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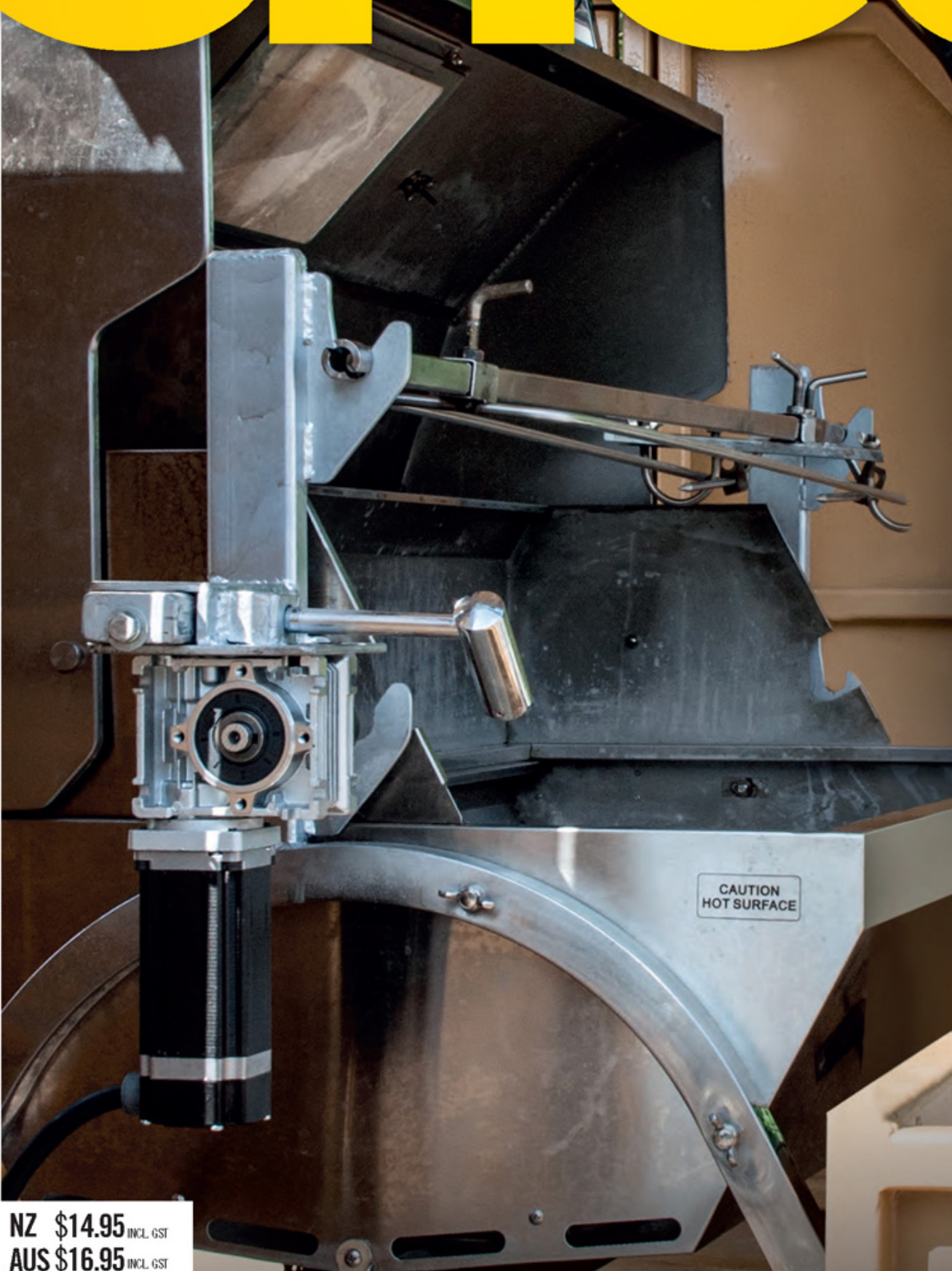
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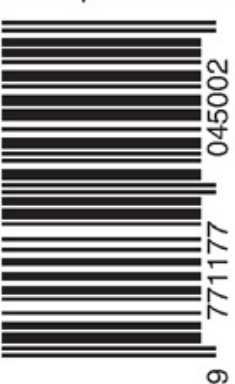
ISSUE 89

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THE FATHER OF INVENTION



This issue of *The Shed* has its usual collection of extraordinary sheddies, showing readers how to create useful stuff or sharing how they have full lives just doing what they enjoy.

It must be apparent to all that I am very much in awe of all of the featured sheddies in our magazine because I have not a modicum of the skills of the folks we feature in these pages. I am constantly impressed by the discipline and talent readers possess to get stunning results using their skills and know-how.

Another factor to consider with all the projects we feature is how they keep one's brain sharp. Working with your hands and making the grey matter work harder to figure out and solve issues is the perfect way to stay mentally happy and cognitively alert.

What impresses me even more is that often our featured sheddies are so good at doing projects and builds that they need even more of a challenge.

In the previous issue of the magazine we had Albert Gordge putting a second motor in a car for an engineering

challenge and a bit of fun, and in this issue we have Eldon Peters doing a similar type of project; thinking along the lines of, "I am bored, why don't I try doing this?"

Eldon, who is obviously a very competent furniture maker, was looking for something to stretch his skills and have a laugh so he made a chest of drawers that doubles as a musical organ! Love it.

It occurred to me the saying, "Necessity is the mother of invention" may need a mirror counterpart. How about when you make something just for the hell of it or to have fun and see if you can, we say, "Not necessary is the father of invention"?

Maybe I should be the first to get the T-shirt printed.

One final point of note — both Albert and Eldon hail from Taranaki. What's in the water down there? Whatever it is, can I have some please?

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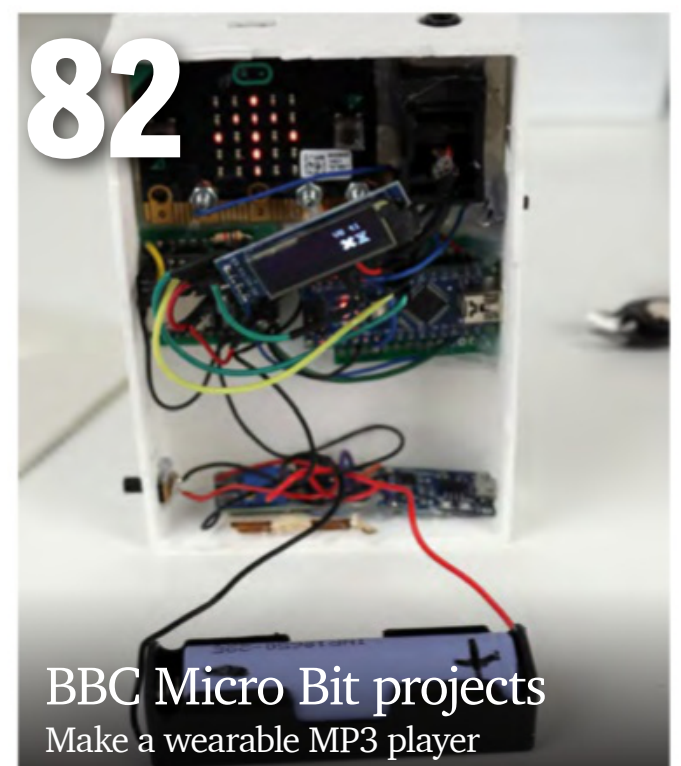
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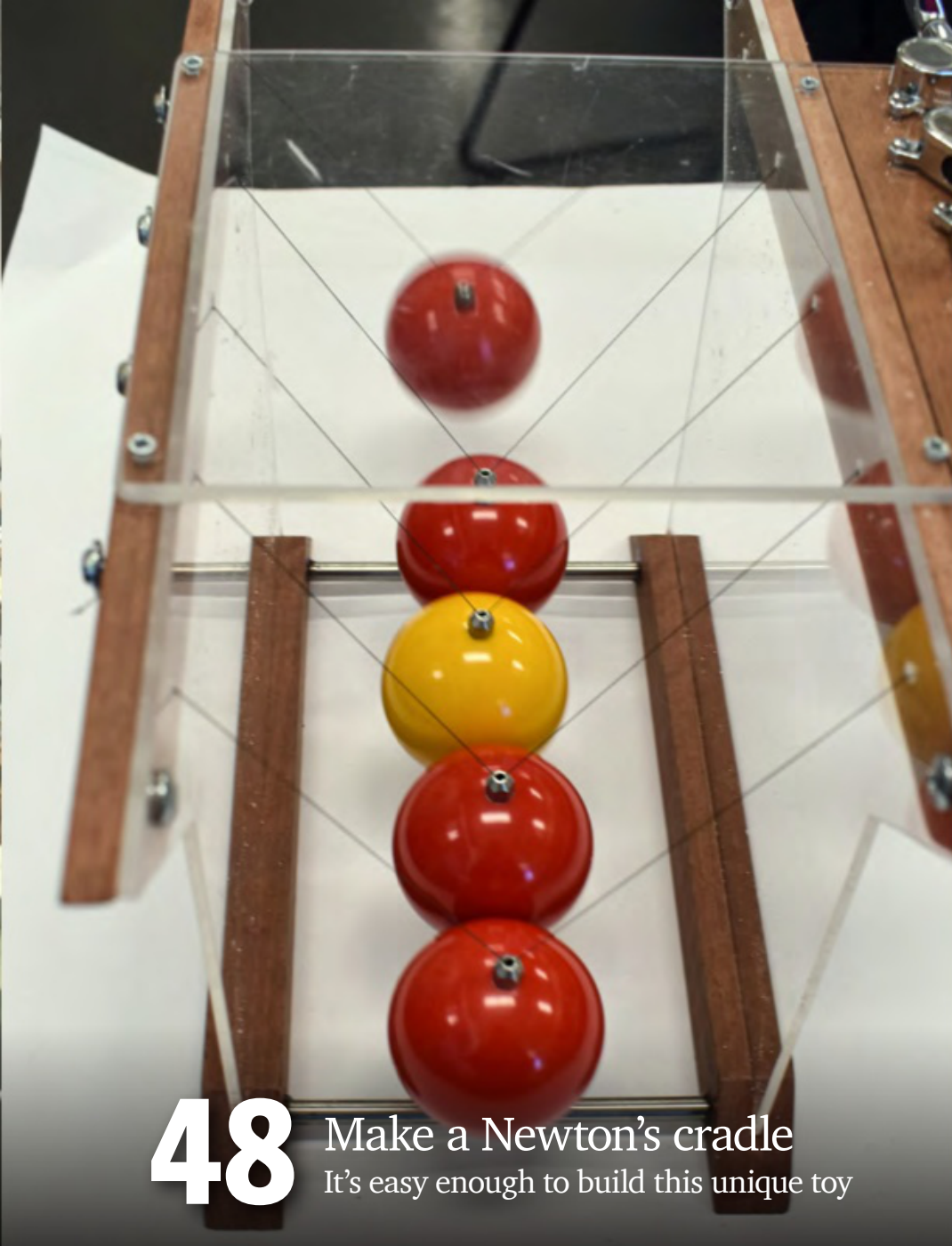
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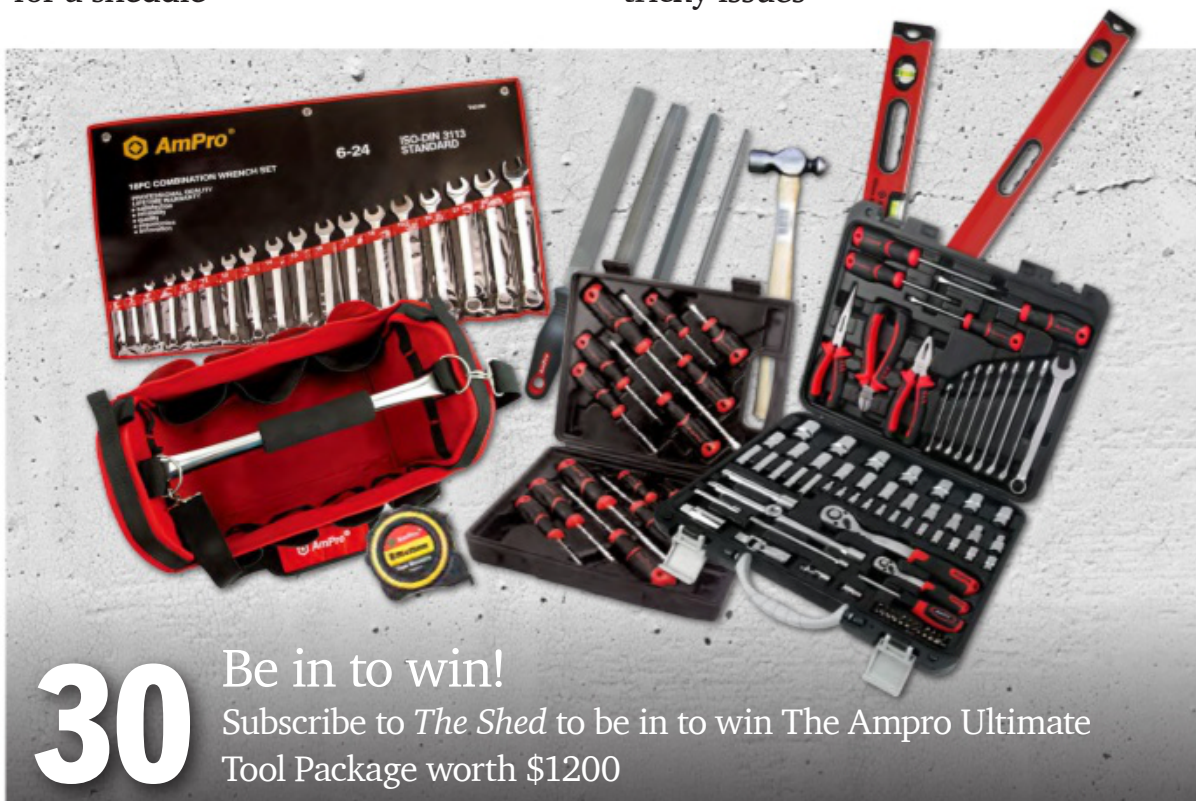
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Off the grid

Learning to think laterally to solve tricky issues

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Spit-roast barbeque





A RIGHT ROYAL ROASTING

A FUNDRAISING INITIATIVE HITS A FEW HICCUPS AND SOME LESSONS ARE LEARNT ALONG THE WAY

By Nigel Young and Gavin Melville Photographs: Nigel Young and Juliet Nicholas



The cost of running a Menzshed far outweighs the income from annual membership fees. Even with minimal overhead and administrative costs, the annual fee times the number of members is clearly not enough, particularly given the capital outlay, ongoing maintenance, and the expense of components and parts that many tools require.

Even indirect costs such as health and safety requirements, public liability insurances, and auditors if your organization is a trust, means that money has to be found from somewhere.

In trying to address this issue, the Halswell Menzshed decided to raise funds via a fundraiser, or to put that

When it comes to raising money, food is always a good method

another way, instead of seeking funds for a particular requirement or cost, they would use them to build something

that, in itself, would help to raise further funds. And when it comes to raising money, food is always a good method — witness the number of sausage sizzles outside hardware stores every weekend.

A pig spit-roaster, mentioned at a committee meeting, soon became the project of choice, and very soon it was underway. A funding application for \$1600 for the actual spit-roaster put to the Hornby Working Men's Club was subsequently granted. This was in line with the club's ongoing focus on community and hospitality. With the money in place, the project began.

Design decisions

The first decision was the platform, which would need to be a trailer. Would it need to be custom built, or could an existing one be adapted? One member offered an old one that had seen better days and was only used for rubbish removal, but it turned out to be too small and lightweight.

The running gear however was suitable, so in the end a new purpose-built trailer was built around the

salvaged wheels and axles. Two members with extensive engineering experience got to work, and it wasn't long before the platform was established.

The trailer is 1700mm long and 1485mm wide, with an eventual height of 1550mm. The steel was purchased from United Steel, and built from 50x50x3mm rectangular hollow section (RHS), with 40x40x3mm RHS used for both cross bracing and the tow bar.

The spit-roast framework was made

from 25x25x2mm RHS and clad with 1.5mm riveted galvanized sheet steel. Gas struts for the gull-wing doors were bought from a local supplier, as were the lights. Inside the cover is a 1200mm long LED lighting tube, gas bottles were mounted on the tow bar below a 240V electrical switchboard. Significant attention was paid to earthing. The paint was sprayed on by one of the members, while the signage was purchased from Speedy Signs. ▶



The bones of the spit-roaster



The position of the two nine-litre gas bottles and the powerbox



The two 9kg gas bottles mounted behind the towbar



The LED strip lighting in the gull wing of the trailer



Placing the pig for the first time at around 10.30pm at night. The motor subsequently failed at 2am

Cooking crisis

The first commission for the new yellow-painted spit-roaster was a fundraiser for a local school, and this turned out to be its last. The guy on spit-roast watch duty — sleeping in one of our project camper vans — didn't get much sleep that night. Something broke. In the middle of the cooking. At two o'clock in the morning. With a 65kg hot pig roasting. And a deadline of 9am. And as if that wasn't enough, wind was causing a loss of heat as — due to the size of the pig — it couldn't be properly enclosed. So temporary windshields had to be quickly made to mitigate this further problem. But

ovens, so the event had a happy ending. But another time they might not have been so fortunate.

The problem turned out to be a gearbox failure in the motor-gearbox combination that came with the spit-roaster. Although the specs seemed to be appropriate, it still failed. Its upper limit was 80kg, but that was ultimately shown to be optimistic. The supplier replaced it under warranty, but a further stage between it and the spit coupling was deemed to be necessary. Various other solutions were considered: a quarter-horse motor with V-belts

and pulleys was the obvious one. However, the fundamental problem was that a 1440rpm motor had to be reduced to 1.5rpm, which was too big a reduction in such a confined space. Using pulleys would have required a two-step solution — the first one being a belt, but the second would need to be a chain as the slow speed meant that slipping would have become an issue. In addition to this was the physical size of such an arrangement. It would have required a redesign of the entire project, and end users would need a high degree of familiarity with it. ►

And as if that wasn't enough, wind was causing a loss of heat as — due to the size of the pig — it couldn't be properly enclosed

for the moment, there was a crisis. Fortunately, the school was next door to the Menzshed, which is on the grounds of St John of God hospital, and the facilities manager is a member of the Menzshed.

So, the pig was cut into smaller pieces in situ, placed in roasting dishes, and finished off in the hospital kitchen



Stuffing the pig with onions — promises of succulent pork ...



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The completed trailer with the spit-roaster donated by the Hornby Working Men's Club. Note some of the electrical earthing that has been installed throughout

The key to a low speed

Given that the intention was to hire out the spit-roaster, that was not an option. So another solution had to be found. A search online produced a variety of options — one was a windscreen wiper motor with a reduction. That would have been a 12V solution, which would then need to be accommodated.

One member of the Menzshed with an electronics and mechanical engineering background suggested a stepper motor drive through a worm gearbox.

This allows very low speeds, in this case 1.5rpm, without loss of torque, because a stepper motor has maximum torque when stationary.

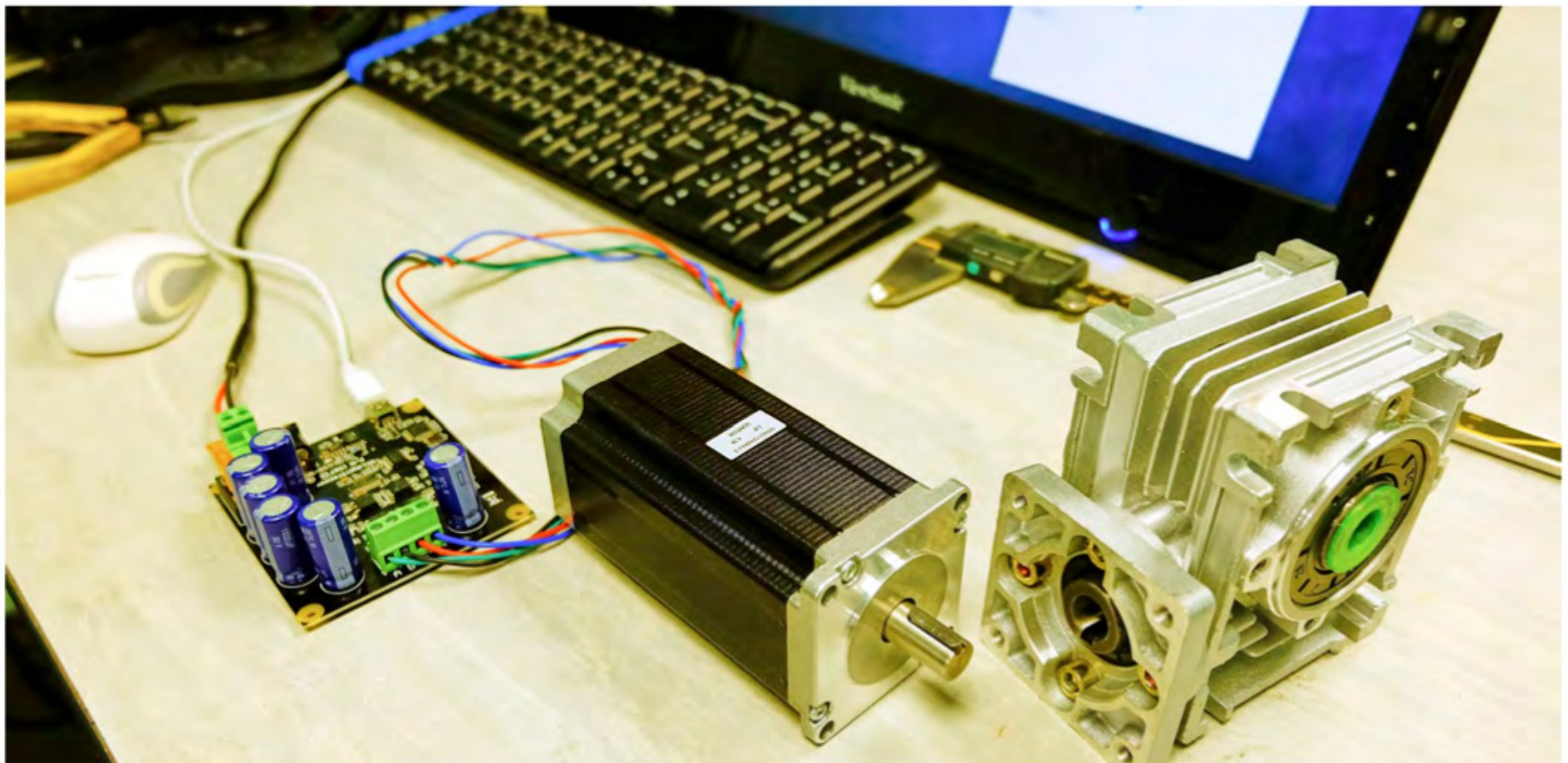
The gearbox reduction ratio is just

*Although the
[motor and gearbox]
specs seemed to
be appropriate, it
still failed*

10:1, instead of the at least 1000:1 needed with an AC motor (or brushed DC motor). The stepper motor advances at 200 steps per revolution (see page 11). The cost of all this was also an issue. Once upon a time such a solution would have costed about \$1K, but the Menzshed ended up with change out of just \$200.

What is also interesting here is the

capabilities and depth of experience and knowledge shared within the Menzshed. The entire project was planned, built and then replanned and rebuilt, without having to go to a third party: it all came from the members themselves. The problem was very specific, and yet the solution came from within the ranks. The motor and gearbox unit is totally sealed, so inclement weather conditions will not be an issue. The compact nature of this stepper motor and gearbox solution is in stark contrast to what a motor and pulley / V-belt solution would have required. A stainless-steel cover further protects the motor and gearbox from its immediate fat-and-residue-producing environment. ►



The new motor and gearbox configuration awaiting installation

Why a stepper motor and how - Gavin Melville

Existing spit-roast gearboxes are fragile because of the small motor and large reduction ratio, and have little torque. This is either because high reduction ratio gearboxes lose power in each gear (rule of thumb: expect to lose 15 per cent power per gear pair, and because four to six mating pairs involved) or because slowing down a 1440rpm motor electrically lacks speed control and torque at low rpm.

A stepper motor is much better at low rpm, and conversely lacks torque at high rpm, so would have lost half its power at 1200rpm, with 3000rpm would be

a sensible upper limit. With 200 steps per revolution, motion appears smooth and no steps are visible. Stepper motors are simple internally and have no rapidly moving parts. Just Google 'stepper motor construction' to see how they work.

A stepper motor needs a DC power supply — in this case 12V was available — and some driving electronics, but these can come from the same source as the motor/gearbox. The gearbox, with its 14mm keyed output shaft, is a very solid oil filled unit. The maximum current fed to the stepper motor is controlled by the driver module in eight steps, with the motor just

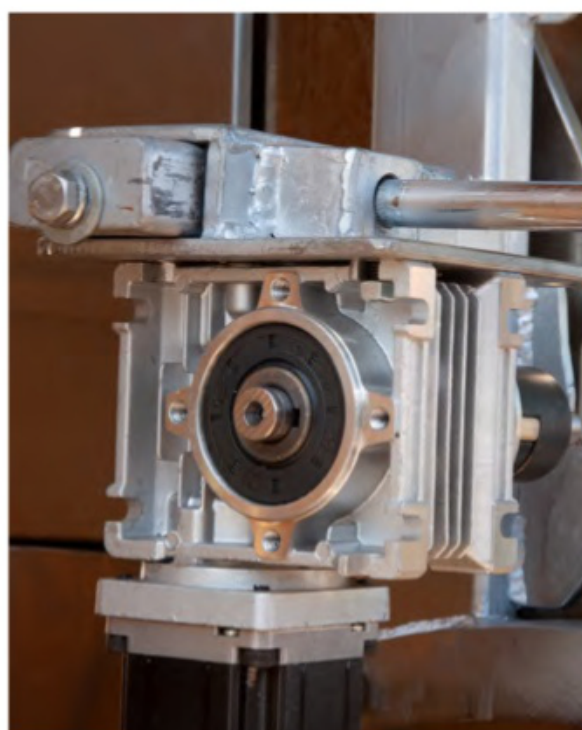
stopping if overloaded, however a shear pin was fitted as a backup.

The motor and gearbox were purchased online from AliExpress, and cost about NZ\$100. A stepper motor driver from the same source was driven by a small microcontroller (similar to an Arduino — actually an Adafruit Feather). The total programme was five lines.

If anyone needs more info, or help implementing a low speed motor or the software, visit Gavin at the Halswell Menzshed in Christchurch or email him at gavin.melville@ensigne.com.



The new gear shaft



The other end of the shaft



The gull-wing configuration — is this the Mercedes-Benz 300 SL of spit-roasters?

Clever engineering

Mechanically, the gearbox is impressive. Despite its size, the high quality is obvious and testimony to automated production and assembly — it is unlikely to have been touched by anyone throughout its manufacture. Robotics at its best, reflected in both the quality and the price.

The motor has one other interesting feature: it runs on amps not volts. The significance of this is that the motor takes the amperage it needs, regardless of the size of the contributing motor. The advantage is that it enables

The entire project was planned, built and then replanned and rebuilt, without having to go to a third party

both a 240V mains supply through a switchboard on the trailer, as well as the use of a 12V battery-operated backup alternative. The new motor and gearbox combination is now so effective that

it was decided that a shear pin on the drive of the spit would be a good idea, just in case the spit-roaster got hung up in any way.

The original coupling between the motor/gearbox and the roaster was fine, so it was reused without modification.

The final issue was the method of mounting the pig — already mounted on the spit-roast shaft — and the solution was a purpose-made slide and lock arrangement, as it's much easier to take the motor to the pig rather than the pig to the motor. ►



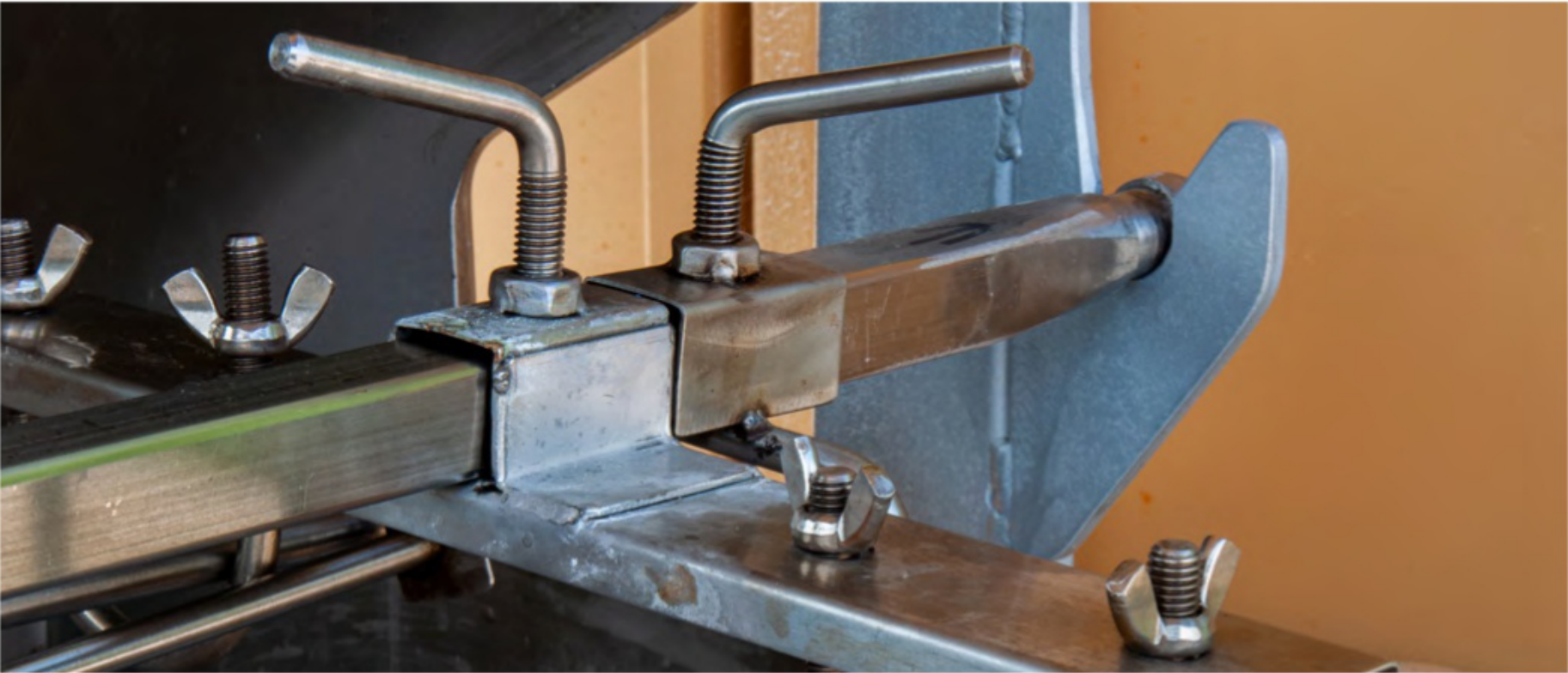
The spit-roaster and another Menzshed project: a bicycle-repair caravan



The two ribbon burners



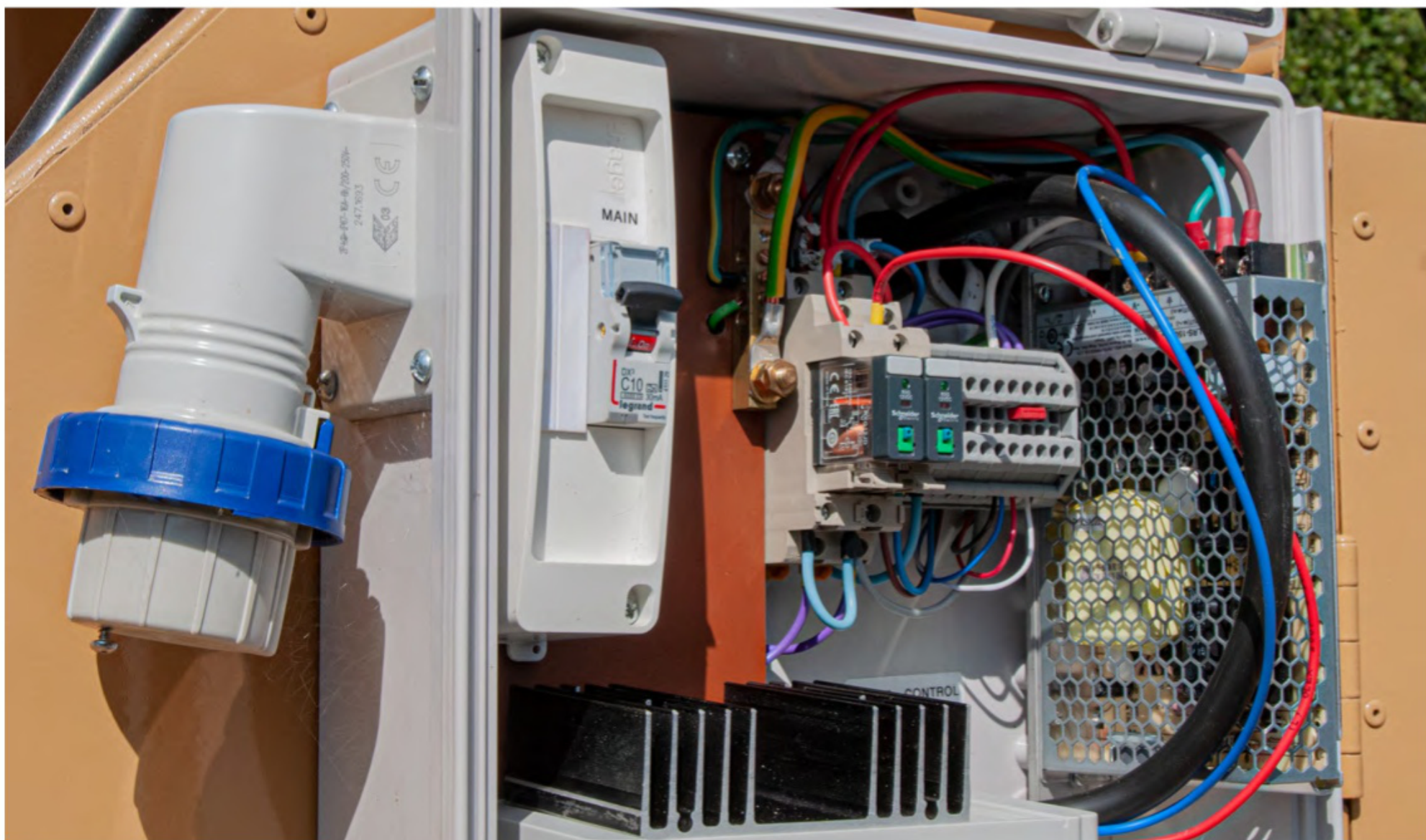
The switching for the overhead LED lighting



The mounting connection for the spit



One of the MenShed members inspecting the installation of the new gearbox



The electrical heart of the spit roast

Compliance and gas

From a compliance perspective, the electrical fit-out is the same as a caravan, while the gas — in this case the two 9kg bottles stored over the tow bar — will be carried out by a local company for the required certification. The bottles are simply swapped as and when required. The trailer itself is fully registered and warranted, and can be towed behind any vehicle.

The cooking is done via two ribbon burners in the base that run the length of the spit. A fat-collection tray is included, and the whole trailer has been designed for ease of washing down and cleaning. Hygiene is always an issue in projects such as these, with the very real risk of food poisoning having to be accounted for.

This project has not been a commercial enterprise; rather, it

is a goodwill-and-profile exercise, bringing in some funds along the way. All funds go back into the Menzshed, with cost recovery and fun being the priorities. While the initial capital outlay will always be an issue, the value of the spit-roaster is its ability to generate bonhomie, rather than an income, with the results able to be measured in social values rather than economic ones.



Inside the spit roaster



Halswell MenShed founder Roger Spicer with the new spit roast trailer



The spit roast inside the trailer

MENZSHED NATIONAL CONFERENCE 2020

A warm southern welcome awaits sheddies at the 2020 Menzshed National Conference to be held in Dunedin over 17–19 April. Registration is now open, and the theme is Communities and Wellbeing Bring Sheddies Together, with the event set to feature speakers and panels on a wide range of topics including shed management and logistics, men's health and wellbeing, shed projects and community relationships, and new and innovative technologies.

