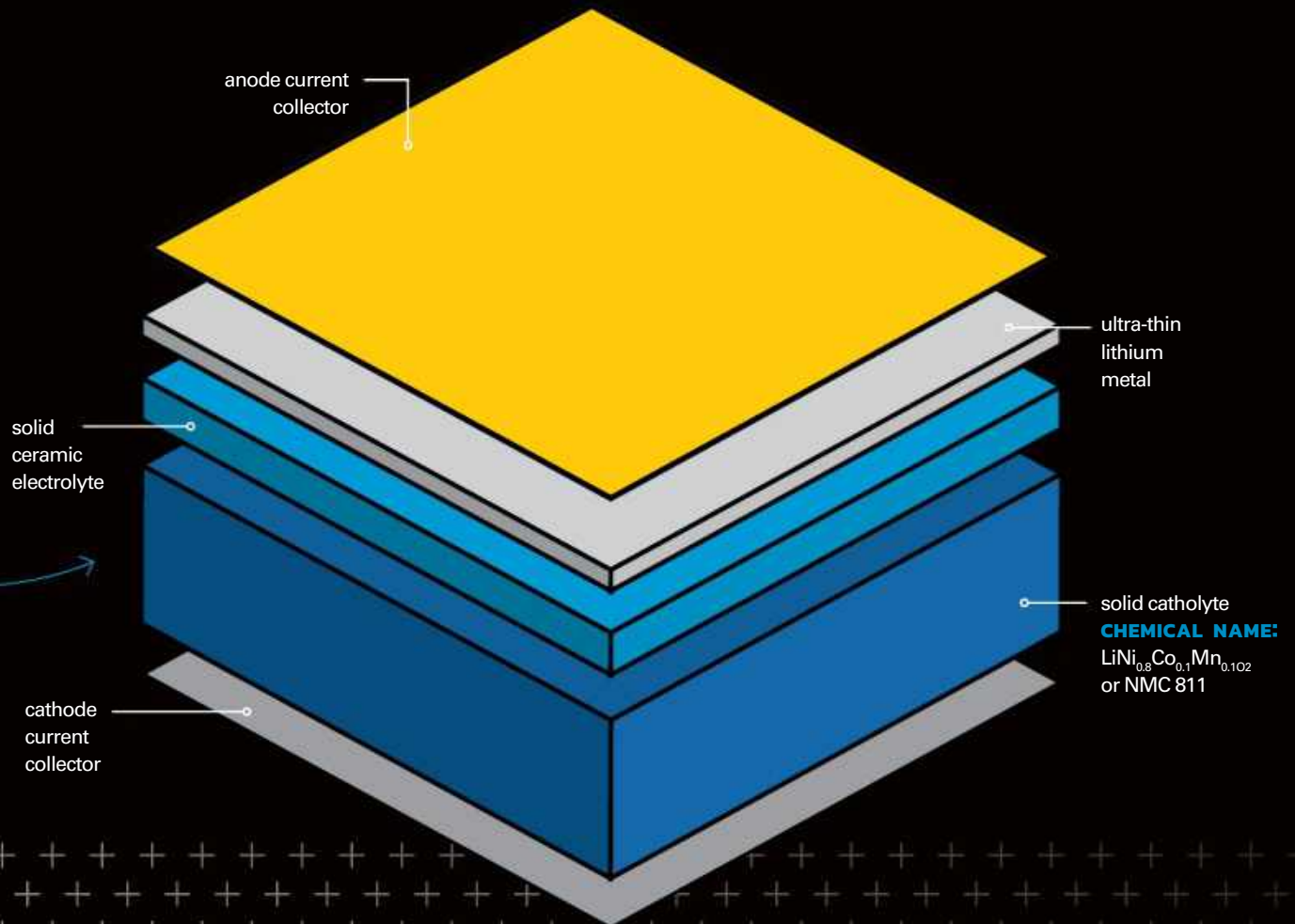
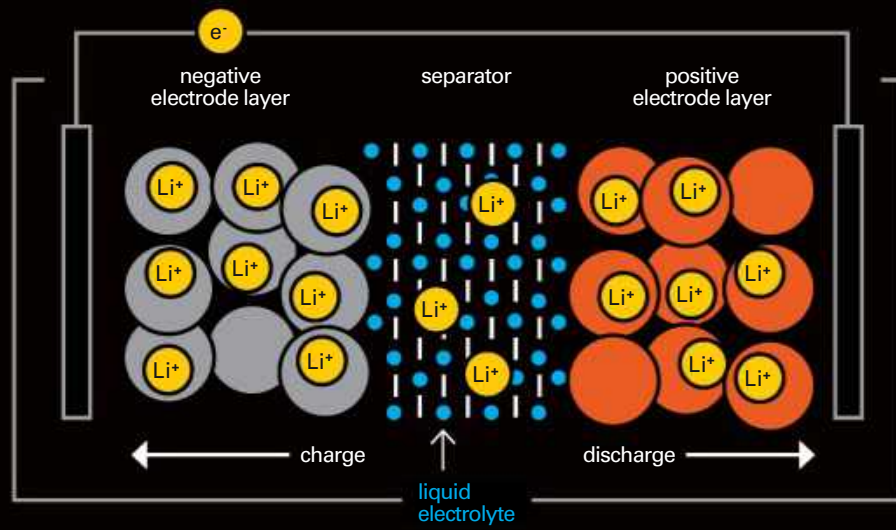
‘Lithium metal is the highest-capacity material we know of,’ says Jun Liu, PhD, a

‘We could reset our expectations for battery life. It could be as long as 25 years or even half a century.’



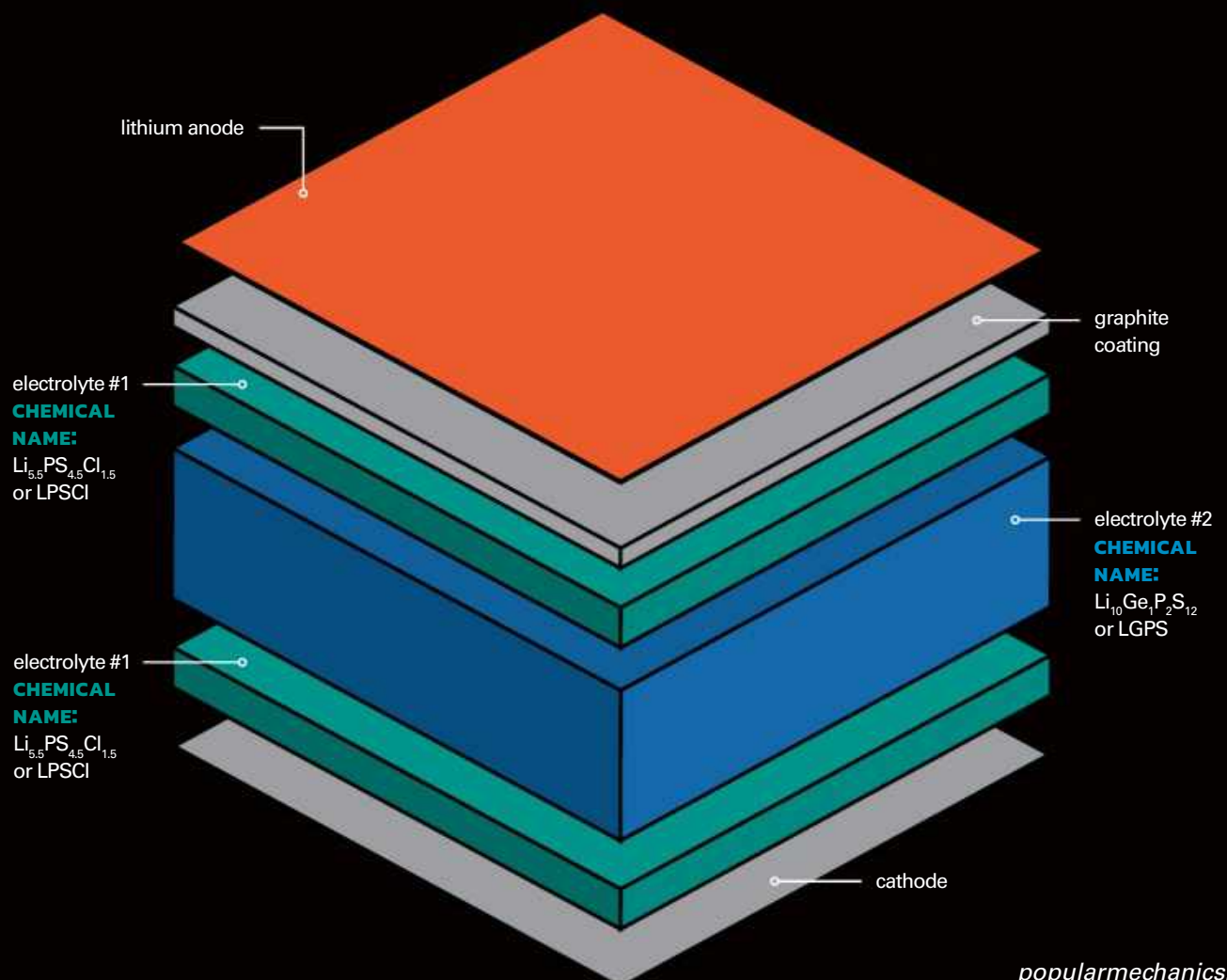
HOW LITHIUM-ION BATTERIES WORK

Lithium-ion batteries operate on the same principles regardless of their materials. To power a device, lithium ions travel from the anode (negative) through the electrolyte and to the cathode (positive), discharging electrons. To recharge, they receive an electron and travel back to the anode. A traditional lithium-ion battery uses a liquid electrolyte with a separator between the electrodes to prevent short-circuits while allowing the ions to pass. In a solid-state battery, the electrolyte is a solid material, like a ceramic, which stops the growth of dendrites and also prevents short-circuits.



HARVARD'S LAYERED ELECTROLYTE BATTERY

The Harvard cell's construction is unique for its three layers of lithium-compound electrolytes. The outer layers are highly stable, but susceptible to dendrites. The middle layer is unstable but stops dendrites. Li says the design is more effective for preventing dendrite damage – which the battery's 10 000 cycles certainly support.



director at Pacific Northwest National Laboratory in Richland, Washington. There, Liu leads a consortium searching for the electric-vehicle battery holy grail: light, fast-charging, and resistant to corrosion. He believes they've found that in recent lithium-metal advancements.



TO TAP LITHIUM'S potential, researchers have spent decades working through the metal's numerous roadblocks. Chief among them, says Liu, is its reactivity. 'The difficulty is, lithium metal is too reactive. You can think of it as corrosion – if you get it in contact with anything, it corrodes everything.'

The main form of lithium corrosion in batteries are dendrites, which are branched lithium structures that grow out from the anode. Dendrites, which are also a problem for lithium-ion batteries, can puncture battery parts and short-circuit the cell. In a traditional lithium-ion battery with a liquid electrolyte, that can lead to a fire. The liquid electrolyte is a flammable solvent just waiting to be ignited – it's the fuel behind the battery fires on aeroplanes that have made recent headlines.

Scientists eventually landed on a solution that prevented the growth of dendrites and eliminated the risk of fire: a solid electrolyte – often made of a ceramic similar to a semiconductor – that replaced the flammable liquid electrolyte and physically blocked the growth of dendrites. And if dendrites still manage to push through the ceramic electrolyte, there's no flammable reactivity.

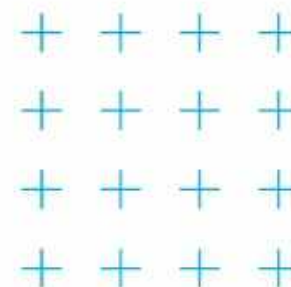
Solid electrolytes present additional challenges. They must match the relatively easy seal between a liquid electrolyte and the cathode and anode – the liquid simply forms around them. Lithium is at least malleable at room temperature and can be pressed into the craggy surfaces of a material, but there's still the connection to the cathode. And the brittle nature of ceramics – which leads to dendrite-friendly cracks – poses additional manufacturing difficulties that companies like Solid Power have had to solve.

The next fundamental hurdle is rechargeability, says Neil Dasgupta, PhD, a materials science and engineering professor at the University of Michigan who studies solid-state lithium-metal batteries with Sakamoto. Lithium-ion batteries meet an industry standard of charging more than 1 000 times before they significantly degrade, he says. 'If you're plugging your phone in five times a week for four years, you've already charged



▲ Dasgupta's research includes a manufacturing method that allows batteries to charge in 10 minutes.

Dendrites puncture battery parts and short- circuit the cell. That can lead to a fire.





▲ Sakamoto and his team created a battery with double the output of lithium ion.

▶ Electrode coating of a foil that will be dried, cut, and stacked into cells at Sakamoto's lab.

it over a thousand times.' Solid Power won't share how many cycles its current prototypes can reach, but Will McKenna, the company's communications director, says they're still pushing to surpass the 1 000-cycle bar.

