SCRAP HEAP HACKING

TECH TRASH CAN BE A GOLDMINE – GET OUT THERE AND FIND YOUR NEXT PROJECT!

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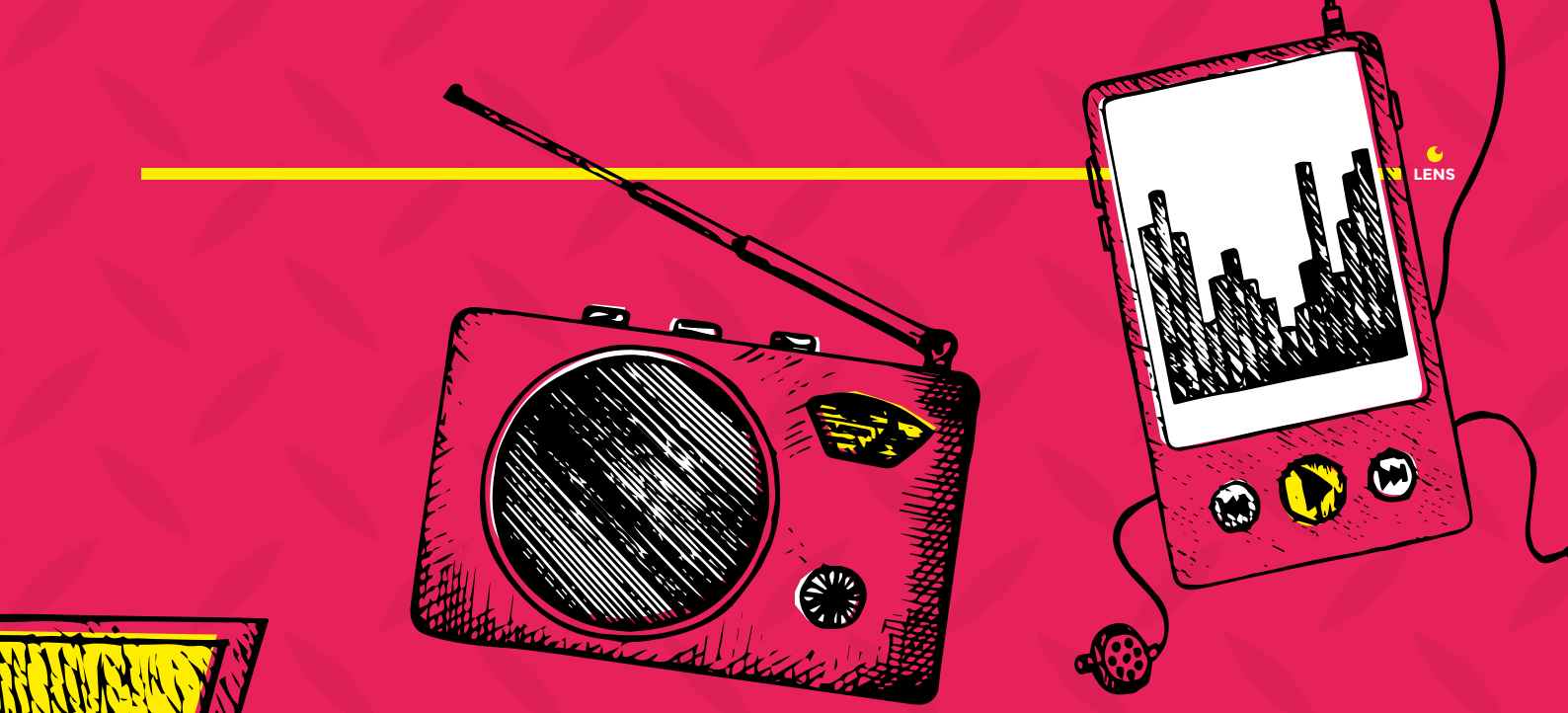