Menzshed New Zealand is a registered charity that exists primarily for the mutual benefit, success, and support of and access to member sheds.

The movement has gained momentum over the past 10 years, with more than 108 sheds incorporated across New Zealand and a further 30 in development. The movement is a semi-finalist in the 2020 New Zealand Community of the Year Awards.

"It's great to see the efforts of our shed members across the country coming to fruition and the movement as a whole growing so quickly in New Zealand," says Menzshed national president Trevor Scott.

The national conference 2020 will be jointly hosted by the North Dunedin Shed Society and the Taieri Bloke's Shed and held at Tolcarne Boarding Residence, St Hilda's Collegiate School.

It's expected that more than 100 members from affiliated New Zealand Menzsheds will attend, along with a delegation from the Australian Men's Sheds movement. The conference is also open to non-Menzshed members who have an interest in finding out more about the movement.

The conference will be opened at noon on 17 April by the Hon. Dr David Clark, MP, with mayor of Dunedin Aaron Hawks and Trevor Scott.



The conference is also open to non-Menzshed members who have an interest in finding out more about the movement

Keynote speakers

Several keynote speakers have been confirmed for the Friday afternoon, including Ass. Prof. Debra Waters who is an expert on ageing well. Jim Hopkins will be the master of ceremonies.

On Friday afternoon, there will be a tour of Otago Polytechnic's workshops demonstrating new technologies and including a walkthrough of the award-winning Polytechnic Student Village, constructed of cutting-edge timber laminate.

Saturday will see a mix of guest speakers and Menzshed presentations covering operating logistics, finance and charity options, men's health, technology, the digital age, and project stories from individual Menzsheds. The conference dinner will be held at Tolcarne, and Menzshed New Zealand Annual General Meeting will be held on the Sunday morning.

Travel opportunities

With the conference falling the weekend after Easter this could be an ideal opportunity to further explore the Otago region, including attending Warbirds over Wanaka, taking a harbour cruise, or visiting the Taieri Gorge railway.

Conference sponsors include Otago Polytechnic, Resene, Carbatec, and Fair Dinkum Sheds.

Menzshed sheddies wishing to register can do so at menzshed.org.nz/conferences.

For more information, email conference@menzshed.nz or phone 022 163 8661.



WAIKATO LEADS THE WORLD IN ASPARAGUS-PICKING TECH

IF YOU ARE LOOKING FOR AN ENGINEERING ROBOTICS PROJECT THE UNIVERSITY OF WAIKATO WILL FIND YOU SOMETHING YOU WON'T GET ELSEWHERE

By: Ian Parkes

Dr Shen Hin Lim is well on the way to developing the first effective asparagus harvesting machine. He can't claim to have held a lifelong fascination with the tasty vegetable spears but when you turn up at the University of Waikato's robotics engineering team looking for a project to get stuck into, what could be better than a problem that has defeated engineers for generations.

It comes as something of a surprise to learn that even in today's mechanised high-wage societies that the current crop of asparagus spear collectors just don't work. Almost all asparagus is harvested around the world by people with sharp blades bending down to cut them off. That's back-breaking, unpopular work and the labour costs in New Zealand are considerable. It's a problem growers here and around the world are keen to solve.

The answer is a machine

Hin says the machines available to date either damage the produce or they are too slow. Getting a machine that worked would be a breakthrough but Hin is aiming higher. The main issue is labour so his goal is to create remotely-monitored, fully-autonomous asparagus harvesting.

“spotting potential of Xbox Kinect, Microsoft's readily available hardware”

He began the project in 2016 by looking at the machines developed so far and decided to go for a completely fresh start.

One of the big challenges in asparagus harvesting is identifying which shoots to pick.

Unlike a lot of crops which are

harvested in one swoop, asparagus farmers need to spot spears ripe for cutting among those still growing, and keep going over the ground rain or shine.

Modern imaging tech meant he could start some way down the track. Cheap high-resolution cameras supplied the images readily enough but how to process them? Developing that technology from scratch would take a lot of programming, let alone translating that into instructions for the cutter.

A software shortcut

The team realised that with a bit of lateral thinking they could take a shortcut. They decided to unlock the asparagus spotting potential of Xbox Kinect, Microsoft's readily available hardware and software module, which was designed to carry out 3D *(continued on page 54)*

EXPOSED WIRING

I've been reading your great magazine for over 10 years, and I hate to be 'that guy' but I was a little concerned about one of the articles in this month's issue [The Shed Issue No. 88].

In the music box, a mains-powered light was added, operated by a relay from the controller. There is clearly exposed mains wiring inside the unit, and this really should be contained in a safe case.

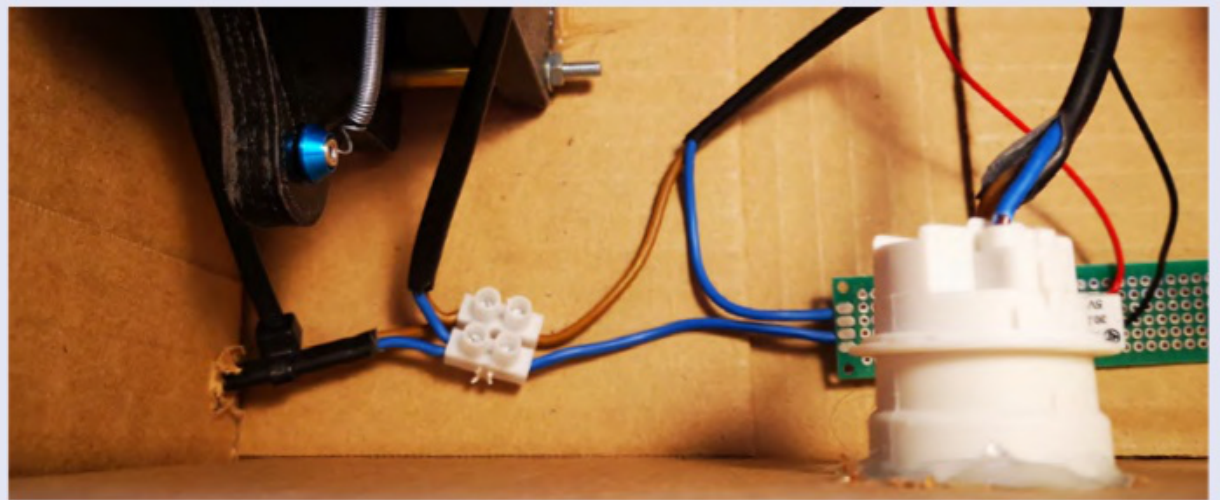
I would suggest that a cardboard box tied shut with a piece of string is not a suitable container for mains wiring. Although you would like to think most people wouldn't open the box and poke around, the fact they could easily do so is potentially dangerous.

Kevin Steele

Thank you for your comment Kevin, you are absolutely right.

These projects are prototypes and the most important aspect is showing how they can be built instead of keeping them totally closed. The idea is that they should inspire readers to make their own projects based on the same principles.

In this specific case, the cardboard is just like the spring charger simulator, a decoration based on my original design. With this project, as well as others, they



are finished with robust and secure connections. All my creations will be shown at an electronics fair or exhibition where it is difficult to control what the kids are doing while moving between the stands in a crowded space.

In this particular case, when the prototype worked well and after testing for some days, I added a small insulation plate to the interior behind the two soldering points of the relay contacts and glued the box closed.

Finally, one important consideration is using the right power source for the devices to avoid unexpected overheating. As a matter of fact, it is riskier to have overheating if you stress the 5V powered microcontroller than an oversized relay to power that LED lamp.

As well as the security aspects, there

are also some other details that are not shown, as I consider them obvious. For example, when I photograph myself soldering I don't wear protective glasses, but this is just so I can shoot.

It has been suggested that a behind-the-scenes video showing how the images and video are shot might be a fun way to illustrate the projects to our readers. We shall see.

Enrico Miglino

Letter
of the
MONTH



LETTER OF THE MONTH PRIZE

Every issue, our Letter of the Month winner will receive a gift bag of great Selley's products. This month's prize pack is a selection of Selley's products to clean your well-used barbeque. Remember, "If its Selley's it works"

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Aldon Peters in his shed with
his musical chest of drawers

THE CHEST OF MUSIC

MAKING A CHEST OF DRAWERS THAT IS ALSO AN
INSTRUMENT PROVES A CHALLENGING PROJECT

By Ray Cleaver

Photographs: Rob Tucker

What's the difference between
a pipe organ and a chest of
drawers?

Nothing at all, according to
Eldon Peters of New Plymouth. Few
people head into their shed to play
tunes on their chest of drawers but
Eldon does just that, having made a
functioning instrument from one.

The project may also answer the
perennial question of what architects
get up to when they retire and the
shed beckons. Eldon's remarkable
contraption appears to the eye to
be a perfectly functional home-
made kauri chest of drawers. The
difference is that it is also a working
musical instrument! ►



Clamping the unit together

A learning exercise

Eldon enjoys working with wood. “Woodwork has interested me since primary school but my musical abilities and knowledge was limited to playing the recorder,” he says.

“I’ve never played the organ or keyboard before but I sure learned a lot musically on this job.”

The 66-year-old New Plymouth architect retired 18 months ago and the project was created over three years. The organ is played by opening and shutting the drawers. Eight of the drawers cover an octave in the key of C major, and two larger drawers play C and G.

“Then there’s three bottom drawers but they are just that — storage drawers,” he says.

“The musical drawers are like pistons, with a single cloth-flap valve at the back, and they force air into wooden organ pipes at the back of the

unit to play the notes.”

The operation was built from scratch and the project required a lot of head-scratching and research.

“I found a formula online for the

“I ... thought it all looked quite straightforward. Then things got complicated”

pipe size to match the note required and thought it all looked quite straightforward. Then things got complicated,” he recalls.

“I knew about the amount of wind required from playing the bass recorder. The length of the pipe gives the note and the size of it gives the volume and tone, but the slot where the air enters the lip of the pipe is crucial.

“To establish the air pressure I sought advice from a mechanical engineer and hooked up some plastic pipes containing water and measured the rise of water in inches, then converted inches of water pressure to pascals, which I could plug into a formula.

“Then the fun started.”



The chest of drawers taking shape

A combo of oak and puriri

The organ pipes are made of English oak with small puriri blocks at the end.

“The oak is from old furniture, about 60 years old, so it’s very dry and stable,” Eldon tells us.

“The puriri is a fine-grain timber and I could machine it to the nearest thousandth of an inch.

“Creating the very fine slot at the base of the pipe, which takes the air current, called the ‘wind sheet’, involved a lot of trial and error. The air travels through a slot that varies between 18 to 30 thousandths of an inch thick, depending on the note.”

To plane out the shape for the wind sheet, Eldon bought a cheap hand plane and adapted the blade by grinding it down and drilling out the ‘frog’ (the slot under the plane). He used the plane like a router to make the parallel slot on the pipe for the wind sheet.

The pipes are held in place with little clips made of kwila.

At the back of each drawer is a group of round holes for the airflow covered with a simple cloth-flap valve made of square pieces from an old cotton sheet. ►



Left: Gluing up an organ pipe

Below: Testing the air pressure of a drawer

Bottom: The pipes in place





Putting the parquet top together

The chest of drawers

Building the wooden chest of drawers was well within Eldon's scope. He made it from recycled kauri with dovetail joints.

"I'd been saving kauri for a lifetime and the project was a good use for it," he says.

Some of the kauri had come from renovations on his late-Victorian villa.

The drawer sides needed to be stable and he made these from 12mm birch ply.

The carcass and backs of the drawers are made from 18mm poplar ply and the bottoms of the drawers are 10mm poplar ply. The drawers are sealed with felt to minimize air loss.

"The drawer heights actually get bigger as you go down the unit.

"It's a traditional thing in joinery to counter the optical illusion of drawers getting smaller when looking down from above," he explains. ►



The pipes and protective musical stave



Build tools

Eldon's DeWalt thicknesser was a vital tool for the project, along with an old Tanner buzzer he acquired from a builder.

The wood was cut to size with an old Ryobi draw saw and his 14-inch Ascent bandsaw.

A wood lathe and a drill press make up his power tools in the shed.

He finished the drawers off with Briwax Danish oil.

"It's very forgiving and comes up well," he says.



Right: The sound hole of a pipe

Below: A completed oak pipe

Bottom: Notes marked with keys from an old typewriter



Parquet top

The top of the unit is a pattern of 5mm thick, small kauri shapes done in parquet.

“I wanted more than the usual chevron pattern, so I added square pieces,” Eldon states.

“The top is a sandwich panel with parquet on both sides of a ply core. The bottom layer is rimu, the top layer kauri.

“I made each layer into a blanket with masking tape holding it together and glued with Titebond wood glue, which worked well. The whole blanket was then glued to the core with Norski epoxy resin with glue powder added.”

On the back of the drawers is a screen to protect the pipes from damage. It is an assembled shape from 5mm square kauri sticks and is based on a musical stave, showing the first

notes of Beethoven’s Ode to Joy.

The drawer handles are shaped like organ stops and the musical drawers are marked with their notes with keys off a vintage typewriter.

Eldon made wheels for the unit

It ... is based on a musical stave, showing the first notes of Beethoven’s Ode to Joy

with three laminated pieces of wood with each piece turned 60 degrees for strength.

“I glued the pieces together with a two-pack epoxy glue — CRC Builders Glue. It worked well,” he says. ►

The pipe organ

The pipe organ operates by driving air down various pipes from a keyboard and most organs have controls called ‘stops’ that play many ranks of pipes of differing timbre, pitch, and volume.

The majority have one or more keyboards played by the hands or feet that creates a continuous supply of wind, allowing it to sustain notes for as long as the keys are pressed.

This is where it differs from the piano and harpsichord, where sound begins to dissipate immediately after a key is depressed.

The smallest portable pipe organs may have only eight pipes, like Eldon’s; or bigger models with one or two dozen pipes up to the giant cathedral organs with over 33,000 pipes.

Early versions of the pipe organ can be traced back to ancient Greece in 3BC. By 6 or 7AD, bellows were used to supply Byzantine organs with wind.

The first organ in England was built in the 10th century in Winchester Cathedral. It was quite a huge machine with 400 pipes, which needed two men to play it and 70 men to blow it!



Reconstruction of ancient Roman Aquincum pipe organ



Left: The kwila clips that hold the pipes in place
Below: One of the cloth flaps that acts as a valve
Bottom: Pipe installation





A challenge

Eldon even put in an on-off slider that vents the holes if needed.

“You don’t want to be getting something out of a drawer at 2am and wake the house up,” he says with a grin.

“It’s primarily a set of drawers to store things in, not a musical instrument. I really made it for a laugh. It will go to my son and family to use.

“It’s been a fun and interesting challenge.”

Eldon gives us a demo before we leave. He opens and shuts the drawers to play Beethoven’s Ode to Joy.

You can hear it being played and watch a clip of Eldon talking about the project on *The Shed* website. 



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STEEL JUST TOO HARD TO BEAT

IF YOU KNOW WHAT YOU WANT IN A SHED, JUST GET ON WITH IT — UNLESS YOU CAN MAKE IT BIGGER

By Ian Parkes Photographs: Tony Carter

Harley Coombe didn't want a steel shed. "I'm a wooden-shed man," he says. "It's easier to modify and hang stuff on the walls."

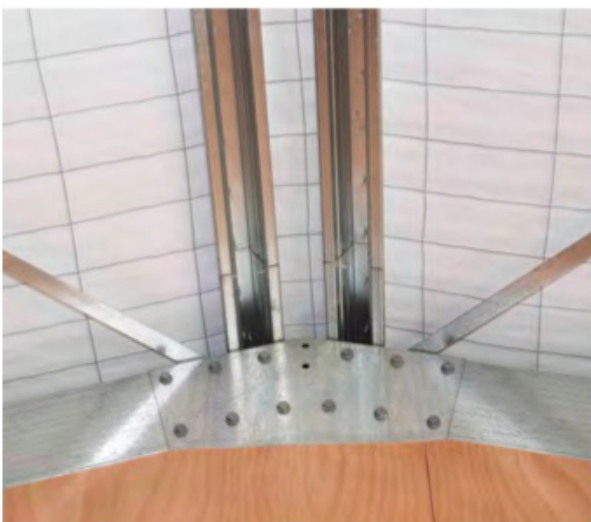
But after getting a couple of quotes he thought he'd better get a couple of quotes from steel shed suppliers too. "Even the best of the wooden sheds wasn't within cooee," says the Taranaki mechanic.

And it didn't take him long to decide

"I just like to get on with it and there was no messing about. I said I could give them a level patch of clay and just handed it over to them"

to go with the local KiwiSpan supplier: "I just like to get on with it and there was no messing about. I said I could give them a level patch of clay and just handed it over to them. The other guys, there was more humming and harring and I could see right away these were the guys for me."

Harley had given them a list of basic requirements. He wanted height to fit in a tractor he was doing up and a



Robust construction went up fast



boat, with space for motorbikes, and a hoist, and it had to fit within a building consent envelope. KiwiSpan came back quickly with some plans and a quote.

They gave him both three- and four-bay options, which prompted a quick rethink. “I talked it over with some mates and had a look at another shed and of course they said you need the biggest shed possible,” Harley recalls. “The price difference for the extra bay wasn’t that great so we went with it.”

Owner operator of KiwiSpan Taranaki Joel Schrader says, “that’s what we do”.

“We quote exactly what the client wants and then give them a couple of options. You can save a bit of money here or for not much more you can have an extra bay. You only do it once and you can never have too big a shed. That’s something that never happens, Joel says: “We’ve never had a complaint that a shed is too big.”

Joel says Harley and Susan had a budget in mind but they worked out the cost per square metre and the bigger shed worked out cheaper so they went with that.

“They were great to deal with,” says Joel. “They knew exactly what they wanted, they liked the quality of the KiwiSpan shed, and they were ready to get on with it.”

Harley said his new shed went up very smoothly — it was more straightforward than the house build that was going on at the same time.

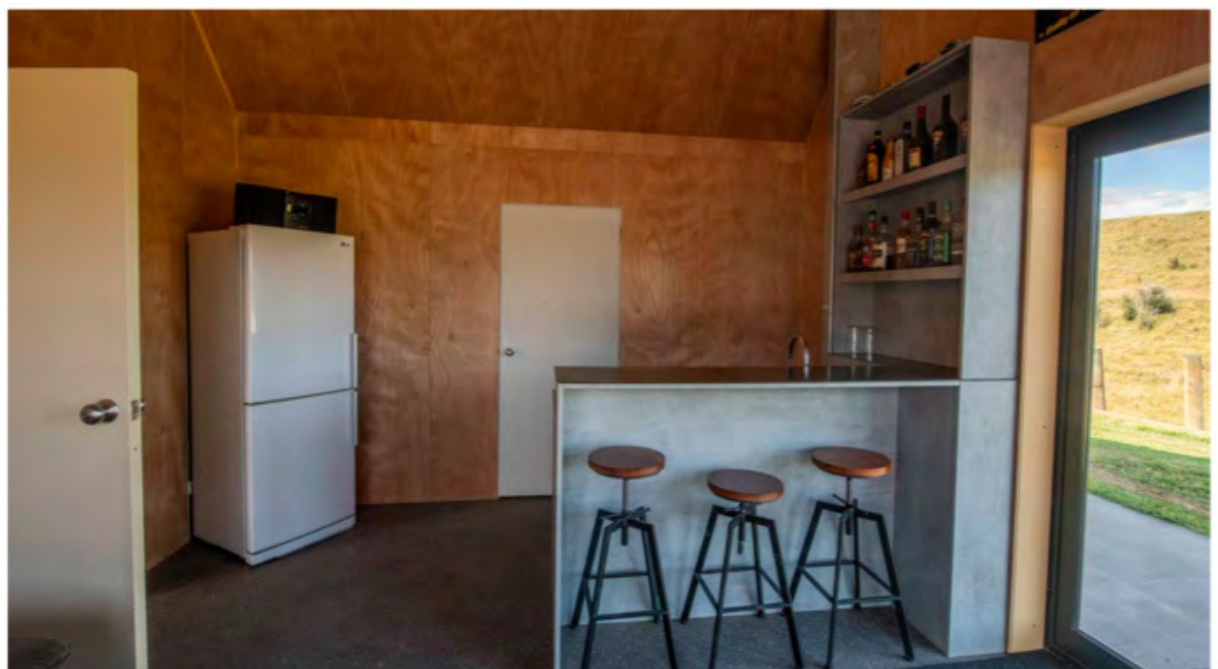
The shed also went up fast, which

meant it became handy storage for materials for the house build during the winter. “That was part of the plan,” Harley says.

Harley added the water tank, catching water from the roof, and he lined one end of the shed with plywood. That gave him the ‘man cave’ area he was after with the original

idea of a wooden shed and the ability to hang stuff wherever he wanted. He chose to line it to the roofline, just for the extra sense of space — something he is not short of.

Harley is delighted with the shed, and his decision to go for the extra space to really make the most of a great opportunity to create a great shed. 📁



Plywood panelling creates a cosy man cave (above) and a hoist adds access and provides storage (below)





TACKLING STAINLESS

A GUIDE TO WELDING STAINLESS STEEL

By Greg Holster — Photographs: Jude Woodside

I get so many people asking me what is the best way to weld stainless steel. There are many different versions of the best way. Hopefully this article will give you Sheddies a few helpful hints on welding stainless. For the sake of simplicity, I will stick to the common 300-series stainless steels.

One of the things I like about welding stainless is that the welding machinery is generally the same amperage and has the same material thickness capability as mild steel. Within reason, you could say they were cousins.

However, there are a few differences

with some of the physical and chemical properties of stainless steel compared with mild steel and this can affect your welding variables. And, no, I am not going to give you a chemistry lesson.

Austenitic stainless steels are the most common types that we come across in day-to-day life. Marine fittings are normally 316L; the likes of kitchen benches, shower trays, etc, are often 304L. You will notice when purchasing MIG wire, TIG rod, and arc-welding electrodes that the wires have an 'L' designator, indicating that the material or consumable has a

carbon level that falls in the low end of the carbon range. You will find that most consumables also have an 'Si' designation, which means that the consumable has a higher silicon content, which provides more weld pool fluidity and controllability.

The coefficient of thermal expansion for these austenitic 300-series stainless steels is about 50 per cent greater than that of mild steel. This translates into a recipe for more distortion than you may find when doing mild steel work. So my advice to minimize warping,



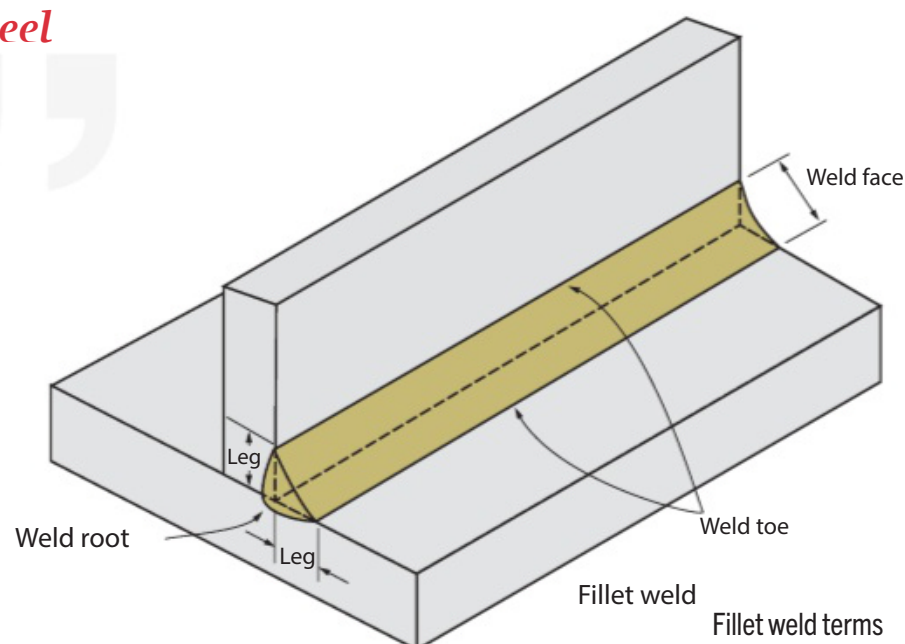
in particular on lighter gauge sheet metals, is to try welding at the lowest current or level that you possibly can. However, not too low, as you still need good fusion between the consumable being used and the parent stainless steel.

If you're using MIG, don't be afraid to move quickly. Faster travel speeds mean less heat input. The higher silicon in stainless wires helps the weld flow at these faster welding speeds. Practise on scrap pieces and you will be pleasantly surprised. Stainless steel also has lower thermal conductivity, which means that heat created from the welding process does not dissipate from the welded area as quickly. Whichever process you

Don't be afraid to move faster than you would with normal mild-steel MIG welding

choose, this also means that the welding will not require as much amperage to achieve good fusion because the heat is not leaking away from the welding area as rapidly. A heat sink attached to the weldment can be a good idea. Stainless steel's lower

electrical conductivity means that your wire-feed speed will be at a similar rate to that when welding mild steel. You will notice that the weld pool appears ►





Stainless steel 316L MIG wire



MIG welding stainless steel

to produce a lower current level with stainless-steel welding than with mild steel. Something to mention regarding the lower conductivity of stainless is that maintaining a consistent contact tip / tungsten electrode to material distance is more important when welding stainless steel. This is because inconsistent variations can result in a greater degree

of change in welding current levels. I like to keep a short arc no matter what process is being used and a steady hand is also important.

Welding mild steel to stainless is an easy and painless procedure. Use 309LSi as it has a higher percentage of chrome and the carbon content is also higher.

And let's not forget stainless steel's

corrosion resistance, which means it doesn't rust like steel does. This is possible because stainless has higher levels of alloys in the base metal, mainly chromium and nickel. These higher levels of goodies in stainless also decrease the weld-ability and you can have a wrinkled or ropey weld profile if settings and techniques are out of sync.



Stainless steel MIG weld using argon



MIG weld with Stainshield Universal

MIG welding

As far as wire feed (amps) and voltage settings go, most good, single-phase MIG welders should have a recommended settings chart on the door of the machine or in the instruction book. If for some reason it does not have settings for stainless steel, then use as a starting point the recommended settings for mild steel. From here you can adjust the settings to fine-tune the MIG welding arc. You may need to run a slightly higher wire-feed speed rate than you would with mild steel. A higher voltage setting may be needed. This will help wet out the weld pool a bit more, giving a flatter face and better shape at the edge of the weld bead, especially when using part-helium mixtures in the shielding gas. Don't be afraid to move faster than you would with normal mild-steel MIG welding. Feeding stainless wire needs no special options; no fancy liners, just normal V-groove rollers. I like to use 0.8mm wire, usually 316LSi, as this will cover 304, 308, and 316 applications.

Use only a forehand or push technique, not backhand or dragging. Pushing will give a nice flat mitre-fillet weld.

Often on thin stainless sheet, short circuit or dip transfer mode will be your best machine setting. This will transfer the least amount of heat into the piece you are welding. Dip transfer has a much lower heat input than arc welding or TIG welding. While dip transfer has a lower heat input and can

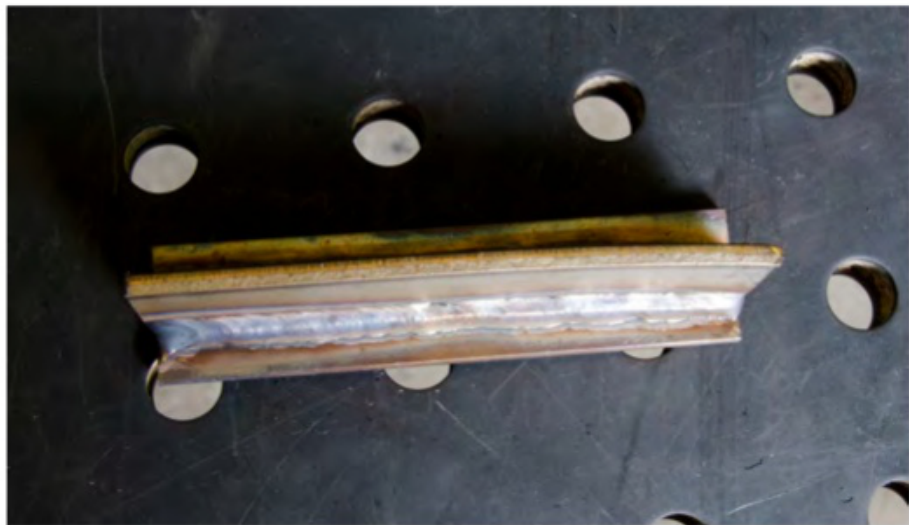
If you're using MIG, don't be afraid to move quickly. Faster travel speeds mean less heat input

reduce the chances of burning through on thin sheet, it can also produce a cold, rounded-looking weld bead.

Let's clarify what is meant by 'dip transfer' in MIG. Let's assume your machine is 250A single-phase. As you set your machine from its lowest setting to maximum, there are three changes the arc will go through. The first is short-circuit metal transfer, or dip transfer. The second is globular transfer, and the third is spray arc.

These three transfers describe the manner in which metal is transferred from the MIG wire to the weld pool on the parent metal. In 'dip transfer', you hear a fast 'crackling' sound, often likened to the sound of bacon frying. At low amps, dip transfer is a stiff arc ideal for thinner materials. 'Globular transfer' is when the droplets of weld burn off and drop into the weld pool. It makes an uneven, splattering sound, with the odd little hiss here and there. Globular transfer is not often used in industry. It's more like the rough ride from dip until you get to spray. 'Spray transfer' is exactly what it sounds like — a nice hot, hissing sound as the hot metal transfers in a steady stream.

The factors that affect the molten weld metals are the welding current / wire-feed speed, voltage, wire size, arc length, power supply (transformer or inverter), and the type of shielding gas being used. Using stainless 0.8mm 316LSi wire, dip transfer will occur up to about 150A. Between 150 and 180A we have globular transfer and above this we have spray transfer. For 0.9mm add about 10 per cent on top of these amperages. ►



An example of distortion caused by too much heat



Chromium oxides on underside of weld



Typical settings for fillet welding 5mm stainless



Stick welding stainless steel

Shielding gases

If you want to do things the right way, using a recommended stainless-steel shielding gas is extremely important. I like to use Stainshield Universal which has 55 per cent helium, 1.5 per cent CO₂, and the balance is argon. There is a 2 per cent CO₂, 98 per cent argon mix as well which is also very popular. These gas mixtures are made to maximize penetration, sidewall fusion, and break up the surface tension in the weld pool. I get asked quite often if you can use pure argon instead of paying for another cylinder that may not be used up completely.

The metallurgist's answer to that is no. You will get a hot, globular, unstable weld pool, with below-average sidewall and toe of the weld fusion. The weld will be rounded and ropey looking. The Sheddie's answer to this question is what service is your project/weldment doing? Corrosive resistance will be fine, strength

average, and the look — depending on how well you can weld — may be a bit below average. But that's what grinders and flap discs are for. I have used straight argon to do the odd little job on MIG and given it a good grind afterwards.

*These gas mixtures
are made to maximize
penetration*

So can you weld stainless with standard mild steel Argoshield mixes? Again the metallurgist's answer is no. But you can weld with these gases. The problem is the CO₂ in these mixtures is far too high. It can cause cracking and the carbon content will rise. It forms chromium oxides and the corrosion resistance goes out the window. But once

again, consider what purpose the item will serve. The problem here is the weld will look perfect but it won't show the metallurgical deficiencies. Many muffler/exhaust shops still weld stainless exhaust pipes with CO₂ and mild steel wire. This is because everything is bracketed or mounted. The mufflers themselves are all MIG welded or TIG welded with the correct gas and consumables.

There is a stainless flux-cored wire that uses CO₂ as its shielding gas but this is for heavier sections of stainless and the chemistry in the flux counteracts the problems that CO₂ can cause.

The Stainshield Stainless mixes with between 25 and 55 per cent helium are quite good for mild-steel MIG welding, especially the Universal which has 55 per cent helium. Although it may be a bit more expensive, if you want to do a lot of stainless and mild steel, consider this as an option.

TIG welding stainless

When you want to start welding stainless steel, there are a few points of the TIG process that are very important to maintain stainless steel's corrosion resistance and strength. Just like MIG welding, stainless distortion is a problem so minimizing heat input is a priority. Choosing the correct TIG filler rod is also similar to MIG. Some people actually use MIG wire as a TIG filler. When welding 300-series stainless, keep to the simple fillers — I would suggest 316LSi.

Joint preparation is more important when welding stainless steel than when welding mild steel, mostly because of distortion. Bracing, strong backs, or heat sinks are all good options, so try to make room for one of these options when choosing a joint prep. A clean, dry, and oil-free set-up is also vital.

I won't get into the different types of TIG machines but what you need is a DC power source. High-frequency start is a bit of a luxury and I don't mind using scratch start or lift start. TIG welding stainless uses argon gas. A negative electrode, positive earth should be the terminal set-up with

argon gas set at around 6–10 litres per minute.

Use a thoriated tungsten electrode ground to a point. The size of tungsten is dependent on the amps being used and material thickness. I use a 2.4mm for everything from 1mm to 10mm. TIG torch cup sizes range from 6mm diameter to 15mm. Larger sizes give the operator

*When good results
are achieved, for
goodness' sake record
the settings*

a wider envelope of shielding gas but can make seeing the end of the tungsten more difficult. The answer to that would be to use a gas lens set-up. A gas lens streams the argon gas through the nozzle more like a beam or channel. This means that the tungsten can be protruding up to 20mm or more if you turn the argon flow up. This is awesome for teaching welding as it makes seeing and controlling the weld pool so much easier.

The thing about the TIG welding

process on any material is you are welding the lowest manual welding deposition rate and normally at very slow welding speeds. This can make welding stainless steel much harder than normal mild steel. Learning and improving your TIG welding technique will enable you to weld faster, while still retaining the same weld quality. This has an effect on heat input and therefore results in less distortion. By the way, when good results are achieved, for goodness' sake record the settings.

Thoroughly clean the area to be welded. Cleanliness cannot be stressed enough. It's not like MIG or stick where you might get away with welding over a bit of oil or unclean metal. If you try to TIG weld over oil, grease, paint, or heavy oxide, you will contaminate the tungsten electrode and the weld pool and upset the weld chemistry.

Make sure that the weld joint area and also the filler rods are as clean as possible. This is an important preparation. Remove all oil, grease, paint, rust, and dirt. Contaminants such as these may result in arc instability, contaminated welds, and/or contaminated tungsten. ►



TIG weld in stainless using argon



Stainless electrodes



Butt weld in TIG



Clamping pieces makes TIG welding easier



TIG welding stainless to mild steel



The completed weld

Clamping

Clamping when welding and tacking stainless may be needed if the work piece cannot be held during tacking or welding. Remember, you need both hands for TIG welding.

Tack welds

On thin materials, it is a good idea to make short 2–3mm tack welds close together, as the heat will distort the joint as it is being welded.

Good welds

So what constitutes a good weld? Look for good penetration into the base material, not too much penetration or oxides on the underside, a nice flat bead profile, or a nice flat mitre fillet if doing a fillet weld. Good bead width and good fusion at the edges of the weld are also important. Beware of ‘undercut’. This is where the toes or edges of the weld have burnt grooves into the base material. If this is the case, you have probably welded too slowly, welded at too hot a temperature, starved the weld pool of filler rod, or done a mixture of all of these. The amount of filler rod is something the operator will decide on depending on the profile needed. Practise on an offcut first. Keep the

tungsten as close as possible to the weld pool — this will give you good penetration and aid in reducing heat input. Remember to let the argon flow until the tungsten has stopped glowing. If you have post flow, set it at 10 seconds or more. An oxidized tungsten makes for a dirty start or tack.

Oxidization and discolouration of

My little angle grinder turns out to be as important as the welding part of some of my projects

the weld area can really spoil a nice weld. If sanding or polishing to clean up welding beads, make sure you use iron-free abrasives or you will quickly see the rust spots forming. You will get oxidation on the back side of thin sheet. This chromium oxide should be cleaned off, as it is a given it will rust or oxidize. Back purging will stop this happening and there are also tapes and fluxes available, such as solar flux.