Much of the emerging research on lithium-metal batteries focuses on how many charge cycles research batteries can sustain. A team at Harvard University made news in May 2021 when they published findings that their lithium-metal cell held its charge over an astonishing 10 000 cycles.

At 10 000 cycles, we could reset our expectations for battery life, says Xin Li, PhD, one of the Harvard researchers behind the battery. '[It] could be as long as 25 years or even half a century.'

However, Harvard's battery is a paper-thin version of a coin cell – like a watch or hearing aid battery. And these proportions are likely not the same ones for most commercial applications down the road, where batteries will be much larger and thicker, and have different ratios of materials.

The Harvard findings, however, still get more impressive. Their lithium-metal battery





This new technology could mean recharging a car in the same time required to fill a fuel tank.

cell was able to recharge in just three minutes. If this technology can reach electric vehicles, that would mean being able to recharge a car in the same time (or less) required to fill a fuel tank. Most EVs currently need at least three hours to recharge.



THE WORLD GOT its first look at a solid-state-battery electric vehicle at the Tokyo Olympics, where Toyota, working with Panasonic, outfitted a fleet of its LQ concept cars. The bubble-shaped LQs could be seen following the men's and women's marathons and even starred in commercials for the rescheduled Olympic Games.

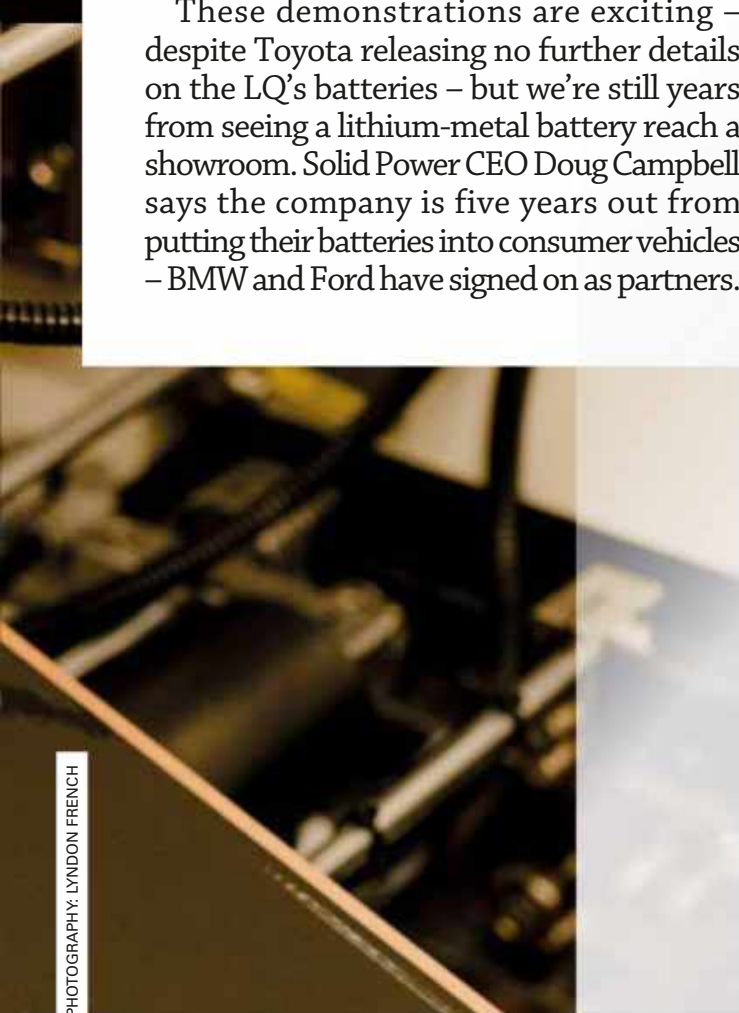
These demonstrations are exciting – despite Toyota releasing no further details on the LQ's batteries – but we're still years from seeing a lithium-metal battery reach a showroom. Solid Power CEO Doug Campbell says the company is five years out from putting their batteries into consumer vehicles – BMW and Ford have signed on as partners.

The company's current target is an OEM battery that's almost twice the energy density of today's auto cells and that charges to 90 per cent in just 10 minutes.

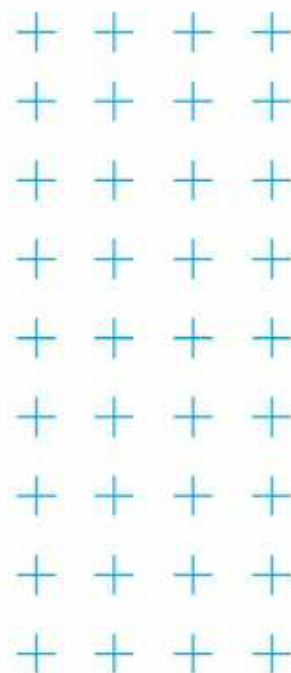
The company, he adds, is years ahead of most rivals, thanks to its research on adapting existing lithium-ion manufacturing technology.

'Most other groups, with the exception of a few behemoths based in Asia, are still entrenched in that research and development phase,' Campbell says. Toyota, for example, says their solid-state battery is likely to come in 2025 – no car included. Sakamoto runs a solid-state-battery startup, in addition to his work at the University of Michigan, and says the recent push to develop lithium-metal batteries arose after electric vehicles became viable and in-demand. 'I'm surprised how quickly a light went on and at this outpouring of financial support and interest in solid-state batteries,' he says. 'There's no commercial product yet, but there's all this investment.'

The push for solid-state batteries can give us a world in which electric vehicles recharge in minutes and pacemaker batteries last half a century. There's only the question of when we'll get there. **PM**



PHOTOGRAPHY: LYNDON FRENCH



BY WARREN DENHOLM



HOW I RESTORED A

LEGENDARY WOODEN

Britain delivered more than 6 700 de Havilland DH.98 Mosquitos during WWII, but when Denholm's team began their build, none of the planes were airworthy.



WWII FIGHTER PLANE



I HAVE BEEN WORKING ON AEROPLANES FOR AS LONG AS I CAN REMEMBER,

but resurrecting vintage combat aircraft is the most challenging and rewarding specialisation I've encountered. I started focusing on warbirds when someone asked me to help them rebuild a Hawker Sea Fury fighter, and over the ensuing decade, my small New Zealand company AvSpecs took on more projects for local and international clients, including American-built Curtiss P-40 fighters and British Supermarine Spitfires. But the restoration community in New Zealand had always mused about the legendary, nearly extinct de Havilland DH.98 Mosquito, a former RAF WWII plane made almost entirely from wood.

The Mosquito was a unique piece of the United Kingdom's wartime history. It was a versatile twin-engine workhorse used as a fighter, bomber, reconnaissance plane, trainer, attack aircraft, ship hunter, and radar-equipped night fighter. In February 1944, a squadron of 18 Mosquitos conducted a low-altitude bombing of the Amiens prison in German-occupied France, freeing dozens of prisoners and French Resistance fighters. When a mission required speed and precision, the RAF called on Mosquitos.

A Mossie was fast; a pair of Rolls-Royce Merlin engines drove 12½-foot (3.8 m) propellers that could pull its airframe through the sky at more than 400 mph (644 km/h). With those double V-12s screaming, practically nothing could catch a Mosquito going flat-out. It was an intimidating plane while it was active, and it was an intimidating restoration. Instead of the standard rivet and sheet

metal processes common in aircraft resurrection, the Mossie required thousands of hours of working with screws, glue, and a lumberyard's worth of timber.

My friend Glyn Powell brought the original Mossie restoration project to life almost single-handedly. He spent years gathering Mosquito fragments, manuals, parts, and plans from all over the globe in the hopes of one day resurrecting his own. His main challenge was tracking down the Mossie's unique laminated-plywood, tapered cigar-shaped fuselage moulds. Almost all of the cumbersome and heavy moulds disappeared or were destroyed after World War II. Glyn devoted all of his time – seven days a week for maybe 10 years – to scouring the world for the drawings he needed to build the mould.



PHOTOGRAPHY: PREVIOUS SPREAD: GETTY IMAGES



- ▲ Mosquito assembly, 1943.
- ▶ The build's original air-frame endured 40 years of decay.

PHOTOGRAPHY: GETTY IMAGES (TOP), COURTESY WARREN DENHOLM (RIGHT)

A wartime advantage of Mosquito construction was that it could happen almost anywhere. A majority of the aircraft could be knocked together in a furniture shop – everyone from piano makers to cabinet builders put the planes together for the war effort – but creating the Mossie's smooth triple-layered wood fuselage was a complex endeavour involving thousands of parts. The large and costly moulds were the key to the process, and even after years of searching, Glyn couldn't find the critical plans.

Undeterred, he resorted to reverse-engineering the moulds from the factory's fuselage drawings, calculating their exact shape by lofting





- ▲ The two fuselage halves come together.
- ◀ Copper bonding prevents interference in the electronics.

a detailed pattern between hundreds of known points on the plans. When I first saw Glyn's hand-made fuselage moulds, I was amazed by his tenaciousness and workmanship. Each 37-foot (11.2 m) cedar piece, affixed to a long workbench, looked like half of a giant cigar, scarred with slots to accommodate the aeroplane's interior bracing. The most vexing part of the project was now well in hand, and a Mosquito revival had never been closer. When an American client took delivery of an aircraft that AvSpecs had just completed, I suggested to him that, with Glyn's help, a Mosquito project might actually be within reach. What followed was a three-way partnership to accomplish something that had never before been attempted.

We began looking for an original aircraft to serve as the foundation of our Mosquito build, and we soon located a mangled and rotten airframe that had been all but lost to the elements in Canada. The fuselage woodwork was extremely

dilapidated. The engine installations and landing gear were missing and the wing was rotten and beaten up. The fuselage was too weak to support itself so we divided the carcass into separate chunks and shipped it home to New Zealand in three shipping containers.

Our job as aircraft restorers is to start with as much as we can and replace as little as possible but the Mosquito was a special case. About 40 per cent of this plane, by weight, was deteriorating wood and brittle glue. Every inch of the airframe needed to be fully reconstituted using the vintage methods and materials. The only safe way to rebuild a Mosquito that could dependably return to the skies was to embark on a huge woodworking project.

Glyn and his crew started with the fuselage, the most intricate part of the build, consisting of two vertical body halves made up of three layers of wood. These pieces began with Glyn's half-cigar-shaped moulds, each with seven slots cut into them to fit the plane's laminated spruce interior bulkheads.

The first layer of 'skin', or the inner wall of the fuselage, was made from 1/16-inch (1.58 mm) birch plywood. This is flexible wood but it needed help bending around the complex curves of the aeroplane body, so the skin was made up of hundreds of individual pieces of ply fitted together with 15-to-1 scarf joints. This means the edges of the pieces were cut at a steep angle, leaving more room for glue and making for a stronger union than a butt joint.

It was the glue that had been used, not the wood, that necessitated a nearly total rebuild of the Mosquito airframe. During World War II, combat planes were built to last for months, not years. Extended exposure to the elements was absolute murder on wooden Mosquitoes. Doors and hatches leaked in England's misty, rain-soaked climate, and flying units in the Far East complained that the oppressive heat and humidity mowed through more Mosquitoes than the enemy.

But even if a Mosquito has been babied for decades, its original urea-formaldehyde glue will degrade. Wooden parts can last for a century or more, but the vintage adhesive that keeps all of that lumber flying becomes brittle and unreliable over that period, making any restoration project that retains that adhesive decidedly unsafe to fly. Glyn employed a tough marine-grade epoxy resin for our restoration.

We screwed and glued the birch plywood 'skin' around the moulds and secured the layer with metal bands so that the glue could cure. At the same time, we glued a collection of test pieces that would ride inside the Mosquito in a small bag and measure the viability of the glue in the future. The original specification for the adhesive calls for a tensile test on a one-inch² glue sample between two strips of American black walnut. The glue must hold 500 kg without fail, so future operators will be able to check if our glue joints – secured in 2018 – still meet the original specification.

After the birch skin inner wall of the fuselage was ready, we added the middle layer – made from 1/2-inch (12.7 mm) balsa wood – around an intricate web of spruce reinforcing bands and frames circling the fuselage, spanning from the nose to the tail, and reinforcing the areas around the cockpit, hatches, and other openings.

A hobby shop in Auckland supplied us with 410 m of 100 mm-wide and 12.7 mm-thick balsa planks. When finished, there were no voids



WHEN MOSQUITOS CRASHED THE NAZIS' PARTY

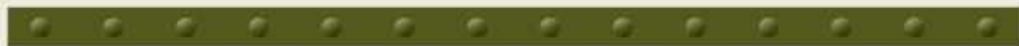
→ As their grip on Europe loosened, Nazi Germany appointed 30 January 1943 as a national day of celebration to bolster morale. The date marked the 10th anniversary of Adolph Hitler's rise to the Chancellorship, and German high command planned a day of rousing speeches on international radio. But in England, the RAF saw the occasion as an opportunity to stick a thumb in the eye of Germany's top leaders and break the facade of Nazi invincibility.