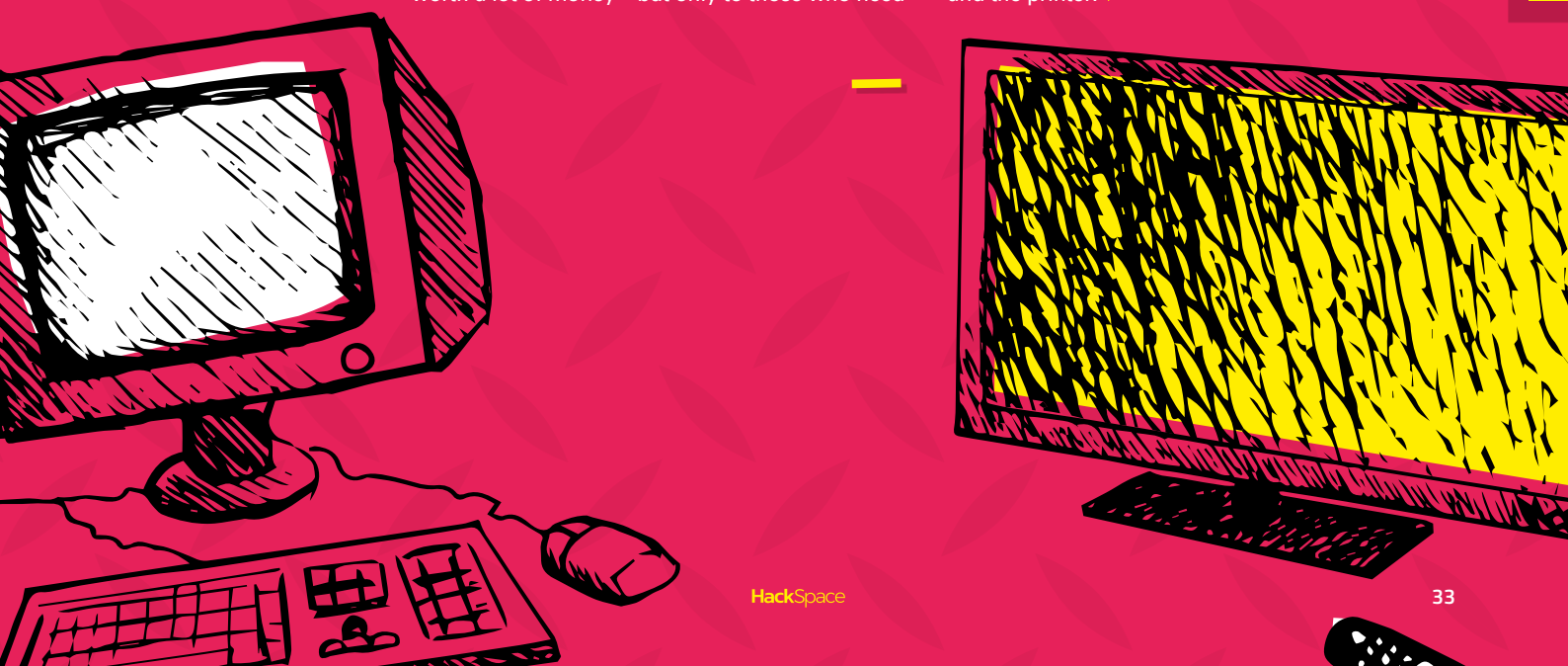
It's no secret that e-waste is a huge problem in the world. The UN estimates that up to 90% (£12bn worth) of the tech we're done with ends up dumped where it shouldn't be. Lots of these contraptions contain a feast of parts and components that can be put to good use in projects. There's also a big cost advantage – the more you scavenge, the less you have to spend on parts.

It pays to be careful when taking apart old junk, especially anything that involves electricity. Always turn things off well in advance of going near them with a screwdriver – and if you don't know what you're doing, don't do it!