Passivating paste or pickling paste is a good alternative for cleaning up

welds, especially if you want to show them off. But be prepared for criticism, as everybody becomes a welding expert when they find out you’ve done it yourself.

Depending on the type of finish you require, most fabricators will want to sand and polish back the welds. My choice was a 4½-inch (115mm) Hitachi angle grinder complete with iron-free cutting, grinding, sanding, and polishing discs. My little angle grinder turns out to be as important as the welding part of some of my projects.

Every good welding professional, if they are honest, will tell you that they were more proficient with the angle grinder or the scrap bin long before they were proficient with good welding techniques. Nothing is different in my shed; my trusty angle grinder sometimes gets a good workout, mostly by my choice. The reality is that no matter how magnificent the weld looks, or which process used to do the welding, if you have good penetration and the weld is going to be ground flush anyway, who cares how pretty or ugly the original weld looked? But I am a realist. I might not quite be a Rembrandt with a welder but I am certainly a Michelangelo with a 4½-inch grinder and a flap disc. ►



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Gas lens

A 'gas lens' works by directing the gas into a laminar flow to cover the electrode and the weld pool. A 'laminar flow' is a flow of fluid or gas that has little turbulence. It focuses the gas flow in much the same manner as a laser directs a stream of light. Because the flow of gas is more focused and less turbulent, the effective shield is longer, meaning the tip can project further but still be sure of being in the shield. It allows you to see the tip better and subsequently the arc. The gas lens is a more effective use of a gas shield for TIG.

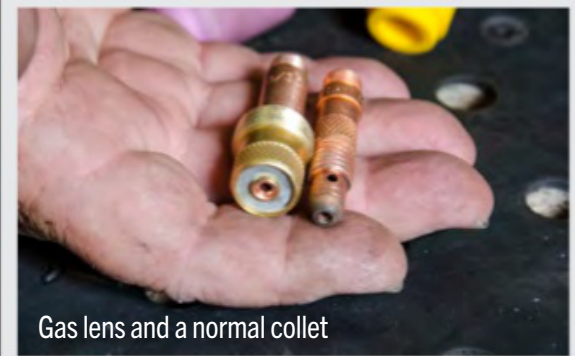
The lens replaces the usual collet and includes a porous that helps to improve the gas flow. They are especially useful on alloys, including stainless steel and aluminium.



Gas lens on the right showing the laminar flow compared with standard gas glow



Gas lens components



Gas lens and a normal collet



Arc weld on stainless steel. Note the glassy slag and the typical colour



Welding stainless with low voltage

Arc welding

Arc welding stainless is a breeze, as long as you don't want to weld anything really thin, or weld out of position. Much of it comes down to joint configuration — maybe a butt joint becomes a lap joint, or a backing bar can be used. I have welded tube 1.5mm wall thickness and have sleeved the joint.

Some of the advantages

- Lower skill level required.
- You can buy the 2.5mm 316L arc rods in small rod packs. I always keep a few on hand.
- No shielding gases required. Single-handed operation; two if you shake like I do.
- Normally low spatter when welding with small-gauge stainless electrodes.

- Can be used outside.
- Tacks are flat. Stainless rods run really smoothly and at lower amps than mild steel rods.
- I like the fact that I can turn the machine on, stick a rod in, and weld.
- No tungstens to grind, no gas cylinders, good basic 'in the shed' making fire with an arc rod.

The disadvantages

- You need a good fit-up and gaps can create easy burn-through. Once you have burnt that hole, it just keeps growing.
- Arc rods can be difficult to use out of position. Learners will not find it easy to weld tube or sheet with a 1.5mm thickness or less.

Practise first — get the amps right with smooth movement and you'll have no problems.

Safety

Be aware the fumes wafting past your nose have chrome and other nasties in them, so keep that in mind. Also the reflection off bright stainless can give you a real burning-arc tan; not a good look.

If you are stick welding, be aware of the slag — it's glassy. As it cools, it will 'ping' off without warning. Get a hot sliver of that in your eye and you won't be very happy.

Practising makes welding fun and will give you a real sense of achievement. Don't throw away those old stainless sinks and shower trays — build yourself that smoker, wood-fired spa heater, an artistic stainless garden sculpture or barbecue hood ...

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Shine like a diamond

It's been a long-time Kiwi favourite for a very good reason — Autosol Metal Polish is the ideal way to clean, polish, and protect all types of metal surfaces.

Always a smart option for having a tube on hand should the need arise to remove corrosion, tarnishing, or discolouration, it's also super simple to apply. The Metal Polish lacks the toxic elements that many other polishes contain, so its NFS Food Safe Grading formula is safe to use on metal kitchen benches, pots, and pans. You won't find any pollution-causing microplastics, either.

Autosol Metal Polish can be found in a range of sizes at leading automotive, hardware, and engineering stores nationwide. For more info, visit hobeca.co.nz

Smooth and steady

Looking for a high-quality, direct-current TIG welder for your perfect home shop set-up? The Smootharc TIG 200 DC from BOC Gas & Gear might just be the perfect solution.

Ideal for working with stainless steel, the TIG 200 DC allows you to get the job done cleanly and quickly while laying down the perfect row of pennies. It's a great welder, no doubt, but the best thing about this deal from BOC might just be that this the full package, coming with a TIG torch, gas hose, regulator, and work return lead, can be yours for just \$810.30. This deal is only running from 1 March 2020 until 30 April 2020, or while stocks last, and doesn't include delivery charges, so contact your local BOC Gas & Gear or head to boc.co.nz for more info.



Professional performance vacuums

Shop-Vac's new range is here and led by the L Class wet-and-dry vacuums that trap over 99 per cent of the dust generated when connected to your power tool. The Shop-Vac Pro 20L, 40L, and 60L vacuum cleaners all feature a blower port that turns your vacuum into a powerful blower, plus their wet/dry cleaning power really takes care of those tough clean-up jobs. The Shop-Vac Pros have power tool plug-in capacity for dustless drilling, sanding, and grinding, plus the auto start/stop function works with compatible power tools. These models are bagless but they come with an optional collection bag, as well as a 2.4m x 32mm lock-on hose, two Posi-Lock metal wands, dual-surface nozzle, wet/dry nozzle, round brush, crevice tool, gulper nozzle, HEPA cartridge filter, and a tool adaptor.

Pricing on the Shop-Vac Pro range, which meets WorkSafe New Zealand guidelines starts from \$320. Get more information from Fox & Gunn, the new official distributor of Shop-Vac in New Zealand, at foxgunn.co.nz.

High Viz tape measures

The Komelon High Viz tape measure range takes the traditional metal tape measure to the next level with features including a high-visibility blade, a comfortable-to-handle chrome case, and a slide lock. The blade is nylon coated for added protection, with accuracy provided by the Class II-level precision printing for easy reading of the measurement gradations. The high-carbon steel blade extends smoothly, and the true-zero magnetic end hook is triple riveted. These quality tape measures come in a variety of lengths priced between \$30 and \$50.



Plug or cap it with Stockcap

When you are pulling apart engines, machinery, and hydraulics, and you need protection to plug-off or cap fluid lines, ports, and threads, throw away the rags and the tape and contact Hi-Q Components. Hi-Q stocks the Stockcap range, manufactured by Australia's Sinclair & Rush, which produces hundreds if not thousands of protective plastic caps and plugs for applications including high-temperature masking, shipping protection, contamination control, and health and safety. For more information or to request a catalogue, email sales@hiq.co.nz or phone 0800 800 293; buy online at hiq.co.nz.



Versatile cordless heat gun

The DeWalt DCE530N cordless heat gun is ideal for stripping paint, thawing pipes and much more. Choose between high (530 C) or low (290 C) temperatures for different applications. A lock-on switch means you don't have to hold down the trigger, improving comfort, and air vents expel hot air from the sides to reduce the risk of overheating. It can be used to shrink tubing around electrical cables, bend PVC pipes, thaw pipes, dry filler, remove decals and stickers, and loosen nuts and bolts. The cordless heat gun retails for \$218 and you can visit bunnings.co.nz for more information.



German precision

German manufacturer Mafell has been producing high-end portable carpentry equipment for nearly a century, and the P1cc jigsaw carries on that fine tradition. After sitting down with carpenters and engineers from around the world, Mafell took the feedback on board and determined that jigsaws needed to be far more precise than what was previously available on the market. The end result of all that R&D is the P1cc, a jigsaw that handles like an absolute dream, offers 11 different blade types, and even blows air across the floating blade to prevent burning. The P1cc is compatible with the Mafell guide rail system, as well as T-shank blades from most other manufacturers.

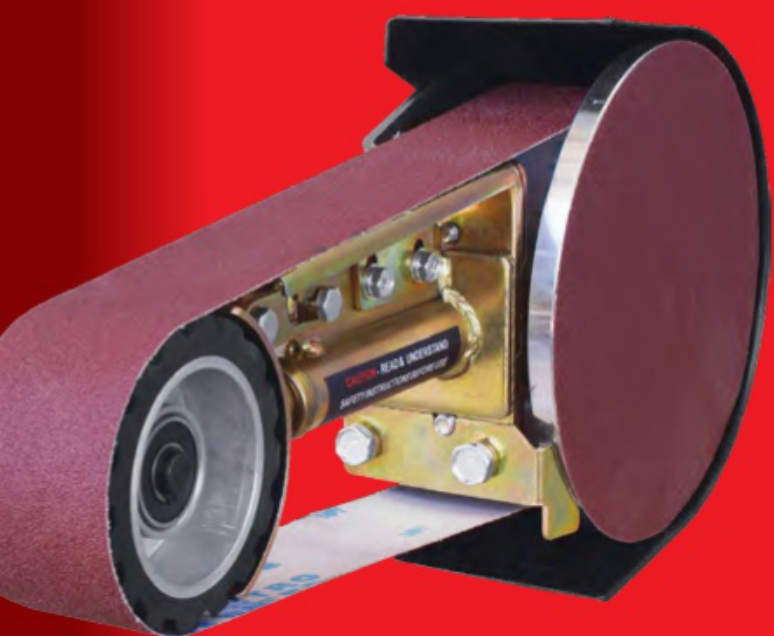
This beauty of a jigsaw will set you back \$1288 including GST, and you can find more information at jacks.co.nz.



Do it all

Want to get more from your bench grinder? The Aussie-designed Multitool attachment can be used on most bench grinders, replacing the grinding wheel. This converts your traditional grinder into a multi-use work station ideal for grinding, sanding, shaping, sharpening, polishing, and refinishing. The Multitool is super efficient and versatile, allowing for grinding, sanding, or polishing in four different positions — rubber contact wheel, platen, disc, or free-strapping. It can also be swivelled vertically or any position in between and is simple to adjust and even easier to swap out worn belts on.

Robust and maintenance-free, the Multitool comes with a fitting kit and a three-year warranty — it's the perfect way to expand the usefulness of your existing bench grinder. A special price of \$386 is on offer up until 30 April — head to isl.co.nz for more info.





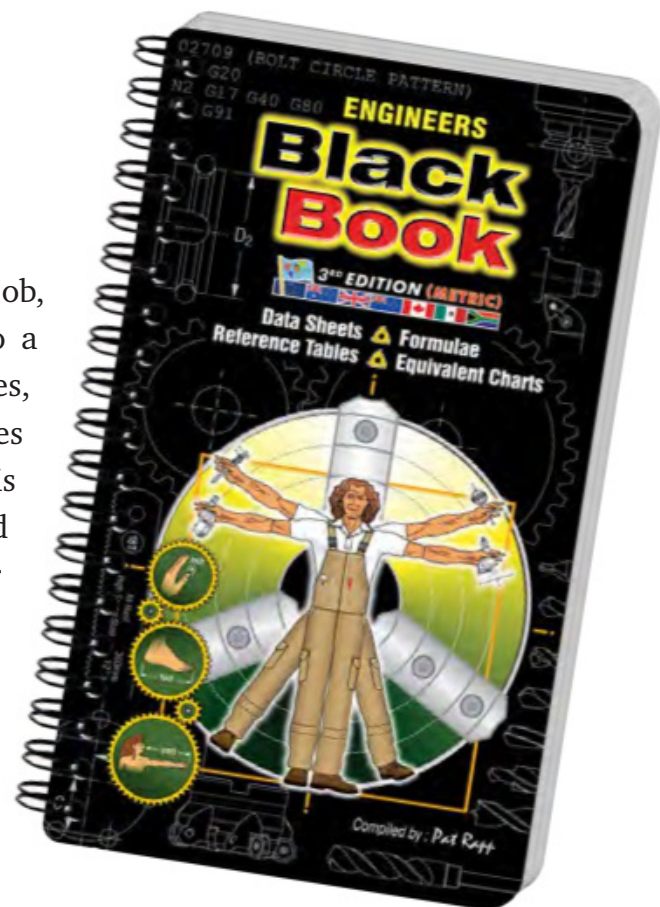
All of the power, none of the cord

The GCM 18V-216 professional mitre saw from Bosch is all about cordless flexibility, without compromising on power. Able to foot it with big 1600W corded mitre saws, the bi-turbo brushless GCM 18V-216 absolutely hums through anything you can throw at it, without having to deal with the inherent limitations and lack of manoeuvrability found when using a corded saw.

Thanks to its use of just one grunty ProCORE18V battery, the new Bosch mitre saw is incredibly lightweight, meaning it's easy to carry around from job to job and handles beautifully when in action. The GCM 18V-216 has a cutting depth of 70mm, making it perfect for a huge range of different projects. Head to bosch-pt.co.nz for more information.

Go to the source

When you are on the job, it can be a pain to go to a computer to look up tables, or find that tip on drill angles you saw somewhere. This handy little ring-bound book puts it all in your pocket. The *Engineers Black Book* is the ultimate reference book for engineers, tradespeople, apprentices, machine shops, tool rooms, and technical colleges.



It has 234 pages of tables, standards, illustrations, grinding wheel info, conversion factors, tapers, lubricants and coolant descriptions, nuts and bolts, spur gear calculations, tungsten carbide specs, plastics specs, sharpening information, G-codes, hardening and tempering guides, formulae, geometrical construction information, the weights of metals, engineering drawing standards, tolerances, keys and keyways, tapping, drill sizes, speeds and feeds, equivalence charts, and more. Available at all leading hardware, industrial, trade, and DIY suppliers.



Hafco Mini Wood Lathe

The Hafco Woodmaster WL-14V Mini Wood Lathe (order code W385) will suit both the seasoned pen turner or enthusiast hobbyist looking for a reliable and sturdy compact lathe. The lathe is made from cast iron for strength. Its two-step electronic variable-speed motor offers low-range spindle speeds from 450rpm to 1800rpm, plus a high-speed range from 900rpm to 3850rpm. The 0.55kW motor also has a variable-speed dial with a digital read-out and the drive can change direction at the flick of a switch, handy for sanding and finishing. Priced at \$655.50 incl. GST. For more information call into Machinery House, or see machineryhouse.co.nz/W385.

Festool still setting the pace

Many of the standard features of today's portable circular saws originate from Festool's TS55. The latest generation of TS55s are innovating again with an ultra-slimline housing providing a side clearance of only 12mm, and a guide wedge for greater safety and precision. A movable, transparent window also offers a clear view of the scribe mark. The RRP of \$1090 plus GST includes an extraction attachment, saw blade and 1400mm guide rail. Order number 561655. For more information see hml.co.nz





Stay sharp

Swedish company Tormek does one thing, and does it very well. Makers of the finest sharpening equipment available, Tormek has a long tradition of getting it right when it comes to keeping your tools cutting as efficiently as possible. The Tormek T8 guarantees the most precise sharpening performance for all your edges, and there are a huge range of specialist jigs to suit whatever tools you might need to bring back from the dead. Tormek is confident that it can provide the cleanest edge possible with its T8, and do so quietly and efficiently, without losing half the blade in the process. A night spent in the shed methodically sharpening all your tools' blades to the point of perfection — is there anything more satisfying than that?

The T8 retails for \$1295 including GST, and you can find more information at jacks.co.nz.

Goodbye mould and mildew

Selleys No Mould prevents mould and mildew build-up in usually damp areas of your home, like the bathroom and shower. It's an ideal solution to use when renovating your bathroom or when you're replacing old mouldy silicone. All you need to do is follow four easy steps: Remove any old silicone from the surface; spray the area with Selleys Rapid Mould Killer to make sure the area is hygienically clean and remove soap residue; rinse the surface and dry thoroughly; then apply Selleys No Mould, making sure you push the sealant into the joint. Wait for one hour and you're ready to go. You'll have a waterproof seal and mould will no longer grow.

Selleys No Mould is priced at \$19.80 and more information can be found at selleys.co.nz.



Clean your grill with a grin

BBQ & Grill Cleaner from 30 Seconds works on all interior and exterior BBQ surfaces, and is specially formulated to clean up grease, animal fats, vegetable fats and general barbecue grime and dirt, so you can cook with confidence at home or on holiday. It is fragrance-free, water soluble, biodegradable, phosphate-free, non-flammable, and made in New Zealand, and it comes in a recyclable one-litre trigger pack. See 30seconds.co.nz/product/bbq-grill-cleaner.



Make an impact quietly

The M12 Fuel Surge 1/4-inch hex hydraulic impact driver (M12FQID-0) is Milwaukee Tool's quietest 12V impact driver. It delivers best in class sound at only 76dB(A) in wood-fastening applications. Its fluid drive hydraulic powertrain reduces metal-on-metal contact within the tool, delivering quieter operation, smoother performance, and increased durability over a standard impact driver. Mode control allows the user to choose between four different speed and torque settings to suit different applications. For more information, see milwaukeetool.co.nz.



PURE PHYSICS

**MAKING A GIFT WITH A SCIENTIFIC BENT REQUIRES
PRECISE CONSTRUCTION WORK**

By Coen Smit

Photography: Coen Smit

If you're a sheddie like me you will be torn between the desire to build, and the space to put your creations. One solution, of course, is to make things as gifts for family, friends, or work colleagues.

A perfect gift, which is often sold as an executive toy, but is equally suitable for anyone you know who has even a slight

scientific bent, is a Newton's cradle.

As most of you will no doubt be aware, and can easily see from the accompanying photographs, Newton's cradle is a series of spheres suspended from a frame which at rest just touch each other. If one of the end spheres is pulled back and released to collide with the next sphere, the kinetic energy

released should transfer to each sphere in turn sending the last one off into the opposite direction, only for it to return and repeat the process. It sounds simple and it should be; however, there is some very careful and precise construction work involved to make the cradle work effectively, which makes it an interesting project for sheddies.



Drilling and tapping the boule ball



The boule cradle in action



The boule balls and fishing line that triggered the project

Ya gotta start somewhere

My first attempt involved some boule balls, which no matter what configuration I experimented with, could only manage the first part of the action, sending the furthest sphere out but not repeating the process as it returned of its own accord.

I experimented with adjusting the weight of each sphere to ensure they were identical and varied the cord length and type, as well as the width and height of the frame, all to no avail. Each boule ball weighs 750 grams, and I did have partial success using only three balls, but any more than that and it simply wouldn't work. Subsequently,

There is also a correlation between the elasticity of the sphere and its mass

I found an article that mentioned that the elasticity of the material from which the balls are made plays an important role.

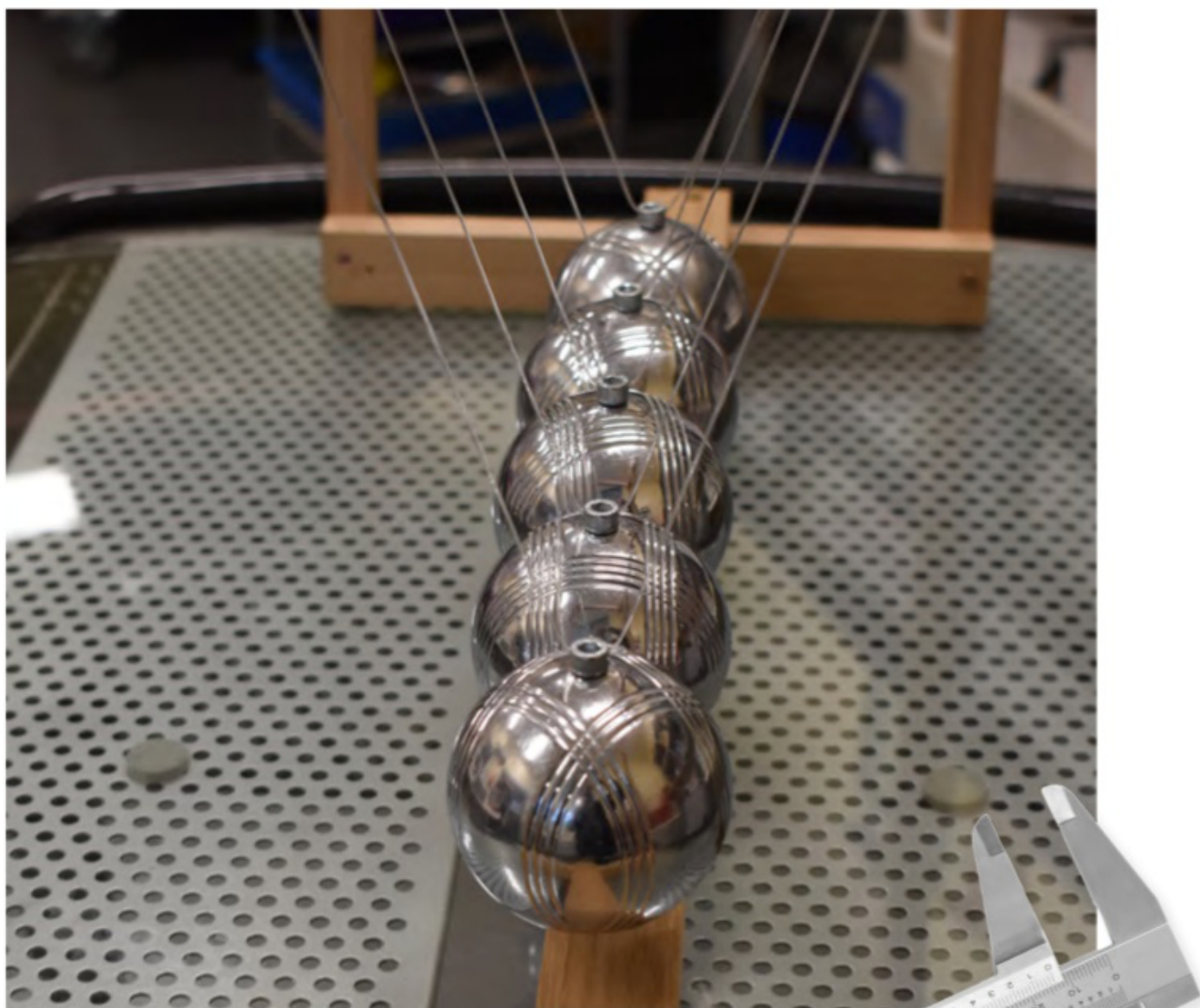
Despite having a chrome and steel shell, the boule balls I used are filled with a pinkish powder which may have affected their elasticity. There is also a correlation between the elasticity of the sphere and its mass. Once the mass becomes too large relative to the elasticity of the material, the cradle will not work properly. I suspect that this may also have contributed to the poor performance. ►

Billiard balls, maybe

So I decided to abandon this particular cradle and opted to try again using billiard balls. There were two reasons for my decision. Firstly, a colleague had success using them, and secondly, their mass is less and therefore the kinetic energy required to make it work effectively should be less, which might help with the required swing distance.

For a modest \$29 I bought a set of 16 billiard balls online. Although more than I needed, it was the cheapest way to go. I can always use the remaining balls for making other gifts. I also bought some guitar string tensioners and mounted them along one of the top edges so that I could accurately position each of the balls relative to its neighbour — they're ideal for the job as they allow very precise adjustments to be made. About 2.5m of 10-pound (4.5kg) breaking-strain braided fishing line completed the list of materials.

The balls drilled and tapped, ready for stringing



The boule cradle completed



Matching the balls

To minimize discrepancies I checked each ball's diameter and using my Vernier calipers I selected five from the set of 16 that were the closest in diameter, bearing in mind the colour finish I wanted to achieve. I chose five, as it's generally regarded that this is

This is an optimal number to demonstrate the physics involved, although apparently, any number can be used

an optimal number to demonstrate the physics involved, although apparently any number can be used.

The first task was to drill and tap a fitting into each ball so that it could be

strung up. I happened to have some 3D printer nozzles previously bought on the internet for around \$10, and I drilled out the extruder holes to 2mm to allow fishing line to be threaded through them, and filed away the sharp edge created by the drill. Drilling out each ball with a drill to match the required tap size came next. I drilled down into each ball to about 75 per cent of its diameter and tapped in an M6 thread to suit the nozzles.

The mass of each ball needs to be identical, so I used the extra depth

previously drilled out to load the ball with additional lead shot if needed. I had access to a set of digital scales which made the task relatively straightforward. However, if you do not have an electronic balance a simple set of kitchen scales will do just as well. I found the heaviest ball after it had been drilled and fitted it with the modified extruder nozzle, then brought the others up to match its mass with lead shot for a total, individual ball weight of 131.5g.



Fitting the guitar tensioners

Bringing the billiard-ball cradle parts together



The cradle's frame

The next task was to design a suitable frame. Each ball has a diameter of 50mm so a cradle with an overall length of 300mm kept it nice and compact. As the project relied on several mathematical and scientific principles, I continued the theme and used the golden ratio to establish the height and width of the cradle — 300mm divided by the golden ratio meant I had to make it 185.4mm high. Looking at the cradle end on and dividing the height by the golden ratio gave me a required width of 114.6mm. I ended up with a height of 190mm and a width of 140mm — not quite the golden ratio but reasonably close.

Putting it all together was a finicky, fiddly job. I wanted the balls to be able to self-centre at the bottom of the inverted triangle of string. This meant I had to loop each supporting string through the 3D printer nozzle and a small cut off U-section from a paper clip, insert these into the ball, and then screw the nozzle down.

All this had to be done while the ball remained upright so that it would not lose its quotient of lead shot. Next I had to manoeuvre the fishing line through two 3mm holes in the

frame, secure one end to a fixed screw while the other end had to be tied to the guitar-string tensioner, which could then be cranked up to

raise the ball to the required height. It sounds simple enough, but with the failing eyesight of middle age it can be frustrating.



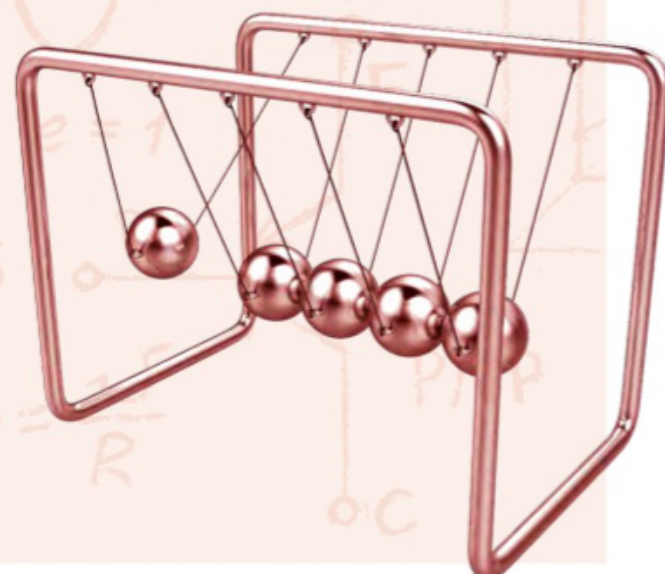
fitting the tensioners

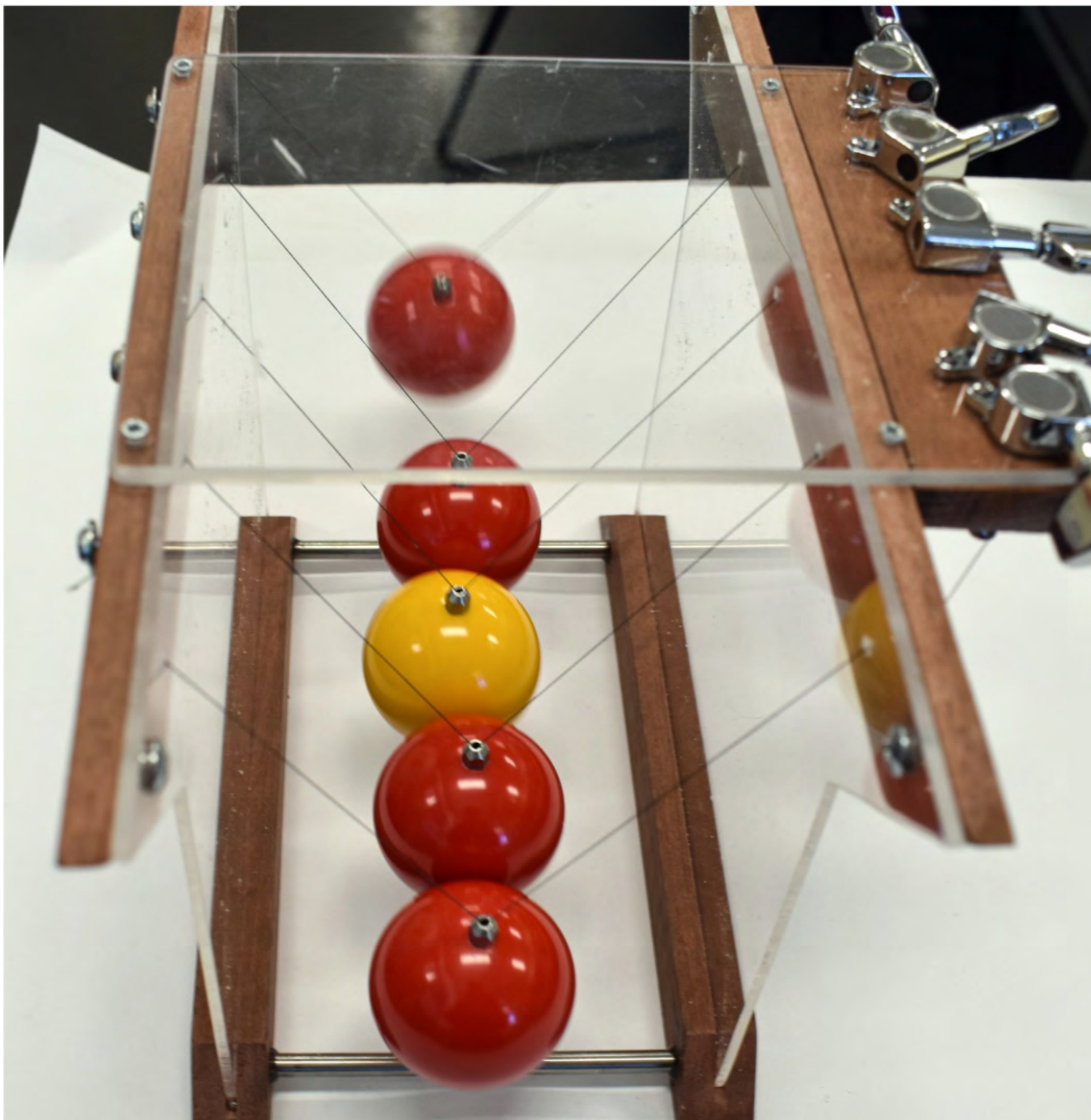
THE SCIENCE UNDERLYING NEWTON'S CRADLE

The cradle demonstrates the concept of the conservation of energy and how energy can be transformed from one form into another. By raising one of the end balls you generate energy of position (potential energy). As soon as the ball is released the potential energy is converted to kinetic energy as gravity draws the ball down. As it strikes the second ball in the row, some energy is converted into sound energy and the remainder is transferred to the other balls in the

row until it reaches the last one. This ball, on absorbing the transferred energy, has no option but to swing away from its neighbour, thereby converting the remaining energy back into kinetic energy and rising up and away until it converts its kinetic energy back into potential energy. The cradle will now repeat the process but in the opposite direction. As this process repeats energy will continue to be lost in friction, sound, and air resistance, eventually dampening the movement

until all energy has been dissipated and only gravity acts on the spheres.





The cradle in action

It worked!

However, the end product was its own reward. The billiard-ball version of the cradle works as it should, transferring the kinetic energy directly onto the last ball in the row and then repeating the process as that ball loses its momentum at the end of its swing and gravity drags it back. Its movement is quicker than I achieved with the three-boule-ball version and the balls can tend to twist on their fishing line if released slightly off centre, thus upsetting the motion of all the spheres. However, if released carefully, its movement is exactly as the physics suggests it should be.

What would I change next time? Rather than balls, could cubes of steel or short cylinders of steel bar be just

It could also be made from steel to give it an industrial look

as effective? Another alternative might be to swing the spheres or bars using a different method such as bars with swivel joints at either end. This would

eliminate having to delicately position each of them as they can be constructed to be a precise length and their motion couldn't be affected by an inadvertent twist as the ball is released. Of course the project also lends itself to more inventive arrangements for the frame. In this instance I opted for a fairly simple, straightforward frame made from a combination of Perspex and myrtle, however it could also be made from steel to give it an industrial look.

Alternatively, you could use driftwood branches to create a unique frame that contrasts its unstructured nature against the precise engineering of the spheres and their method of suspension. 

(Continued from page 17)



motion capture and facial recognition. Feeding it the right algorithms to recognise spears over the threshold 250mm height in a thicket of other spears was still enough of a challenge.

The next step was to sort out the cutting mechanism. A scissor arrangement seemed best but Hin concedes that, after a couple of days, performance drops off as the blades get sticky with a build-up of fresh asparagus fibre and pulp.

A washing or wiping mechanism might solve that issue but the team needs to settle on a cutting system first. One of the problems with testing prototypes both locally, in the Waikato, and with grower Tendertips in Levin, is the relatively short growing season. That was partly alleviated after growers in America heard through Agritech New Zealand of the Waikato team's work with Tendertips. Asparagus farming is doing it tough in America. A peak of around 20,000 hectares under cultivation in California has shrunk to less than 250 hectares in recent years as labour costs for both minimum wage and overtime have increased — even if pickers can be found. The Western Growers association in California was very keen to be involved.

The USA comes aboard

It effectively doubled the testing window by inviting the team to carry on their research in Los Banos, California, during the northern hemisphere season — from March to May. The association is now part of the partnership funding the development programme which also involves Callaghan Innovation, NZTE and New Zealand-based commercialization partner Robotics Plus.

"I find it pretty amazing that a college from New Zealand came all the way out here to California to help us with our asparagus harvest," said asparagus farmer Jake Barcellos in a video on the project on the Agritech New Zealand website.

That's where the more serious challenges for the cutting method became apparent, and why earlier machines weren't successful. Farmers in America like to cut the shoots off below ground. Asparagus can regrow new shoots from the cut stems but the Americans believe the cut stem is better protected in the soil. One of the machines used previously pulled up the shoots a bit before cutting them, but that damaged too many plants, compromising regrowth.

Top-secret plan

Hin agreed with a laugh that that requirement, which is clearly no good for blade life, is making his project more difficult. The Kiwi growers have less of an issue with cutting above ground but if the Waikato team's solution is going to take off with asparagus growers around the world, it needs to work for them too.

So the team has developed a new cutting system that they plan to have ready by April for testing in the US in their spring. Just how they plan to do this is still top secret.

Hin's team comprises just three people, PhD student Matthew Peebles who came on board in 2016 to help develop the ID system and robot designer Joshua Barnett who is developing the cutting system and platform. "They are the ones that are making this work," says Hin.

The collaboration project with Robotics Plus is still some way from completion. "Currently the unit is being pulled by a tractor," says Hin. But the goal remains remotely monitored, fully autonomous harvesting.

Once the identifying and cutting processes are robust, the team will move onto the self-propelling mechanism but, unlike automated asparagus picking, that will not be breaking entirely new ground.