Most of the RAF's bomber fleet was unsuited for a mission so far from home. The 1 100 mile (1 770 km) round-trip flight to Berlin, in broad daylight, would span five hours of exposure to flak and enemy fighters. Only one aircraft in the RAF's inventory had a chance. Mosquito fighter-bombers, faster than the other planes in the fleet and able to sneak in at 250 feet, instead of flying at 25 000 feet, could elude German ground defences to drop bombs and raise havoc amid the festivities. This aerial smash and grab operation would be sudden, terrifying, and intimate.

A trio of Mossies from the No. 105 Squadron led the way. They bullied their way into Berlin's airspace just as Hermann Göring – the German military chief, or Reichsmarschall – began his radio speech to the nation. Bomb blasts and the distinctive rumble of the Mossies' Rolls-Royce engines overhead forced Göring off the air for more than an hour.

Later that day, as Nazi propaganda leader Joseph Goebbels stepped to the podium to address Nazi party members at Berlin's Sportpalast, three more Mosquito bombers from the No. 139 Squadron arrived. As the Reichsminister struggled to speak, the British planes whirled through the skies outside the arena, and the booming response from German anti-aircraft fire brought pandemonium to the ceremonies. One Mosquito went down – the sole British loss of the mission – but the United Press lauded what they called a 'daring raid' on Berlin.

WE'RE NOT SAVING THE WORLD, BUT WE'RE HONOURING THE PEOPLE WHO DID.



in this balsa and spruce layer, which was glued, screwed, and banded once again over the first layer.

Finally, another course of $\frac{1}{8}$ -inch (1.58 mm) birch plywood made up the outer skin of the body of the aircraft. The end result was a strong, light three-layer 'shell' that could absorb enemy fire without breaking apart. The Mosquito's fuselage is close to a true monocoque airframe, meaning the aircraft structure depends on the strength of its skin, not a load-bearing internal framework. The warplane's sandwiched wooden body carries all of the structural load, with no inner supports that might be vulnerable to shrapnel or bullet holes.

▼ The Merlin V-12 engines await installation.
▶ The spruce wing spars span 50 feet (15.2 m) tip to tip.

When finished, the pair of triple-layer fuselage halves came together via wooden plate joints and seven main interior bulkheads. As they became one, they looked similar to the body of a typical plastic model aeroplane kit at the first stages of assembly.

The Mosquito's expansive one-piece wing was next. The wing and tail surfaces, generally, were more straightforward than the tri-layer cylindrical

fuselage. This part of the project recalls the common woodworkers who might have built this plane in the 1940s – the one-piece was meant to be replicable in any wartime wood shop. All that builders would need to generate Mosquito components was a set of plans, the proper tools, and lots of floor space.

The Mossie's burly wing spars are the continuous support beams that extend wing tip to wing tip across the plane and anchor nearly everything else on the aircraft, including the dual Merlin engines and propellers, fuel tanks, main landing gear, guns, and the fuselage itself. They're based in the middle of the fuselage and extend outwards on both sides, carrying more than seven tons of weight once the plane is complete.

A series of laminated spruce beams make up the top and bottom of the spar box, while $\frac{1}{4}$ -inch-thick (6.35 mm) birch plywood constitutes the front and back of the load-carrying structure. Each of the Mosquito's spars had to be assembled while clamped into a jig to achieve the proper dihedral (upward wing bend) shape or forward sweep, in the case of the aft spar, or both.

Where components such as the engines and landing gear would be tied into the spars, we glued plates and reinforced sections of walnut and ash into the spar structure. Each spar is thickest where it crosses through the fuselage and becomes more tapered and lighter near the wing tips.

Once finished, we mounted the spars in a jig and built the wing structure around them. In order to access both the top and bottom of the wing during construction, we orientated the piece vertically in the jig, with the leading edge pointing towards the floor.



Wooden structural members, side to side and front to back, mix with layers of birch plywood skin to give the wing its distinctive shape. Teardrop-shaped ribs, made from a conglomeration of birch, spruce, ash, and walnut, come first, filling out the wing-shaped cross-sections from front to back. A layer of birch plywood follows, then a series of long stringers made from Douglas fir that extend from fuselage to wing tip, tying into each rib along the way. Over that comes another layer of plywood.

▶ Every piece of wood on the final build is contemporary, but fabricated to WWII standards.

The bottom of the wing has large hatches for access to the fuel tanks. These door-sized panels are made from birch and balsa, similar to the Mosquito's fuselage but on a smaller scale and without the dramatic curves.

After we completed the woodwork, we covered all of the pieces with a madapollam aircraft fabric and doped the fabric with a plasticised lacquer to make it more airtight. This process waterproofs the wood, too. After a final round of sanding and painting, the skin of the Mosquito is clean and smooth, mostly devoid of speed-killing seams, wrinkles, or exposed rivet and fastener heads.

The other aspects of the project would be familiar to an experienced World War II-era aircraft restorer: big wartime Merlin V-12 engines encased in aluminium cowlings, hydraulics, a fuel system, flight controls, landing gear, pneumatics – compiling it all took a combination of repurposed parts from other planes, odds and ends from personal stashes, and components we fashioned ourselves from old plans. To get everything in the right place took a lot of studying of collected manuals and drawings.

We found the most peculiar thing about the Mosquito was the electrical system, or rather, how the electrical components were linked together. In order to eliminate static interference, every metal piece of the aircraft must be joined to every other metal piece with an extensive series of copper strips affixed to the wooden interior. Installation was not a particularly sophisticated task, but it was complicated and time-consuming. The de Havilland factory was very particular about bonding. They used 0.5 mm copper sheets cut into long ribbons. Each piece of copper has a lug soldered to it for a mounting screw or bolt to attach it to every metal fitting on the aircraft. This ensured a pathway for the static electricity, thereby stopping any noise that might cause radio interference. We located a coil of copper sheet and found a company to cut it into the correct width, but even though I estimate we used literally kilometres of copper in our first build, we still have enough copper left over to build a whole squadron of Mosquitos! At least when it's done, it looks impressive. The interior cockpit looks a little like a circuit board.

The second strange characteristic of the electrical system is that the grounding wires often have longer runs because they can't be tied into



a nearby metal structural member. This leads to a bigger overall electrical system. And just like vintage British cars and motorcycles, the Mosquito's wiring has a few inexplicable and vexing quirks, including a periodic switcheroo between the ground and hot wire from the power source. But getting zapped a few times is a small price to pay when you and your crew have brought a nearly extinct warplane back into existence.

About 60 per cent of the aircraft, by weight, was made up of vintage Mosquito parts, including a number of components we blasted, inspected, and restored from the Canada wreck. As the plane neared completion, tests ensured that the mix of old and new worked together. We powered up the electronics to check for smoke, pressurise the hydraulics, and look for leaks. Then we tested the flaps and brakes before troubleshooting the fuel system. Once all that was sorted, the first engine runs took place. We did a couple of taxi tests, ending with a high-speed taxi almost to the point of take-off.

When it came time to fly the aeroplane, we gathered up as many former Mosquito aircrew veterans as we could to see it take to the air for the first time. The Mosquito's cockpit is cramped, with two fliers sitting side-by-side. I sat in the observer's seat next to the pilot, and we revved the engines and raced into the skies over Auckland. It was a thrilling experience: I hardly took a breath for the entire 57 minutes. With the exception of a few minor bugs, everything worked well, and we landed safely in front of the crowd.

You have to appreciate how much it meant to the veterans to revisit the aircraft in which they spent those terrifying years in combat. That's where I realise we're not just building an aeroplane and making a living – we're actually having an effect on people's lives. We're not saving the world by doing it, but we're honouring the people who did. – As told to Cory Graff **PM**



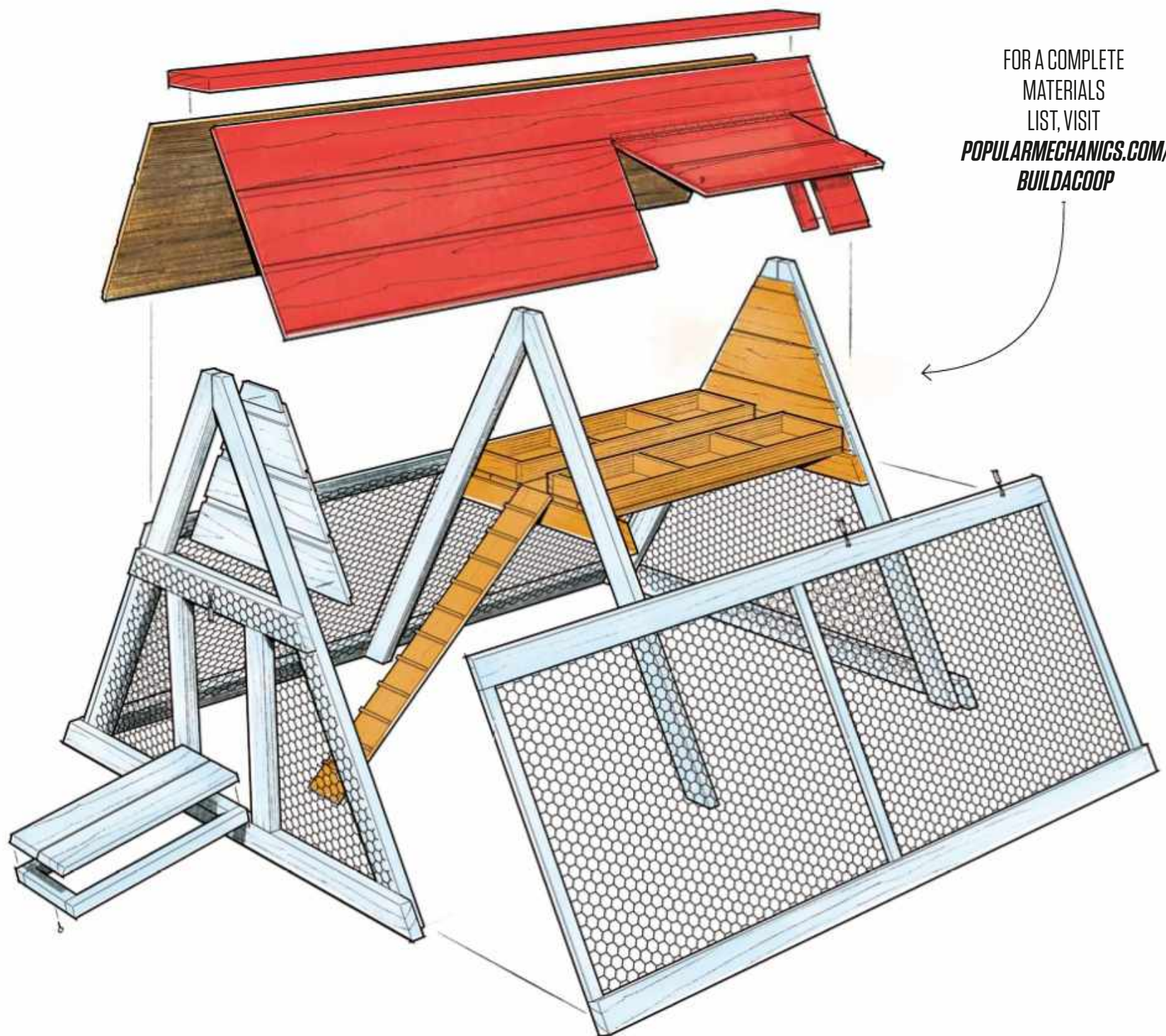
HOW TO BUILD A BACKYARD CHICKEN COOP





**OUR DESIGN
KEEPS YOUR
FLOCK SAFE
— AND —
COMFORTABLE.
HERE'S HOW TO
PUT IT
TOGETHER IN
A WEEKEND**

BY JOSEPH TRUINI



FOR A COMPLETE
MATERIALS
LIST, VISIT
[POPULARMECHANICS.COM/
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MORE THAN 13 MILLION AMERICAN homeowners raise backyard chickens, according to the US Department of Agriculture, and that number is expected to grow over the next several years. You can rear chickens in regions ranging from rural country farms, to suburban neighbourhoods, to congested urban cities. If there's a patch of land, you can raise chickens, and the birds can bring more than just fresh eggs to your home. You might be surprised to discover that chickens can make great pets. They're friendly, curious, entertaining, and have individual personalities.

If you're interested in raising chickens in South Africa, it's important to first check with your town's municipality and its by-laws to confirm that chickens are allowed at your home. A recent study revealed that of the 150 most-populated US cities, 93 per cent allow backyard chickens. Chances are that in South Africa, you will too. That leads us to the next step: getting a chicken coop.

You could certainly buy a chicken coop, but where's the fun in that? Summon your inner DIY spirit and build our simple A-frame coop. Building from scratch could save you thousands

of rands, and you'll be able to construct it to your exact specifications. As shown, our coop takes up less than 4.6 m² of space and can easily accommodate six to eight chickens. (Each chicken typically needs a minimum of 0.4 m² to 0.5 m² of coop space, depending on its size and breed.)