It's important to evaluate any broken gear that's offered to you or your local hackspace, or you'll end up with too much hack and too little space, which is annoying for everyone. Think about the item in question – if you're planning to use it as it comes, what work will need doing and who will do it? Are the tools, parts, and space available at the moment to do it properly? Often things that get offered are worth a lot of money – but only to those who need them. Your hackspace probably doesn't need a giant power-sucking data-centre-grade server, or half a dozen high-end computer uninterruptible power supplies. It often helps to think of it from the other direction: if the hackspace saw this advertised for sale at a fair price, would it buy it? The answer is often no, and if that's the case you should probably turn down the donation.

If you're planning to strip your item of its parts, it's wise to set a deadline. Some hackspaces use different bins with time limits on to prevent junk piling up; others log storage requests and assign times to them when the items are stored. Once you've got the parts, it pays to store them sensibly too – labelled boxes go a long way! Test electronic parts for voltages and pinouts before filing them away, and write your findings down on the item (your future self and other hackers will thank you for it).

This article looks at four common pieces of broken machinery found in junk-rooms around the world: the microwave, the PC, the washing machine and the printer. →



FEATURE

THE MICROWAVE

A USEFUL SOURCE OF HIGH-VOLTAGE GUBBINS, SWITCHES, DIALS, AND OTHER BITS AND BOBS

Right
When your trusty oven has frazzled its last pitta bread…

Microwaves contain a lot of high-voltage electronics. Even when unplugged, these can be extremely dangerous. If you are not suitably qualified, and do not know what you are doing, don't take microwaves apart.

Microwaves are, however, home to a few components you won't find anywhere else. For starters, the turntable can be removed and reused for all sorts of purposes. You might also find a few seven-segment displays, a rotary dial or some buttons, or perhaps a bell with that satisfying 'ding' sound.

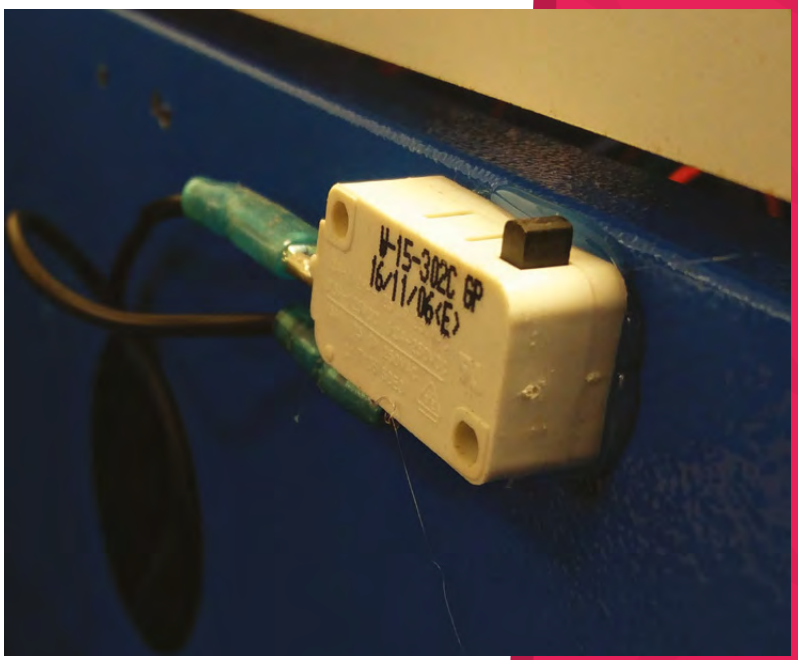
Older microwaves will contain a rotary timer-dial, which could be recycled to make a timer-switch so you don't forget to turn off your soldering iron or hot-glue gun after use (the bell also makes a useful timer). The seven-segment display that some microwaves have for the controller can be useful once salvaged from the circuit board – and usually has a standard pinout. Other components can be salvaged from the control circuitry too – dials and buttons are fairly commonplace. Small microswitches are often used to detect when the door is shut, and can be used as limit switches on 3D printers and CNC machines.