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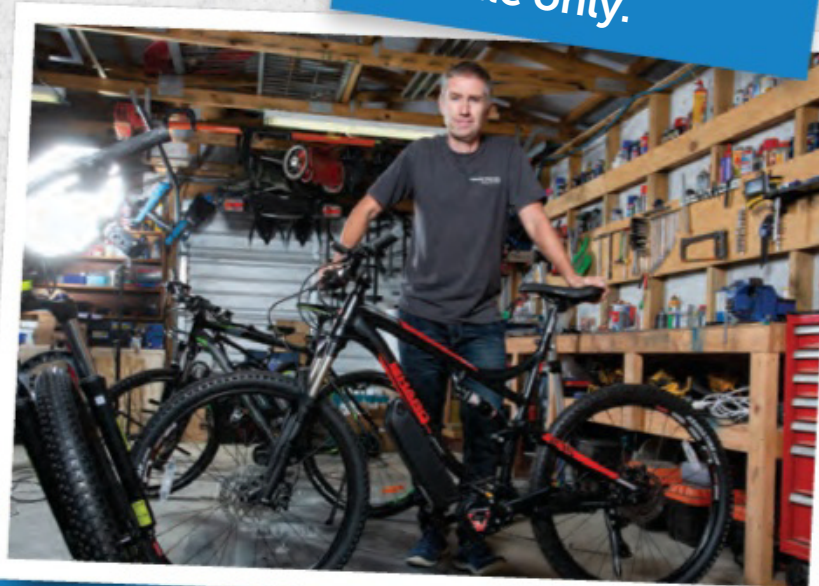
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RINGING IN THE CHANGES

RE-ENGINEERING A ROTARY PHONE WITH A RASPBERRY PI HAS PLENTY OF FUTURE POSSIBILITIES

By Enrico Miglino

Photographs: Enrico Miglino

In this issue we show how to upcycle a rotary phone from the end of the '60s, which with the help of a Raspberry Pi and a few other electronic components will become a 'Pi rotary smartphone'. In the next issue we will look at how many projects can be created with this re-engineered device.

Upcycling a rotary phone into an

original and unconventional interface for a Raspberry Pi opens up countless possibilities limited only by your own creativity. Before opening the device, let's look at the parts for interfacing:

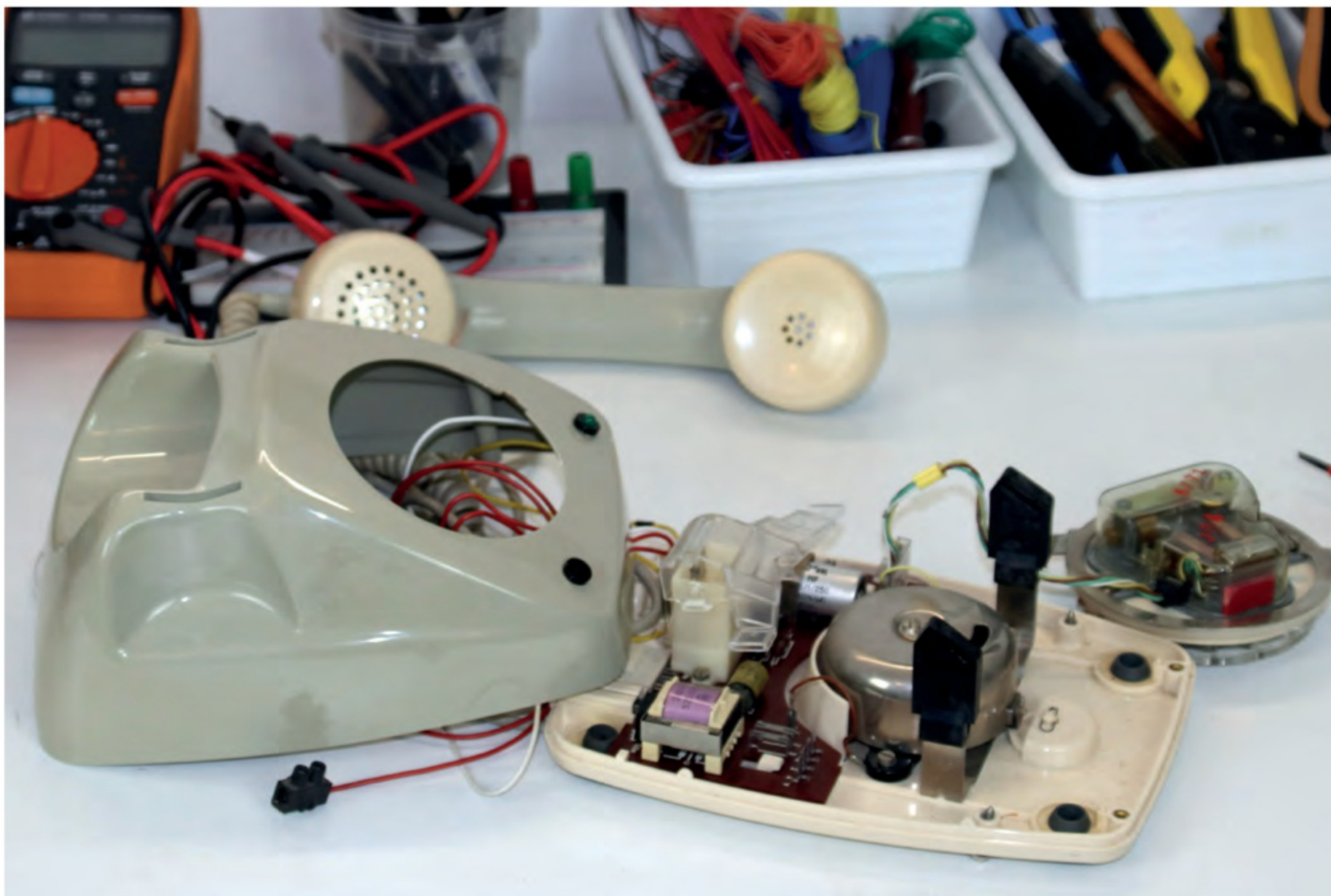
- hang-up switch: detects when the caller picks up the phone receiver microphone
- phone receiver: used by the caller to

hear the voice and speak into

- rotary dialler: the numeric interface that can possibly be used as a numeric keyboard — the most interesting part
- the bell ring: is this really needed? It will be removed to make space for a B3 or B4 Raspberry Pi and I plan to include audio features too.



The vintage rotary phone before upcycling. Note that there are also two LEDs — possibly the result of a past customization — that will be removed. The final version will also include three new LEDs controlled by the Raspberry Pi that monitors the hang-up switch and the rotary dial status



The bell ring

In almost any vintage rotary phone model, controlling the bell ring with digital low-voltage signals may be more complex than expected. The bell is triggered by the vibration of a small metal hammer connected to a solenoid working at a relatively high voltage.

On the telephone board, an analogue circuit with a transformer provides the needed voltage and power from the phone line cable. It would be possible to reverse-engineer this circuit adapting it with 5V, but the risk is that the power needed to work the solenoid would be higher than what we can provide from the circuit without an extra power supply.

There is also a practical aspect to removing the ringer: it gives the space needed to fit the Raspberry Pi inside the phone case.

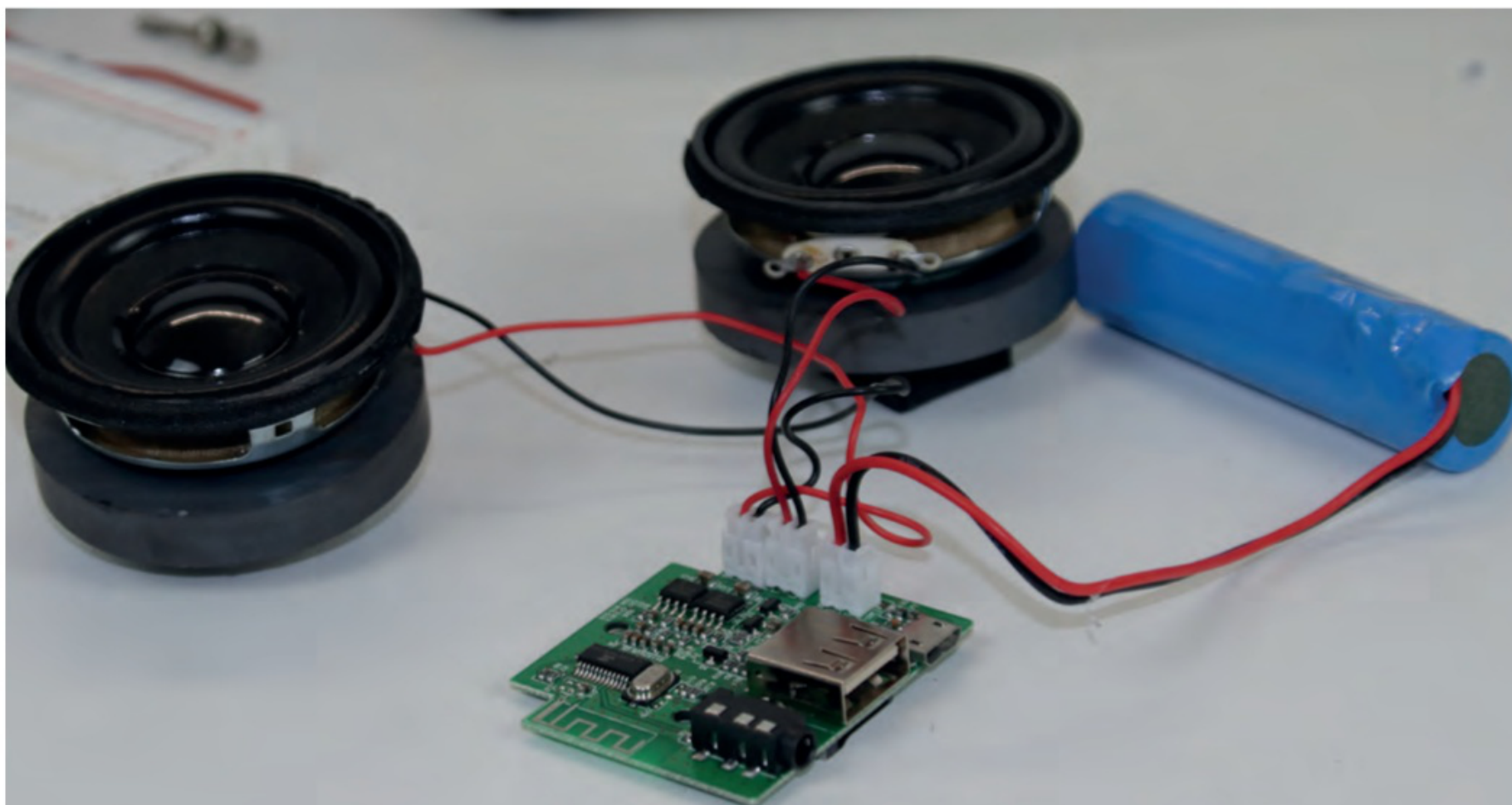
For the audio features, I disassembled a cheap imported Bluetooth portable speaker. There are plenty of models of portable speakers available in any electronic store for \$10 or less, so just check that the speaker also supports a 3.5mm jack audio-input plug, as this is what is needed to connect it to the Raspberry Pi audio. ►



Detail of the inner part of the phone, showing the ringer bell and the solenoid group. Both these parts will be removed as they are no longer needed, creating space to install the Raspberry Pi board



The phone fully disassembled. From left to right: the pick-up (that will host the amplifier speakers), the ringer bell, the phone circuit with the hang-up switch mechanism, the solenoid group and the dialer, the phone plastic base, and the cover at top right



The portable speaker after disassembling and removing all the parts except for the essentials: the control board, the Li-ion battery, and the stereo speakers. I was lucky with this model as it already has connectors on the board making it easy to separate the components and reassemble them inside the phone

What you need

When disassembling the speaker, you should find a Li-ion battery, a couple of small but powerful speakers, and a control board with some buttons. The board may also include a microSD card reader and possibly a USB connector to play tracks from a USB memory stick.

We can ignore these parts, noting the position of the power on-off buttons and the connection mode button.

Pressing the power button for three to five seconds, the device powers on, emitting a sound, automatically setting the Bluetooth mode. With the help of a handy multimeter, I found that the points were closing the circuit and I was able to reproduce the same button behaviour.

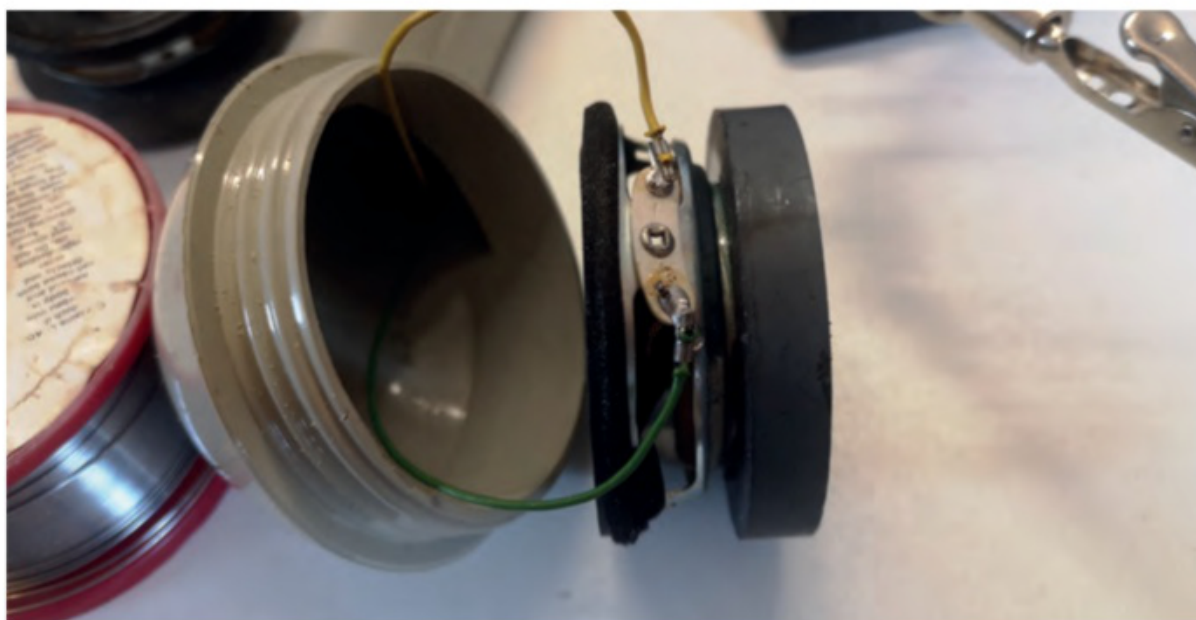
We can control the temporary switch digitally by soldering a couple of wires to the corresponding contacts. You can get the same effect as pressing it by joining the two end wires to one of the buttons.

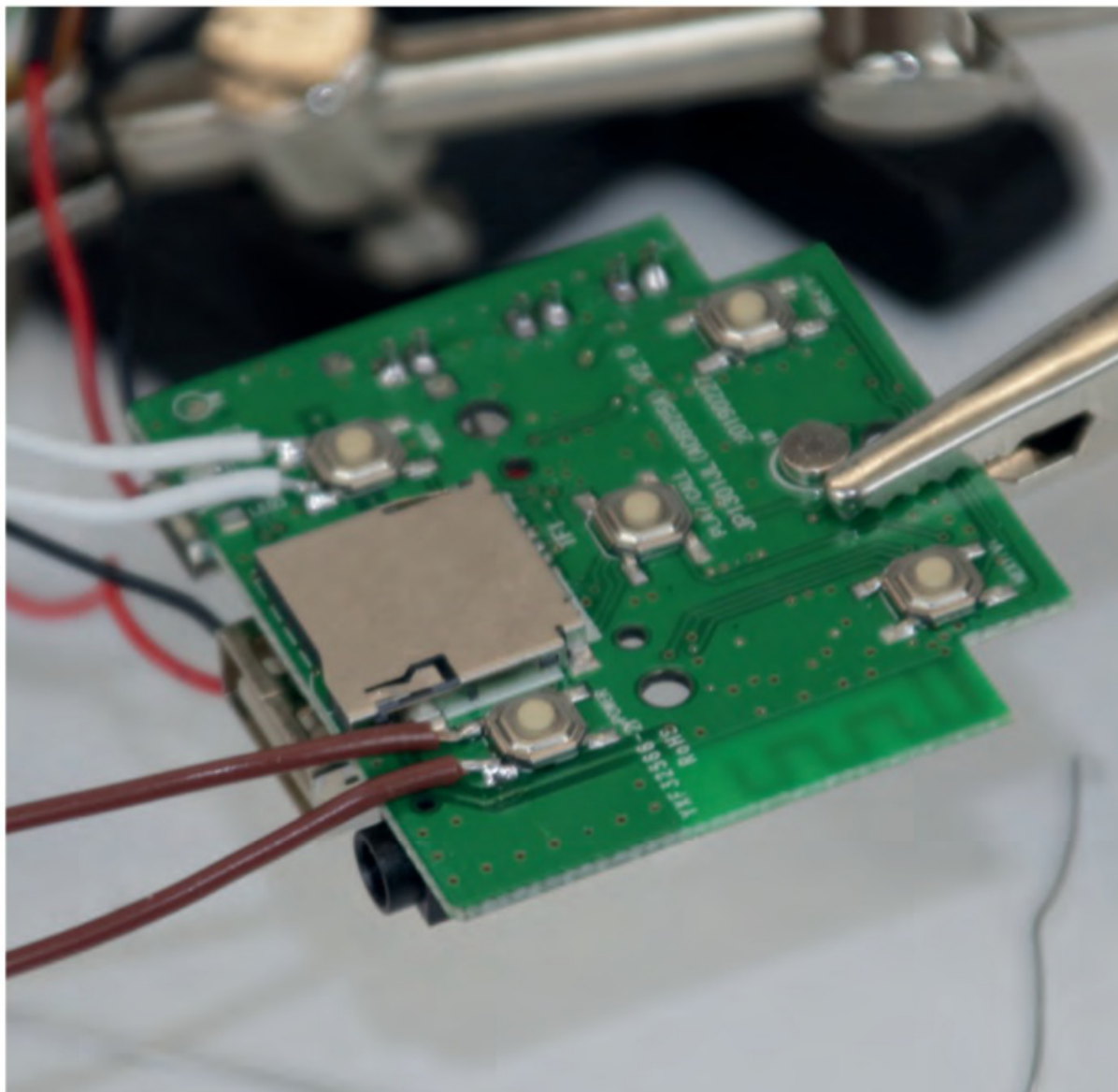
This solution sounds nice (and it is), but it needs the electronics. When we change the state of a pin of the Raspberry general-purpose input/output (GPIO), we provide a 3.3V current level, not physically closing a circuit when we need the equivalent



Using the four wires of the original cable in the microphone holder of the phone, I removed the microphone and speaker to solder the cable terminals to the two speakers. These are almost the same diameter as the internal speaker and mic holder. After sandpapering inside, it was possible to insert the speakers and close the holder with the original caps

Then the speaker connectors were soldered to the other side of the cable on the phone side, preserving the aesthetics of the device





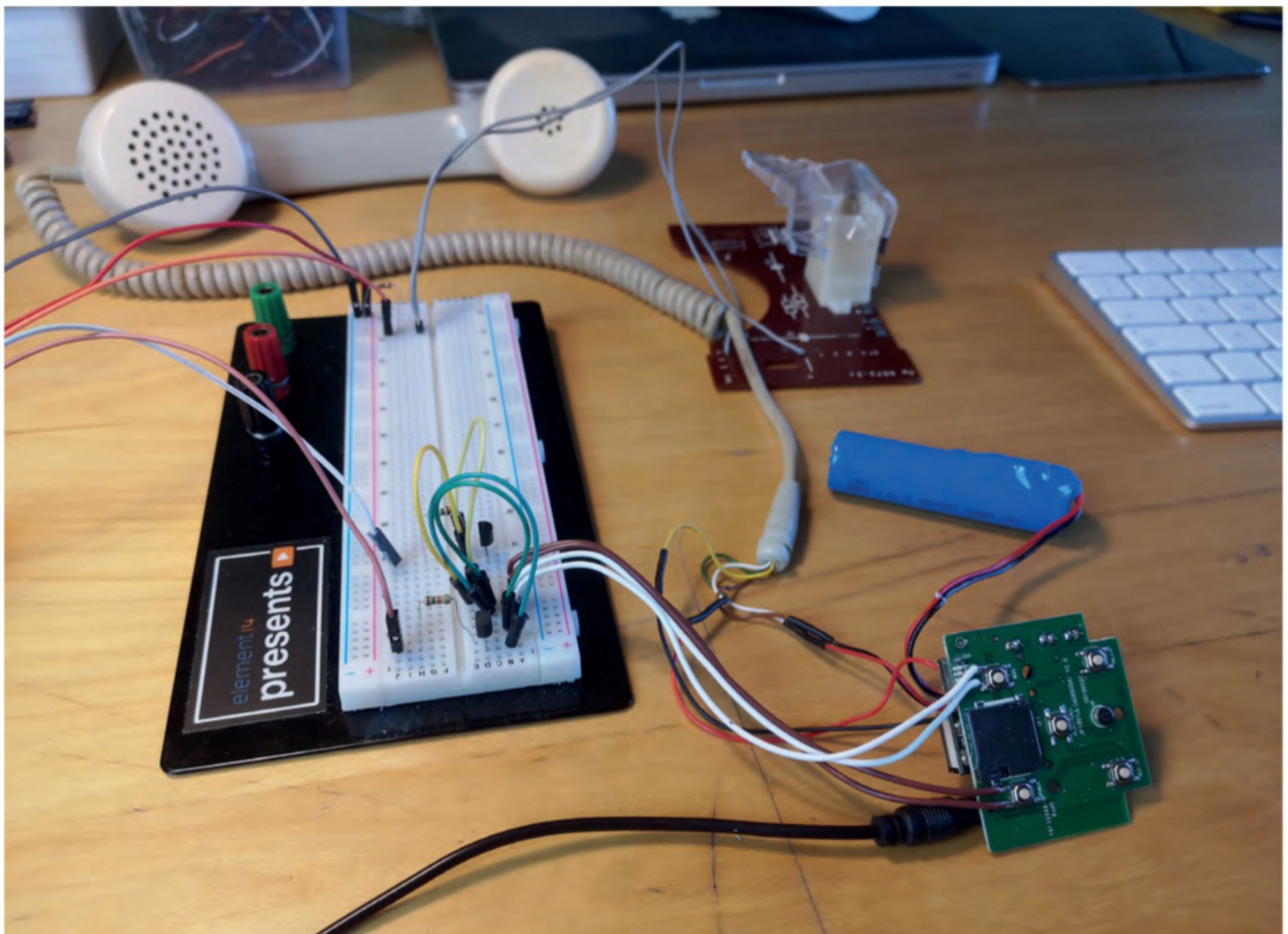
Detail of the amplifier control board with the wires soldered to the temporary switch buttons corresponding to power on-off and play mode setting

of a relay. The solution is not as complicated when using a common NPN transistor (I used a PN 2222A) for every button. The two soldered wires coming from a button will be connected to the collector and the emitter of the transistor that is normally open (same as the button in its normal state). Sending a digital signal ‘high’ from a GPIO pin to the base of the transistor — and so powering the transistor itself — the transistor closes the circuit and the button is pressed.

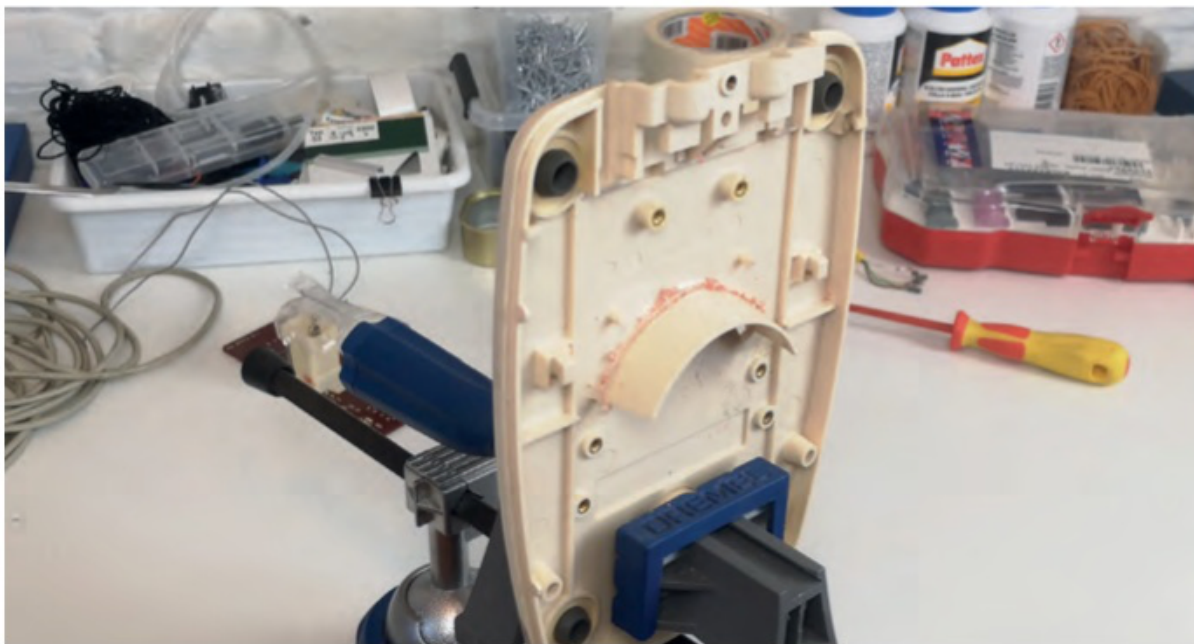
Getting what you need

When making some tests on a breadboard, I noted that the speaker power on-off button needs to be pressed for five seconds to execute the function, while another three seconds was needed to complete the power sequence, including the sound.

However, the mode setting button has different functions depending on how long it is pressed. If the mode ▶



Detail of the breadboard test circuit with the two PN2222A NPN transistors to simulate the button press on the amplifier board



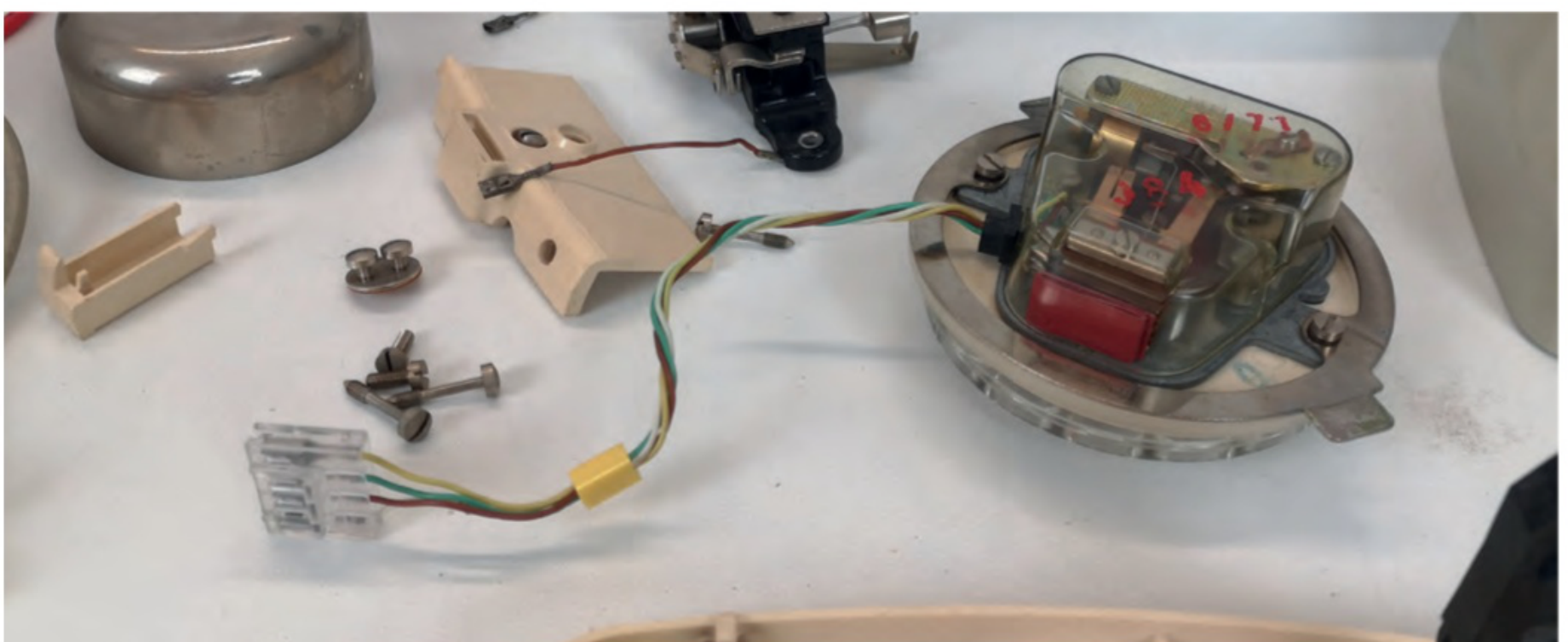
To make space and fit the Raspberry Pi inside the phone, the protective plastic piece behind the bell ringer was removed by cutting it with a Dremel

button is pressed for about three seconds you get the notification sound that the device is waiting for the Bluetooth pairing. Pressing the button once for less than one second sets the portable speaker board to the wired audio-input mode, which is needed.

This is an example on how the speaker works, but you can expect very similar behaviour with a wide range of devices of the same family. By experimenting, it is not difficult to discover the sequence to execute the manual functions with the Raspberry Pi writing a simple Python script. ►



The base of the phone after the removal of the plastic support; the bottom rounded hole will be useful for cooling the Raspberry Pi after inserting it in the space behind the rotary dialler



Detail of the back of the rotary dialler with the four wires still assembled with the connector. Other models of rotary diallers — using the same technology — do not include the wires in their assembly but only expose four screws to connect the wires

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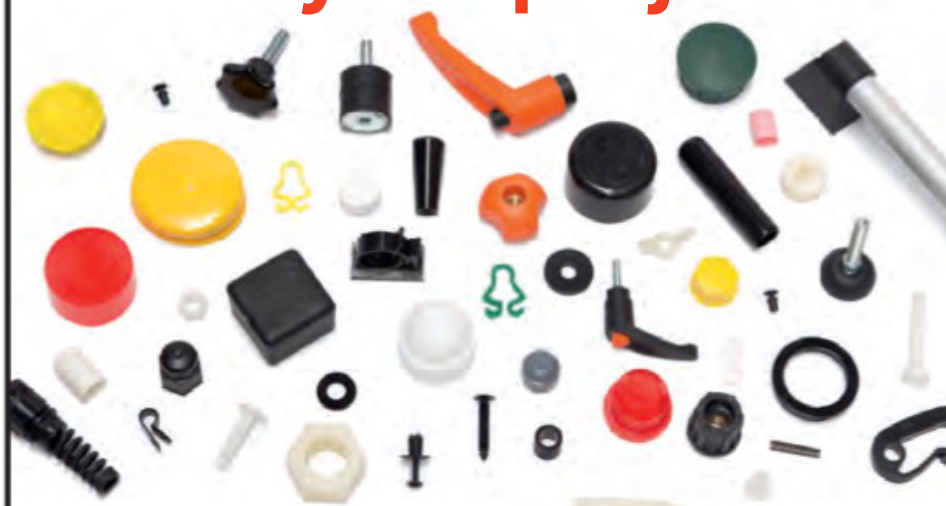
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Connecting the switch and dial

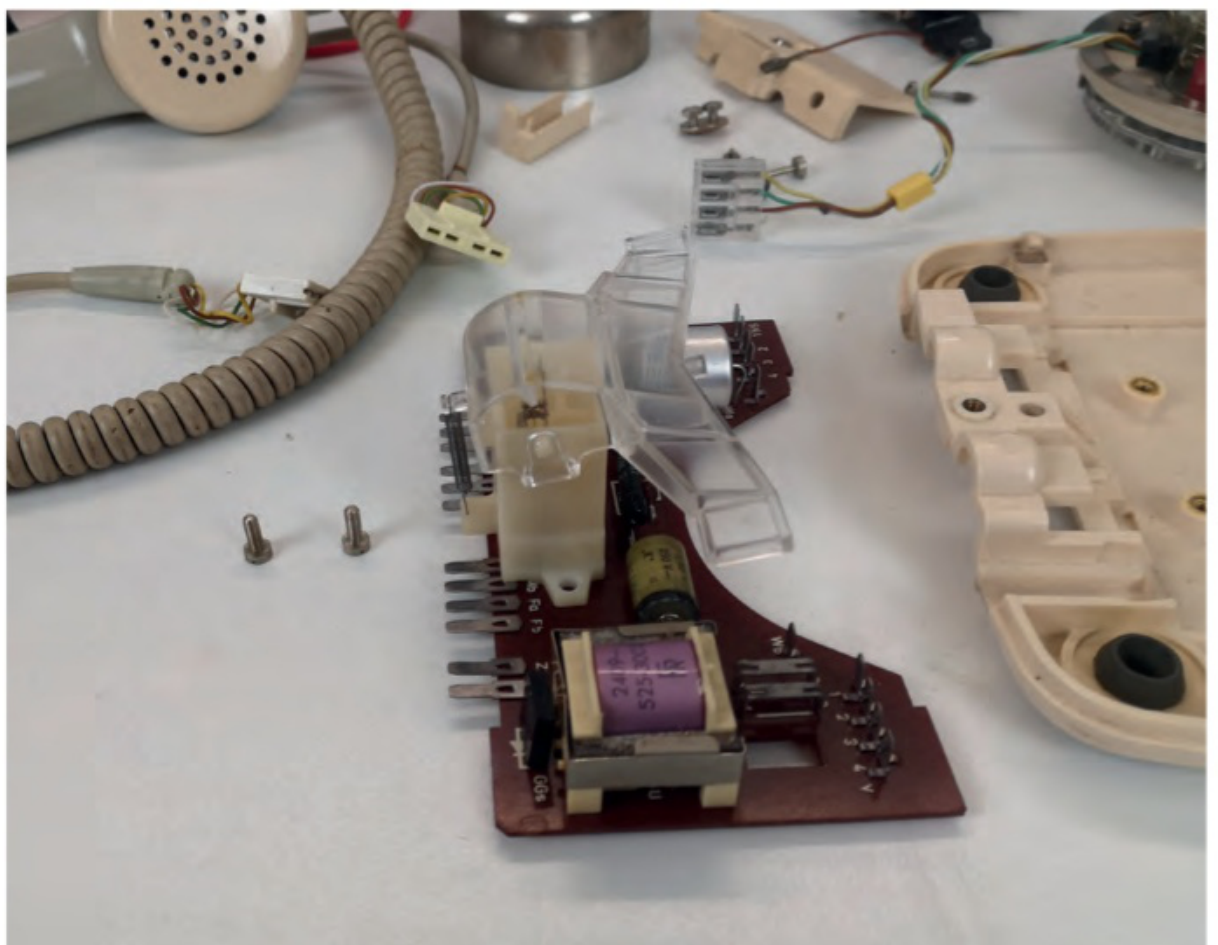
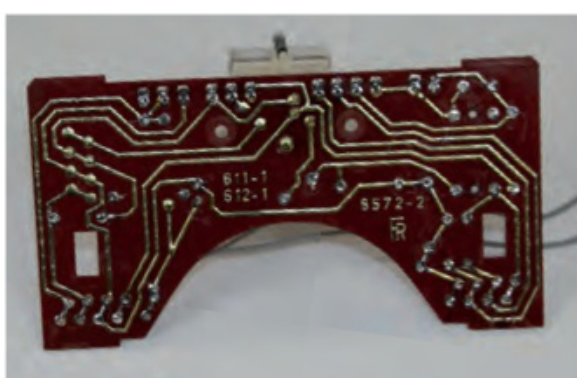
The easiest phone component to connect is the hang-up switch. After removing the ring bell and the solenoid assembly, I completely disassembled the phone to remove the electronic circuit screwed onto the base of the phone case; then I desoldered all the components leaving only the bare printed circuit and the hang-up switch mechanism.

Following the printed circuit tracks with a handy multimeter I searched two points on the printed circuit board (PCB) connected to the switch where I soldered a couple of wires that will have to be connected to the Raspberry Pi to detect the switch state.

The final part, which I found a bit challenging to control, is the rotary dial.

In this case, we cannot be sure that a different rotary phone than the model I used will have the same coloured wires, but you will be able to find four wires or two wire screws to connect the dialler to the rest of the circuit.

In the design and wiring illustrations of this article I refer to the characteristics of my dialler. It is necessary to perform a simple reverse-engineering operation to decode the four wiring colours using a tester.