The coop has three A-shaped frames, which are built out of 2x4s (actual 38 x 89 mm). The upper portion of the frames is covered with a plywood roof, and the lower section with chicken wire. There's a small fold-down door on one end to let the chickens out when you'd like, and another door cut into the plywood roof gives you access to the roosting loft when you need to gather eggs. The total cost for all the wood, hardware, fasteners, and stain should run to about R5 000. Choosing your chickens is its own adventure (*see sidebar, p65*), but you should be able to buy baby chicks from farm-supply stores.



STEP 1 CUT THE RAFTERS

Start by using a power mitre saw to cut the six 2×4 (38 × 89 mm) rafters to length. Cut the bottom end of each rafter to 30°. Measure up from the bottom end 1 727 mm and trim the top end to 60°. (If your mitre saw doesn't cut to 60°, see the sidebar on p63.) Next, trim off the pointed tip at 30° to create a 50 mm flat top. Also, cut three 38 × 89 mm collar ties to 915 mm long, mitring each end to 30°.

STEP 2 BUILD THE A-FRAMES

Fasten two rafters together at the top with one 100 mm-long decking screw, and then attach the horizontal collar tie to the rafters with 60 mm decking screws [1]. Be sure to drill counterbored pilot holes first. Cut two more 38 × 89 mm planks to 712 mm, mitring each end to 30°. Fasten these pieces, called collar tie blocking, to the collar ties on two of the A-frames. The two frames with the double-thick collar ties are used at the front and back of the coop. The remaining A-frame, which has a single collar tie, is situated in the centre of the coop. Once you've assembled the three A-frames, apply a coat of semi-transparent stain (we used light blue) to all surfaces. Staining the parts as you go is much easier and neater than trying to apply it once the coop is fully assembled.



STEP 3 MAKE THE ROOF

A 1.2 × 2.4 m sheet of 16 mm-thick textured plywood siding will keep your chickens safe and dry. Use a circular saw to rip the sheet in half lengthwise, creating two 0.6 × 2.4 m panels. Apply a solid-colour stain (ours was barn-door red) to both sides of each plywood panel. Fasten one of the roof panels to one side of the A-frames using 40 mm decking screws [2].



STEP 4 ADD WIRE AND SIDING

Staple chicken wire to the lower portion of the rafters [3]. Then screw a 2.38 m-long '2×4' – called a side plate – horizontally over the





chicken wire and across the bottom of the rafters [4]. Enclose the triangular openings above the collar ties with three pieces of pine 19 × 184 mm channel siding cut to fit. Mitre-cut the ends of the siding to 30°, and slide them into place [5]. Secure the siding pieces with 50 mm finishing nails driven through the back side and into the rafters. I used channel siding because I like its rough-sawn look, but you could substitute pine 19 × 184 mm planks or even plywood. Once you've installed the siding, screw on the remaining plywood roof panel.

STEP 5 CUT THE LOFT DOOR

Use a circular saw to cut out the roosting-loft door from the plywood roof panel. Cut the door 425 mm wide × 812 mm long [6]. Next, take some 12 mm-thick plywood and cut three 76 mm-wide strips; make two 397 mm long, and one 812 mm long. Glue and screw these plywood door cleats around the inside of the roosting loft doorway; allow the cleats to extend 25 mm into the opening. Now cover each cleat with a strip of adhesive-backed vinyl weatherstripping [7]. The 10 mm-thick × 19 mm-wide weatherstripping will help seal out rain.

STEP 6 BUILD THE LOFT FLOOR

Create the floor of the roosting loft by cutting five 19 × 140 mm pine planks to 1.11 m long. Lay the planks across the collar ties and fasten them with 50 mm finishing nails [8]. Next, make two 280 mm-wide × 1.1 m-long nesting boxes out of 19 × 64 mm pine. Set the boxes along the sides of the roosting loft floor and secure each with two 40 mm decking screws.

STEP 7 BUILD THE RAMP

Make a 1.12 m-long ramp from a 19 × 140 mm plank, so the chickens can access the roosting loft from the ground. Mitre-cut the ends of the ramp to 30°, then attach 14 mm² cleats, spaced about 100 mm apart, so the chickens can climb the ramp without slipping. Fasten the ramp to the centre collar tie with a continuous hinge. Then cut a 200 mm length of wire from a wire clothes hanger and screw it to the centre of the collar tie directly above the door. Twist a small screw eye into the edge of the lower end of the ramp. When it's necessary to move the coop for cleaning, raise the ramp and slip the wire into the screw eye.

STEP 8 ADD THE ROOSTING-LOFT DOOR

Take the door you cut out of the plywood roof earlier and secure it over the roosting loft with an 800 mm-long continuous hinge [9]. Then, lay a 2.4 m-long 38 × 89 mm plank across the tops of the three A-frames and fasten it with 75 mm decking screws [10].

STEP 9 ADD THE TRIM AND WIRE

Next, cut two 19 × 89 mm horizontal trim pieces to 2.38 m long. Use a table saw to bevel-rip the top edge of each to 30°. Take one trim piece, butt its bevelled edge tightly against the lower edge of the roof panel, and then fasten it to the rafters with 40 mm decking screws [11]. Cut 19 × 38 mm vertical trim pieces to fit snugly between the 19 × 89 mm horizontal trim and 39 × 89 mm side plate; attach the 19 × 38 mm trim pieces



IF YOUR MITRE SAW DOESN'T CUT TO 60°...

Building the chicken coop's three A-frame assemblies requires cutting the upper ends of each rafter to 60°. But what if your mitre saw only cuts to 45°? Here's a simple way to retrofit your saw to cut the 60° mitres.

Start by making a cutting guide from a piece of 19 mm plywood or offcut. Cut the guide about 100 mm wide and at least 305 mm long. Rotate the mitre-saw blade to 30° and trim off one end of the guide. Next, clamp the guide to the

mitre-saw table, as shown [1]. Now, to make a 60° cut, rotate the mitre-saw blade back to 0° and lock it in place. Hold the rafter against the 30° mitred end of the guide and make the cut, as shown [2]. The result will be a precise 60° cut.



with 50 mm finishing nails [12]. Staple chicken wire to the opposite side and both ends of the chicken coop. Install the remaining 2.38 m-long side plate, then cut two 39 × 89 mm end plates to 1.8 m long; mitre the ends to 30°. Fasten the end plates to the bottom of the rafters using 75 mm decking screws [13].

STEP 10 CUT THE ENTRANCE

Frame the entry opening for the fold-down door by screwing in place two vertical 38 × 89 mm planks [14]. Space the 610 mm-long planks precisely 310 mm apart, making sure each is perfectly plumb. Then cut out the chicken wire from within the doorway opening.

STEP 11 ATTACH THE DOOR AND FINISH

Next, build the 305 mm-wide × 600 mm-tall door frame out of 38 × 38 mm. Then cover the back of the frame with two 600 mm-long 19 × 140 mm planks, which create a solid walking surface for the chickens when the door is folded down. Attach the door to the 38 × 89 mm end plate with a continuous hinge [15]. Hold the door closed with a single gate safety hook. Install two gate safety hooks to secure the plywood door over the roosting loft. Finish up construction by installing the remaining horizontal and vertical trim pieces on the opposite side of the coop. Now, set the chicken coop on a level spot in your yard, fill the nesting boxes with soft hay, and welcome home your new flock. **PM**

PHOTOGRAPHY: HENRY HUNG (BUILT STAGES), SHUTTERSTOCK, GETTY IMAGES (WHITE LEGHORN)

FOUR CHICKENS TO START RAISING NOW



IF YOU WANT A GREAT PET: SULTANS

These were originally bred in Turkey as ornaments for the Sultan's gardens. Today, they are on the Livestock Conservancy's Critical List, so look for them at online/mail order hatcheries instead of your local feed store. Sultans typically weigh just 1.8–2.7 kg and lay about 50 bright white eggs per year – ideal for those looking for a lap hen, rather than an egg producer.

IF YOU WANT LOTS OF EGGS: WHITE LEGHORN

This is the archetypal bird you might imagine when thinking of a chicken. The hens lay about 280 eggs a year – they're hardy in both winter and summer – and they're easy to find at most places that sell chickens. They are a bit flighty, however, so they won't make the best pets, but if you're looking for consistent eggs from the backyard, these hens will deliver them.

IF YOU WANT FLAIR IN YOUR FLOCK: AMERAUCANA

This species lays blue-green eggs, but they're not just nice to look at – the eggs are large, in part because these hens don't stress easily. Ameraucanas rarely go 'broody' and sit on their eggs for long. You can consistently expect up to 4 eggs per week. What's more, these birds are hardy in colder climates and have sweet temperaments. They enjoy being around humans.

IF YOU DON'T HAVE A LOT OF SPACE: BANTAMS

Bantams can be one-fifth the size of a typical chicken, ideal for those with less coop space. Bantams can be traced back to the 1500s, when they were bred to supply eggs and meat on cramped ships. These hens make great pets for children because they're easy to hold. While the eggs are pint-sized, too, Bantams produce about 200 eggs per year. – Erica Somes

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SMOOTH OPERATOR

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REVIEWED

WORX SANDECK SANDER

1» The Sandeck 5-in-1 comes with three main plates, which are easily interchangeable. 2» The orbital plate, with its sanding disc in place. 3» As the name suggests, the finishing plate is for completing the job. 4» The shape of the detail plate gives you access to harder-to-reach places. 5» The finger accessory is used in those tiny, awkward spots. 6» If your project requires it, the contour accessory is used to round off edges, neatly and symmetrically.



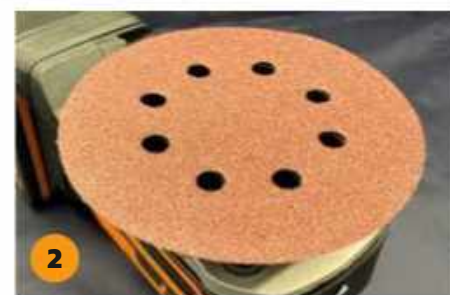
SANDING IS SUCH A CRUCIAL PART OF so many DIY tasks, particularly when it comes to woodworking. And different types of sanding machines are generally required for different materials, or aspects of projects. Sometimes you need a sander that removes a lot of material, while at other times a more delicate device is required, used at the end as a finisher for a perfectly smooth appearance. Typically, DIYers end up owning several sanding machines to handle each of these different jobs.

With the 20 V Sandeck Multi-Sander, WORX has a product that caters to most of your sanding requirements around the home and workshop. It's a five-in-one tool: a random orbital sander, a finishing sander, a detail sander, and two additional attachments – a contour sander and a finger-sander – complete the quintet. In short, you'll use the random orbital function for the initial rough sanding. Next, the finishing plate (with suitable grit sandpaper) smooths the surface to your desired state of completion. The detail plate offers access to harder-to-reach spots, and the finger attachment works in very tight or awkward spaces, such as the louvres on shutters. Lastly, if the project requires, the contour fitting neatly rounds off edges.

The Sandeck handles dust rather cleverly, too, via its DustStop micro filter dust bag, which actively reduces the airborne particulates in your workspace. Using a connector that's included in the box, a workshop vacuum extraction system can be attached to this tool, in place of the dust bag, to more effectively remove dust while you're working.

The three main plates are attached or detached quickly and simply using WORX's tool-less Hyperlock sanding pad interface, which creates one ton of clamping force to keep the selected plate in place. Just unclamp the lever on top of the device, wind it in an anti-clockwise direction, and then remove and swap out the plate underneath. To secure the new plate, wind the lever in a clockwise direction, and then clamp the lever back down into position. A variable-speed rotating dial allows you to adjust the intensity of the sanding motion.

No matter which plate you're using, changing sandpaper is quick and easy using paper with hook-and-loop ('Velcro') backing. Align the holes on the paper with those on the plate, for optimal dust removal, and you're



↓ TOOL REVIEW

SPECIFICATIONS

- » **Battery:** 20 V Li-ion, WORX PowerShare Compatible (not included)
- » **Maximum speed:** 10 000 opm
- » **Orbit action:** Up to 2.5 mm (rotary); up to 1.8 mm (detail)
- » **Speed settings:** 6
- » **Weight:** 1.27 kg (excluding battery)
- » **Power rating:** 40 W



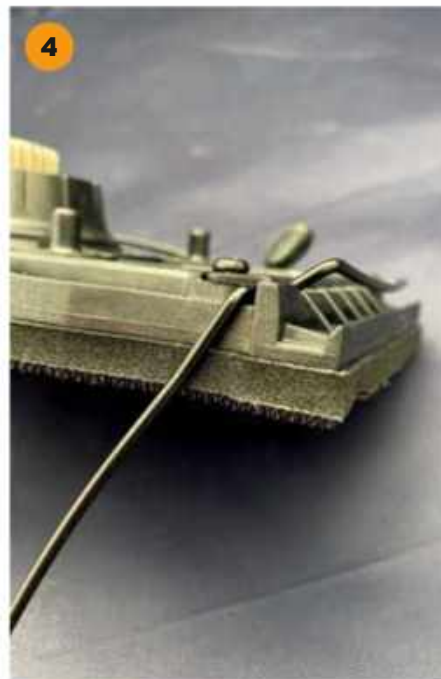
1 and 2» Swap sanding plates using the WORX Hyperlock system – flip the lever up, then wind in an anti-clockwise direction to release the plate. Reverse the process to attach the new one. **3»** Sandpaper is attached using hook-and-loop ('Velcro') backing. Line up the holes, for optimal dust removal. **4»** Standard (non-hook-and-loop) sandpaper can be clipped on to the finishing plate. **5»** A carry bag is included with the device.

good to go. A starter pack of sandpaper for the various plates is included in the box, along with a hole punch for modifying paper you purchase in the future.