It's worth leaving behind the controller PCB once any components of use have been stripped from it, and much of the high-voltage stuff is unlikely to be of use to the average hobbyist. You can, however, net a free light bulb and holder, which almost every microwave seems to have. →

MOTOR BECOMES UV CURING OVEN

One useful bit that can be salvaged from the microwave is the motor that rotates the platform inside. This might be an AC motor, which means you'll need a power supply to drive it; once disconnected from the other parts, however, the original control circuitry can be used for that. The folks at Norwich Hackspace are currently working on repurposing an old microwave turntable to become a UV curing box for their new SLA 3D printer. The platform will be used to rotate the model to ensure even curing from the UV light, which itself will be contained in the casing from the original microwave.

Left Norwich Hackspace's UV curing cabinet was made from an old microwave and scrap anglepoise lamp



Left Microswitches are a useful part to have on hand. This one, salvaged from an old microwave, has been fitted to a cheap laser cutter as a useful door interlock switch

TRANSFORMER BECOMES STICK WELDER

One of the most coveted parts of a microwave is the transformer. It turns the mains electricity, supplied to the microwave when you plug it in, into high-voltage but low-current electricity. In the microwave oven, this powers a magnetron to make the microwaves which cook the food, but it can be repurposed into a rudimentary arc welder. It's unlikely to replace a proper setup, but can be a fun experiment and a learning exercise in high-voltage electronics.

OLD PCS

BEIGE BOXES YIELD SOLDER EXTRACTORS, ROBOT ORCHESTRAS, AND POWER!

Old PCs are commonplace in hackspaces around the UK, and make for a great source of really useful components. The main electronic hardware is usually pretty useless – nobody wants a slow old processor, and the reason the PC has been donated is probably because it wasn't up to the job any more. But there can be some exciting parts for an eager maker to scavenge from the remains.

It's highly likely that if your PC is of a fair age, it'll be designed to be opened and repaired, so a Phillips screwdriver should let you in. Usually one of the side panels will come clean off, and lets you get to everything else. If it's a newer or fancier model, it will probably be harder to crack into – in general, the older the PC the better – but sites like iFixit might have instructions for your particular model. PCs are often really dusty on the inside, so a good vacuum (or air blast) is a good first step. →

Right
Old PCs are a lot easier to meddle with than hermetically sealed Macs

HARD DRIVES

Hard drives also contain some useful bits. They can be a pain to open (lots now use non-standard screws and hefty metal cases for data protection), but once you crack into them there are some useful parts to loot.

The powerful brushless motors inside them use three-phase electricity – they're probably not worth salvaging (there are plenty of other places to find motors). One part that is worthwhile, though, is the powerful Neodymium-Iron-Boron magnets that magnetise and demagnetise the discs inside the hard drive to store data. They're super-useful for making cases snap open and shut in a really satisfying way, for hanging steel tools, or for finding escaped screws. You'll find them in the corner near the writing arm.

Paweł Zadrożniak uses old computer and scanner parts along with some Arduinos to make awesome-sounding electronic renditions of popular music. The 'voice coils' in hard drives provide the percussion section – you've probably heard his music, and can see 'The Floppotron' in action over on his YouTube channel at **hsmag.cc/pHufAc**. He's also written an extensive series of blogs about his project.

POWER SUPPLY

It's usually pretty easy to tell where the PSU is – firstly from the power socket on the back of the case, and because there are bundles of wires snaking towards it. Remove the screws from the back, cut the wires, and slide the metal box out to release it. PCs use a variety of voltages, which means that the power supply will likely power whatever low-voltage tech you're using. Typical supplies include GND, 12V, 5V, 3.3V and also usually -5V and -12V (white and blue). Most units also have the facility for a power switch and a 'power good' indicator built into the supply. From this you can create a bench power supply: a really useful tool to have on your workbench for testing components and powering projects. All it takes is a nice case and some 4mm jack terminals.