Detail of the phone circuit. Thanks to the big components on the board and the external connections, all of which use plug connectors, desoldering the board and removing all the components was not difficult. Due to the simplicity of the circuit the PCB has conductive tracks only on the bottom side

A common technology

Fortunately, despite the colour coding adopted by the producers, the technology behind the phone rotary dialler has remained the same for decades.

We should expect two wires that close a contact when the rotary wheel is rotated clockwise; the contact between these two wires remains closed until the rotary wheel has not been released and returns to its original position rotating counterclockwise.

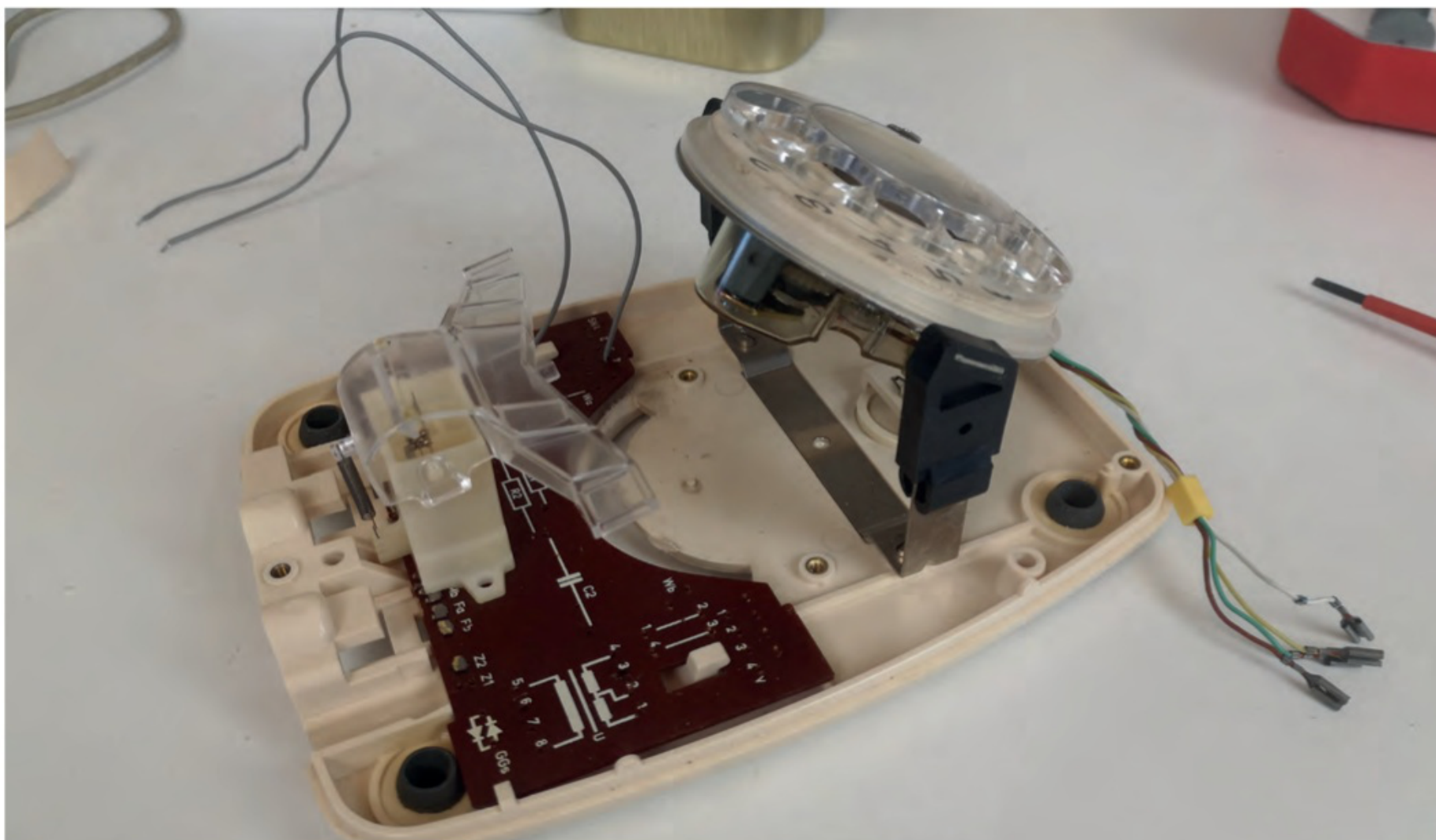
Continuously reading from a Raspberry Pi GPIO pin we can determine when the user starts dialling a number.

The other two wires close and open the contact multiple times when the rotary wheel is released to compose a number generating a series of pulses according to the dialled number. The cipher '0' corresponds to 10 pulses, '1' corresponds to one pulse, and so on. Also in this case, we read the number of times the status changes (the number of impulses, read from another Raspberry Pi GPIO input pin).

The circuit is not complex but it is important to use the right resistor values and pull the current correctly to the Raspberry Pi GPIO pins to avoid reading oscillations. ►



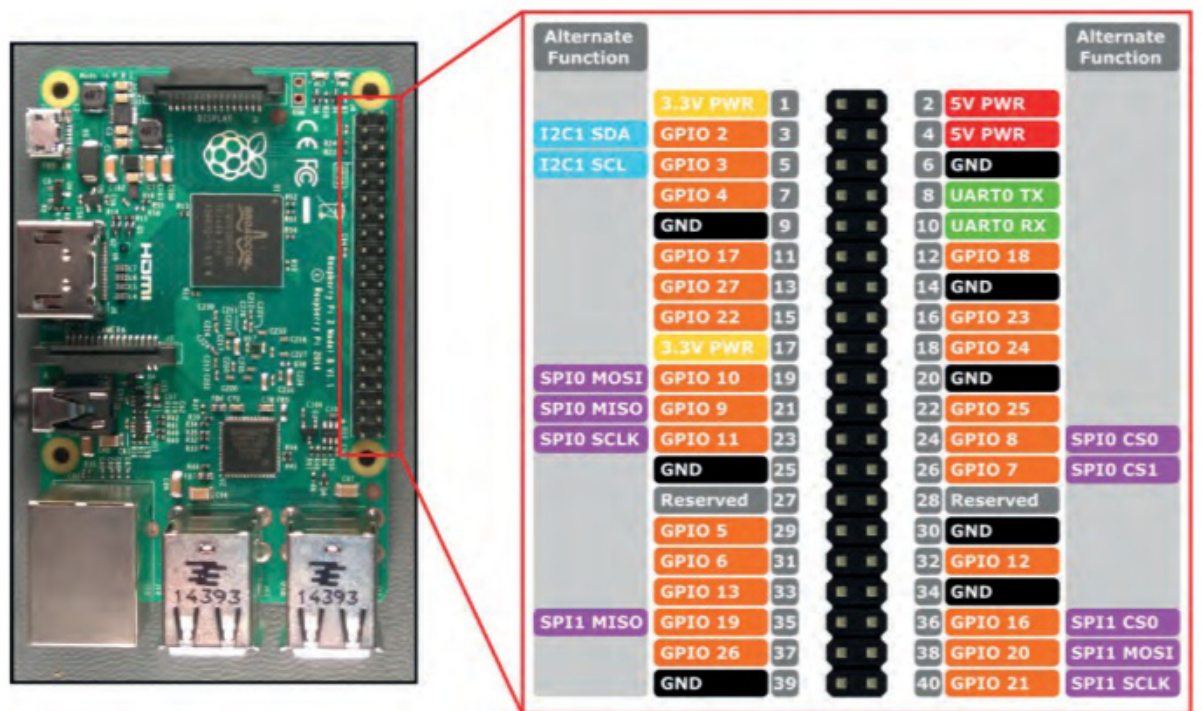
Bottom and top view of the phone board after removing all the components and connector terminals. The two grey wires are soldered onto the clean printed circuit on the bottom side, detecting the hang-up switch



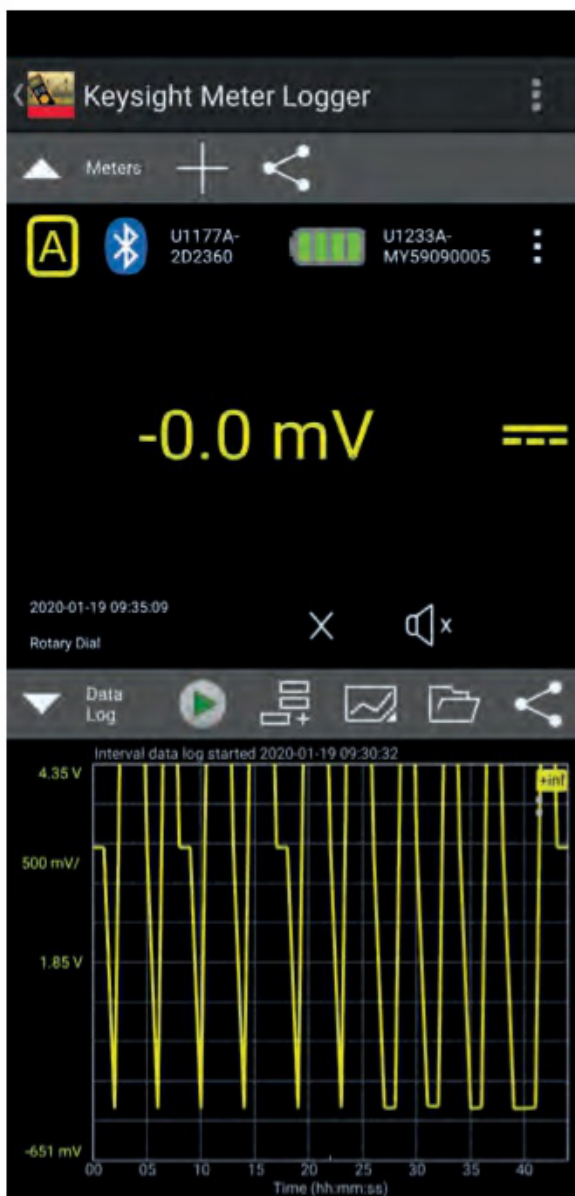
The base of the phone ready to assemble and wire the new components. Note the printed circuit without the original components desoldered; only the hang-up switch remained in place with the two grey wires soldered to be connected to the new circuit for detecting when the user picks up the handset. The rotary wheel on the right shows the four wires (yellow, green, white, brown) that will be soldered to the circuit prototype board mounted on the Raspberry Pi

Testing the best position to fit the Raspberry Pi inside the telephone. I had to remove the plastic protection to the ring bell to keep it aligned to the base as the pick-up handset should be free to move up and down (the transparent plastic lever on the left side behind the Raspberry Pi)

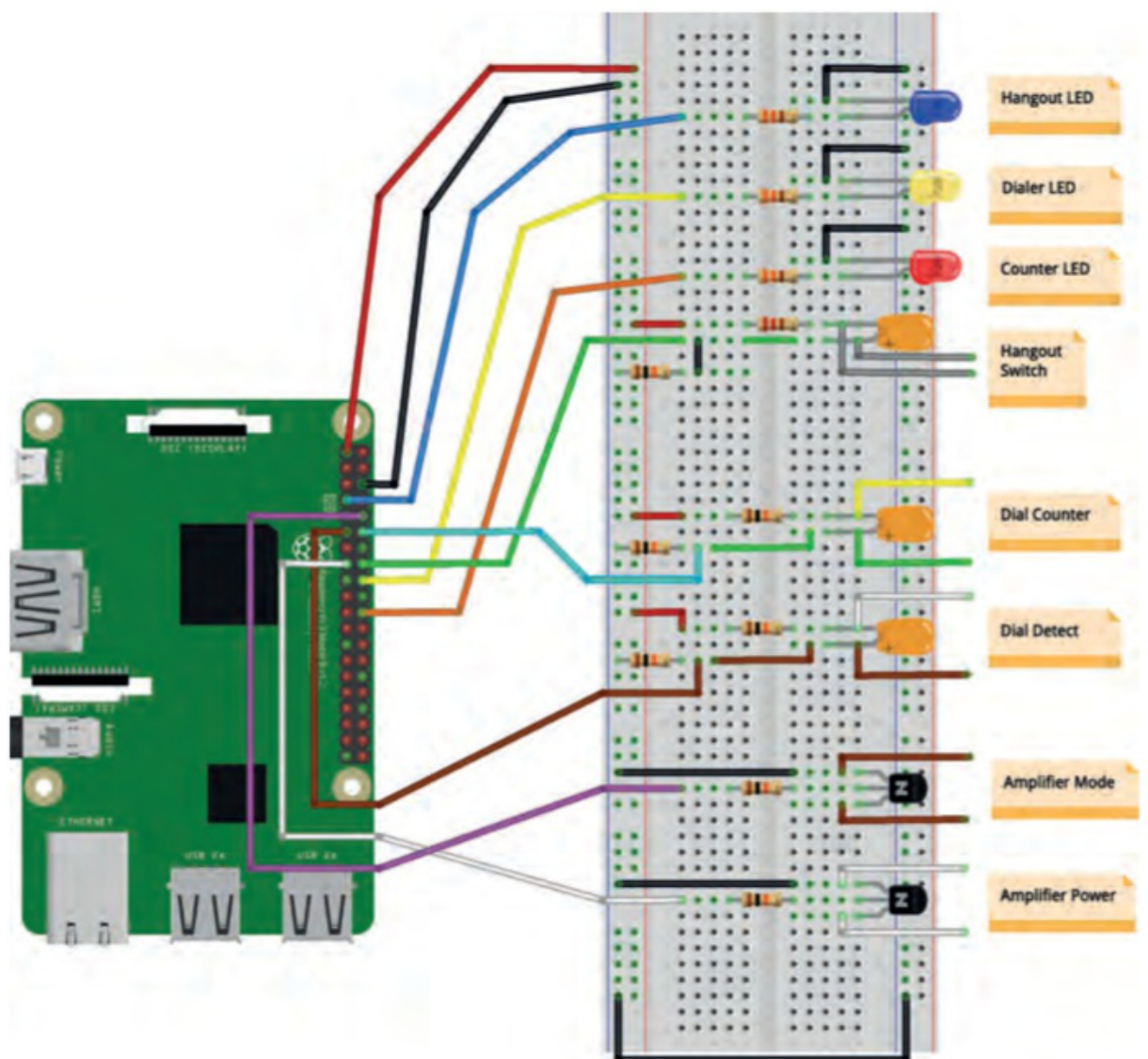




The Raspberry Pi 40 pins scheme of the board GPIO



An example of the pulses' train detected by the Raspberry Pi when the rotary dialler wheel is released to dial the number zero



The full control circuit schematics of the Raspberry Pi controlling the phone and the amplifier functions

Something to avoid

Note that the reading on the hangout pin is the same circuit we are reading as a temporary switch button. To avoid multiple readings when the contact is closed, we will add a 0.1 microfarad (μF) capacitor between the two wires — a simple debouncing component smoothing the read persistence signal for some milliseconds to avoid false-positive readings.

With a B3 Raspberry Pi or one of the later models — including the most recent Raspberry Pi B4 — it is sufficient to set up the device with the Raspbian Linux operating system, including the desktop interface.

After installing the system, you should enable the VNC server — included as part of the Linux installation — to reach the machine with the VNC Viewer application from any other computer connected to the

same LAN, avoiding having to connect the Raspberry to a screen, keyboard, and mouse.

For more details on how to install the Raspbian Linux and set up the Raspberry Pi, look at raspberrypi.org/downloads/raspbian/.

In the next issue, we will move on to the second part of this project and create some very intriguing applications for this Raspberry Pi rotary phone.

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RAISING THE BAR

YOU NEVER STOP LEARNING ABOUT BREWING. HERE ARE FIVE TIPS FOR MAKING BETTER BEER

By Bryan Livingston
Photographs:
Robyn Livingston

I often hear from home brewers: “I’ve been making beer for a while now but I’m still not happy with the taste ... it’s good but not great. How can I make a beer like that craft beer I tasted last week?”

There is no easy answer, as it depends on how you are brewing and the processes that you have. But I do have five tips that will help you to make better beer. Some or all might apply to you and should help improve the quality of your beer.





Cleaning and sanitization

Everybody thinks they clean well enough but it is important to review cleaning procedures. Cleaning and sanitation are complementary processes, not alternatives. They aren't one and the same. Each time we brew, residue from the beer remains inside your fermenter, seals, and taps. Often this isn't seen by the brewer as they do their normal cleaning process. Everything looks clean — but is it really? Beer residue dries and becomes a breeding ground for bacteria, which can contaminate your next brew.

Cleaning is the process of removing anything that could lead to a contaminated fermenter. There are a number of products that break down dried beer and which product you use is dependent on the type of fermenter you use.

For plastic fermenters, the pink cleaning powder is great. It is made from

chlorinated trisodium phosphate (TSP). You need to fill your fermenter to the top, add the pink powder and leave it to soak (I normally leave mine overnight). The next morning you will have a thick sediment on the bottom of the fermenter that is all the contaminants that have

*Everything looks clean
— but is it really?*

been stripped off the inside of your fermenter. Empty the fermenter and rinse well with fresh water.

Stainless fermenters use different products because you can't use chlorine-based cleaners as they could pit the stainless. Powdered brewery wash (such as Five Star's PBW [Powdered Brewery Wash]), non-chlorinated TSP, and the Grainfather Cleaner are all good

products used for cleaning stainless fermenters.

Remember to also clean taps, O-rings, airlocks, and grommets as part of your cleaning process.

Sanitizing is the final process before mixing your next brew. It involves killing any bacteria that may have entered your fermenter since the last clean. No-rinse sterilizers (usually made from sodium percarbonate) or acid-based sanitizers (Star San or Total San) are contact sanitizers and only need to come in contact with a surface to sanitize. Usually one-litre shaken inside a fermenter and left to sit for 10 minutes will suffice.

Sanitizing alone will not normally remove built-up material inside your fermenter.

Ditch the sugar

Most of us started brewing with a can of malt and 1kg of sugar. This makes a ►

beer between 4 and 4.5 per cent alcohol. The problem is that while sugar is very efficient for making alcohol, it also thins out the malt flavour of the beer.

A common comment from novice brewers is: “My beer tastes a little watery or thin.” Table sugar used in brews can also lead to a cider taste in the beer. This green apple taste (acetaldehyde) is made by the yeast when converting sugar to alcohol and you don’t want this taste (a beer fault) in your beer.

Ditching the sugar and replacing it with extra malt will make a beer fuller bodied and will avoid a thin or cidery-tasting beer. Try adding a second can of un-hopped malt to your brew in place of the sugar.

Use fresh ingredients

Your beer kit has a shelf life of up to two years. Unfortunately the older the kit is the less fresh flavour there will be in your beer. Jazz up your brew with extra malt and hops.

Try adding a second can of un-hopped malt to your brew in place of the sugar

Malted grains: You can add freshness back into your brew by steeping some adjunct grains, bringing this malt tea to the boil after the grains are removed, and then adding

to your fermenter before pitching your yeast. Common adjunct grains include light crystal, biscuit, toffee, and even chocolate and roast barley malts.

Hops: Hops add bitterness, flavour and aroma. This is determined by the length of time the hops are boiled. Most kits already have the bitterness in the kit, so adding hop flavour and aroma can easily be achieved by a five-minute steep in boiling water in a coffee plunger and a dry hop into the fermenter.

Yeast pitch rates

After the malt and hops, yeast is your next biggest contributor of flavour to your beer. Different strains of yeast contribute different flavours, so yeast selection is





very important. But equally as important is the pitch rate of the yeast. A sachet of yeast in a beer kit can be anywhere between 5g and 11g of yeast.

Yeast count: An 11g sachet is generally designed to be pitched into 19 litres with a starting specific gravity (SG) of less than 1.050. In New Zealand, our beers are typically 23 litres (five imperial gallons) and many of our IPAs and APA beers are stronger than five per cent (i.e., above 1.050SG). If we underpitch our yeast we can get off flavours and fruity esters (pear and strawberry) that are undesirable. It can also lead to a beer fault called 'diacetyl', which leaves a sweet butterscotch flavour in your beer. This is a sign of under-pitched yeast that hasn't finished the fermentation properly.

Yeast starter: You can either double pitch your yeast sachets or build a yeast starter before you pitch the yeast into your brew. As a very rough guide, adding a yeast sachet to 100g of dried malt extract in one litre of water and leaving a brewing temperature for 24 hours should double your yeast count. This is like making a mini, low-strength beer to get the yeast count increased before being added to your

fermenter. The bigger the yeast count, the lower the risk of off-flavours and esters in your beer.

Different strains of yeast contribute different flavours, so yeast selection is very important

Temperature-controlled brewing

An identical beer brewed with exactly the same ingredients in summer often tastes very different from the same beer brewed in winter. The temperature that the yeast ferments at has a big impact on the flavour of your beer. Some beers like Saison and Belgium Farmhouse Ales and some yeast strains like kveik (a Norwegian strain) ferment best at warmer temperatures.

But if other strains are brewed too warm they become very estery and fruity and have that 'old home brew' taste.

Controlling the fermentation temperature so that the beer ferments

at its preferred temperature is key. You want to avoid swinging temperatures during fermentation, as this leads to off flavours in your beer. Sheds and garages with an iron roof will get very hot during a summer's day and cold at night.

Many home brewers now brew inside an old fridge connected to a temperature controller, so whatever temperature they dial up on the controller is the temperature that the beer ferments at. The fridge provides insulation from outside temperatures in your garage and cools to the set temperature on the controller. A good controller will cost around \$75 from your local home brew shop.

You never stop learning

After 30 years of making beer and wine, I still find ways to improve my brewing. If you aren't happy with the taste in your beer, then become a sponge and soak up advice from others who brew. Talk to the team at your local home brew shop and join brewing groups to share ideas and tips to improve your beer. Happy brewing!



KEEPING CRAFTSMANSHIP AFLOAT



Dr Kere Kemp and Allan Hooper

A SPECIAL SCHOOL IS ENSURING THE TIME-HONoured TECHNIQUES OF BOATBUILDING ARE PASSED ON

By Tom Rodwell — Photographs: Tom Rodwell and The Shed



A clinker dinghy: soon copies of this prototype could grace many a shed



Timber, rope, and metal join forces in traditional boatbuilding



Dr Kere Kemp holds an offset aloft



The view from the stern

Visit any city waterfront and you'd be forgiven for assuming that boatbuilding is the high-priced preserve of the playboy. A visit to an anonymous warehouse in the backwater Auckland suburb of Te Atatu Peninsula tells a different story.

Restoration projects and practical workshops intermingle here with anecdotes and the Pythagorean theorem, and there's always an undertow of big

stories that swell from small details. At the New Zealand Traditional Boat Building School (NZTBS) you get very much a sense of a living history adapting to modernity with all the ingenuity of the skill's forefathers.

One tutor recalls his Dickensian days as an apprentice shipbuilder in the navy: "We filled the decks with 'oakum' — old rope that we'd tease out by hand just like prisoners in Her Majesty's prisons in

Britain used to, spinning it out gradually like wool, working it for hours on our knees, then poking it into the gaps between boards. Then we'd pour pitch into the seams. Today they just use polysilicone in a gun, and pitch is rarely used."

"But there's pitch on my boat," says another tutor. "Where the lead ballast mounts up against the wood of the fin, it's full of pitch. Bolts come down and screw it all up, and pitch oozes out." ►

Workshops



Reflecting the finer points and the practicalities of boatbuilding, the NZTBS workshops and lectures truly advocate for craftsmanship. The workshops are certainly slanted towards vintage tools, techniques, and timber, but the school is not wedded to the past, and embraces new technology in healthy moderation. Throughout the year you'll find weekend courses for a variety of skill levels, with expert teachers and small class sizes, at the NZTBS facility in Te Atatu Peninsula, around 20 minutes on the Northwestern Motorway from Auckland's CBD.

A typical two-day essential workshop skills course covers the use, set-up, and maintenance of hand tools, before moving on to a primer on epoxies, resins, and glues, then a section on gluing or fibreglassing plywood, and an invaluable section on reading plans and drawing components from scale drawings ('lofting').

For the experienced boatie there are valuable courses such as a winter

maintenance course, featuring many solutions for looking after your craft. For general woodworkers there's niche courses on marquetry, veneering, and steam bending.

Veteran boatbuilder Allan Hooper runs a regular session on lofting — the tricky art of translating two dimensional plans (known as 'offsets') into the physical realm. Ask any tailor or dressmaker — even the best of design intentions can get lost in translation from paper to mannequin to model.

A popular recent offering was on safe and design-focused use of composites — polyester laminates through to carbon fibre — plus a section on vacuum bagging. "Where you want to get epoxy into all the nooks and crevices of the layers of materials, what you do is seal the piece into a bag and then pump in or apply the epoxy, and then suck it out via a vacuum," says school tutor Kere Kemp. "It adds a lot of strength by really forcing the epoxy into all the spaces." Alongside

this is the use of peel-ply, a synthetic fabric — in this case taffeta, popular for making wedding dresses in the 1970s — draped over the epoxied wood, which after curing can be sanded, painted, or epoxied once again. The result is totally waterproof. The course was run by Adrian Pawson from the esteemed multinational mast, boom, and rigging firm Southern Spars, which shows that the NZTBS isn't shy of modernism.

Meanwhile, the occasional model boat building classes for young people are a reliable school-holiday pleaser, also run during Auckland Council's Heritage Week. An evergreen is the half-model course, with attendees walking away from the session with their own example ready for wall-mounting.

You can learn more at the school's website, nztbs.org.nz, or by subscribing to their newsletter via info@nztbs.org.nz. NZTBS workshops are frequently listed on the eventfinda.co.nz website also.

Preserving traditional skills

Tree resin or modern synthetic fibres, electric routers, or planes made from scavenged car suspension springs — the NZTBS sails far and wide. Inevitably there's the swapping of stories: audacious fishing tricks, seas of floating pumice, the smell of land after weeks afloat. Less the glam yachting scene, instead this boatbuilding is part of the magical yet very human narrative of seafaring, where man once navigated by the birds and the stars, and gauged the water's temperature by hand. The school itself functions as a vehicle for the preservation and transmission of that lineage.

It was a near thing though. Formed in the mid 1990s in an old Royal New Zealand Air Force building in

Auckland's Hobsonville, the full-time school became a victim of the late 1990s' National Government's capsizing

*Instead this
boatbuilding is part
of the magical yet
very human narrative
of seafaring*

of vocational training programmes, forced to watch as the stream of apprentices dried up.

This added insult to injury for a sector already crippled by Muldoon's

tax changes in 1980, designating boats as luxury items, adding 20 per cent to the price tag.

That era, says one of the school's trustees and tutors, Dr Kere Kemp, was when New Zealand fell off the curve in boatbuilding craft. In other countries there was enough work in restoration for classic timber techniques to continue, but in New Zealand the industry transformed into a luxury market of big flashy products made of plastic, fibreglass, and aluminium. For tutor and professional boatbuilder Allan Hooper, schooled in the classic way, it destroyed the industry: "It really killed me I can tell you. I went into school teaching." ►



The ever-functional traditional bucket



Applying dinghy clamps with care



The view from the bow

Bespoke tools



Unsurprisingly a storehouse of old tools, the NZTBS crewmembers are advocates for their efficiency — and minimum clean-up. “You’d be surprised at how fast it is to work with these tools,” says NZTBS school board chairman Stephen Cranch, also a contemporary furniture maker. “Unless you’re in a factory with a production line waiting, by the time you’ve set up a router and fuffed around, often a hand tool is all you need. It’s really just a few swipes and it’s all over.”

The lofting board

The intricacies of boat design properly springboard from the imagination into physical reality here. The NZTBS often works with lofting processes to plan, draw, and scale parts directly, no computer-assisted design (CAD) needed. Traditionally just a handful of lofting boards per boat may have been used, with the remainder done by eye. Plus, lofting reveals how design decisions can affect the amount of water displaced by a craft, and therefore speed and efficiency. “Every boat is a compromise,” says tutor Allan Hooper. “There’s no such thing as the perfect boat, although some designers would like to think they’ve come very close.”

Dinghy clamp



These oversize clamps are a good few decades old. Like an overgrown clothes-peg, they deploy power and a softness of touch when holding two overlapping pieces of a hull together. Applied here in clinker-built dinghy construction,

the clamps keep things in place before fastenings or adhesives are applied.

Scotch bead



Nothing more than an offcut with a sharpened screw head, this wee beastie is used to carve a curved groove into a plank of wood (thanks to the underside of the screw head). Next step, is to plane the edge of the plank into a similar-looking curve. Marry this up to a second plank — et voila, the illusion of a strip of beading. Ingenious and, as a cheeky nod to its Scottish namesake, a penny-pinching practice. It disguises and makes cheery what would otherwise be plain and minimal. Scotch beading can even be found in numerous spots on the unflashy coastal trader *The Daring*, the 153-year old shipwreck rescued from the Kaipara Harbour recently. “It was used extensively around the deck and the forepeak areas,” says Cranch.

Arras plane



One of the many planes in use at the school, this fits comfortably in the

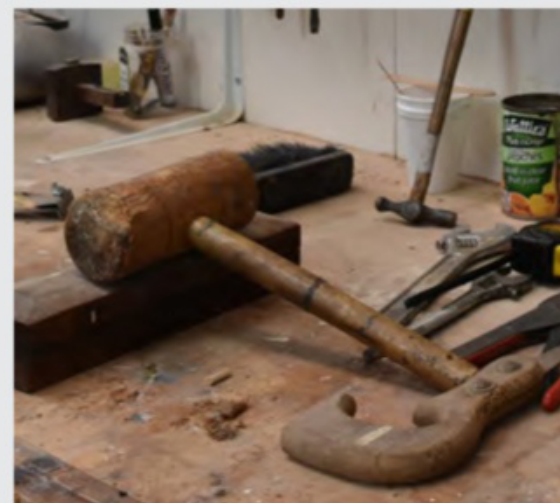
hand for careful work. “Most of those tools were made by the boatbuilders themselves,” says Cranch. “They would just be a bit of car leaf spring (used in early vehicle suspension system) or some other piece of metal they could sharpen as a blade, grind up the profile they wanted, and then make a wooden plane for it. We’ve got a lot of tools that you’d never guess what they were for until you start working with them.”

Marking gauge



Details in traditional boatbuilding would vary from builder to builder, with nearly all projects completed by eye. What mattered was uniformity in the boat, and even if they weren’t exactly the units of measurement we know today, they contribute to the individual style of a boat. Via tools the style would be passed down from father to son. Here, a simple gauge obviates the need for a tape measure in dinghy/clinker construction. “Accuracy doesn’t matter, as long as it’s all the same,” says Cranch.

Mallet



A pleasingly caveman-esque mallet provides the muscle.

The industry disappeared

In the new world of bean counters, classic boatbuilding as a widespread profession gradually drifted the way of do-it-yourself home renovations: a world of well-meaning, but often flawed projects by the owners themselves, who typically would only ever gain one or two projects under their belts. Young traditional boatbuilders had no market to work in.

The inevitable happened around 2009 when the Hobsonville lease wasn't renewed, and despite being financially solvent all the gear was rolled into storage containers and the school went into hibernation.

Gradually over recent years, a conglomerate of passionate Aucklanders came to the rescue, reforming the school

as a charitable trust, partly with an insight from the US.

“There has been a resurgence of boatbuilding schools in the US, especially in the Pacific Northwest,” says Dr Kere Kemp, who has lived there for more than 20 years. “They’re not just teaching; they’re morphing into a combination of traditional and ►



A trusty knee is called into service



Further fine-tuning with a chisel



Careful heat-gunning tidies things up



Old ribs are gently removed



New ribs await in the steam box



A new rib is tested



Cleaning the gaps for the new ribs is an important step

Often handicraft is an encounter with history. One such example was a recent NZTBS course in steam bending timber, a skill found historically in architecture, craft, and furniture making, and a feature in hull construction throughout the world.

This workshop was conducted as part of the rehab of a 35-foot whaling boat owned by the Te Waitere Club in the Kawhia Harbour. This craft was actually a lighter copy of a true whaler, designed back in the day for racing and still used for that by the club. A jaunty but serious kauri vessel, the blue boat is both nimble and robust. The attendees worked on the de-ribbing process, dismantling the interior seals, then cutting out old nails. Every second rib

was cut out, at the same time cleaning up and stripping the hull with a bit of gentle heat-gunning. Replacement ribs were eventually manhandled in, fixed in place with external copper nails, then trimmed to size.

Going slowly, the team worked in the old ways. Form is function here, and any change to the structure of the boat could have ramifications elsewhere. With both a 'dolly' (a hunk of steel, pointed at one end), and hammer and chisel, the rib is gradually worked free by one man, while others hold it in place.

Meanwhile a replacement rib awaits in the steamer (and can go back in to stay pliable if further adjustments on the hull are needed), a handmade

affair connected to a specialized kettle. Hardwoods are used here, their two-cell structure meaning that there are gaps between fibres and they are subsequently more flexible. Oak, willow, and cane were traditionally used in the UK, and locally the supplejack vine was used for coracles and craypots.

When ready the new ribs are bent into rough shape by a trusty knee, the team works each into place, then extra length is sawn off at the rim of the hull. There's a continuous process of slow chiselling, incrementally modifying the existing space if the rib doesn't fit first time. It's design on the fly. The rib is then nailed from the underside using copper nails, pushing at the same time with the dolly, with rivets added later.

modern, and expanding into other areas that are related to the boatbuilding trade, like electrical, plumbing, and engineering — all of the bespoke systems that boats require.”

Simultaneously the school realized that while New Zealand has a magnificent sailing fleet and an extensive boating culture, its wheelhouse extends beyond boatbuilding to include furniture makers and indeed woodworkers

Craftsmanship itself is its product, and this has universal appeal

of any level or background.

Craftsmanship itself is its product, and this has universal appeal, for a number of reasons.

“We want to help people enjoy making things with their hands; there’s an awful lot of pleasure in that,” says NZTBS board chairman Stephen Cranch. “You can see in people’s faces the enjoyment they get at our workshops, including the events for kids. They have so much fun, and you see their different personalities — some of them come up with the wackiest designs ever, but it’s what’s in their heads, it’s great.” ►



Above: Lapstrake work by Allan Hooper, overlapping planks carefully

Below: Methodical hand-tool work leads to fine detailing





Kitset dinghy



The NZTBS is developing a kitset clinker/lapstrake dinghy pack, a tribute to a design by legendary Auckland designer and boatbuilder Des Townson, the inspiration behind this example by Allan Hooper.

Clinkers, possibly named for the sound water makes slapping against the side of the boat, feature overlapping timber techniques dating back to the Vikings and beyond.

For more information on this beautiful project, due to be available in mid 2020, contact the school via email at info@nztbs.org.nz.

Real value in building projects

Further, there's soul in this meditative, repetitive journey of following in the practical footsteps of past generations. "Yes, there's something about fathers and sons," says Cranch. "Without getting too wishy-washy — everyone reacts differently — but some people do get very deeply into their projects, and you can lose hours working on something with your hands. It's hard to find the time for it though, that's the challenge," he says.

"We're all working longer than I

remember. My father was always able to religiously be home by 5.30 on the dot and be working on his boat. It's all changed now, with all the distractions. There wasn't much to do back then but build a boat." Restor+ing a family boat, Cranch says, is a way to be close to someone's personal decisions. "They probably made some errors if you look hard enough, but that doesn't matter, if you're part of it."

For the foreseeable future the NZTBS will draw a certain kind of enthusiast,

offering workshops and lectures, low-key camaraderie, and a diverse crowd of pupils (even rocket scientists are welcome, apparently).

And then there's those lines, says Kere Kemp.

"Somebody once told me, that when you see the lines on a boat that's meant for you, the lines sing to you. My wife and I saw a little 26-foot daysailer in Seattle, in really bad condition, designed in 1908, but with just glorious lines. And I was hearing orchestras." 