So how affective is this tool? We put it through a number of tests, and it produced admirable results in the types of applications for which it's intended. Keep in mind though that this tool wasn't necessarily designed for commercial or professional users, who need purpose-made tools for demanding tasks on a daily basis. For example, it isn't a belt sander, a heavy-duty tool that's intended to remove a lot of stock very quickly. We feel that the Sandeck is perfectly suited to the home DIYer or hobbyist, who has particular sanding projects that they need to do from time to time. You might find it a little tricky to find unbranded replacement hook-and-loop paper for the contour and finger accessories.

Being cordless, it's versatile and easily manoeuvrable. Batteries aren't included in the box, but the Sandeck is compatible with the WORX PowerShare platform, where the WORX range of 20 V batteries is interchangeable with any other 20 V WORX device, including power- and garden tools. Sharing batteries makes a lot of sense, and saves you money. Just keep in mind, though, that the battery and charger will need to be bought separately.

Will this sander replace all your other sanders? Well, it's certainly a jack of many trades, and will save you money by fulfilling the roles in your workshop typically filled by several machines. We definitely recommend it if you're starting out, or if you're on a budget and looking to bolster your selection of power tools. **PM**



**WORX SANDECK
FIVE-IN-ONE
MULTI-SANDER**

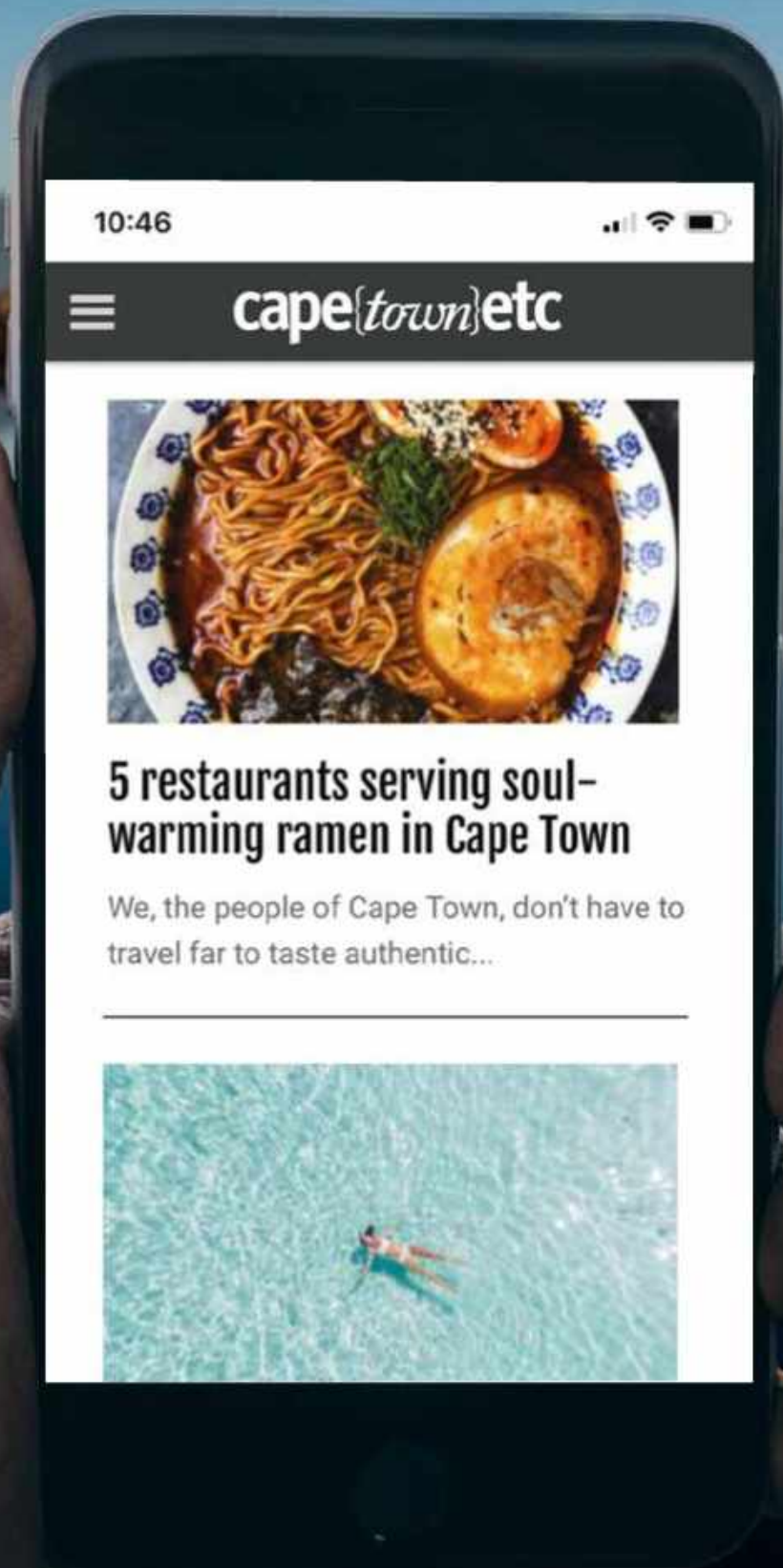
- » **RRP:** R2 665
 - » **Product number (SKU):** WRX WX820.9
 - » **Includes:** Sanding machine; dust bag; random orbital plate; finishing plate; detail plate; finger plate; contour plate; paper punch; sandpaper starter kit; vacuum connector; carry bag.
- worxtools.co.za

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DIY PROJECT

PART 2 OF 2

BUILD A CLASSIC LAP DESK

This is part two of our classic lap desk build, a challenging intermediate-level project that incorporates all of the traditional joints – lap joints, mortise and tenons, and dovetails – we have covered this year. If you missed it, get your hands on the September/October issue to learn all the steps required to complete the build.

/ BY TOBIAS LOCHNER; TECHNICAL: MATTHEUS ODENDAAL /

IN THE WOODWORKING feature in our previous issue, we started this project by covering the steps needed to build the dovetailed carcass and base panel.

In this, the second and final phase of the build, we create the lid of the lap desk with its breadboard ends, as well as the final assembly, installation of hardware, and addition of the finish.





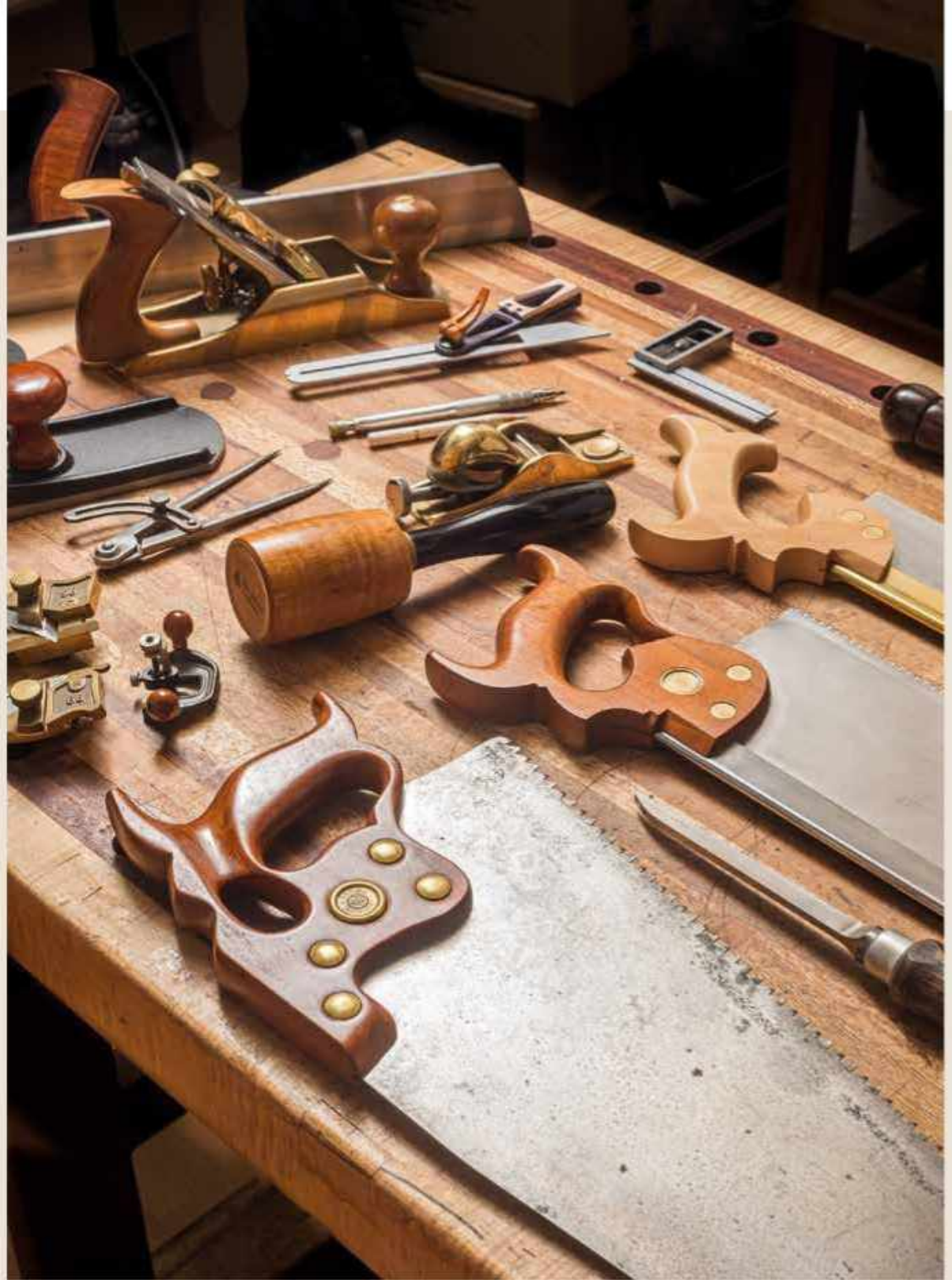
WOOD FOR THE PROJECT

Brendan and Seamus Harcourt-Wood from Rare Woods South Africa generously sponsored the beautifully grained boire wood for this project.

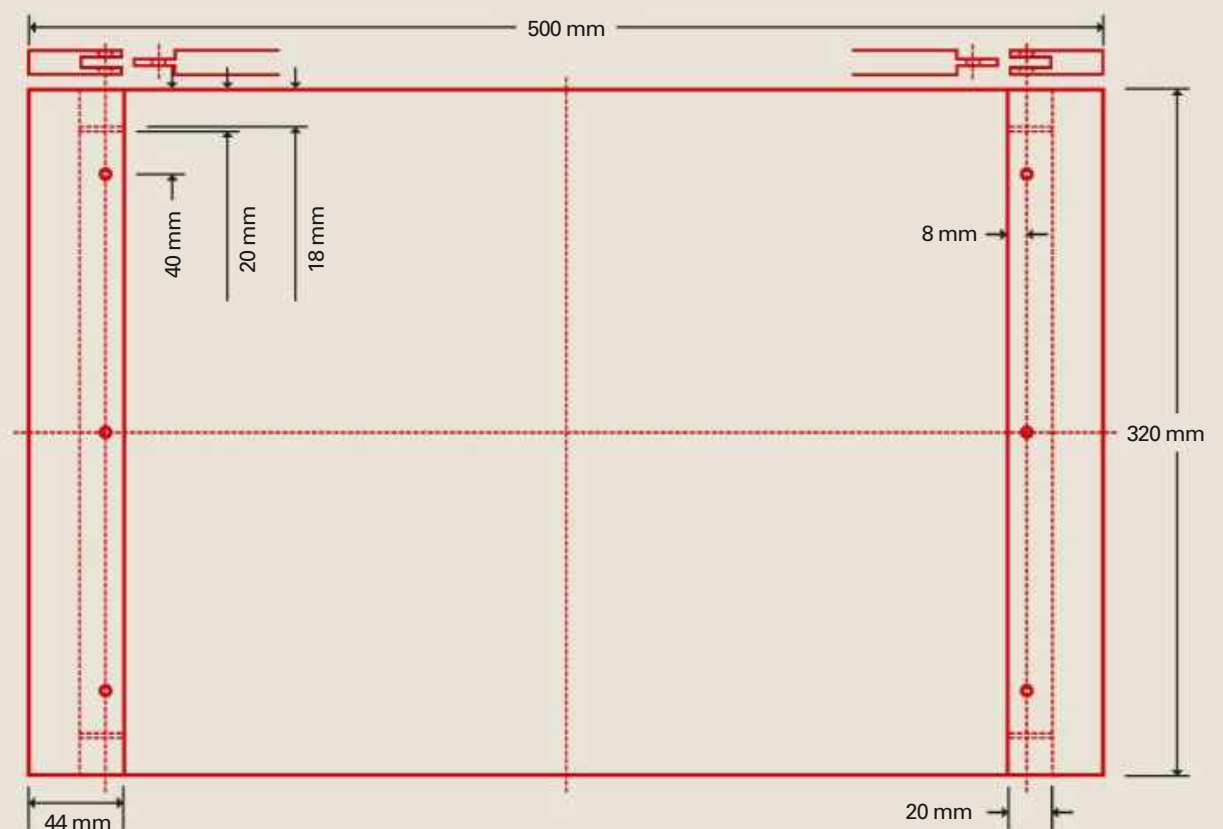
BOIRE (*DETARIUM MACROCARPUM*, *DETARIUM SENEGALENSE*)

Boire is regarded as a tough and durable wood. It remains smooth under friction, making it ideally suited to its primary use as flooring. It's also widely used in furniture making and boatbuilding.