FANS BECOME SOLDER EXTRACTORS

As well as keeping you cool, PC fans make great fume extractors for use while soldering. Generally, fans will run fine from just a DC voltage, but with three- or four-wire fans there's a chance you'll need a microcontroller and some guesswork to make them spin. The wires often plug into the motherboard with standard 0.1mm connections, which makes them super-easy to connect to your projects. They usually work from 12V.

Far Left
Tim Parnell housed some PC power supplies in laser-cut and sheet-metal cases to make these sweet bench supplies

Left
This fan was salvaged from an old PC. One coat hanger later, and it's an adjustable solder fume extractor or desk fan!

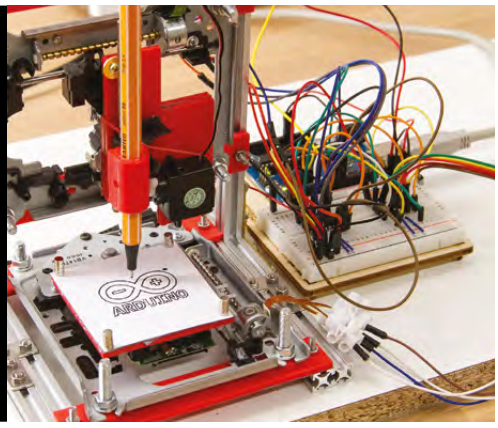
Below
One awesome thing to make out of old CD drive mechanisms is a CNC machine. Adi Dax made this cool pen plotter machine out of a couple of old CD drives, some H-bridge motor drivers, and an Arduino. There's an in-depth (though German-language) tutorial on his blog at hsmag.cc/qxZeQg

DISC DRIVES

The CD or DVD drive on a computer contains another load of useful motors – this time a brushless one (used to rotate the CD), some DC motors (used to eject the drive), and a stepper (used to move the laser head). They also have plenty of gears and mechanisms, and are generally a lot easier to take apart than hard drives.

One thing that's normally best to leave is the laser diode that reads the CD or DVD. These are pretty low-power by modern standards, are a pain to drive, and are also potentially quite dangerous. If you're in the market for a laser diode, you're probably better off just ordering one direct from China.

A very cool project is Andrey Chilikin's CD drive tea dunker. He hooked up his CD drive to a Raspberry Pi and used it to ensure his cuppa was the perfect shade. You can find out more on Andrey's GitHub page at **hsmag.cc/VwSBDm**.



WASHING MACHINES (AND OTHER WHITE GOODS)

WHO NEEDS CLEAN CLOTHES WHEN YOU CAN HAVE A BARBECUE?

Washing machines are somewhat bigger than the other appliances featured in this article, but in turn lend some bigger and beefier parts. They also seem to be discarded moderately often (average lifespan eleven years), so they aren't too hard to get hold of (as long as you can transport them to your teardown location). More often than not it seems that the controller circuitry is the first thing to break – so all the mechanical and high-voltage electrical goodness is there for the taking.

They're also not too tricky to dismantle – occasionally requiring specialist screwdriver heads, but otherwise simple. Some side panels will usually come off first, revealing more and more screws. Once you've removed the panels you can start removing the other components, until you find the drum.

It's worth leaving most of the seals, pipes, and such-like. After a few years at the daily grind, they're likely to be less than pristine, and probably won't be pleasantly scented either. They also aren't terribly useful, usually being custom-made to fit proprietary parts. The control circuitry is likely to be fairly proprietary too, though it can yield some nice LEDs and dial switches. →

MOTOR BECOMES WIND TURBINE

The motors in a washing machine are usually really beefy, and can be used to power some pretty crazy contraptions. You can't simply hook up the motors and go – you'll need specialist control circuitry for that. The Post Apocalyptic Inventor does a great job of explaining the ins and outs of controlling these motors on his YouTube channel at **hsmag.cc/sFbTqA**. These motors have been used for all sorts of things – large-scale robotics and DIY power tools to name just two.