Hand tools reporting for duty



The steam-box kettle



Hardwood timbers are preferred for steam bending



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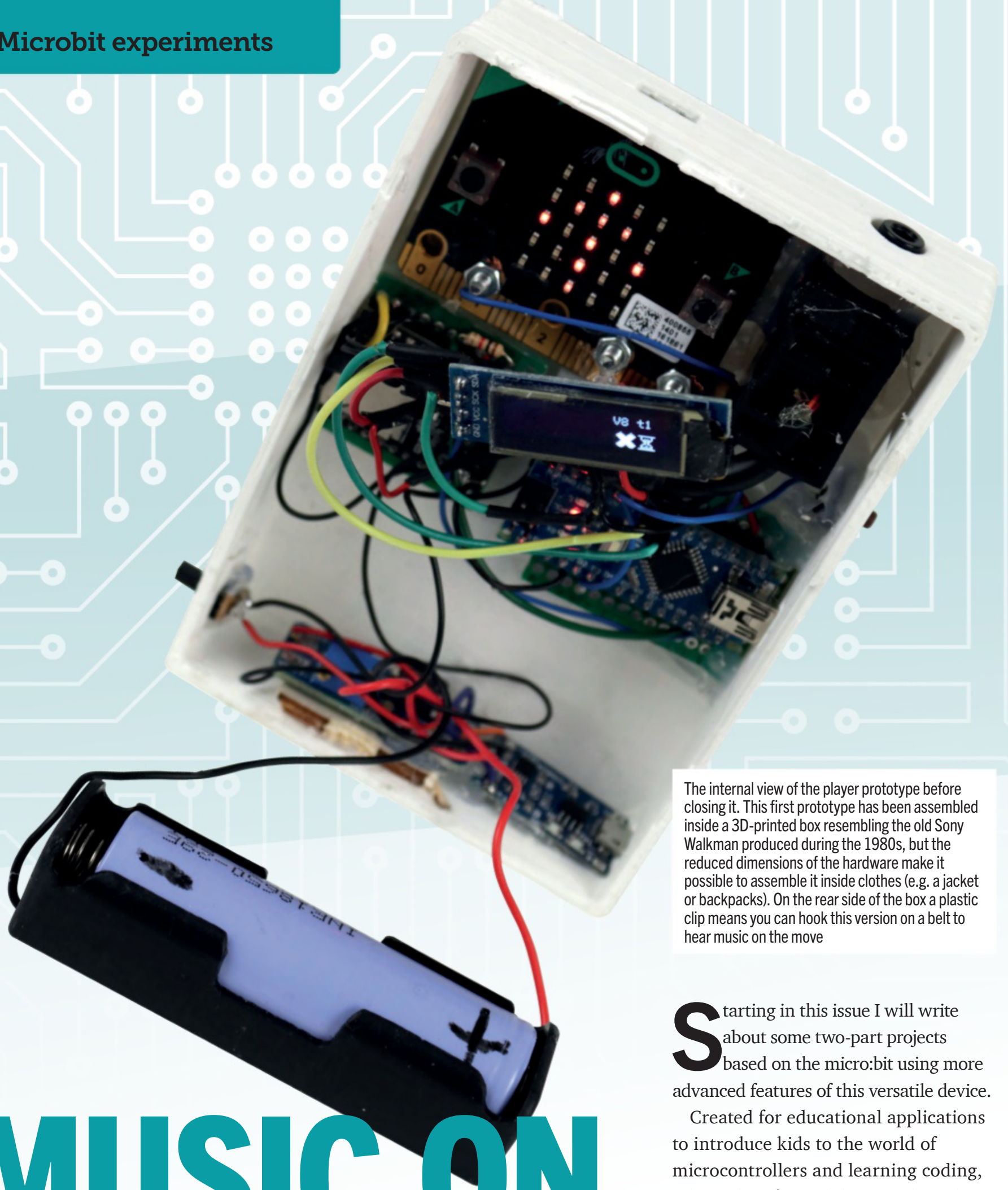
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The internal view of the player prototype before closing it. This first prototype has been assembled inside a 3D-printed box resembling the old Sony Walkman produced during the 1980s, but the reduced dimensions of the hardware make it possible to assemble it inside clothes (e.g. a jacket or backpacks). On the rear side of the box a plastic clip means you can hook this version on a belt to hear music on the move

MUSIC ON THE MOVE

MAKING A GENERAL-PURPOSE, WEARABLE MP3 PLAYER

By Enrico Miglino

Photographs: Enrico Miglino

Starting in this issue I will write about some two-part projects based on the micro:bit using more advanced features of this versatile device.

Created for educational applications to introduce kids to the world of microcontrollers and learning coding, it has a lot of possibilities and can be used for complex projects.

The Tijlplay project I describe this issue is a very nice example of open source and knowledge sharing. This micro:bit project has been designed and created by Benny Malengier, co-founder together with Cristina Ciocci of the Ingegno Maker Space in Gent, Belgium (www.facebook.com/IngegnoMakerSpace/). The idea for this project came to Benny after reading about the MP3 player I built with the Arduino Uno – in the musical box project featured in *The Shed*, Issues 87 and 88. Here it is replaced by an Arduino Nano to save space.

Stepping up with this project

The hardware architecture of this new build is very similar to the musical box project, but Benny added some interesting features that make a new and original device.

He decided it should resemble the iconic Sony Walkman, an old-style portable cassette player. The Tijlplay is a small, wearable MP3 player that, thanks to the micro:bit and Arduino Nano working together, can do more than just play music on the go.

The device has to be battery-operated to make it wearable. Together with a reduced size this is the other reason for using an Arduino Nano: both the Arduino and the micro:bit microcontrollers are powered by 3.3V.

A Li-Ion rechargeable battery is connected to a small USB charger taken from an old electronic appliance as well as a DC-DC voltage regulator. It is a small circuit you can find online or in any local electronics outlet for very little money (try searching with the keyword “LM2596 DC to DC Buck Converter”); this way, the battery can easily power both the microcontrollers.

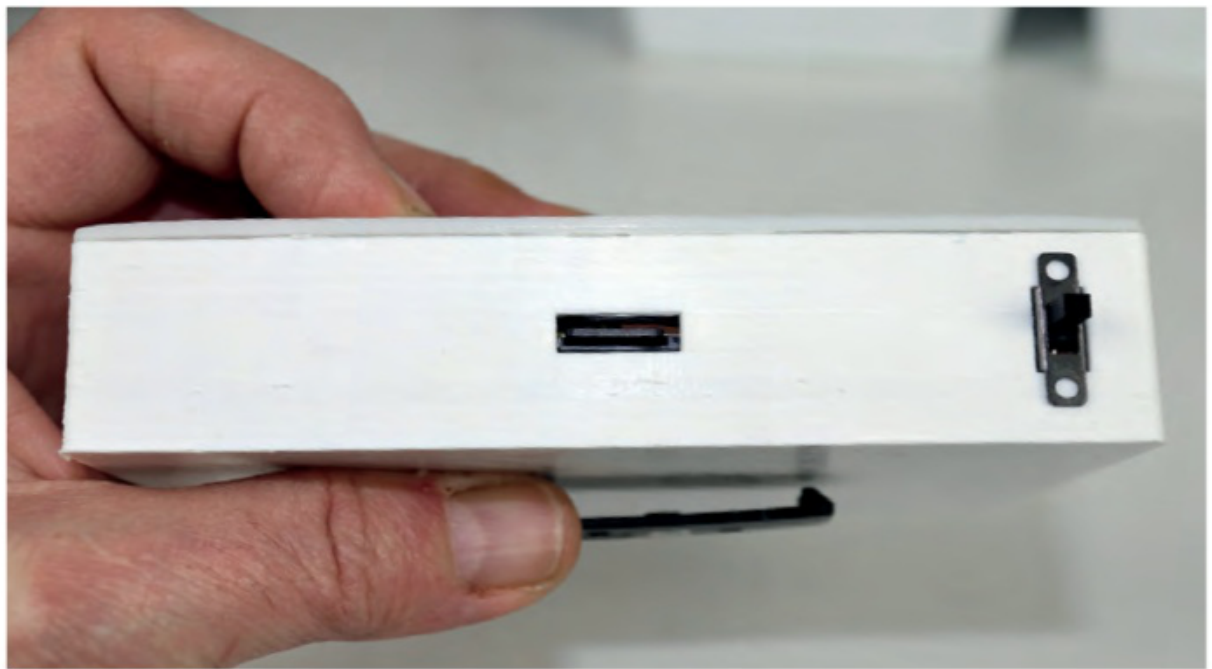
The Tijlplay can do more than just play music on the go

Go back and research

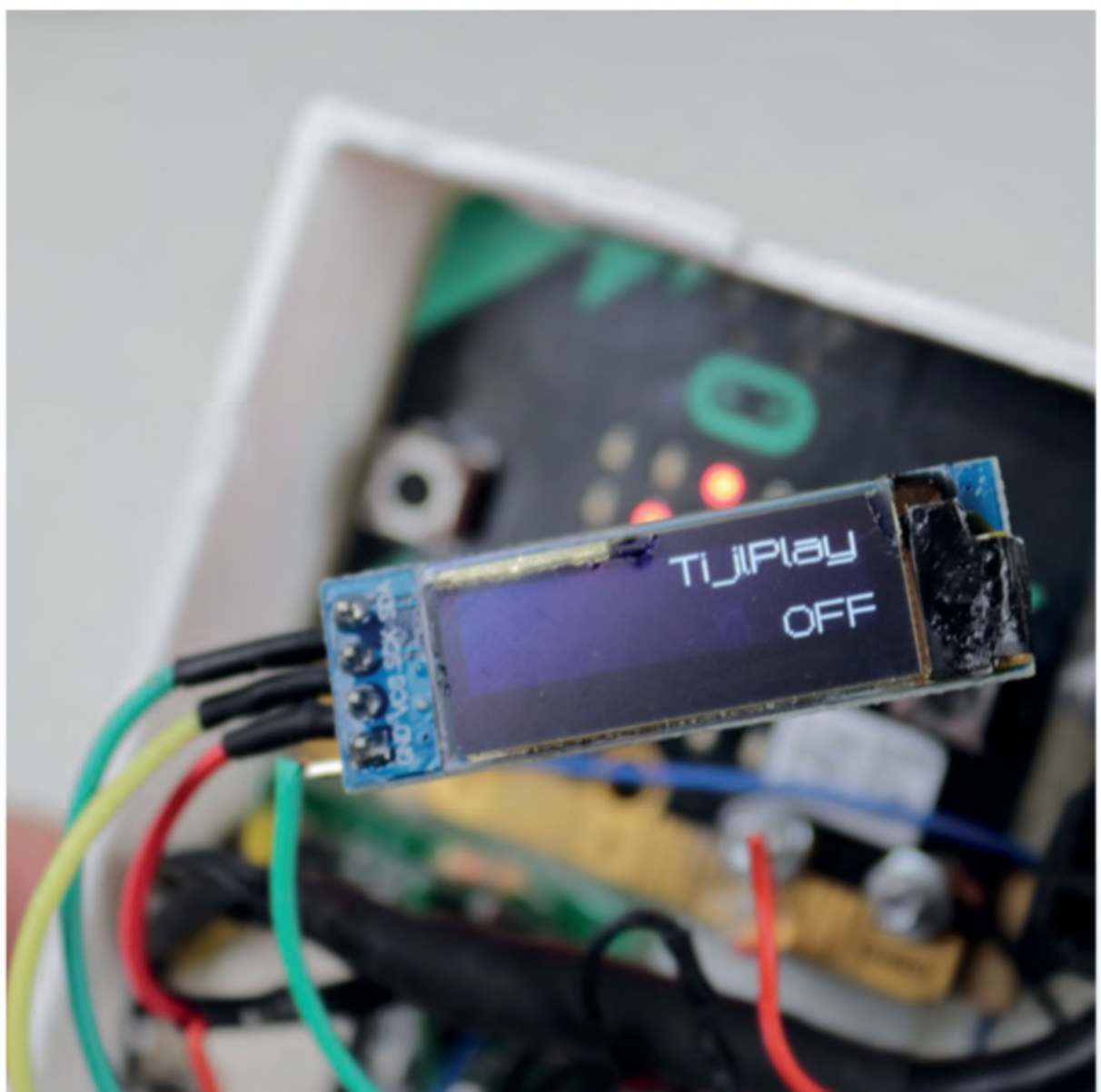
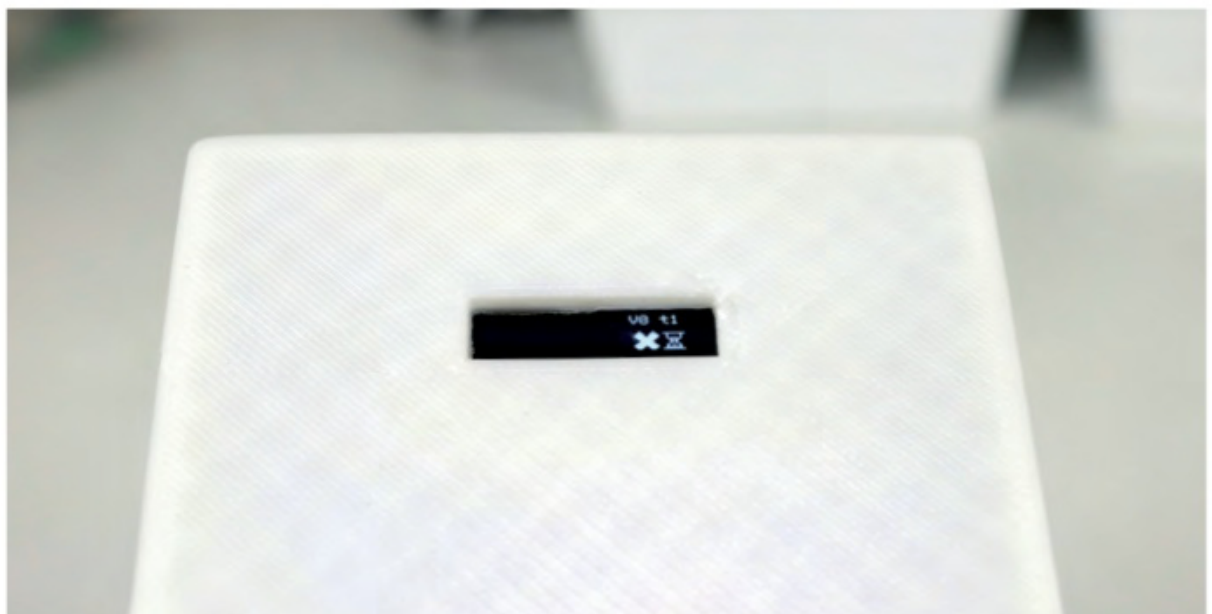
The Arduino Nano has a smaller form factor than the Arduino Uno but it has the same General Purpose Input Output (GPIO) pins.

For more detail on how the Arduino Nano should be connected to the micro MP3 player, read the micro:bit feature in Issue 87 of *The Shed*.

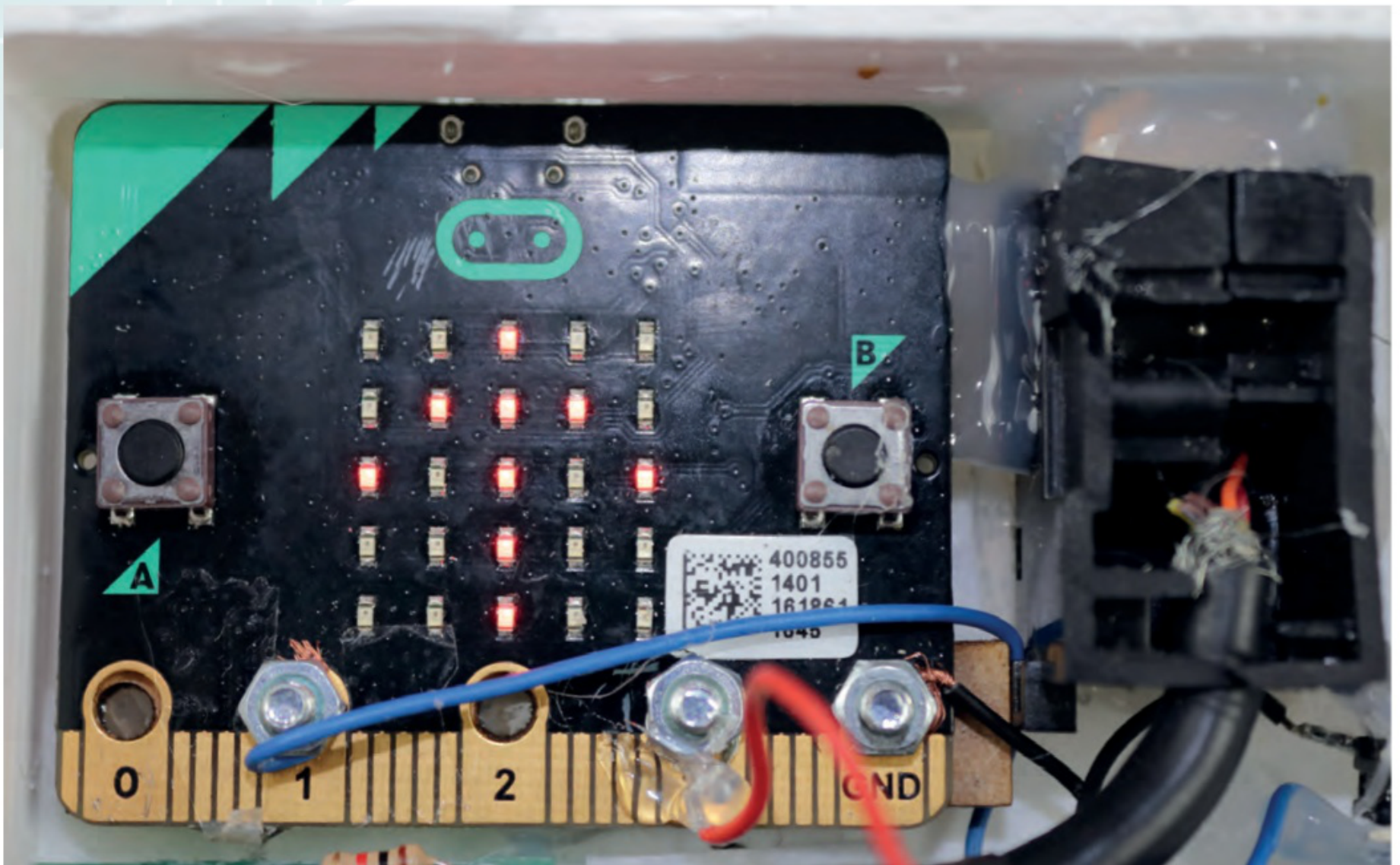
The Arduino Nano acts as the MP3 player, thanks to the micro player connected to the serial pins. In this build the player can accept both a micro SD card or a USB memory stick. Both the connectors are available from one of the sides of the first prototype box. The audio output is provided by soldering a 3.5 mm jack to the micro player to plug in the earbuds.



The right side of the player hosts the micro SD card holder, the modern replacement of the cassette tape, and the on/off button. The plastic clip to hold the micro:bit walkman on a belt is in the foreground



The front side of the device with the small OLED display showing the status of the player, motion status, and other parameters. The content of the display is easily customized with any other information



The micro:bit positioned on the top side of the box, internal and external view. The image shows to the right of the micro:bit the earplug stereo jack connector, recycled from an old desktop audio card. Note that the pin number 1 and the power cables are connected to the micro:bit by three screws using the large holes available for the pins 0, 1, 2, and the two power connections

One extra hole on the box makes it possible to connect the USB cable to the micro:bit for programming



The left side of the box shows, from left to right, a USB connector for an optional USB memory stick instead of the micro SD to store the music tracks, a push button that can be used to change the status of the player, the mini USB connector to program the Arduino Nano, and the micro USB port for the battery charger

Making the box an advanced and original wearable device

The Arduino player is controlled by the micro:bit using a single pin to activate the playing functions and in this configuration the micro:bit covers some other interesting roles, making the box an advanced and original wearable device.

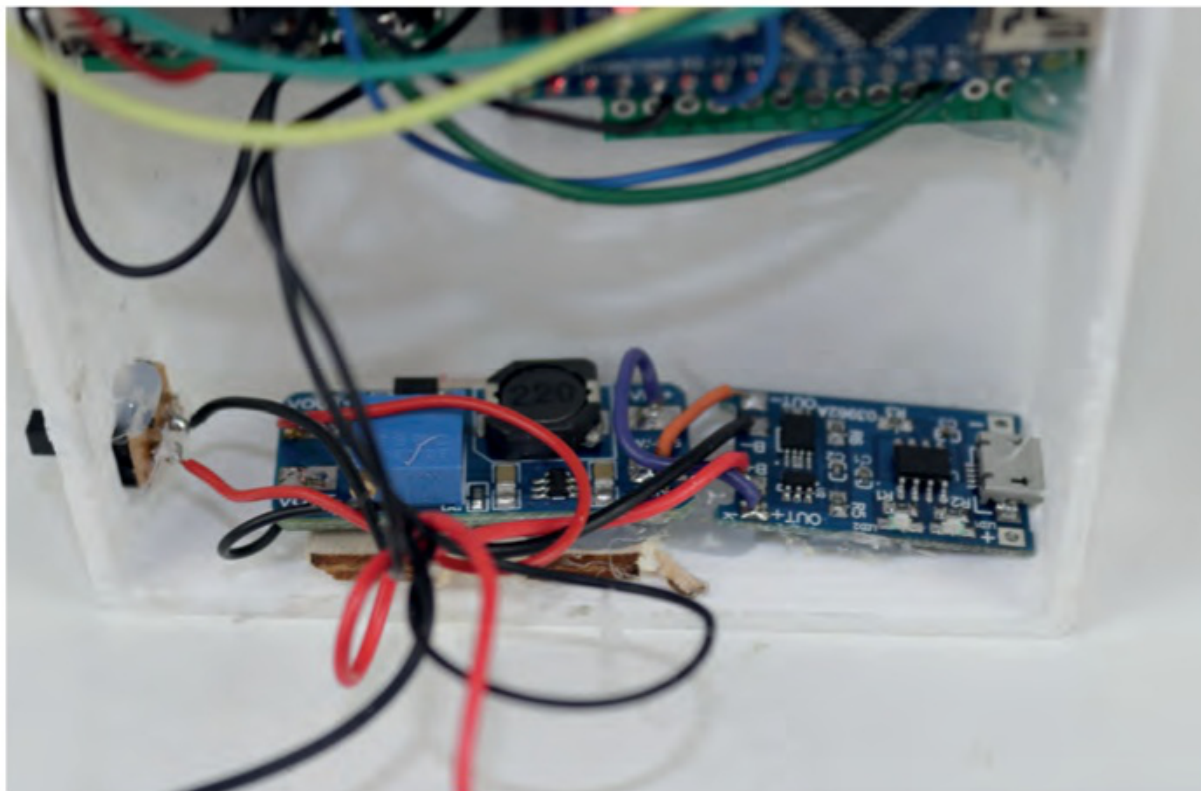
This device doesn't have the traditional play, pause, stop buttons,

etc. that you would expect on a portable music player. Instead it activates the tracks with its internal sensors, in particular, the inclinometer and the accelerometer.

Suiting your mood and activity

The prototype behaviour is just an example of what it can be programmed with on this small platform. We can customize the way the micro:bit interprets motion and information and it then reacts by playing the right music. For example, according to its speed and the motion, it will play relaxing music when walking, or high-energy music while running, as well as any kind of sound message or track associated with the different kinds of motion detected by the device.

Before we take a look at the logic of the software I will explain the development platform. A micro:bit is a very powerful and versatile microcontroller, but to get better results we should move from the javascript programming (mostly used



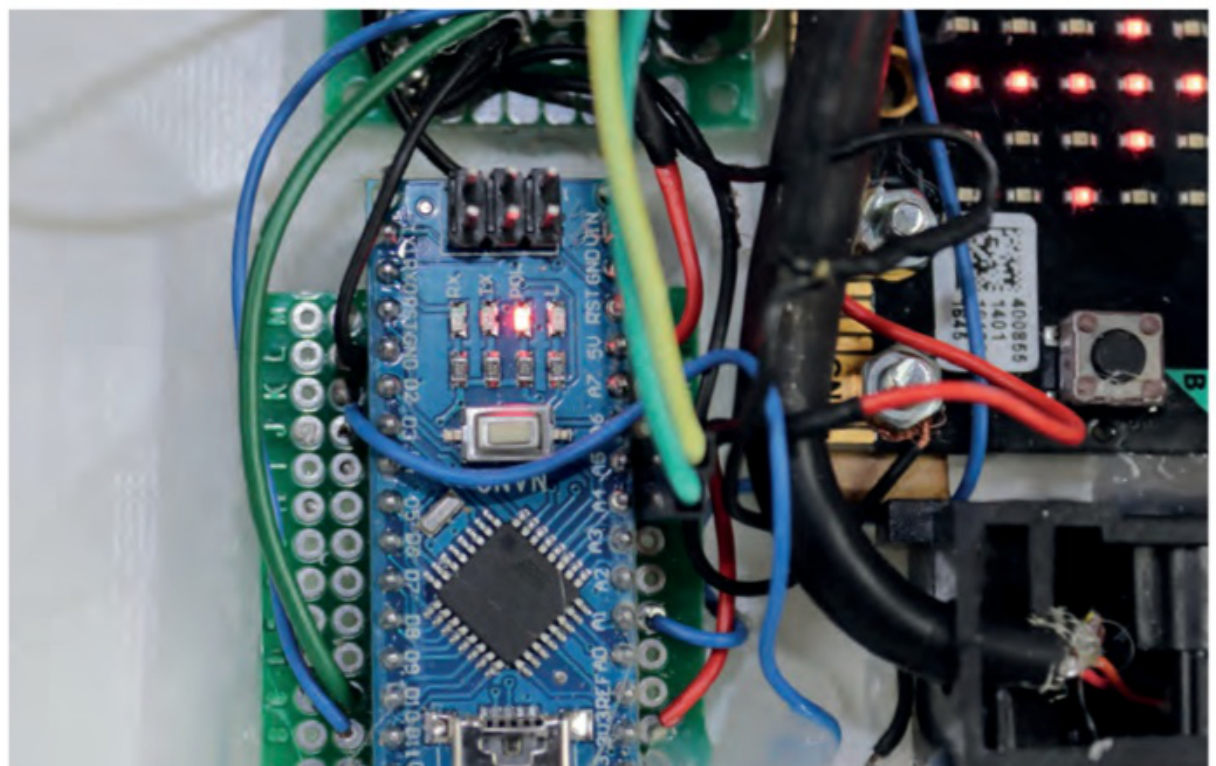
The power supply group at the bottom of the box. On the right side a simple USB battery charger circuit is wired to the current regulator to power both the Arduino Nano and the micro:bit

for educational purposes) to something more complex.

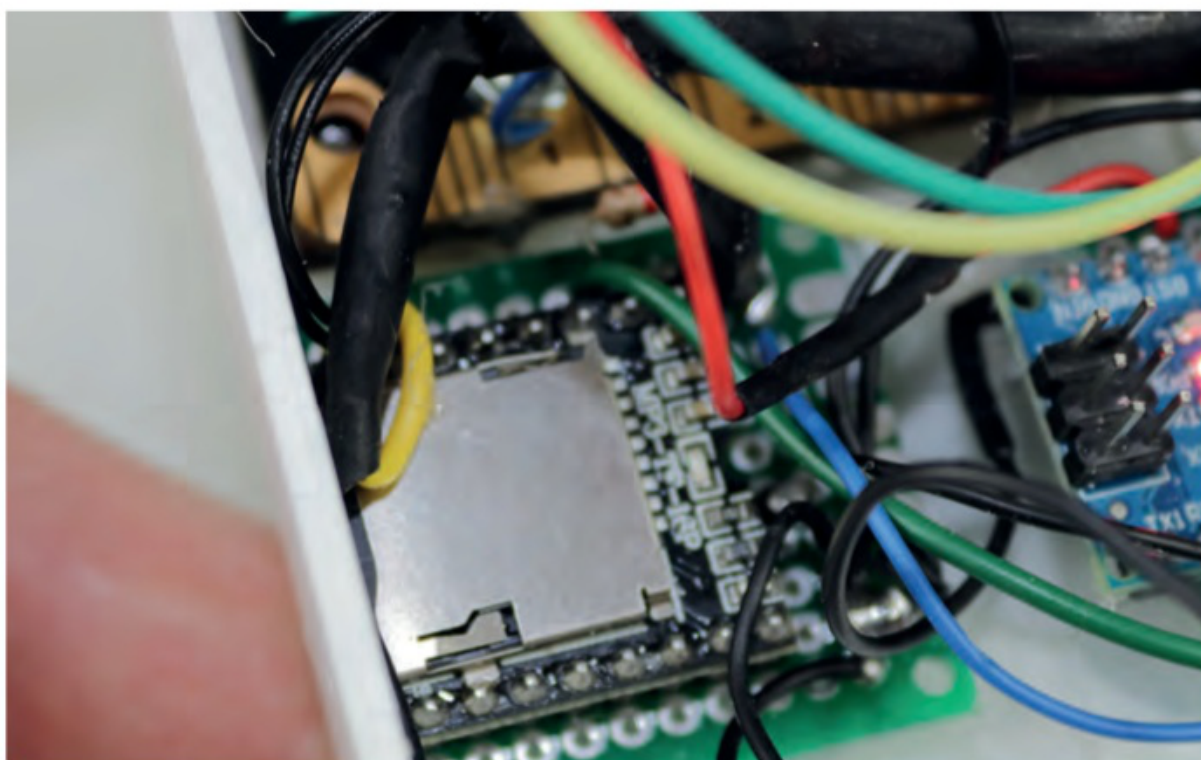
The software of this project has been developed in microPython, a version of the Python language specific for the micro:bit and other small microcontrollers. There's no need to worry about this difference as micro:bit remains a very easy board to program and there is a very good development platform that makes coding easy.

Storing all types of movement

In the next issue, we will see the final build of this project, paying special attention to the software, introduce the “mu code” platform, and the final creation of Tijlplay, the



Detail of the Arduino Nano board. For easier wiring the Arduino has been soldered on to a prototyping PCB. One pin from the Arduino Nano connects the micro:bit while the serial pins of the Arduino control the MP3 player



Detail of the all-in-one MP3 player. It is controlled by the serial pins of the Arduino Nano and can read an external USB memory stick instead of the microSD card

There is a very good development platform that makes coding easy

wearable intelligent music player.

The software has been divided in two parts. The first part is needed (but this job has already been done) to collect different human moving conditions identifying the fingerprint of the movement — such as walking, jumping, running, etc.

The most important acceleration and inclination changes characterizing every kind of movement are then stored in the player program.

Depending on the kind of movement

identified, at this point we can then allocate movements to the desired set of music tracks.

Another possible application is detecting special gestures, like tapping with a hand on the case to instruct the micro:bit to change track, replay, stop, and so on.

Don't miss the second part of this project on the next issue of *The Shed*, Issue 90.



Software download

Software and materials will be available on <https://github.com/alicemirror/SmartPlayer>

Electric Bikes





TAKING CARE OF BUSINESS

GET THE MOST OUT OF YOUR E-BIKE AND YEARS OF HAPPY CYCLING WITH REGULAR SERVICING

By Rex Thorley
Photographs: The Shed

Let's face it, e-bikes are everywhere and they are here to stay. If the thought of extra complications and potential breakdowns are putting you off

buying one then you're not alone. Would you like an e-bike that you can build and maintain yourself?

Something that goes better than most, is easy to service and diagnose,

with readily available parts and plenty of support, is becoming a priority for a lot of people looking for an e-bike that won't end up as landfill in a few years' time. ►



Crank puller in action, make sure it's all the way in before using



Main mounting nut needs to be tight

A priority for a lot of people looking for an e-bike is that it won't end up as landfill in a few years' time

There are quite a few different types of drive systems available these days and most of them go well but they are all made differently so it is impossible to cover them all. This article focuses on maintaining and overhauling the Bafang BBS range of mid-drive motors. This is the same motor that was featured in last year's September/October (Issue 86) edition of *The Shed* on how to convert your existing bike to electric. They are renowned for being a tough and reliable unit and make a great option for someone with some mechanical skills — in other words you.

Motors can get stressed

All e-bikes require extra long-term maintenance and these motors are no different.

Luckily they are relatively straightforward to service and overhaul.

The best way to make any mid-drive e-bike last is to let it rev. All electric motors like to rev and the way to do that is to turn your legs at a reasonable speed. A lot of riders presume that because they have a motor helping them that they can ride in top gear while giving their legs a holiday. This results in a low pedalling speed or cadence which puts extra stress on the motor and electrical system. It also wears out your chain and gears prematurely, costing more money when servicing.

The Bafang BBS range of motors come in 250watts through to 1000w, however the basic steps covered here are very similar for all models.

Step one

Rechecking motor mounting hardware after 300–400km:

The main motor mounting nut needs to be done up tight. They can loosen after a while when everything is new so they need to be checked and retightened after 300–400km. If these come loose the motor will drop down and rattle which will cause wiring damage.

The left-hand crank has to be removed and to do this you will need a crank puller tool. These are available from kit resellers and bike shops. Make sure the nuts are really tight. They can take a lot of torque so don't be afraid to crank them up. I use a special socket and a 600mm long 1/2" bar which bends when the nut is tight.



Remove seal by outside lip



Seal should go in by hand



Removing right-hand gear cover

Step two

Checking motor seals 3000–5000km:

You will need the crank puller for this job too. Remove both cranks, front chainring, and the plastic gear cover that is held on with seven small Phillips screws. Inspect the gears and casing for any sign of moisture or dirt.

Make sure there is still sufficient grease around the gears and add some good-quality gear grease if necessary. Don't get too carried away with this as they don't require a huge amount. I also add a small amount of high-quality oil stabilizer from Moreys or Lucas as this helps the grease stick to the gears and not get pushed to the side. The original gear cover is more of a dust shield so if you intend getting your motor wet often I would suggest an aftermarket cover which is more effective for keeping anything nasty out.

There is a seal on the left side of the motor which can be removed and refitted without destroying it. You will need a small, sharp-edged flat screwdriver for this. The trick is to prize the seal out by the outside lip, not the inside as normal.

If you take your time the seal will pop out undistorted and you can check inside for any moisture. If all is good pour a few drops of the oil stabilizer in the motor while it's sitting on its side and refit the seal with your fingers. The seal should pop back into its notch and sit evenly without too much pressure. ►

Step three

Inspect controller housing 3000-5000km:

Once the controller is free check the area for moisture, etc. Because motors are always going from cold to hot they can draw in moisture over time which will settle in the bottom of the housing. If you do have to clean up anything, hold the controller up with a bungee or similar so it isn't hanging by its wires. Apply a thin layer of grease to the gasket to reassemble and make sure the gasket is sitting correctly with no humps or hollows. Be careful not to pinch any wires when refitting. Tighten down the three bolts evenly to ensure gasket is sealing correctly.

Disconnect the battery and main loom connectors and check for moisture.

Check your tyre pressures. This can be a big factor in getting less range than normal and thinking that your bike isn't going like it used to. Check them every month.

Make sure the chain is lightly oiled.

Make sure you read the section here on how to look after your battery. It's worth the time.



Removing right-hand gear cover



Stripping down the motor

If your motor has done 50,000km and has never been serviced then there's a good chance it could need an overhaul. It's best to remove the motor to do this.