The sapwood is pale brown in colour. The heartwood is typically medium-brown to bronze with dark streaks and sometimes other hues, such as oranges and yellows. The species sometimes has interlocked grains, and a very good uniform texture. Boire cuts, planes and joints well, glues strongly and finishes beautifully. With great visual appeal, boire represents good value for money.



LID ASSEMBLY



CUTTING LIST

Component	Quantity	Length	Width	Thickness
Rear panel (laminated from narrow stock for stability)	1	478 mm	100 mm	10 mm
Front panel	1	478 mm	70 mm	10 mm
Side panels	2	312 mm	100 mm	10 mm
Base panel	1	488 mm	320 mm	10 mm
Insert panel	1	298 mm	100 mm	6 mm
Lid panel: 2x 'breadboard end' components 1x laminated centre panel	1	500 mm 320 mm 450 mm	320 mm 44 mm 320 mm	10 mm 10 mm 10 mm

WHAT YOU'LL NEED

CONSUMABLES

- » For joinery layout: 3M Blue Painter's Tape
- » Glue: Titebond I Adhesive
- » Finish prep: Smirdex ceramic mesh sanding discs (P120, P150, P180)
- » Finish: undercoat – Osmo Wood Wax Clear Extra Thin
- » Finish: Topcoat – Osmo Poly-X Gloss Hard Wax Oil
- » Finish applicator: X-Wipe lint-free medical-grade paper cloth

HARDWARE

- » Three brass-butt hinges plus screws
- » Countersunk brass screws

TOOL LIST

- » Rip saw
- » Tenon saw
- » Dovetail saw (Japanese or Western)
- » Coping saw
- » Pair of dividers
- » Mallet
- » Bench chisels
- » Sliding bevel
- » Try square
- » Combination square
- » 0.5 mm mechanical pencil
- » White pencil
- » Router plane
- » Apron plane
- » Shooting plane
- » Jack plane
- » Jointer plane
- » Smoothing plane
- » Eggbeater drill
- » Marking gauges
- » Marking knife

PROCESS

(Please note that steps 1 to 9 of this project ran in the September/October 2022 issue. If you missed out on that, email subscriptions@hsm.co.za to request a back issue.)

STEP 10 [Lid centre panel]: The lid is 10 mm thick. For stability, the centre panel is laminated from narrow strips, and we used a 'breadboard-end' joinery technique to ensure it remains flat in use, and during seasonal humidity changes.

Glue and assemble the centre panel section of the lid as you did with the base panel. It's not necessary for all of the strips to be the same width; rather rip-saw wider strips into narrower ones. Our strips all ended up between 40–55 mm wide.

With the centre panel glued up, scraped clean and flat, plane all four edges true to the faces and square up the panel to a final size of 450 mm x 320 mm.



↓ WOODWORKING

STEP 11 [Lid joinery – ‘breadboard’ mortises]: Cut and square up your two 44 mm-wide x 10 mm-thick ‘breadboard-end’ components that will fit on to the end-grain edges of the completed lid centre panel. This will be done with dowelled mortise and tenon joinery, as per the CAD drawing.

On the chosen jointed edge of each breadboard-end strip for the lid, lay out your 4 mm-wide x 20 mm-deep mortises over the length of the component. Ensure they are perfectly centred across the thickness of the component. Using either your table-mounted router, table saw, or plough plane, excavate the mortises (grooves) on both breadboard ends.

Due to the narrow thickness of these two components, do not make the fit of the mortises and tenons too tight (slightly firm hand pressure is sufficient), as the centre panel must still be able to expand and contract across the grain with seasonal movement. Our rule-of-thumb is to always test the fit of any two jointed components continually until the desired fit is achieved.

Once you are entirely satisfied with the fit of both joints, make sure both breadboard ends are absolutely flush on both the front and back of the lid using an extremely finely set block plane.



STEP 12 [Lid joinery – ‘breadboard’ tenons]: On both ends of the lid centre panel, scribe a shoulder in from the edge at 20 mm. Using your marking gauge, scribe the tenon on each end to match the mortises. The tenons should be 4 mm thick and perfectly centred within the 10 mm thickness of the panel. With a sharp chisel, kerf the scribed shoulders of the tenons cleanly and chop down by the required 3 mm on both faces of the two tenons. Excavate the tenon faces down to the scribed lines using a router- or shoulder plane. It’s advisable to continually test the fit as you go to ensure accurate results. Trim 20 mm off both ends of both tenons, as per the CAD drawing.

Create a strip of stock measuring 20 mm x 18 mm x 4 mm. Later on, this will be inserted into the mortise gap, left by the trimmed ends of the tenons. At 18 mm wide, they’ll allow a 2 mm gap between the tenons and the inserts for seasonal movement.





STEP 13 [Dowels]: Mark out the centre- and outer-dowel positions on both breadboard ends, as per the CAD drawing. With both breadboard ends accurately clamped on to the centre panel, and with a 6 mm brad-point drill in your drill press, drill out the centre hole and the two outer holes. Separate the components. Now, parallel to the shoulders and by 1 mm in either direction from the centre marks, elongate the four outer holes in the tenon panel only. With the centre dowel not having any play, and the outer dowels allowing the centre board to expand and contract from and towards the centre, seasonal expansion and contraction over the width of the centre panel has been catered for.



STEP 14 [Lid assembly]: Glue the centre dowel into both the mortise and the tenon. The outer dowels are only glued into the mortise and not into the tenon, which allows for seasonal movement.

Once the lid assembly is complete, add in the 4 mm-thick mortise caps at both ends of each tenon – do not get any adhesive near the expansion–contraction gaps.

When the adhesive is cured, trim off the dowel waste. Using a block plane, gently ease all of the lid edges and sand the entire lid, working through the grits up to P180.



↓ WOODWORKING

STEP 15 [Installing the hardware]: Lay out the butt hinge mortises on the rear panel, at 20 mm in from the rear corners of the carcass, and with one hinge in the centre. Excavate the hinge mortises so the hinge leaves are perfectly flush with the substrate. Drill and screw the three hinges into the rear panel.

Using the installed hinges as the reference, turn the carcass upside down. Carefully mark out the positions for the hinges on the lid. Excavate the hinge mortises into the underside of the lid. Drill pilot holes and install the hinges. Unscrew and remove the hinges and set them aside.



STEP 16 [Final finishing and assembly]: Now that all three of the sub-assemblies are complete, a little sanding and careful inspection is all that's required. Once everything is neat and finished to 180-grit sandpaper, you can apply your preferred oil-based finish to all of the components. We used Osmo Poly-X Oil 3011, applying one coat to the inside of the desk, and two coats to the outside – with eight hours of curing time between coats – using lint-free paper towel.

Finally, your desk can now be assembled. Screw the base panel on using countersunk brass screws, and attach the lid.



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THAT'S A WRAP

If you've followed all of the woodworking articles in **POPULAR MECHANICS** this year, covering the traditional joinery techniques, you should feel confident in tackling this Shaker lap-desk project. You will also be well on your way to taking on many more woodworking and furniture-making challenges.



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THIRTY YEARS AGO, the 'Keep America Beautiful' campaign was in full swing. Kerbside recycling had become widespread, and the need to transform mountains of plastic had grown. This included high-density polyethylene (HDPE) plastic. HDPE is a thermoplastic polymer recognised for its outstanding tensile strength, large strength-to-density ratio, and high impact resistance and melting point.

My entrepreneurial partner, Mark Phillabaum, and I wanted to create the best possible product with this extremely durable, weather-resistant material. We landed on outdoor furniture – with a focus on the Adirondack chair – and Polywood plastic lumber was born. Today, we primarily source milk jugs, the most consistent supply of HDPE, from nationwide recycling centres and worldwide, ocean-bound hotbeds of plastic.

Polywood plays a role in the sustainability aspect of 'what do we do with collected postconsumer plastic?' We are caretakers of the Earth. It's a mindset that transcends into how we manufacture products and achieve zero waste. We aspire to do something meaningful for future generations. **PM**



HOW IT'S DONE

“ Machines process, clean, flake, then pelletise baled postconsumer plastic. Next, a vacuum moves and stores the pellets into silos where they combine with other secret materials to become genuine Polywood lumber boards. The lumber boards are dyed, heated, and formed to match the size needed for the furniture. Three separate cooling tanks solidify the material, before it's cut and routed in a CNC machine. From there, the pieces are packed and sent for shipping. – *Bryce Glock, Polywood Retail Sales Manager*

POWER



GEN3

SURGE



Viewed as a testbed for future production-ready, all-electric passenger cars, the ABB FIA Formula E championship has made impressive strides over the course of its first eight seasons. With Cape Town set to host a race early next year, we attended the Monaco e-Prix and the official reveal of this series' latest-generation car.

THE GOAL IS TO INTRODUCE closely contested car racing to the streets of some of the most iconic city centres around the globe. So the fact that, since 2021, the Formula E series has been granted full access to one of the most famous street circuits in the world is significant.

While annual races in Paris, London, New York and Berlin are viewed as showcases, having the hallowed 3.34 km-long Monaco track cordoned-off specifically for this relatively new racing series, now in its eighth season, highlights both the influence and stature that this future-focused formula carries.

This is also the only time in a calendar year that the performance potential of an all-electric Formula E car can be compared directly to the lap times of their more illustrious Formula One counterparts (see sidebar on p86).

Won by former-F1 driver Lucas Di Grassi, Formula E's inaugural race was held at Beijing's Olympic Park in September 2014. In claiming victory, Di Grassi had to not only negotiate the attentions of a field of similarly accomplished competitors, but also a mandatory mid-race car swap. This switch into a second car was necessary to ensure drivers had enough combined performance to complete the 25-lap race distance. By season five in 2018, in addition to being faster and more durable in terms of close-quarters racing than its predecessor, the second-generation Formula E racer with its updated 54 kWh battery (up from 28 kWh in the Gen1) could complete a race distance on a single charge.



1



2



3

1. Mercedes-EQ driver Stoffel Vandoorne won the Monaco race, on his way to claiming the 2022 driver's championship. **2.** A pit-stop to change cars was required to complete race distance in early Formula E seasons. **3.** A role now fulfilled by Porsche, the series' first safety car was a BMW i8.



THE BUZZ

HOW A FORMULA E RACE IS RUN

The first thing to acknowledge within the Formula E set-up is that it includes some big-name drivers, both established and up-and-coming. Jaguar TCS's South African sporting manager Gary Ekerold confirms that by competing exclusively on street circuits in cars fitted with treaded, all-weather tyres that offer less-predictable levels of grip compared to the slick items used in other racing disciplines, drivers need to be at the top of their game. That said, young drivers such as Nyck de Vries and Kiwi Mitch Evans currently impressing in Formula E seem destined for Formula One.

Grid positions are decided by a relatively entertaining knock-out-format qualifying session, which eventually sees the fastest two drivers going head-to-head on track. A modern Formula E race is 45 minutes, plus one final lap, in length. With all cars starting on a full charge, the driver is required to carefully manage available energy levels to still make it to the finish line in the fastest time possible.

With a single-lap distance at each venue measuring no more than 4 km, close racing is guaranteed as each driver is required to leave the optimal racing line twice during a race. This 'detour', however, activates an Attack Mode that affords the drivers up to 30 kW more performance potential for a predetermined period of time. Somewhat more contrived is the availability of a 'fan boost' that offers a selection of the most-popular drivers on a racing weekend (determined via social media) the advantage of short (yet potentially race-winning) blasts of performance.