A really ingenious use for the motor is in DIY power generation systems, where the motor can be reconfigured to generate power from motion rather than the other way around. Timot Peter built a wind turbine from an old washing machine motor, blades made from PVC piping, and a custom electronic control circuit. The turbine can produce up to 600 W of power, plenty of juice for keeping your phone topped up in the wild. He's produced a video guide to his build on YouTube at **hsmag.cc/SNTxON**.

Above
The beefy motor often comes with an associated pulley belt and wheel. Remove the big bolt in the centre, and the pulley wheel is all yours…

Credit
Wapster (Flickr) CC

SHEET METAL

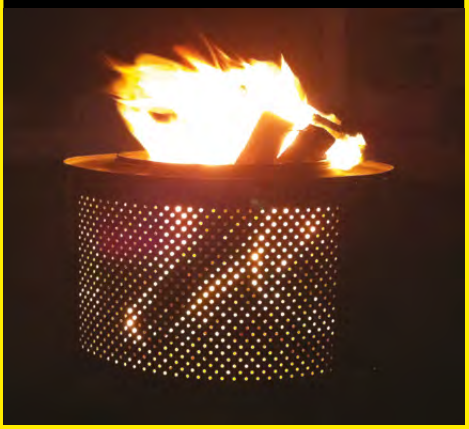
Sheet metal is a pretty useful thing for makers, and you're almost guaranteed to find a good amount in any large white goods machine. It's also easy to remove, because it's the first thing to come off and is just held in place with screws. Most panels are steel, powder-coated, or painted on one side. Many common tools can be used for cutting sheet metal, including shears, angle grinders, or the appropriately named 'nibblers' – most hackspaces have one or more of these in their armoury.

Sheet metal is very useful for making professional-looking cases for projects – especially those that have to be heatproof, or used outdoors. It's tricky to weld thin steel without specialist equipment, but it's easy to bolt or rivet it together to make custom shapes, and it can be bent using a straight edge, or curved with the aid of a roller.

THE WASHING DRUM

The most commonly reused part of the washing machine is the drum. If you attach a light source, and construct a suitable mounting for the relatively heavy drum, it can make for a funky luminaire with very little effort.

Washing machine drums can make useful portable fire pits or patio warmers; the metal won't melt or rust (it's stainless steel), and the holes allow plenty of oxygen in to feed the fire. Just attach a set of feet to keep the heat from scorching your patio. It's worth double-checking and removing any plastic or rubber from the drum, though – you don't want to end up producing any toxic gases. Sometimes the drums are used to make rudimentary barbecues – or, simpler still, a garden planter.



Left
Fire is usually safer well contained!

Credit
Quinn Comendant (CC-BY-SA)

FEATURE

MULTI-FUNCTION PRINTER

A FEAST OF MOTORS, MECHANISMS, AND MORE!

Right
No home is complete without a printer graveyard

Printers are another hackspace junk-room staple. Whilst a little more challenging to take apart than PCs (lots of highly customised bits of clip-together plastic), they provide an excellent source of motors, mechanical parts, and miscellaneous other stuff. To begin with, remove any rubber feet, which will likely hide screws. Undo all the screws, and then snap off all the plastic parts you can until you can see some useful bits.

The main attractions in the printer are of course the motors – you can usually find a variety of types. Printers also contain nice meaty power supplies, but the documentation can be hard to find because they are all customised units – and with wires often all the same colour, figuring out what's what is really hard.