If it's been abused and needs parts replacing and cleaning out you will need another special tool to remove the main axle nuts. They aren't super tight and once removed allow you to remove the complete axle/gear assembly. There are two needle roller bearings and two

The seal should pop back into its notch and sit evenly without too much pressure

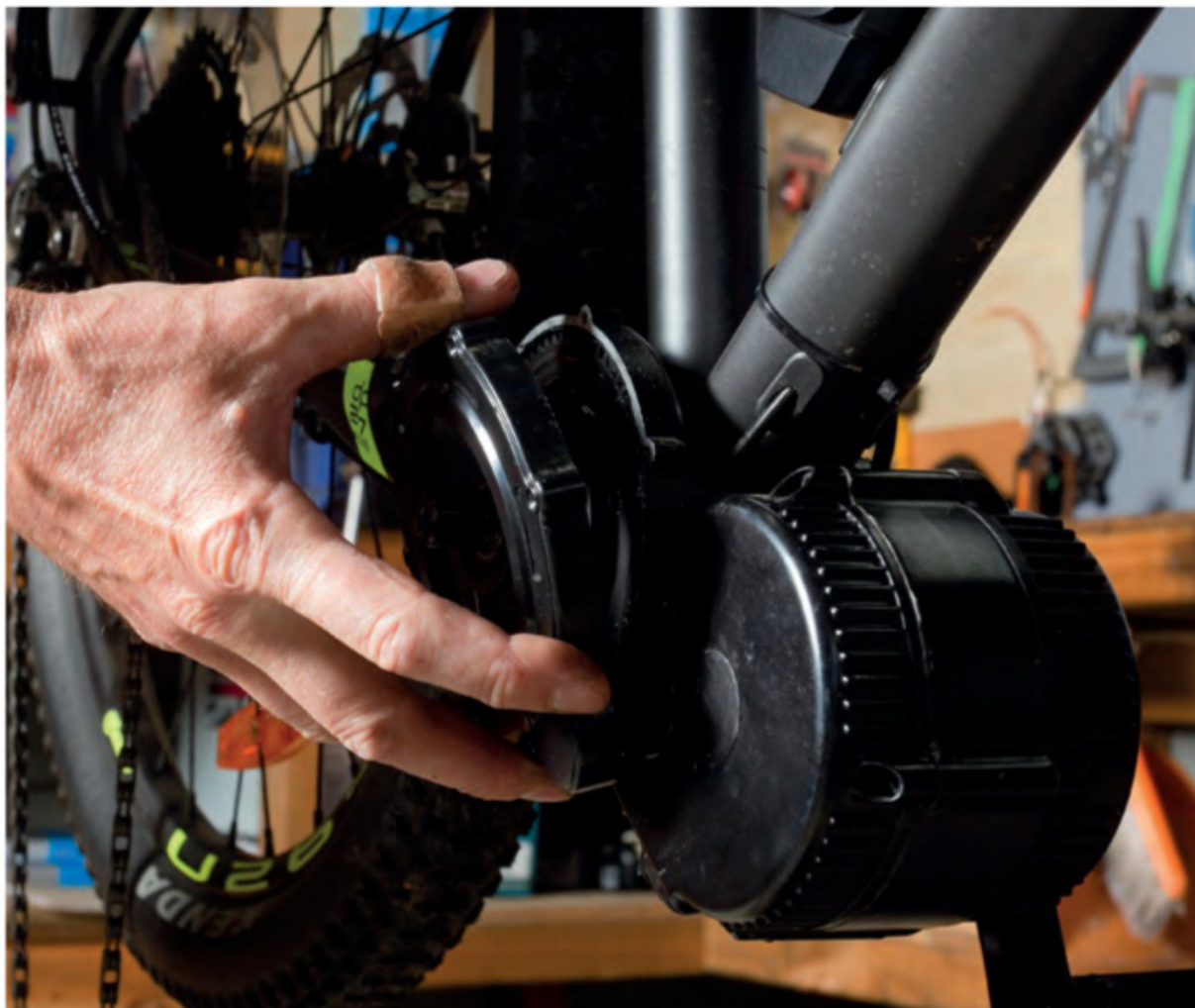
sets of thrust bearings that will need to be inspected or replaced for the axle. If they have had water in them then they will definitely need to be replaced.

On the back of the large gear there is a magnetic plate which tells the controller when you are pedalling so that it can provide power. Sometimes these plates can crack and create an intermittent on/off power supply which won't show up as a fault code on the speedo. There is also a one-way clutch inside the back of the gear. These don't give much trouble and the chances are that if water has got into this as well then it's probably better looking at getting a new motor. ►



These motors have throttles fitted, which is a great thing, but in the hands of the wrong person or someone who hasn't been told how to use them they can burn out motor windings.

There is a lot of heat generated in an electric motor so if the throttle is used when the bike is in the wrong gear and it can't rev high enough then all that heat can burn out the windings or melt the nylon gear that goes between the motor shaft and main reduction gear. The same can happen if you use the highest power settings in the wrong gear. You wouldn't take off in top gear in a manual car without ruining the clutch and the same applies to mid-drive e-bikes.



LITHIUM-ION BATTERY CARE FOR E-BIKES

Keep your batteries at room temperature

That means between 20–25°C.

The worst thing that can happen to a lithium-ion battery is to have a full charge and be subjected to elevated temperatures. So don't leave or charge any lithium-ion battery in your bike if it's hot out or in direct heat. Heat is by far the largest factor when it comes to reducing lithium-ion battery life.

Performance and range will also decrease in cold temperatures. Avoid charging your battery in sub-zero temperatures. Fortunately New Zealand's climate in general is favourable for keeping a battery in a healthy state.

The bigger the battery the better. The more watt hours the better.

Batteries deteriorate over time, whether they're being used or not. The bigger capacity or amperage battery you can afford or get with your bike the better. You can work out the Watt hour size of your battery by multiplying the volts x amp hour rating. For example if

your battery is 36v and 17.5ahrs then $36 \times 17.5 = 630$ Watt hours.

This is considered the start of the bigger battery sizes in the e-bike world. You will get more range and have peace of mind that you won't be pushing that fancy e-bike up the last hills. The battery will be less stressed under higher loads and should last longer than a smaller battery when cared for correctly. It's important to remember the ageing characteristics when purchasing batteries. Make sure to ask for ones with the most recent manufacturing date.

Quality cells make a quality battery that lasts

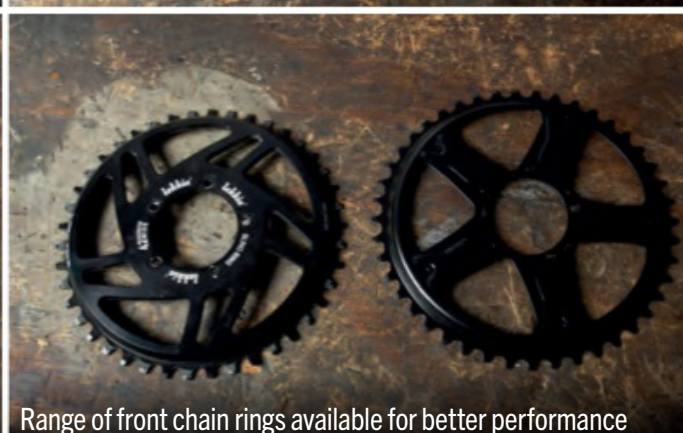
Batteries are the one thing you can't afford to skimp on. If the battery seller cannot confidently tell you the brand of cells, the capacity, and the charge/discharge rating of each cell then are they really the experts they claim to be?

E-bikes can draw a lot of current and it's not enough just to have a branded battery pack as there are various types of cells within each manufacturer's range and not all are suitable for e-bike use.





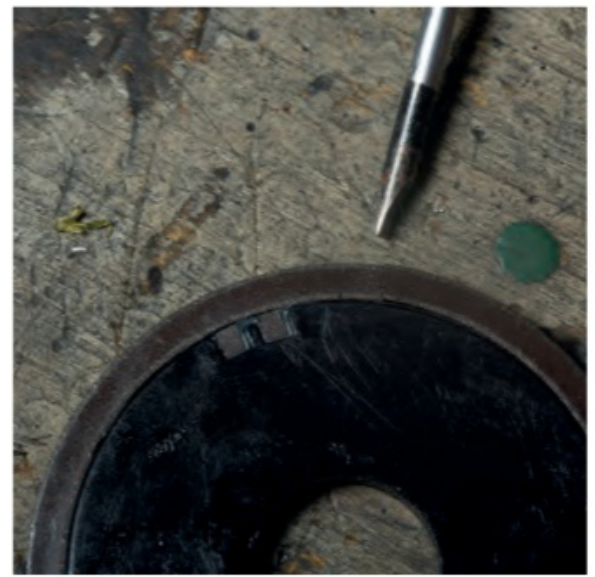
Better quality seals available



Range of front chain rings available for better performance



Removing controller housing



Removing the motor housing

Before removing the motor housing you will need to disconnect all the controller wiring.

This is straightforward but the main rectangular plug in the top of the housing will be covered in silicone. Carefully cut through the silicone and take your time. The plug will pull out with a pair of long-nosed pliers. You will also need to free the three motor phase wires from their silicone to allow the motor housing to come off.

To remove the motor housing there are four mounting bolts. The housing can be hard to remove depending on whether the armature stays in the controller end bearing or not. The magnets are really strong and create a lot of resistance, so take your time.

The windings should be a nice copper/orange colour. If they appear dark brown and you can smell that ominous burnt electrical smell then they are history. ►

The last thing to remove is the nylon gear and bearing housing. You will need a pair of good-quality external circlip pliers with small ends for this. There is a bearing cover plate held down with three screws. Remove the screws.

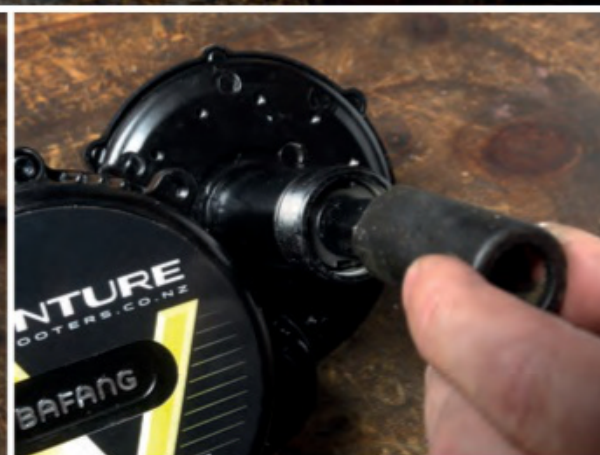
The cover has two small threaded holes which are used to remove the cover. Take two of the controller mounting bolts and thread them into these holes. Tighten the bolts evenly and the cover will lift up. It usually lifts up on an angle so take your time and give

If your motor has done 5000km and never been serviced then there's a good chance it could need an overhaul

the cover a wiggle, it will pop off with a bit of persuasion. Remove the circlips and the gear assembly will slide out along with the gear shaft. The nylon gear should be surrounded by a nice white grease. If the gear is even slightly worn it will need to be replaced as it won't last long if reinstalled. It has a one-way sprag clutch built into it so if this isn't working it's time to replace the gear.

Obviously all the bearings need to turn smoothly and be free of any debris. ►

Controller with water damage



Special tool for removing angle nuts



Removing axle and main drive gear



Axle nuts and seal



Removing the rectangular plug



Removing motor housing can be hard work due to the magnets

LITHIUM-ION BATTERY CARE FOR E-BIKES

Less power equals more life

E-bikes are fun. For a lot of people it's more fun when there's more speed, especially uphill, which also means demanding more power from the motor and battery.

This isn't a problem as most bikes and batteries have inbuilt safeguards to protect themselves but it can shorten the life of your battery. Even though these batteries are capable of producing high current and power for extended periods they prefer to discharge at a more sedate rate. When pushed hard they create more internal heat which can lead to the premature ageing of the cells. The same applies to charging. Most batteries come with a 2 or 3 amp charger which is fine. Please avoid attempting to fast-charge your battery with a larger charger as this also creates heat which can damage the cells.

Only charge your battery just before you need it

For years we have been told that we have to keep batteries fully charged to make them last. This is not the case with lithium-ion batteries.

They prefer to sit in a semi-discharged state somewhere between 40–70 percent.

So unless you are riding the next day please avoid the temptation to put it straight on charge after use

and wait until the night before to charge if practical.

Allow partial discharges and avoid full ones (mostly)

Unlike NiCad batteries, lithium-ion batteries do not have a charge memory. That means deep-discharge cycles are not required. In fact, it's better for the battery to use partial-discharge cycles.

There is one exception. Battery experts suggest that after approximately 30 charges, or approximately 1000–1500km, you should allow lithium-ion batteries to almost completely discharge. Continuous partial discharges create a condition called digital memory, decreasing the accuracy

of the device's power gauge or the speedo's ability to judge battery charge correctly. So let the battery discharge to the cut-off point and then recharge. The power gauge will be recalibrated.

Avoid completely discharging lithium-ion batteries if you can help it

Lithium-ion batteries can deteriorate when left stored in a completely discharged state and this can lead to what seems like a dead battery. They may be able to be rescued but only by an expert with the correct equipment. So you should run your pack to exhaustion, then recharge it as quickly as possible to at least 50-per-cent charge.

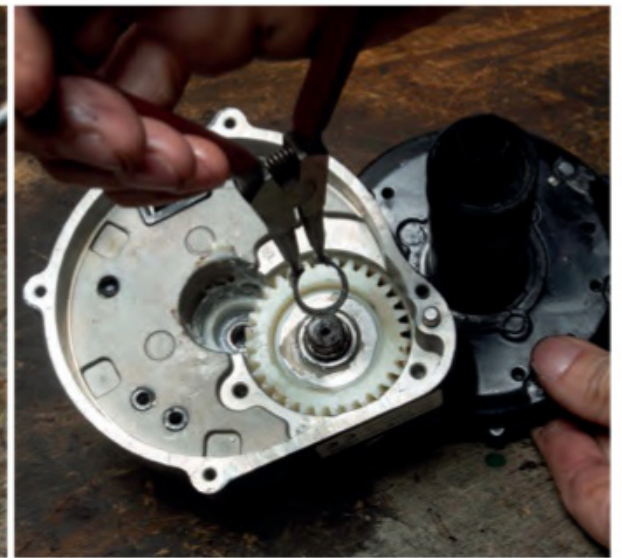
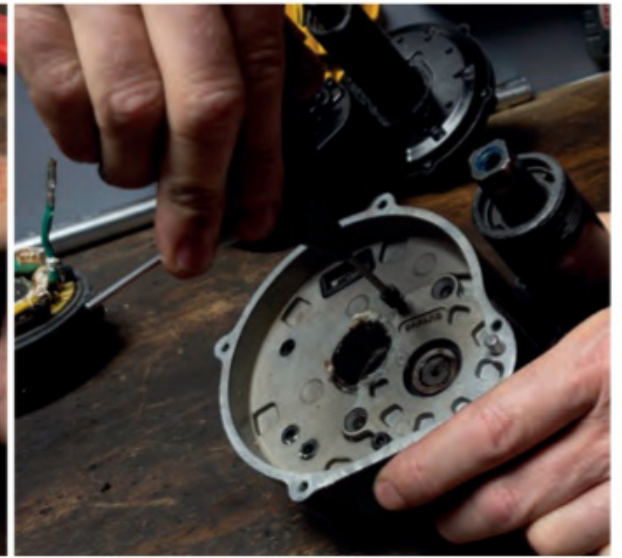
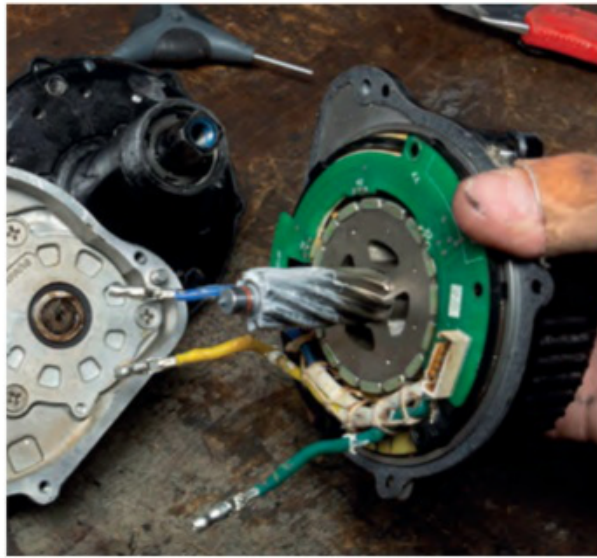


Retrace your steps for reassembly

Reassembly is just the reverse of disassembly. As always make sure everything is clean and use good-quality greases. Make sure you apply some fresh silicone to the controller plugs. When it comes to doing the two nuts up on the left side of the axle make them snug — not too tight and not loose. The axle should turn freely without any stiffness and have no sideways play. The first nut provides the adjustment and the second nut locks it in place.

So there you have it. These motors can be maintained and serviced by anyone with some mechanical know-how and patience. Parts are readily available and don't cost a fortune.

Looked after correctly these Bafang BBS mid-drive motors will give you years of trouble-free service and will outperform most other e-bikes on the market. 



Use the right circuit pliers or you'll be sorry



Getting into the guts of the motor



Example of cracked cadence magnet disk

LITHIUM-ION BATTERY CARE FOR E-BIKES

They don't like being left stored fully charged either and prefer to sit in a mid-charged state.

For extended storage, discharge a lithium-ion battery to about 40 per cent and store it in a cool place.

It is not recommended to store lithium-ion batteries fully charged. In this state oxidation of the lithium-ion is at its highest rate and premature deterioration will occur. Storing lithium-ion batteries at

approximately 40-per-cent discharge and in the refrigerator (not freezer) is recommended if practical for extended periods.

Final thoughts

Lithium-ion batteries are a huge improvement over previous types of batteries. Getting 500 charge/discharge cycles from a lithium-ion battery is not unheard of. Just follow the above guidelines and you will get the most from the battery.



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STOCKING UP TOKYO STYLE

AN EDUCATION IN JAPANESE TOOLS — AND HOW TO TURN ON A COOKTOP

By Ritchie Wilson

Japanese tools are well thought of because of their time-tested designs and the high quality of the steels used to make them. During a recent two-week holiday in Tokyo, tool shopping was one of the things we made sure we did. The

problem was locating tool shops. On a previous visit, Tokyu Hands — the large, multibranch department store catering to artists and craftspeople — was where I had purchased wood saws, spare blades, and a marking knife. This time my search

for replacement saw blades was unsuccessful, as Tokyu Hands now stocks different brands. It did have a very interesting display of knife-making kitsets though, and I bought a traditional 0.5m bamboo ruler which had no numerical markings.



Three chisels

Wonderful Japan

Japan is a good place to holiday: reasonably affordable, outstandingly safe and unusual, and with unrivalled transport infrastructure.

The main aim of this trip was for my wife to visit buildings which are included in the architectural history courses she teaches. Tool buying was a secondary consideration.

In old parts of Japanese cities families tend to live over their businesses. The small printing shop, or restaurant, or bookshop downstairs, open to the street, with the living quarters upstairs. These buildings, perhaps as a result of ancient regulations, are a standard width of about 4m and separated from their

Japan is a good place to holiday: reasonably affordable, outstandingly safe and unusual, and with unrivalled transport infrastructure

neighbours by less than half a metre — just enough room to squeeze through for maintenance jobs.

In most of Tokyo the old inhabitants have been bought out and very large high rises have replaced traditional buildings. So it was almost surreal to spot a small tool shop at the street level of a central Tokyo commercial skyscraper.

Just what I was looking for

The shop turned out to stock the correct replacement blades. About 40m² in area, it wasn't only a tool shop but also, in a corner, it contained a workshop the size of a sofa where they fitted wooden handles to various types of trowels for plastering, concrete finishing, bricklaying, etc. The back wall of the shop was covered with scores of unfitted white oak handles of various shapes and sizes, making it possible to produce a trowel with the optimum custom-fitted handle for the customer.

I bought two saws (one double-sided rip and crosscut), three chisels (24, 15, and 9mm), and two replacement crosscut blades. ►



Kyoto's Concert Hall designed by Arata Isozaki (1995)



Cross cut saw and traditional rulers



Four saws



The relief ground in the back of the chisel blades makes for faster sharpening

Japanese-made tools

Western saws cut as the saw is pushed forward. This means that the saw blade has to be quite thick so that the saw doesn't buckle under the push force. A thicker saw means that more wood has to be removed, as the saw cuts as the kerf is wider and it takes more effort.

sides and to the cutting edge. Western chisels have a flat back. The advantage of the Japanese design is that much less metal has to be removed from the back to produce a sharp edge. Sharpening involves removing metal at the bevel at the front of the chisel, but also from the back to make the back flat. This

This allows the saw blade to be thinner ... leading to a thinner kerf and less sawing effort

Japanese saws cut as the saw is pulled. This allows the saw blade to be thinner, as buckling is now not a problem, leading to a thinner kerf and less sawing effort. The aggressive tooth shape of Japanese saws is now used on most Western saws. If the saw blade is under tension, as it is in a frame saw such as a bow saw or fret saw, buckling is eliminated and the blade can be very thin. Traditional Chinese saws are bow saws.

Japanese chisels have a relief ground in the back of the blade almost to the

is much easier with Japanese chisels, although the Western type would have a longer life. The steel used in Japanese chisels — high carbon steel at the tip, lower carbon steel for the rest — is of very high quality and its heat treatment is excellent.

Japanese sharpening stones produce a very sharp edge rapidly. They use water as a lubricant and coolant. Although these waterstones are relatively expensive they are very well regarded by many woodworkers.



Induction cooktop. The on/off switch is outlined in red. Press and HOLD. Inset are the control panels for the instant hot water (left) and the bathroom heating and ventilation (right)



High tech apartment in the dusk

A Japanese apartment

For some of our time in Japan we stayed at a ‘ryokan’: a traditional, family-run hotel. It had tatami mats on the floor and futons to sleep on which had to be folded away during the day. The rest of the time we stayed at a modern apartment (which we booked online) with high-tech fittings that cruelly exposed our lack of technical sophistication.

the sink bench to control the induction hotplate. All the labels on the panels were in Japanese and this caused problems.

The initial difficulty was turning on the induction cooktop. The red-outlined, soft-touch control did nothing. We emailed the proprietor and he immediately responded: “Have you connected the charger?” The charger? A search under the

All done remotely?

There was a similar dialogue to do with the lack of hot water. It turned out that in our quest to find the hotplate ‘charger’ we had turned off the instant hot water. The hot-water control panel was identified, switched on, and the water temperature set to a satisfactory level. The hot water was immediately hot. Result!

We never met the proprietor. There was no key. We gained admission by entering numerical codes we had been sent by email into electronic locks on an outer door and a different code on the door of the apartment.

By the time we left we were in control. We could manipulate the temperature of the living room and, separately, of the bathroom. The bathroom could be ventilated with a hot breeze for a set length of time to dry surfaces and towels and the extraction fan would remove the damp air for another set length of time.

As for cooking dinner, in the end we didn’t use the hotplate much — the local eating places were so good and affordable.

All the labels on the panels were in Japanese and this caused problems

The apartment was a narrow space of about 30m². It had a double bed, a tiny table, and one chair; a sink bench with a built-in hotplate; a tiny bathroom; and a self-contained toilet with a hand basin set into the top of the cistern. Three control panels were fixed to the walls in various places. One controlled the air conditioning, another the water heating, a third the heating and ventilation of the bathroom. A fourth panel was set into

sink bench revealed a disconnected power lead. Result! But pressing the power button had no effect — we still couldn’t get the hotplate to fire up. “Video trying to turn on the hotplate and send it to me by WhatsApp,” was the reply.

Ohhhkaaay ... but we managed to do this.

“You have to press and hold.”

Result! The water in the pot on the induction hotplate started to warm up!

BRING ON INSIDE-OUT THINKING

LEARNING TO THINK Laterally IS AN ESSENTIAL SKILL FOR THE FUTURE

By Murray Grimwood

Photographs: Murray Grimwood

There is no more useful cranial trait than lateral thinking. Without it we would be short of a lot of inventions, and history would be missing a lot of eureka moments.

Simply put, the application of a way of thinking probably accounts for much of what we call 'genius'. Much can be achieved by throwing away all preconceptions and leaving no stone unturned, sticking only to first principles. Add a dash of logic, and stir well.



... and went cruising



We moved the masts outboard of the hulls ...

A new way of thinking

I first came across lateral thinking at 10 years of age, trying to build a model aeroplane one shop-closed weekend, and loudly lamenting a lack of balsa and glue (with hindsight, what I should have been lamenting was a lack of foresight).

The old man suggested I turn my problem inside out, upside down, and back to front. And left me to it. The result (a fuselage of cardboard blanket-stitched together with wool and sporting wings made from old venetian-blind slats) is a memory which, by a decade, predates knowing

about Edward De Bono and his *Lateral Thinking* book.

Dad was always quicker at it than me. Fast forward to 1980. I'm in a Bondi backyard, having put a 3.6 Falcon motor into an earlier XM ute to tow the boat that two of us have built. Our lease finishes the next day. The XM clutch was driver's side and mechanical; the new clutch was ex-hydraulic and passenger side.

We'd drilled some adjustment-holes down the top-hung clutch pedal, bolted a yachting pulley under the dashboard, and run a stainless cable

from the pedal, up round the pulley, and back through the firewall. We had found the handbrake cable outer from a derelict Valiant, and run it from the firewall, down and around under the sump. Now the resulting Bowden cable pointed aft on the passenger side, but pulling the inner forwards in the vehicle didn't help a clutch lever which wanted to be pulled aft.

Sometimes lateral thinking hits a snag

Fatherly wisdom

A stressed toll call was made to the old man, in Dunedin and totally unfamiliar with our plight.

Within seconds, he'd turned it upside down and suggested: "Why don't you bolt the inner cable to the passenger floor, and push the arm with the outer?" So simple. We were mobile an hour later. (Much later, upcountry, I was to use another of his tricks when that 3.6 blew a head gasket; peening open the squashed copper of the new gasket at the relevant spot and tamping in a half-moon sliver of copper from the old one.)

Mind you, the boat was a good example of such thinking. I'd been building a 16-foot monohull until a flatmate asked to join in the adventure. So we spaced the frames further apart to make it longer, then chopped it down the centre line, shifting the halves apart to produce a catamaran — and each gained a little privacy. In theory, those hulls could slide together and become a self-righting monohull, but sometimes lateral thinking hits a snag. In practice, wave-induced torsional loads locked up the sliding surfaces the way sliding clamps lock up; at the very time you wanted to move it, you couldn't. ►

Right: Launching day — 30 knots here we come!

Below: The original rig configuration — curved one face, flat the other



Above: It was a stressed-ply monocoque structure. The temporary frames are the pile of timber on the right

Below: The XM ute lugging four hang-gliders, an Alsatian, our boat and all the gear, through inland New South Wales. That's snow, where bush fires now rage



Left: Launching day, showing the original rig



Design challenges

The original rig would have been unsuitable and we had nothing to stand it on now, anyway, given that we wanted the hulls to mate, which would have slackened the rigging, dropping a central mast over the side. A few hazy nights followed, jotting down our inside-out, upside-down, and back-to-front ideas on Bondi pub beer coasters. Both being hang-glider pilots and one being an engineering student (he later completed a naval architecture degree) we agreed that two masts gave more leading edge, and that double-surface wings were the way to go. We were also aware they could run afoul of the biplane effect — where the low pressure above the bottom wing interferes with the high pressure below the top one — although we could get over it in the time-honoured biplane manner; by shifting the ‘top’ wing forward.

So we hatched a plan. The two-surface sails would have to have their maximum chord half-way along them, making them reversible. The downwind one would be swung forward, the upwind one swung backwards, both being reversed when we tacked. Neither of us (nor our sailmaker and hang-glider manufacturer friends) saw the Achilles heel and on the beer-coaster sketches we were doing 30 knots already, particularly towards the end of a design session!

Reality meets design

One day of testing revealed the truth(s); first, we couldn’t keep a wire leading edge tight enough; second the fixed camber couldn’t be flattened for stronger winds. Oh — and the masts were too close together ...

More hazy time with the coasters, sketching. Move the masts outboard of the hulls. Cross-brace the top. Add

On the beer-coaster sketches we were doing 30 knots already

We split the design down the centre line, and moved the halves apart



The ute’s job is done; we’re ready to go cruising.



A treasured painting, adapted from the photo on page 102

an X of rigging wire between, plus two tubular forestays, and a single central backstay. Then we bought a \$30 Bernina, learned to sew, opened out the sails to single-surface trapezoids, added four wishbone booms ... and went cruising.

We’d turned it inside out, turned it back to front, but avoided turning it upside down. Just as well, considering. As far as we know it was the fifth biplane-rigged vessel in the world, and was a ton of fun to design, build, and use. And the way of thinking? Right out of the box.

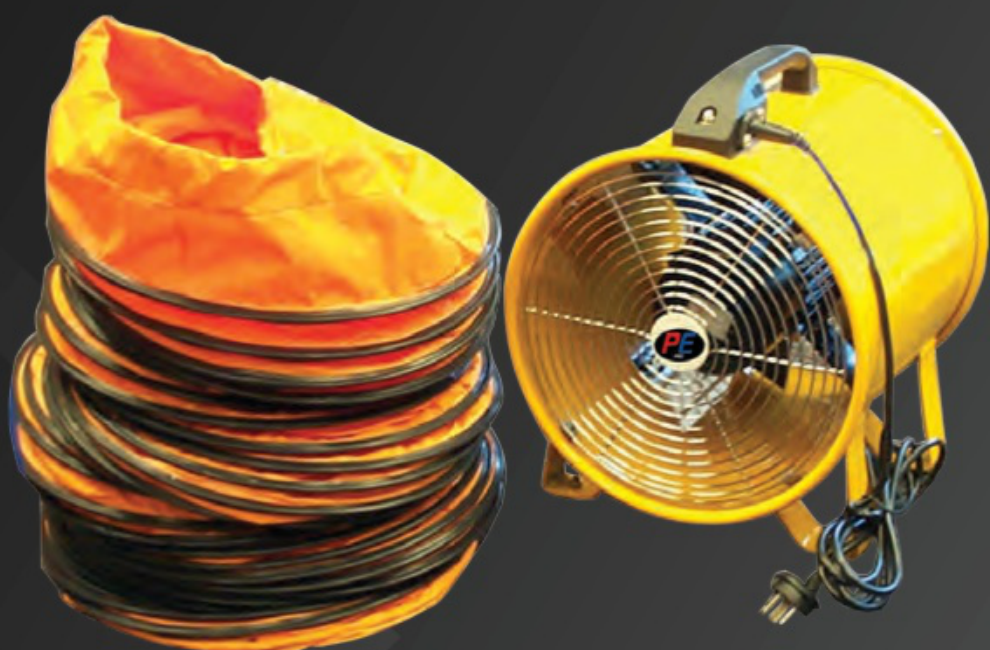
If we’re going to transition to a low-carbon economy, we’re going to need a lot more lateral thinking; a lot more turning things inside out, upside down, and back to front. Bring it on. 

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THE ULTIMATE ENGINEER

A FAMILY TALENT FOR ALL THINGS TECHNICAL
LEADS TO SOME EXCEPTIONAL RESULTS

By Ritchie Wilson
Photographs: Ritchie Wilson

One of the perennial arguments in biology is why living things turn out the way they do.

Is it a matter of inheritance or environment? In humans, for instance, which is more important — nature or nurture? Bob Hayes is firmly of the belief that his skill from a very young age in technical matters is a legacy handed down from his parents and grandparents.

His maternal grandfather was the famous railway engineer Robert West Holmes (1856–1936), who was responsible for the 1889 design of the celebrated Raurimu Spiral on the North Island's Main Trunk railway line between the National Park and Raurimu.

Bob not only inherited his first and middle name from this illustrious ancestor, but also, he thinks, his engineering talent.

Stranger than fiction

Bob left school in 1941 at the age of 12 and started work in a bootmaker's shop

in his hometown of Shannon in the central North Island.

In a sequence of events worthy of a Charles Dickens' novel, his employer killed himself and Bob was left running the business (he was just 13), then the shoe shop burnt to the ground when the fish and chips shop next door caught fire. Finally he joined New Zealand Railways (NZR) as its youngest employee at Shannon Railway Station.

Here his natural affinity for the two-stroke petrol engines that powered the motorized jiggers, which railway porters used to travel to nearby minor stations as part of their duties, was noticed by the Shannon station master. He suggested that Bob take up a motor engineering apprenticeship with Road Services, the bus operating part of NZR.

Heading south

So, in the last year of World War II, at the age of 16, Bob left his family, including his twin brother (who ►

Vertical milling machine



The 1933 Humber 12 with a Salmons and Sons body once owned by one of the tradesmen that Bob Hayes worked with while doing his apprenticeship

Reconditioned Austin 12 clutch throw-out bearings produced by Hayes' Productions

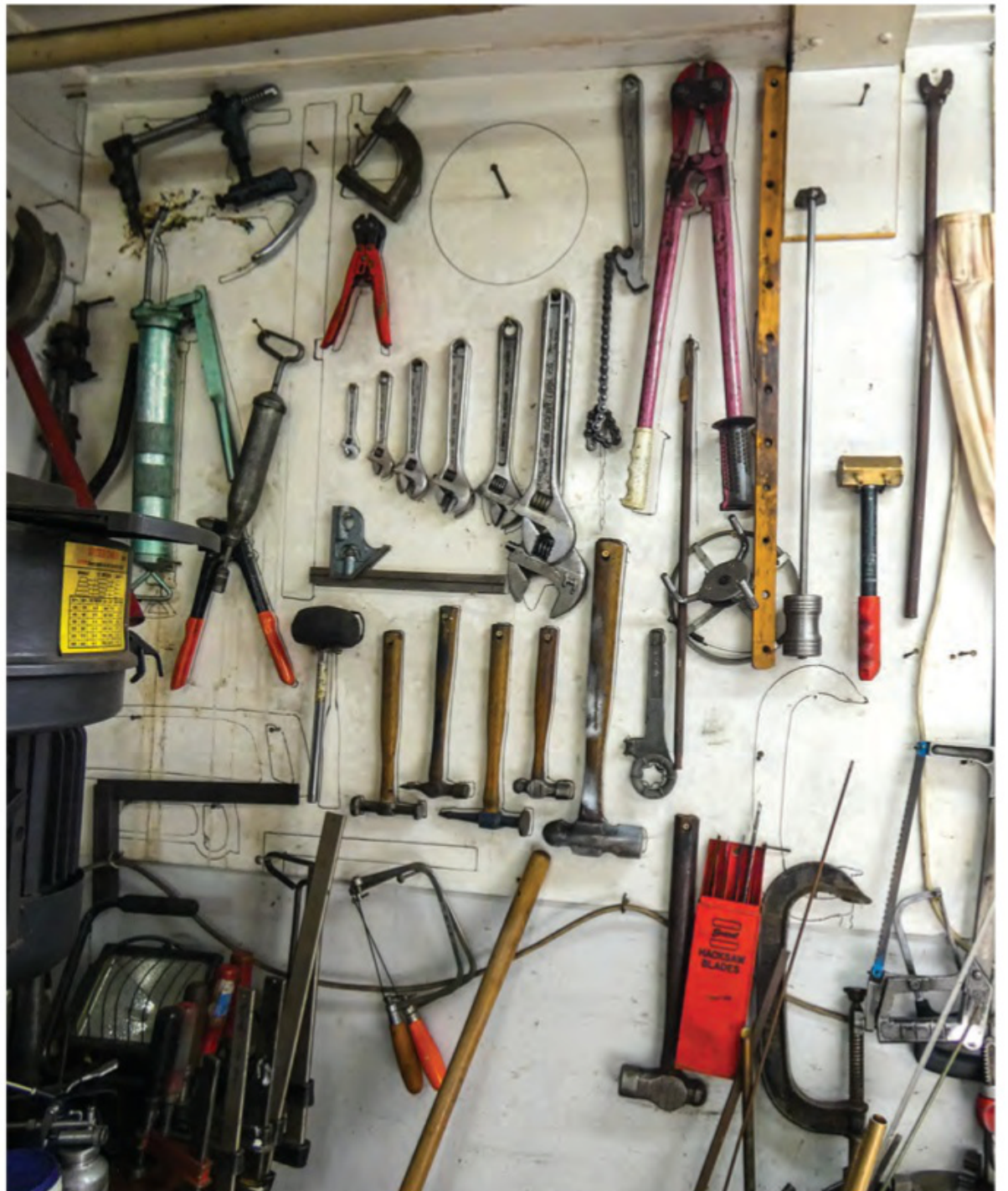


had identical genes and also became a very successful engineering company owner), and travelled alone by rail and inter-island ferry to Christchurch, where he took a room at the YMCA and started work in the art deco–styled NZR Road Services garage in Victoria Street — on a site today completely given over to the monolithic Christchurch Casino. Here he served a five-year apprenticeship to gain the first of several trade certificates and first used the lathes and milling machines with which he became so adept.

In 1954, he achieved his Advanced Trade Certificate in motor engineering. From 1955 until his retirement in 1991 Bob ran his own businesses. First petrol stations, then a forklift repair and manufacturing company, and finally the automatic transmission firm of Auto Transmissions which is now owned by his son Peter Hayes.

Overnight repair service

In the 1970s and '80s, before computers complicated matters, a faulty transmission could be exchanged with a rebuilt unit in short order.



Bob and his collection of project photos





A Taiwanese-made metalworking lathe. Bob says an American machine toolmaker provided the tooling to manufacture the lathe but then, due to political changes, abandoned the plan — but left the tooling behind

Garages all around the South Island would ship faulty transmissions to Auto Transmissions and would receive an as-new one by the start of work the next day. This, of course, required the holding of large numbers of reconditioned gearboxes. An associated company, TransGear, used equipment made by Bob to economically repair worn transmission components. The very high cost of shipping parts from overseas encouraged Bob to design and build reconditioning machines to repair — for example, the teeth on flex-plates which engaged with the car's starter motor.