MY MONACO

WHAT I LEARNT AT THE 2022 MONACO E-PRIX

The most obvious difference between watching a live Formula One race event and a Formula E sprint is the absence of an accompanying soundtrack at the all-electric event. The zero-noise and -emissions status of Formula E are key reasons why this series can be hosted in some of the world's most-legendary cities. But, just like the corresponding exhaust note of your favourite internal combustion engine production car takes some getting used to, so too do the near-silent workings of an all-electric vehicle. (That said, the opening lap of the Formula One race I attended in Germany in 2006 was also decidedly louder than the one performed by the current field of V6-powered hybrid F1 cars.)

Stealthy as they are, the actual racing – especially around a track like Monaco – was more exciting than the most recent F1 race held at this venue. The all-electric race offered a lot more overtaking manoeuvres and, it must be said, changes of lead throughout, than was possible in the F1 race. While Mitch Evans' pole-securing lap at the 2022 Monaco e-Prix was some 18 seconds slower than that set by Ferrari's Charles Leclerc a month later for his front-row F1 start, Formula E in 2023 is guaranteed to be faster.





It's this impressive rate of development and real-world progress that's proved an enticing drawcard into Formula E for some of the world's leading car brands, each seeking to fast-track a switch away from internal combustion powertrain propulsion to a more sustainable battery-electric future.

In the final season of racing with the so-called 'Gen2' car, the 11 teams currently competing in Formula E can make any number of changes to the componentry sited aft of the driver's cockpit. This includes the make-up of the rear suspension, the type of gearbox used and the set-up of the inverter used for converting direct current (DC) from the supplied battery pack to alternating current (AC) for a bespoke electric motor that powers the rear wheels. While first-generation cars used a five-speed sequential transmission, like within a modern all-electric passenger car, common thinking is that a single-speed unit is optimal when it comes to managing available torque.

A critical function, when managing available energy levels throughout a race, is software. Indeed, as confirmed by Jérôme d'Ambrosio, team principal for the Monaco-based Rokit Venturi Racing team, his team has been known to introduce as many as six software updates to its cars per racing weekend. In real-world terms, it was this impressive rate of software development from the Jaguar TCS racing team that resulted in the significant gain in battery range introduced with the mid-life update of the brand's all-electric I-Pace road car.

Left: Jaguar TCS driver Mitch Evans is closely followed by Porsche pilot Pascal Wehrlein on the opening lap of the 2022 Monaco Formula E race. Despite the absence of compelling accompanying exhaust notes, the racing remained close-fought throughout.



GEN3

Season nine of the ABB FIA Formula E series will introduce an all-new third-generation racing car. Said to have been inspired by the shape of a modern fighter-jet, the 'Gen3' car will showcase several under-the-skin upgrades when compared to the outgoing racer.

The most significant of these updates is the incorporation of a second electric motor mated with the car's front wheels. While a rear motor will now offer up to 350 kW worth of propulsion (a gain of 100 kW over the Gen2's unit), a 250 kW front-mounted motor will (for the time being) be used exclusively for the purpose of recovering braking energy. Able to generate up to 40 per cent of the energy required to complete a race distance, this regeneration technology is so effective in slowing the car that there's no longer a need to install supplementary hydraulic braking at the racer's rear wheels. The general consensus within the racing paddock is that this second motor might eventually be re-engineered to offer the option of all-wheel drive forward thrust.

Lighter and faster than ever before, another highlight of the new package is the inclusion of 600 kW ultra-fast-charging infrastructure that could be incorporated into the mid-race pitstops, if these stops are reintroduced.

With sustainability at the forefront of Formula E's vision, the third-generation car's bodywork will be constructed using various recycled carbon-fibre elements from the outgoing inventory. Similarly, the compound of the tyres supplied by new series partner Hankook features up to 26 per cent sustainable materials.

'A machine created at the intersection of high performance, efficiency and sustainability' is how Formula E co-creator and current FIA president Jean Todt describes the Gen3 car. **PM**

POWER UP!

WHAT ABOUT LOAD-SHEDDING?

With the goal of being a completely self-sufficient and sustainable racing series, the Formula E crews make use of their own bio-fuel-powered generators that are transported to each racing venue around the world. All logistics, the service- and pit-lane garages and, indeed, the cars themselves, are powered by these generators – there is no reliance on local electricity grids. Not a bad thing, considering how unstable some of them currently are...



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FORD POWERBOOST

BY MARK SAMUEL

It might not be available in South Africa, but we're expecting many of the innovations in Ford's immense F-150 to appear in the next-gen Ranger that will be hitting our roads soon. *PM* headed to the USA to drive the Ranger's big brother.

'VE ALWAYS ASSUMED that when it comes to bakkies, South Africans are the biggest fanatics, but my recent travels in the United States proved otherwise. Americans love their 'trucks' – you see them everywhere. And most of them are massive – they would dwarf even our largest bakkies that we consider behemoths on our roads.

For years now I've been intrigued by Ford's F-150 pickup truck. Actually, it's more of an obsession. This nameplate is a particularly special vehicle in Ford's line-up – in recent years more units of this truck have been sold in the United States in its various derivatives and spec levels than pretty much anything else. A media release in January this year confirmed that it was the number one vehicle purchased in the US in 2021, with a reported 762 004 units sold from dealerships countrywide. And what's even more staggering is that figure was 156 666 units more than its nearest competitor, which also just happened to be a truck.

And I can confirm that there are many, many F-150s on US roads. During a 10-day road trip around the New England states I spotted countless numbers of these massive bakkies. After all, with their high-riding, broad-stanced profile, they're not easy to miss.

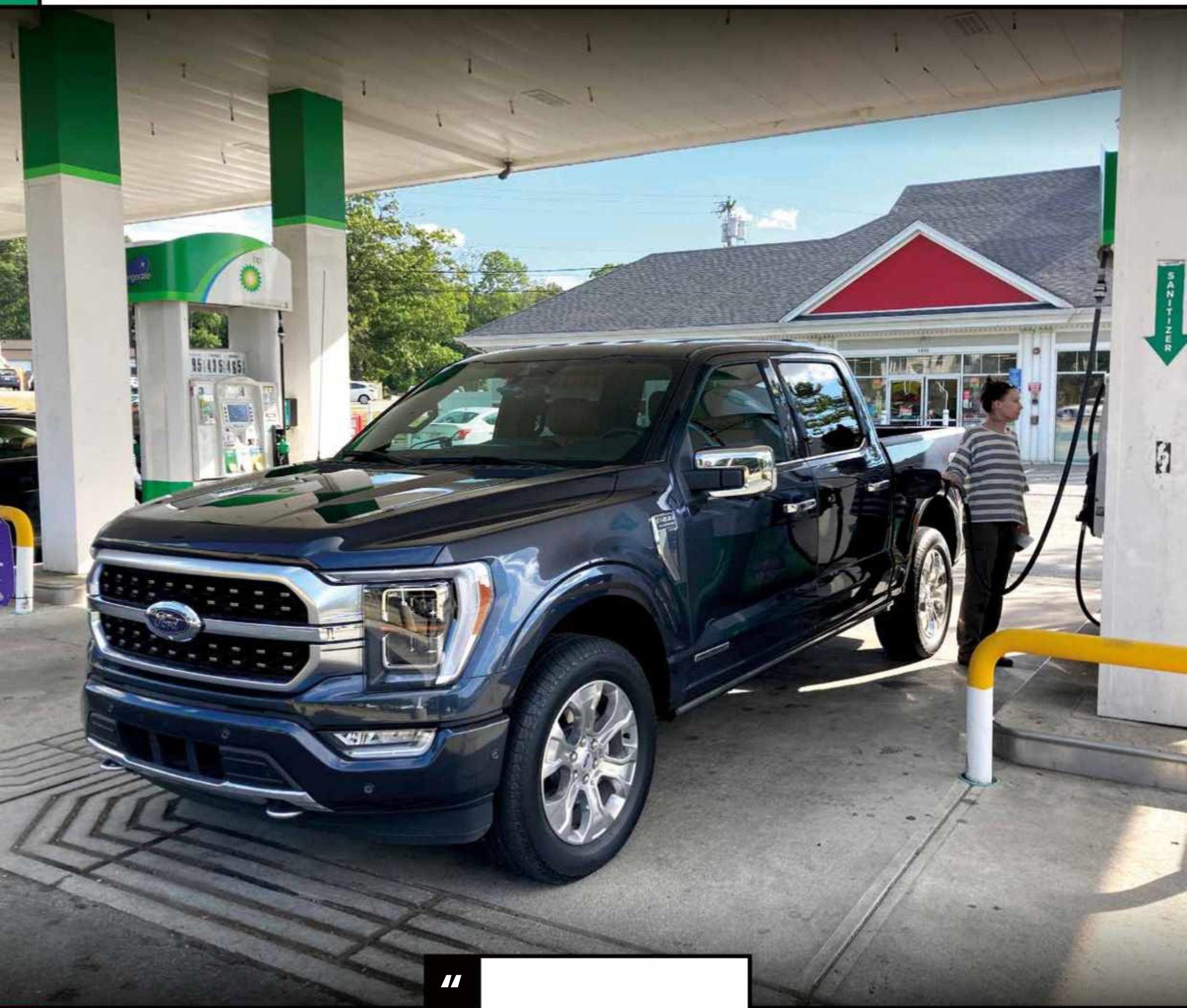
The F-150 is probably the most important vehicle in Ford's line-up in the United States. More units of this truck are sold than any other vehicle, from any brand. It's a big, bold, capable – and highly comfortable – vehicle.



F-150

HYBRID





“

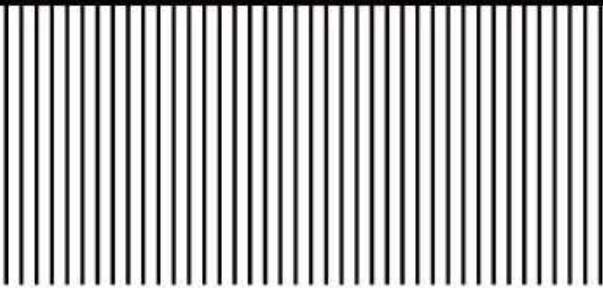
For our trip to the United States I obtained a 2021 Ford F-150 4×4 Supercrew PowerBoost Hybrid from Ford to experience and review, fulfilling a years-long dream to drive one of these trucks. (Yes, for the most part it just feels right sticking to the US lingo and calling it a ‘truck’ instead of a bakkie.)

Judging by its colossal size, fuel economy – or ‘gas mileage’ – was always going to be a concern, and with the recent spike in fuel prices this was particularly relevant. Mercifully, the test unit was a petrol hybrid, housing a 3.5-litre twin-turbo EcoBoost

WITH SOME LIGHT-FOOTED DRIVING, THE ECONOMY READOUT SAID 9.92 LITRES/100 KM WHEN WE HANDED THE TRUCK BACK AT THE END OF OUR TRIP.

petrol engine and an electric motor, delivering a hefty combined power output of 320 kW and a formidable 773 Nm of torque. At the time of its launch, this was the fastest and most powerful version of the F-150 available, aside from the Raptor edition.

With some light-footed driving, the economy readout said 23.7 miles/gallon when we handed the truck back at the end of our trip. In our language that’s a fraction under 10 L/100 km, very good considering the dimensions and mass of this vehicle, and the large 3.5-litre capacity of the twin-turbo-



Left: You fill up your own vehicle at US 'gas stations'. The huge 115-litre tank took some filling, but thank goodness for the hybrid technology that kept consumption to a reasonable level.

Right: The fold-flat armrest makes for the perfect on-the-go workspace.

Below: The model we tested featured a sizeable 12" screen, with user-friendly and intuitive functionality.



FIGURES

2021 Ford F-150 4x4

SuperCrew PowerBoost

- ▶ **Engine:** 3.5 L twin-turbo petrol V6 PowerBoost Hybrid Electric
- ▶ **Transmission:** 10-speed automatic
- ▶ **Max power:** 320 kW @ 6 000 rpm
- ▶ **Max torque:** 773 Nm @ 3 000 rpm
- ▶ **Max towing capacity:** Up to 5 625 kg (for this wheelbase)
- ▶ **0-100 km/h:** 5.4 seconds
- ▶ **Fuel tank capacity:** 115.8 litres
- ▶ **Fuel economy (achieved):** 9.92 L/100 km

Warranty

- ▶ **Bumper-to-bumper:** 3 years/36 000 miles (57 936 km)
- ▶ **Powertrain:** 5 years/60 000 miles (96 560 km)
- ▶ **Aluminium body panels:** 5 years/unlimited miles
- ▶ **Sheet metal:** 5 years/unlimited miles
- ▶ **Hybrid battery:** 8 years/100 000 miles (160 934 km)

Price: \$71 655 (approximately R1 250 000)

petrol engine. The electric motor clearly played a significant role in keeping this economy figure respectable, with around $\frac{1}{5}$ to $\frac{1}{4}$ of each journey's miles driven under battery power. This is a self-charging hybrid – onboard systems are constantly recharging or drawing down on the battery bank, and assessing the optimal time to propel the vehicle on full electric power, and when to fire up the big petrol power plant. I'm sure a pure petrol derivative would've averaged closer to 15 L/100 km, stats that would've had me shedding tears come fill-up time.