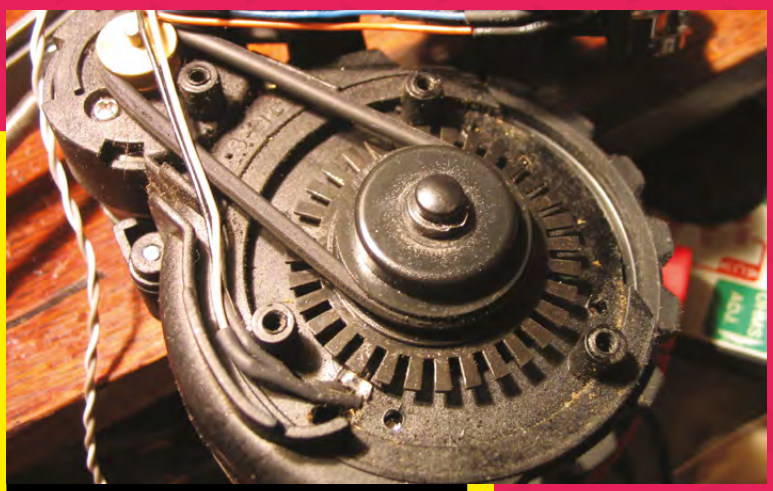
The rods and driving belts are also useful spares for any 3D printer enthusiast, though whether they'll fit your machine is another story altogether. Another thing to look out for is the LEDs and optoelectronic gear in the scanner head. If you can extract them and work out how to drive them, they can be a useful extra for your box of blinkies. The LCD screen, buttons, and control circuitry are likely to take more effort than is sensible to get working – better to chuck that and focus on the fun stuff. It's also worth getting rid of the bulky, customised casing, ink-head, and plastic mechanisms – it's unlikely they'll be useful for anything else.

DC MOTORS

DC motors, which are often used to move the scanner head (in conjunction with an optical encoder), are easy to drive and use in a few projects. They often have their voltage written on them, but if not you can test them out with a variable power supply (start low and gradually move the voltage up). When it comes to driving these motors from your favourite microcontroller or single-board computer, you'll likely want to use a motor driver. Motors use a lot of current (and sometimes a different voltage), and little circuit boards often don't like having large 'spikes' of electricity rushing through their delicate circuitry. Motor drivers are fairly low-cost and easy to use, however, with lots available from all the usual maker-electronics outlets.

GLASS PLATE BECOMES LIGHTBOX

The glass plate that you put documents on when scanning is a useful piece for makes. The glass is sturdy and A4- or A3-sized, making it ideal for a rudimentary lightbox. Your author has made one using an old Amazon cardboard box and a reclaimed fluorescent tube. The plate is supported at each corner on some old blocks of wood, and a bit of hot glue and duct tape holds it all together. I use it often when tracing print-out drawings and sketching project ideas, and it would be easy enough to make a more polished model with a nicer box.



OPTICAL ENCODER

The opto-encoder is a useful and often underrated component. Put simply, it allows you to see how much something has rotated, what angle it's at and, when the motor is linked to a scanning arm, how much of the document the arm has scanned. Encoders are usually customised components, but are fairly easy to work with because they are so simple. The device itself is a small U-shaped plastic casing. One side contains an infrared LED, and the other a photodiode. A disc with black lines painted or engraved onto it rotates between them. When the photodiode doesn't pick up light, the disc is over a black area; when it does, it's in a clear area. You can calculate the angle of rotation by using the equation **angle = (number of pulses detected / number of strips on a the disc) * 360**. You can use this to work out the distance travelled on a wheel, which is especially useful for robotics.

Above
Optical encoders are used in all sorts of applications, from cars to the Roomba robotic vacuum cleaner seen here

STEPPER MOTORS

Stepper motors are a bit harder to drive, but potentially much more useful. A stepper motor works by moving a certain number of steps and then holding its position, which makes them ideally suited to use in CNC machines, laser cutters, and 3D printers, for instance.

You can identify a stepper motor because, unlike a normal motor, it has four (sometimes more) wires leading to it. If you try to turn the motor by hand, it will also be a lot harder with a stepper motor than with a DC motor. You'll need a motor controller for stepper motors too, mainly for the same reasons as DC motors. Controllers usually work for one stepper motor, or two DC motors, and send pulses to a stepper motor to get it to move the desired amount.

SHARING

Have you made something clever out of a broken gadget? Show us (and everyone else) on Twitter @ **HackSpaceMag**

Left
This light-box was made from an old Amazon box, scanner glass, and spare fluorescent tube. It's a useful addition to the workshop – great for tracing patterns from mechanical drawings