Some car makes had flex-plate ring gear which were rather prone to wear. This usually didn't cause a problem until late in the car's life, but in situations that involved frequent starts all day every day, such as with airport luggage tractors, the ring gear would be worn out in just a few months. Bob's machine not only repaired the worn teeth but also used superior metal which extended the teeth's life by years.

Car restoring

One of Bob's workmates during his apprenticeship at the Road Services garage drove a 1933 four-seater Humber 12 convertible which he sometimes gave Bob a lift in.

*He suggested that
Bob take up a
motor engineering
apprenticeship with
Road Services*

It had a body made by the very old, established British coach-building firm of Salmons and Sons and had the company's 'Tickford' soft-top. This is one of the cars which Bob now owns and which he has completely restored.

Before he managed to buy the Humber he had come across a 1934 Austin 18 with exactly the same body — another Salmons and Sons tourer

with the same hood. The Austin had been left engine-less and exposed to the weather for years. Canvas-top vehicles deteriorate rapidly if not stored under cover and so when Bob got his hands on it, it was in very poor condition.

There was a delay while Bob and his wife Andree built a new house with an extensive workshop, but on Bob's retirement work on the Austin started. The original engine was tracked down and rebuilt and the differential and manual gearbox reconditioned. The wire wheels were rebuilt with new rims and spokes. New woodwork, upholstery, and hood were fitted, and the body repainted.

The King's car

One of the instruments on the car's dash was a very unusual transmission oil pressure gauge. Investigation revealed that the gauge was for a Hayes Self-Selector Transmission, which the car was originally fitted with.

You can imagine how excited Bob Hayes was to own a car which had a novel transmission bearing his ►



Bob and his current project — Hayes Self-Selector Transmission components Outdoor table and chairs made by Bob

The first British owner of the car was none other than the future King Edward VIII

The brass radiator is on one side of the wooden firewall and the brass petrol tank on the other. Both were made by Bob Hayes



Ford V8 crown wheel and pinion (CWP) — the raw material for the new Austin back end parts

own name. Perhaps even better was that further research revealed that the first British owner of the car was none other than the future King Edward VIII.

The car had been shipped out to New Zealand for the then Prince of Wales during a proposed royal visit. Bob imported from Britain one of the about 50 Hayes transmissions made, rebuilt it using parts he machined himself, and extensively researched the correct lubricant. Various mixtures of oils were tried and found wanting.

An outrageously expensive synthetic oil, manufactured by an American company in Borneo, is now used and has eliminated the wear problems which caused most of the original units to be replaced with manual gearboxes. Bob describes the Hayes

transmission as “fantastically good” — this, remember, from someone who has spent decades working on automatic transmissions.

The Austin is now owned by Bob’s son Stephen Hayes, and in September Stephen brought it down from Brisbane to take part in the Austins over Australia rally held in Adelaide. It won the Best Austin award.

Keeping Austins running

Rebuilding the Austin and the engineering challenges it threw up led to a cause that Bob is passionate about: keeping as many of these types of cars on the road as possible. Under his Hayes’ Productions banner he makes and sells Austin 12/4 parts: cast-iron brake drums, timing chains and sprockets, crown-wheel and pinions







Tori on top of steel pieces which Bob will make into their replacements. Next to the roller in the foreground is the lathe tool made to machine the constant radii curvature of the tori

(modified Ford units), and reconditioned clutch thrust bearings.

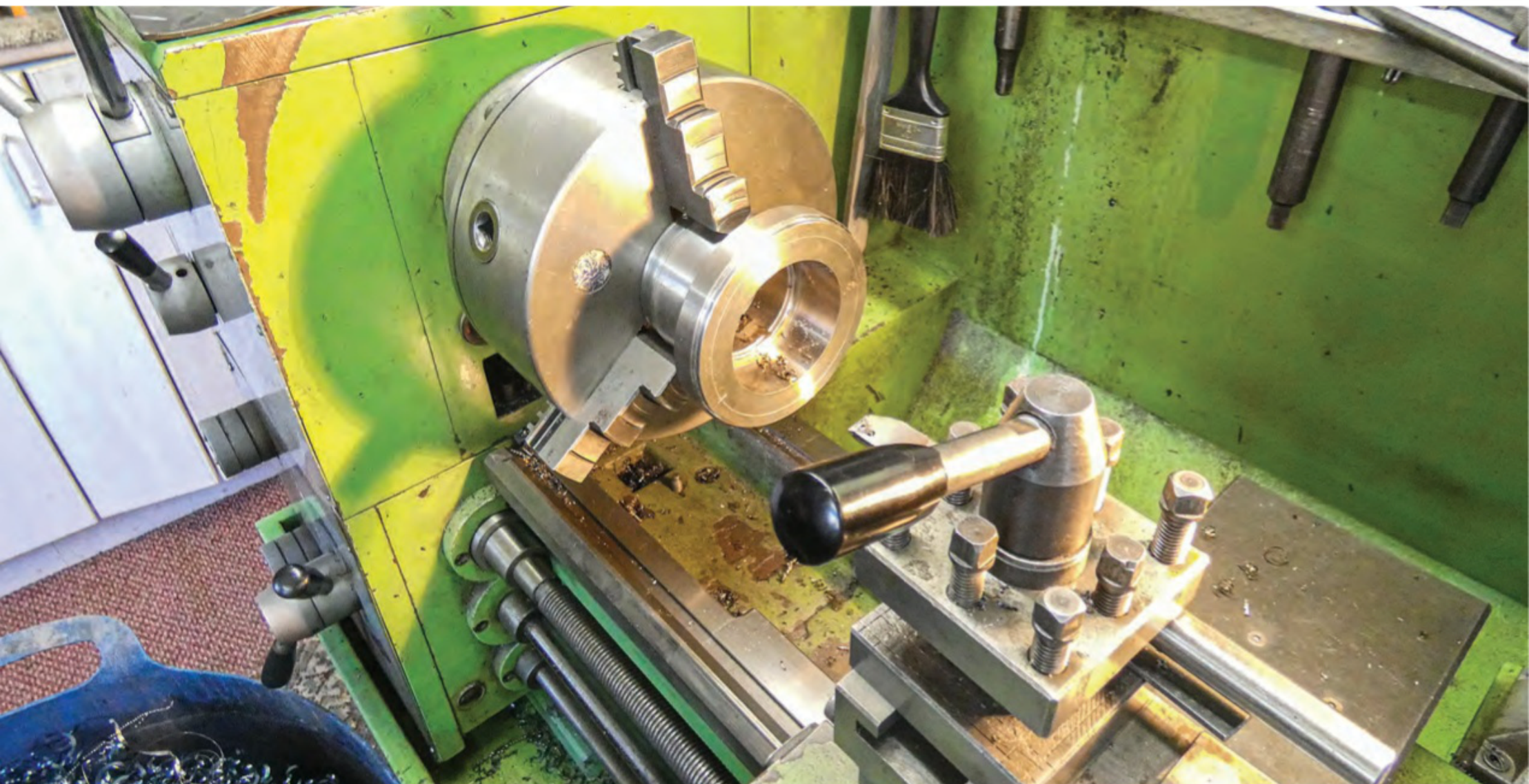
Bob's workshop occupies most of the ground floor of his large home. It is divided into two almost equal halves — half for storage, half for work.

He has a drill press, vertical mill, and a Taiwanese copy of a large American metal lathe. Tool storage boards are above the bench, storage cupboards below. The floor is covered with a huge square of second-hand carpet. He has gas and stick welding sets, and MIG welding set-up. Woodwork is undertaken in the main workshop and in a bay beside the free-standing garage where there is a bandsaw.

Other engineering feats

The things Bob works on are not only car related. He made the very elaborate steel staircase in the house, and also the beautiful steel table and chairs for the upstairs' outdoor entertainment area; all finished in black powder-coat.

When *The Shed* visits, he is in the middle of reworking a set of barstools he designed and made, in the shape of pythons, to incorporate baby snake



Bearing holder for the CWP held in the three-jaw chuck of the Taiwanese lathe



Bob Hayes and his snake bar stools with added footrests

footrests. The snake bodies are made of steel tube and the heads are aluminium castings. He had removed a pneumatic mechanism, operated when the stool was sat on, which opened the snake's mouth and illuminated its eyes, because it was too alarming.

Bob's wife Andree wanted one project to be a smaller car, suitable for her to drive, so the barest bones of a 1909 Renault AX were purchased.

Both Bob and Andree worked on the vehicle and the result would be close to what most people think of when they imagine a veteran car: shiny brass, kerosene lamps, varnished woodwork.

It has a lively performance as well — "it goes like a rocket" — and has resulted in Bob and Andree making friends with fellow owners in the US and having reciprocal visits.

It's good to have mates

In a lucky example of the comradery in the old car world, a complete car ►



Bob taking a skim off the internal surface of the bearing holder. He relies on micrometers rather than a digital readout to determine if enough metal has been removed

The Hayes Self-Selector Transmission

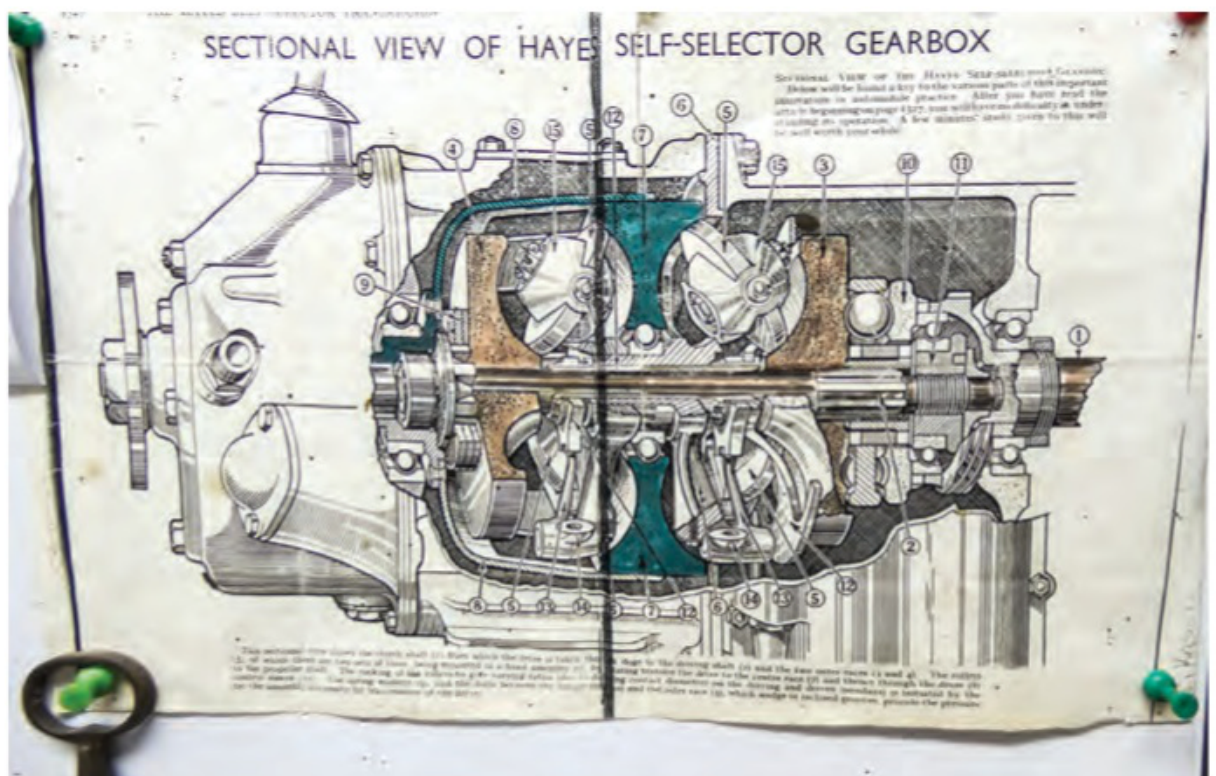
In the early years of motoring, before synchromesh and automatics, changing gear required skill if loud, graunching noises were to be avoided. Mastery of techniques such as double-declutching were required to silently change down. American inventor Frank A Hayes patented a continuously variable transmission (CVT) in the 1920s that replaced the gears of a conventional transmission with hardened steel surfaces transmitting motion by friction. To reduce wear-causing slippage, the steel surfaces are held together with a force of about 14 tonnes.

A disc with a deep and wide circular groove occupying one face is called a 'torus' (plural, 'tori'). Put simply, the Hayes transmission has two hardened steel tori with two quite narrow, hardened steel rollers trapped between them. One torus is driven by the engine, the other is connected to the rear differential. The rotation of the driven torus is transmitted to the other torus by the rollers. When the rollers are at right-angles to the tori the ratio is 1:1. If the rollers are skewed in one direction the ratio is reduced.

When the rollers are moved in the other direction the ratio is increased. The beauty of this transmission is that the most economical speed of the engine can be selected on the hand throttle and then the transmission automatically changes to give the appropriate speed for the road conditions. The result is very good fuel economy compared with that of a conventional car. A modern-day hybrid has good economy for similar reasons.

The hybrid's petrol engine runs at a constant, most efficient, speed to charge the car's battery. The electric motors driving the wheels are then run from the battery at the speed appropriate for the road conditions, the electric motor's efficiency not changing much with different speeds as the petrol engine's does.

The Hayes transmission has a conventional clutch for starting off and a conventional reverse gear for backing up. It was marketed as an option on large Austins for several years from 1933.



It was only later that they discovered the chassis was actually for sale and that they could have bought it

was available for them to study and it spent some months in the workshop alongside the one being worked on. A bare chassis was also lent to enable Bob to replicate its unusually complicated structure. It was only later that they discovered the chassis was actually for sale and that they could have bought it rather than laboriously recreating it. It's taken a while, but Bob can see the funny side of the situation now.

Much of the car is new, including

the castings for the steering box, headlight stands, wheel centres, and brake drums. Bob made the brass petrol tank and radiator from scratch. The oval radiator water tubes are an unusual item and can be obtained new, but only by the Ocontainer load.

Another Christchurch Renault owner had managed to buy enough tubes for two radiators and a deal was done where Bob made two radiators using both sets of tubes — one for him and one for the lucky tube owner.



Transmission torus and one roller in the orientation to give low ratio

Word spread in the international Renault restorers' world that there was someone in New Zealand who was making high-quality parts and a retired American surgeon (who has "three or four" veteran Renaults) contacted Bob offering to buy some. The surgeon was very pleased with the parts and invited Andree and Bob to stay with him and his wife in the US and to accompany them on a two-week vintage car rally.

More driving, less working

Now 90, Bob has made parts for old cars around the world over the past few decades — he would back himself to make anything — but he thinks that he will use his cars more in the future and so won't have as much time to spend on restorations. Although, when we visit, he is starting work on a set of spares for the Hayes transmission.



A COUPLE OF CURSES AND A BLESSING

AN ACCIDENT AND THE CHALLENGE OF WORKING WITH A VERY DIFFICULT MATERIAL HAS SOME PLEASING RESULTS

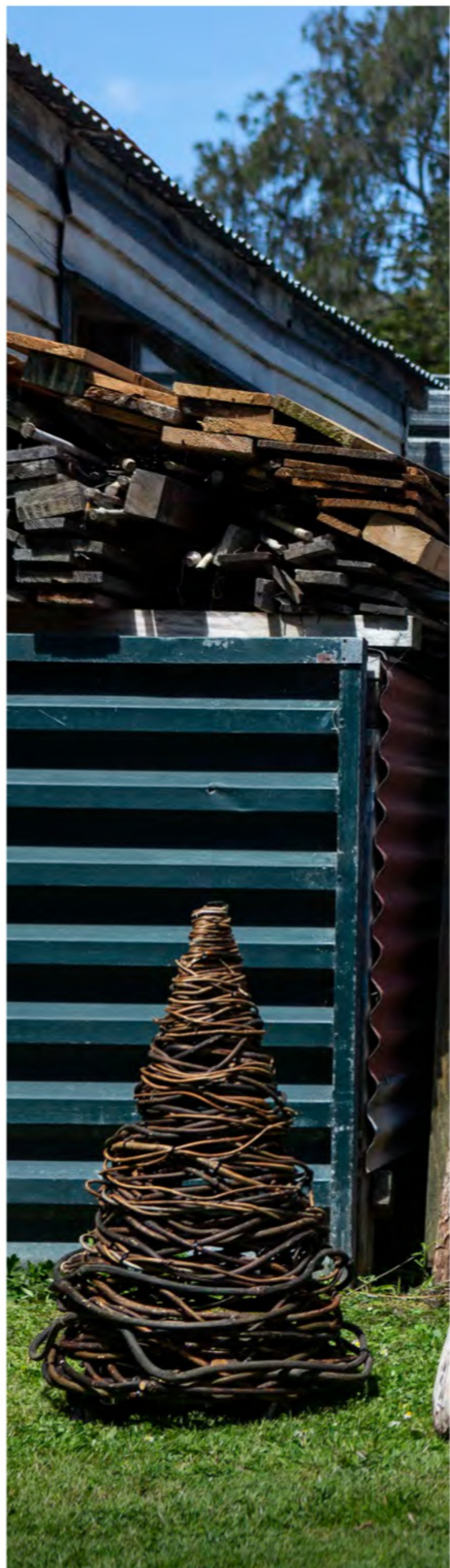
By Helen Frances

Photographs: Tracey Grant

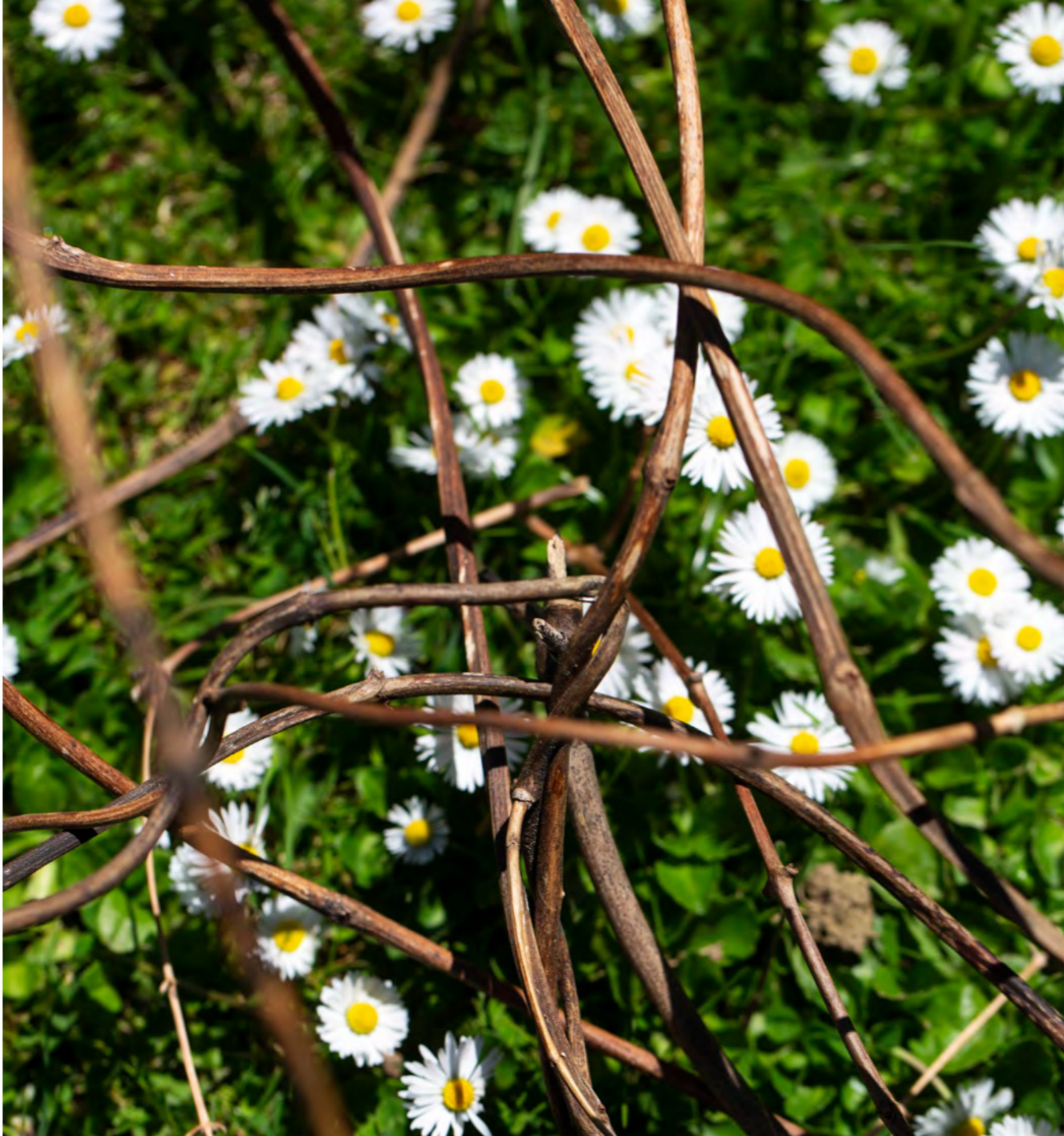
“**B**ushman’s curse” is John Hickey’s blessing. The Whanganui sheddie makes furniture out of the dreaded supplejack vine that makes parts of the New Zealand bush impenetrable to all but the most determined. John is not only determined; he also actively enjoys his forays into the quiet bush around Kai Iwi where robins and fantails keep him company. He manages to do all of this with one artificial leg, the result of a motor accident in 1996 when he momentarily fell asleep at the wheel.

He had been working for 15 years in salvage and demolition, then changed to courier driving, which he thought would be a safer occupation.

“Demolition was such a dangerous job so I thought courier driving would be cushy in comparison. But I was always tired; the body clock didn’t get used to it. I yawned, drifted off the road by about half a metre just before a bridge, and only had time to swerve. I got thrown clear minus my leg. I put a tourniquet on and saved my life. They nicknamed me ‘the miracle man’ at New Plymouth hospital,” John says. ►







Supplejack on the lawn in John's backyard waiting to be woven

What now?

Then, when he found he was unemployable he thought, *I've got to do something or I'm going to go crazy.*

A local farmer suggested he check out the manuka on her land as a possible material to work with.

"It just happened that where there was manuka there was also supplejack. I had seen a picture of a couch made of willow in a book and I thought, *Wow that's cool; I wonder if I can make something similar.* I tried bending the manuka but of course it kept breaking. So I wondered what this vine was all about. I cut a bit and realized I could work with it."

*He has two other legs
— one for everyday use,
the other for the beach
and swimming*

He made his own interpretation of the willow couch, starting with a chair. From the chair came the couch, and from the couch came the swing seats.

Getting the materials is a bit of a mission. John uses loppers and a hand saw, cuts and pulls the vine lengths out from the massive tangle, and makes bundles of around 25 lengths of supplejack, 10 to 15m long, which

he drags out to his four-wheel drive and trailer.

"It's pretty steep in places, although you can also find supplejack in quite open, undulating terrain. In some places it's like a minefield — the supplejack is 45 degrees deep going in and out, so it's hard work gathering the materials. You've got to do a kind of jungle gym thing — acrobatics — and sort of weave your way through it. I've got a special bush leg that's got no foot; it looks like a horseshoe and doesn't get tangled up," John says.

He has two other legs — one for everyday use, the other for the beach and swimming.



John's four legs. He uses the leg with a "horseshoe" foot to go into the bush gathering supplejack and manuka



Detail of Christmas tree weaving. The supplejack is attached with cable ties. Sawing manuka in his garden shed

Supplejack on the lawn in John's backyard waiting to be woven



A great use of supplejack

The supplejack forms the body of the furniture. He makes the frames out of dead, dry manuka, which he also collects in the bush with permission from local farmers. He reckons he is pruning the bush in a way — clearing dead wood away and doing a kind of coppicing with the supplejack, which will grow back again.

“I don't measure anything”

The dry manuka is better than green to work with as it doesn't split.

“If you use green stuff it splits open when it dries and doesn't look good. If I'm making a swing seat or a couch I've got to find long straight bits of manuka and they are quite hard to find so if I bring back green wood I store it and wait until it's dry,” he explains.

He looks for wood with character and colour and has stacks of manuka sitting in the yard awaiting his creative touch, but he uses the supplejack when it's green and malleable.

John makes chairs, couches, swing seats, ornamental bird houses out of totara fence posts, picture frames and easels, supplejack stars, manuka tea-light candle holders, and Christmas trees. He also used to make crayfish pots for which the supplejack was ideal. When he has been productive his backyard is full of furniture, so there are plenty of places to sit. ►



John's methods

He uses basic tools: a handsaw, mitre saw, small grinder, heavy-duty grinder for burnishing, drill, sanding disks, galvanized nails, and hammer.

"You drill and nail everything," he explains. "I drill the nails in on an angle so they stay in. Sometimes if you want to pull a nail out you can't because the manuka grips it. It's like it is super glued in. Sometimes I'll PVA the arms as well as the nails."

John says he does it all by eye and experimentation "I don't measure anything."

And he has already chosen pieces of wood that will naturally make good chair legs, arms, and cross braces.

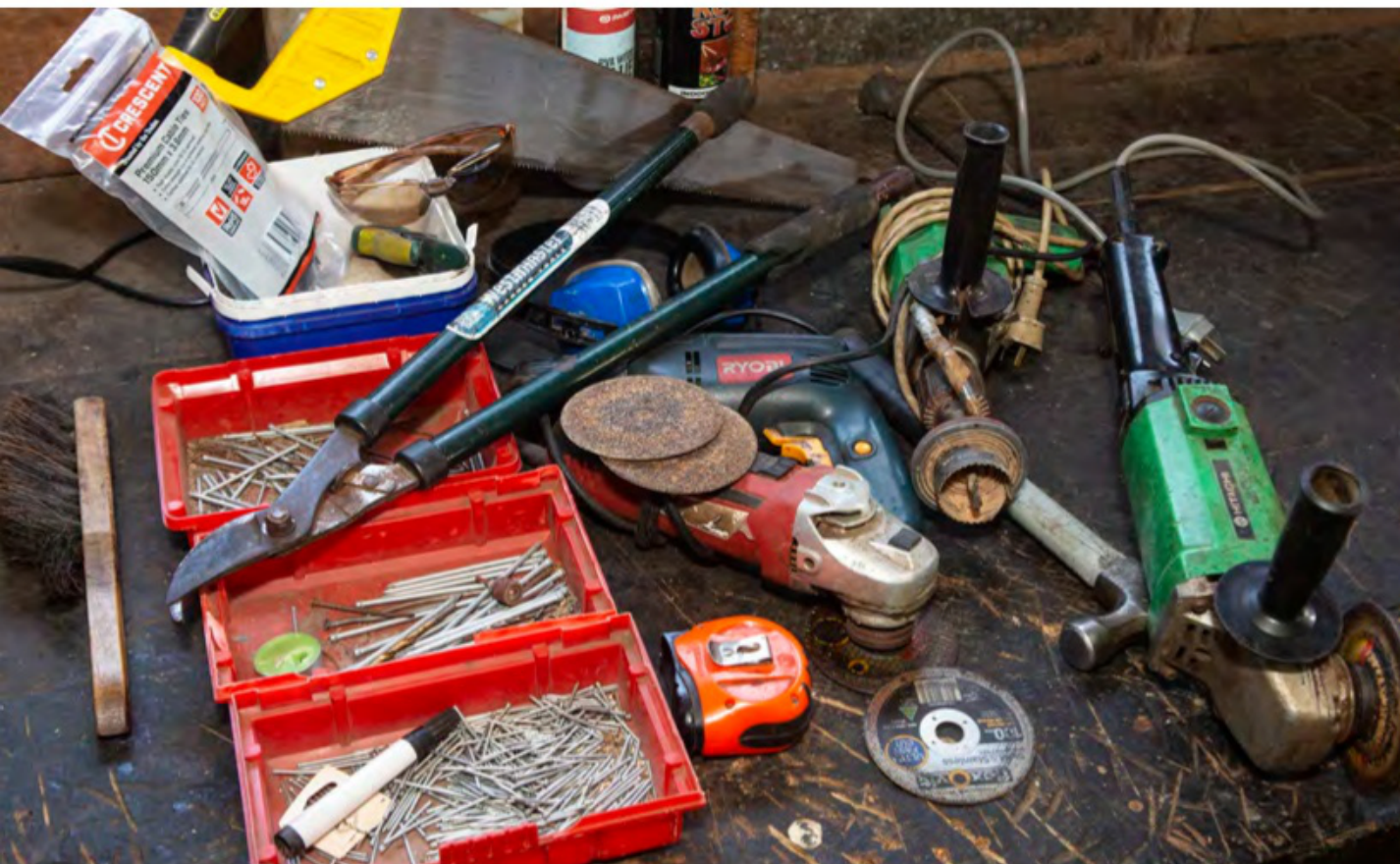
The structure for a chair sits on his rudimentary garden shed table. He makes the front legs sloping back

slightly for aesthetic reasons.

He tells us, "I start by bracing the legs with cross pieces that I know will sit flush just by looking. Then I drill a hole for the nail through the centre where they cross. Screws are expensive and I found galvanized nails were the way to go. I roll the nails in candle wax so they go in nice and easily. Once the nail has passed through I cut the end off so you can't see it. When I burnish the chair black it hides the nail heads completely."

He braces couches to give them extra strength in the middle.

"They are strong. You can stand on them, you can jump up and down, you can use them as a stepladder, and stand on the arms. You can rock back on the back legs and they'll never break. A couch is an extended chair. It's the same pattern."



John uses basic tools such as a hand saw, mitre saw, small grinder, heavy-duty grinder for burnishing, drill, sanding disks, galvanized nails and hammer



Taking supplejack into his shed



Detail of the top of a swing seat



John burnishes the furniture black with an angle grinder to add character and hide the nail heads



Decorative bird house made from totara fence posts

Perfecting the designs

To make the backs of chairs and couches he uses curved pieces of wood, and the braces are also curved so they will sit together. Getting the gap correct between the back and the seat is a matter of fine-tuning and selecting the right pieces.

“I pull it off if I don’t like it. It’s got to be right,” he states.

The swing seats are his design. He used to recycle defunct swing seats,

keeping the springs, recycling the frame, and making a new seat.

But, “Then I thought if I can get the springs why not make my own frame? It looks thin but man it holds the weight.”

If he has all the components together, it takes him about two days to make a chair, whereas a swing seat can take up to two weeks, working four- to five-hour days.

He says the green supplejack turns

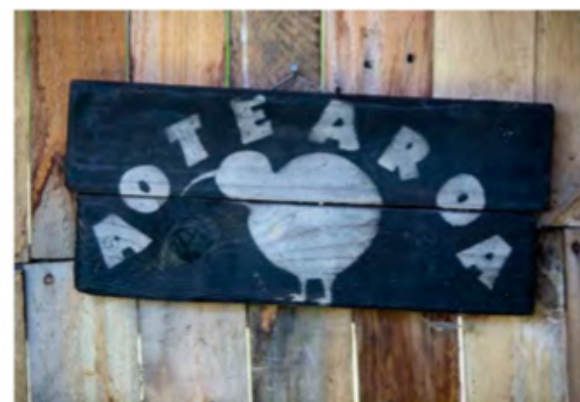
the same colour as the manuka after six to eight months. He drills and nails the supplejack as well.

“You have got to hold it. Supplejack is like a memory steel-type thing; it does not want to conform,” he says. “It’s quite hard on your hands to hold so it’s a bit like one-handed wrestling with a drill in the other hand. You have to make sure you don’t hurt yourself. You’ve got your safety glasses and earmuffs on. Power tools bite if you get it wrong.” ►



Christmas trees have a recycled pallet as a base for four straight lengths of manuka, nailed together in a pyramid shape, woven around with supplejack

Below: A good keen Kiwi - John's shed and backyard are like a mini gallery for his work made from local materials



Christmas trees are popular

And to make Christmas trees he uses a recycled pallet as a base for four straight lengths of manuka, nailed together in a pyramid shape. He locks them in place with cable ties then binds them around with supplejack, starting from the top, weaving his way down.

“People love them. You can put [on] Christmas decorations, cards, lights, flowers, or whatever you want,” says John.

He says that the manuka is so strong he has thought of making a child's jungle gym and taking it to the River Traders Market in Whanganui: “You'd have to peg it into the ground. It's real Tarzan stuff. And the supplejack gets people telling you their stories. You hear the old boys saying, ‘Oh we used to play on this when we were kids, make bows and arrows, and Tarzan slings’. People resonate with it.”

To contact John, phone him on 0274 574 059 or email johnnylightning50@gmail.com.



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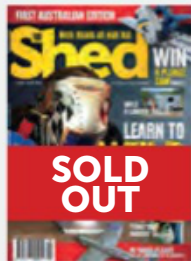
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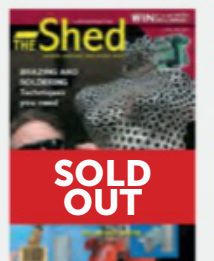
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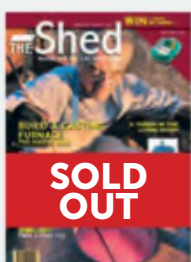
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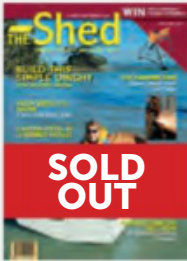
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THE VIRTUES OF CLEANLINESS

By Jude Woodside



It's a new year and I've been cleaning. Specifically, I thought it was time to get the mess in the workshop tidied away and finally sort out my electronics workshop which has things still scrambled in boxes after three years.

I recently built a box for the back of my ute to take tools with me to do a job some distance away. Job done, I needed somewhere to put the box so that it wouldn't be in the way. There was a large and ever-growing pile of rags that needed a home in one corner of the shed. It was the ideal place for the rather large box but equally an ideal solution to the rag storage problem. In the process I found a set of tree-felling wedges that I thought I had lost. The box made a difference and I was seized with the prospect of spring cleaning the shed and fixing all those "round tuit" annoyances.

Next to Godliness

The scrap bin was tidied and sorted, sheet goods to another pile, and all those useful bits and odds and ends in a tidy new bin. Scraps to the kindling pile for winter. My

*A place for everything
and everything in its
place*

electronics workshop is just a small annex, formerly an office attached to the main workshop. I had added a bench attached to the wall and it is ideal for doing smaller projects like electronics. It happens that I have a couple of projects that will require a bit of electronics and I need to get the place sorted.

I started with ... the radio. Well, I like music while I'm working. I inherited a system but I hadn't been able to get it fully functional. It has four decent speakers, two in the annex and two in the workshop. I have an amplifier that I thought had blown a channel so I started by opening it up and discovered nothing out of the ordinary. I plugged it in and found it was working fine.

I have another amplifier, this one was now surplus to requirements so it might as well be plugged in here. But I needed to add an extension to the shelf to sit it

on. I found a scrap of ply the right size, easier since I'd tidied the scraps, and cut it to fit. I needed to scribe the edge where it met the wall and that meant cutting it on the bandsaw.

I have been meaning to add a 15-amp outlet to plug the bandsaw into ever since I came to live here — I've been making do with a 15-amp extension cord. I wanted to fix things as they came up so this had to be done there and then. Nearly all my workshop circuits are 15 amp. It was really just a matter of changing the outlet. I had one on hand too.

On a roll

The shelf finished and the stereo working, I turned to the always vexing question of sorting the contents of several boxes full of tangled power cords and assorted wires. In the process of sorting the power cables I came across an old power supply with a 19V output.

I have an illuminated magnifier that is bench mounted. Sadly, its LED ring failed some time ago and I was unable to determine the fault. I had worked out that it was powered by a rectifier producing about 20 volts DC and what I held was something that did the same thing. A quick threading of the new wire and a bit of solder and I was in business again. Making a spindle for threading all my rolls of hook-up wire gave me the opportunity to finally wire in a solution for powering the drill press by fixing the extension cable overhead to a roof beam.

The process of sorting the workshop has taken rather longer than it might have but it has been rewarding being able to tick off the annoyances along with the serendipity of discovering lost things and new solutions. I am rediscovering the virtues of cleanliness. 

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