External dimensions of this beast are huge – 5 885 (L) × 2 029 (W) × 1 961 (H) mm. You read that right – it's nearly six metres long! Its stance and profile make me feel short, and I'm 1.91 m. Inside the cabin it's plush and pleasant. Excellent sound-deadening characteristics blot out road- and wind noise, and there's space in abundance. Legroom all round is prodigious, and the gap between driver and front passenger is vast... Okay, it's probably 35 to 40 cm, but it's wider than any vehicle I've ever experienced. And speaking of the centre console... The cubby

under the armrest is cavernous, easily swallowing up sunglasses, snacks, drinks bottles, hats, handbags and more. But my favourite feature here, aside from the many cup holders, nooks, crannies and stowage trays, was the armrest that opens up entirely flat to create an on-the-go workspace. (Click a button on the side of the gear-shifting lever and it folds down completely, enabling you to open the armrest to reveal the work surface.) A feature like this makes a lot of sense – the F-150, after all, has evolved as a functional work vehicle. This truck is an ideal companion for contractors, for example, who spend hours each day in their vehicles, tools stashed safely on the back, catching up on emails, invoicing clients and sending out quotes.

While interior space is vast, it's practical and utilitarian too. There are places aplenty to store belongings, *padkos*, and beverages, including trays and holders in the door panels, as well as dual cubbyholes in the dash. Convenient knee-high slots on the sides of the centre console are a nifty spot to stash phones or keys. Rear passengers enjoy climate control vents of their own, and heated seats to boot. Up front you can heat or cool the seats, and enjoy several 'Active Motion' massage options if your back or backside are feeling a bit tense.

Surfaces and incorporated materials are pleasing to touch and hard-wearing, and

81/1000
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easily cleanable if you've been away camping for the weekend or using the truck as a workhorse. Doors and dash are a blend of premium-feel plastics, suede (or something that feels a lot like it), and attractive stitching.

The 12" central touchscreen is the interface through which you control the infotainment system, apps (such as Apple CarPlay and Android Auto, satnav, and others), as well as the vehicle's settings and preferences. Beneath the screen are good ol' analogue controls for the audio system, and air conditioning, and a tray underneath all of that offers wireless charging for compatible cell phones.

Driving on the right side of the road, and seated on the left, takes a little getting used to. It's the ingrained habits, such as glancing in the central rear-view mirror (positioned to your front-left in South Africa, but on the front-right in the US) that require a bit of brain reprogramming. Turning into the correct side of the road at intersections is quite important, too. Fortunately for me, Ford refined this truck to a point where everything, from the driving position and view from the cab, to the height of the pedals (electronically adjustable, by the way) seems to meld with your body, and driving on the



'wrong' side of the road quickly felt right. While the truck's sizeable dimensions require cautious manoeuvring, the 360° camera system made parking and negotiating tight spaces no trouble at all. Open-road cruising is pure pleasure – the high ride height, responsive yet not twitchy steering, adaptive cruise control, and oodles of power under foot make the miles melt away effortlessly.

When the terrain ahead requires it, four wheel drive is selected using a cluster of buttons next to the steering wheel. There's 2H, 4H and 4L, as well as 4A (or 'Auto'). A dial in-between those buttons adjusts the drive mode and operates the diff-lock, and the Pro Trailer driver aid makes towing a lot safer. Did I mention this engine derivative can tow up to a whopping 5 760 kg in certain body configurations?

In addition to the customary 12 V power outlets that you find in every vehicle, this truck features multiple AC 20 Amp sockets backed by Ford's ProPower Onboard, an ingenious system that turns the truck into a mobile generator that can operate electric

Top: The F-150's off-road credentials are noteworthy. And this engine derivative can tow up to 5 760 kg!

Left: Push a button to make the gear-shift lever fold down, so the armrest workstation can open out flat.

Below: Most vehicles in the US are big, but, at nearly six metres long (our Toyota Hilux is 5.3 m long), the F-150 is immense.



↓ PM GARAGE

tools and power-hungry accessories. The standard system in this F-150 model outputs 2.4 kW, but rather amazingly can be specced up to output 7.2 kW of juice. With the latter, you get four 120 V 20 Amp outlets as well as a 30 Amp 240 V socket, providing enough mobile electricity-generating capacity to power a work- or campsite. Can you imagine

the popularity of a feature such as this for South African households that are regularly plunged into load-shedding darkness? I particularly liked the collection of plug points in the rear of the load bay, the ideal location for leisure or professional users.

For a double-cab the load bay is huge, and the high sides ensure your gear and

equipment stay put. Various brackets and tie-down points provide multiple options to fasten things down, and a powerful load-bed light means after-dark operations are stress-free. The tailgate has received particular attention from the design engineers, traits that have been carried over to the next-generation Ford Rangers coming soon in South Africa. The needs of tradespeople have been catered for: Lower the F-150's power-operated tailgate (with built-in fold-out step) and you'll see slots to accommodate clamps for construction projects, moulded depressions for pens, pencils and your travel mug, and textured non-slip surfaces for your accessories. There's even a ruler (with both inches and centimetres) marked out for in-the-field measurements.

Wheels and tyres are big (275/60R20), but they look in-proportion on this large vehicle. Ground clearance is significant, at 239 mm, but with the long wheelbase dimensions some off-road obstacles might still present a challenge, such as terrain with steep breakover angles. For most challenging situations, though, including mud, slush and snow – conditions this truck encounters a lot in the northern hemisphere winter – this beast will manage admirably.

The F-150 isn't available in South Africa, so perhaps you're wondering why reviewing it even matters. For me as a vehicle enthusiast, and especially one who enjoys driving large cars and off-roaders, it's interesting to see products from other automotive markets, and to assess how their innovations might influence the designs and technology of our vehicles. Experiencing first-hand the technology and features housed in this F-150 made me even more excited about the next-generation Ford Ranger that's being launched in South Africa. I expect a lot of the F-150's features, technology and styling has been adopted in the Ranger. (Watch this space for my experiences with the new Ford Ranger, as I'll be putting it through its paces in the desert terrain of Namibia soon.)

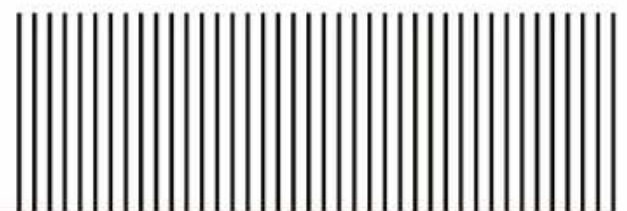
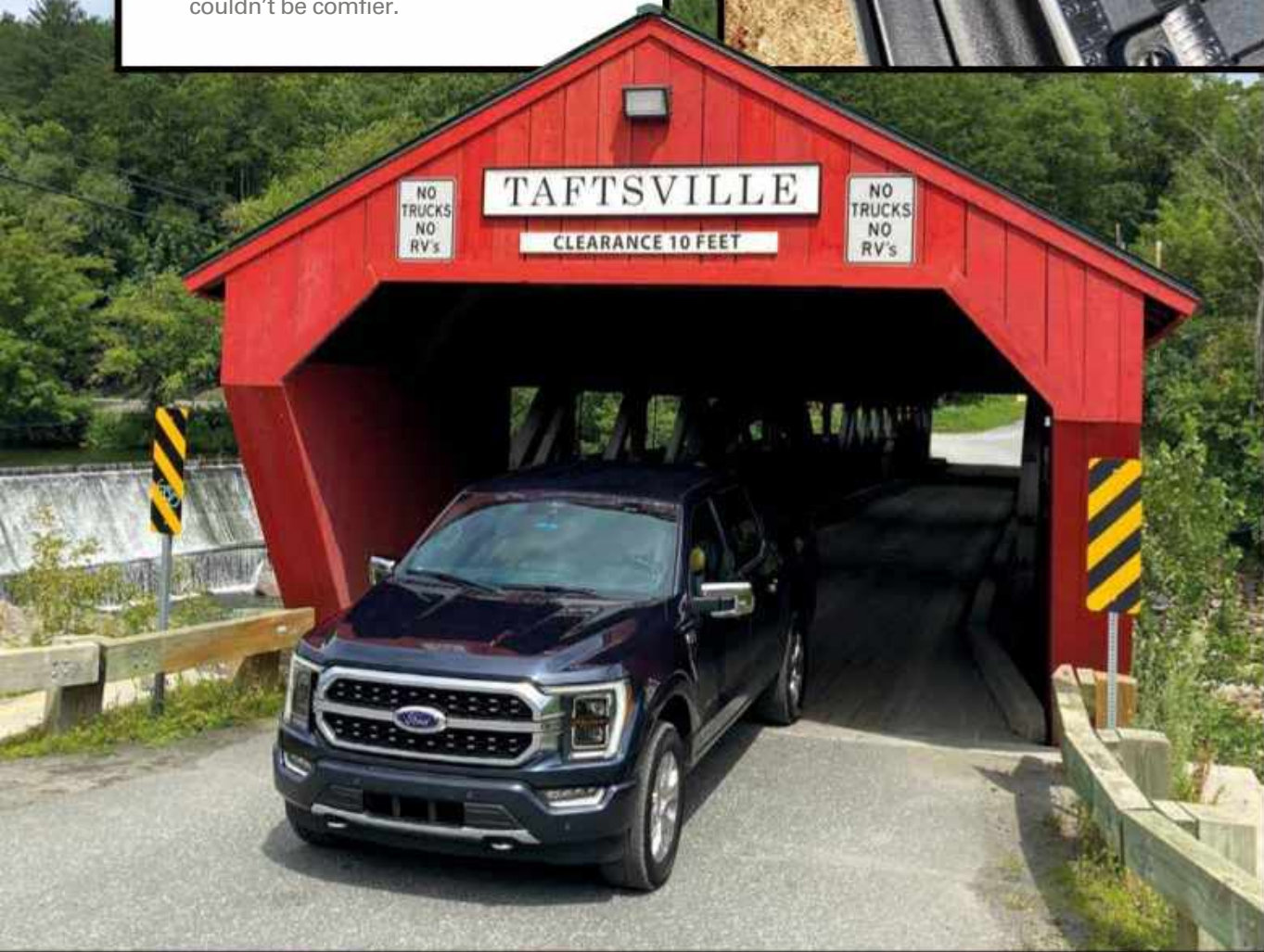
Did the F-150 live up to all of my expectations? Unreservedly, yes. It's a powerful work- and leisure vehicle that not only looks good, but has both the features and pedigree to back up its visual appeal. Right, Ford South Africa, bring on the new Ranger, ASAP! **PM**



Above: The ProPower Onboard system turns the F-150 into a formidable mobile electricity generator.

Right: The multi-function tailgate has a ruler, clamp points, and depressions for your cup, pencils and iPad.

Below: Road-tripping in the US couldn't be comfier.



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Clever tips and lifehacks

'CAN'-DO ATTITUDE

You'll notice in the photo that the floor of my garage is tiled. It's the flooring option the previous owner had put in.

It works just fine, and for the most part is relatively easy to sweep and keep clean, except for some tarry blotches that dripped off the bottom of my bakkie when I had corrosion-protection sprayed on to the chassis and various underbody parts.

I was having a hard time removing the marks, until I tried spraying them with

WD-40. I couldn't believe the results! I sprayed the solution on to the sticky, tarry spots, and left it to do its thing for a few minutes (it actually started dissolving the substance the instant it touched it). When I returned a little while later, the tar had mostly lifted, and it was then just a simple case of scraping and wiping off the remaining residue.

I'm always amazed at the many and varied uses of WD-40.

Mike Samson



WIN

WIN WITH MASTER LOCK

Write to us with your tip and you could win a prize from Master Lock. This issue's top contribution has won:

Master Lock M1 Excell Padlock:

The boron-alloy body of this lock is 50 per cent stronger than standard padlocks, and the octagonal boron-carbide shackle provides maximum cut resistance.



Master Lock 4-Dial Combination Lock:

The 6 mm-diameter and 26 mm-long shackle is made from cutting- and saw-resistant chrome-plated steel. Set your own combination.



Master Lock Keyed Locking Cable:

The 1.8 m-long self-coiling braided-steel cable is designed for maximum strength. The vinyl coating prevents scratches and protects the cable.



Master Lock Rod Lock:

The 15 mm-wide metal body and 3 mm-diameter steel shackle and cable are highly resistant to tampering and cutting.



Master Lock Tower Combination Lock:

Set your own combination on this sturdy padlock featuring a 37 mm-wide zinc body.



Send your tips to

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with the subject line: 'Do It Your Way'.
Regrettably, only South African residents are eligible for the prize. Prizes not claimed within 60 days will be forfeited.

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