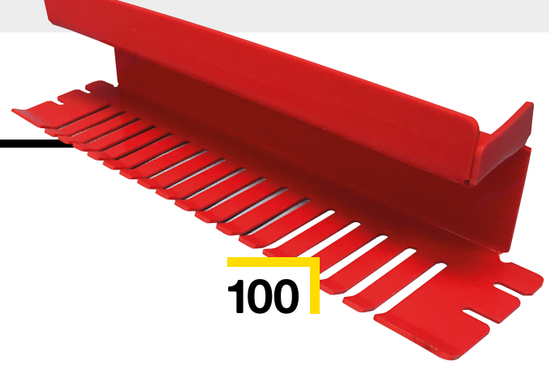
Contents



100

06 SPARK

06 **Top Projects**
What's impressed us this month

16 **Objet 3d'art**
Everything 3D-printed in its right place

18 **Meet the Maker:** Jen Fenner
How to build a business out of a makerspace

22 **Columns**
Has Moore's law run its course?

24 **Letters**
How a no-blame culture saves lives

26 **Kickstarting**
Harness the power of the sun with cheap hardware

30 **Hackspace** Makerspace Hull
Inspiring creativity in the city of Wilberforce

35 LENS

36 **Robotic music**
Replace musicians with reliable funky robots

54 **How I Made:** OpenWorm
Create life in the form of a C. elegans nematode

58 **Soundscapes to Landscapes**
Citizen science to monitor the sound of wildlife

62 **Interview:** Ugo Vallauri
Why we should all repair, re-use, and recycle more

70 **Improviser's Toolbox** Umbrellas
Stay dry and entertained with these foldable membranes

Tutorial

Hold on

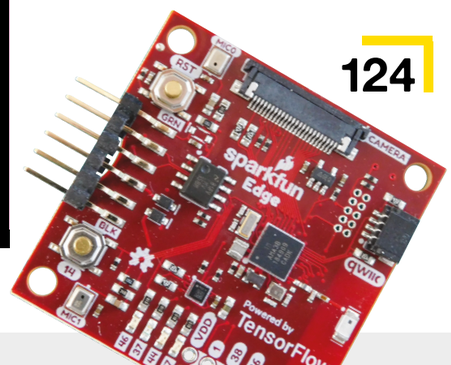
88 Impose order on your workbench

Cover Feature

Robotic Music

Build, program, and play your own unique instruments

36



124

122

98

Direct from Shenzhen

Third hand

114 Third hands – for when two hands just aren't enough

Interview

Ugo Vallauri

62 Meet the co-founder of the Restart Project – fighting for your right to fix

06

75 FORGE

76 **SoM** TFT screens
Simple displays for data feedback

78 **SoM** CircuitPython
Animate pixels to create a moving mammal

82 **Tutorial** LORAWAN
Extend the range of the Internet of Things

88 **Tutorial** Get a grip
Advanced workbench techniques from the pros

94 **Tutorial** Colour sensing
Build a chameleonic ornament

98 **Tutorial** Digital callipers
Measure work with digital precision

100 **Tutorial** Cable organiser
Cut, bend, and craft acrylic into useful shapes

104 **Tutorial** Temperature control
Keep food at a constant temperature – with rubbish

108 **Tutorial** Stay sharp
Keep your blades sharper than Sean Bean

113 FIELD TEST

114 **Direct from Shenzhen** Third hand
Augment your puny human hands with extra holding power

116 **Best of Breed**
The best keyboard add-ons for clicky inputs

122 **Can I Hack It?**
Will the PlayStation Classic bend to our will?

124 **Review** SparkFun Edge
Bring internet-free artificial intelligence to your builds

126 **Review** Creality Ender 3
Get a working, solid printer out of the box for £200

128 **Review** Sonoff Mini
Turn stupid devices into smart ones with this switching unit

129 **Television Review** Blown Away
Enter the world of artisan glass-blowing

70

Some of the tools and techniques shown in HackSpace Magazine are dangerous unless used with skill, experience and appropriate personal protection equipment. While we attempt to guide the reader, ultimately you are responsible for your own safety and understanding the limits of yourself and your equipment. HackSpace Magazine is intended for an adult audience and some projects may be dangerous for children. Raspberry Pi (Trading) Ltd does not accept responsibility for any injuries, damage to equipment, or costs incurred from projects, tutorials or suggestions in HackSpace Magazine. Laws and regulations covering many of the topics in HackSpace Magazine are different between countries, and are always subject to change. You are responsible for understanding the requirements in your jurisdiction and ensuring that you comply with them. Some manufacturers place limits on the use of their hardware which some projects or suggestions in HackSpace Magazine may go beyond. It is your responsibility to understand the manufacturer's limits.