

Smarter tech for selfies, activity tracking, staying in touch, audio description, gardening and more.

Gadgets

by Caramel Quin

**HANDS-ON
REVIEW...**

... bit.ly/eandt-gadgets

AirSelfie Air Pics

£120

Less a drone, more a flying camera or a really long selfie stick. You throw Air Pics gently into the air, then it pulls back and frames a shot of you and your companions. Photos are sent wirelessly to the phone app where you can apply filters and share directly to social media.

airselfiecamera.com



Garmin Lily

from £179.99

This smartwatch was designed for women, by women. So it's small and stylish but also packed with serious features. The touchscreen watch face can be customised and displays health and wellness monitoring plus smart notifications from your phone. You tailor it, choosing activities and features via the app. garmin.com

Blueair HealthProtect

from £639

This new range of air purifiers goes beyond filtering out airborne particulates including allergens, particulates, odours and VOCs. These models specifically target bacteria and viruses, ensuring germs are captured and then killed, not recirculated. Features include air-quality monitoring, geofencing and voice control (Google Home or Amazon Alexa). blueair.com



Yardroid **£2,000**

The problem with robot lawnmowers is that they don't do the rest of the gardening. This bizarre invention looks like a military rover (or a goth Big Trak?). It's pricey, but as well as mowing it handles automated watering, leaf blowing, identifying and killing weeds, even snowploughing.
yardroid.com



Yo-Yo Machines **£26-36**

Innovative free designs from the Interactive Design Studio at Goldsmiths, University of London that help you stay in touch with loved ones. Flutter By (pictured) communicates movement playfully. Build them yourself from household materials, affordable components and a no-solder breadboard. Instructions and shopping lists are all online.
yoyomachines.io



Envision Glasses **£3,000**

These combine Google Glass 2 with Envision's award-winning AI technology for visually impaired people. Artificial intelligence recognises visual information and describes it to the user: not just reading text and scanning barcodes, it also recognises faces, helps you navigate the environment and find items. Priceless.
letsenvision.com



Brilliant engineering at a hefty price.
By **Paul Dempsey**

The Teardown

Apple AirPods Max



IFIXIT/APPLE

OK, £549 FOR a pair of headphones? If you could, would you? Well, maybe.

I spent a good slice of my childhood caddying dad's 'test' LPs as we schlepped around hi-fi shops, remembering little more than the price of the turntable or amp that he bought – he could recite every spec. Since this is Engineering & Technology, it is fair to assume the readership contains a higher percentage of audiophiles than average.

But Apple has launched its AirPods Max, its first non-Beats over-ear headphones, at a challenging time.

As the price demands, this is a heavily engineered product. It has an aluminium-led industrial design that discreetly bellows 'quality', a thoughtful interior layout, and a range of audio features that fully exercise Apple's dedicated H1 headphone ASIC.

Yet right now there is reduced demand for high-comfort, noise-cancelling headphones from one key market: the frequent traveller. Moreover, numerous reviewers have found that the AirPods Max feel tied to an ecosystem where the best available audio quality from Apple Music is 256kbps AAC compression as opposed to the lossless option aficionados tend to prefer.

There are even areas where it feels Apple has been rather mean. There is no 3.5mm jack nor any adapter bundled with the headphones. Instead, the user must pay an extra £35 for a Lightning-to-audio cable. Then, the Max's case has drawn fire partly from the bemused because it looks like a bra but mostly because it does not fully cover – and thereby fully protect – such an expensive product.

Finally here, if the battery does drain completely there is no passive mode (though with 20-hour capacity, a 15-minute fast charge providing an hour's play, and an ultra-low-power standby mode, that is hard to achieve).

Nevertheless, audiophiles can be forgiving if the product delivers results in terms of sound and, for headphones, comfort. Here, Max scores highly.

In its full active noise-cancelling mode and a separate



The AirPods Max's ear cushions, typically the most vulnerable spots for wear and tear, are both replaceable and repairable

'transparency' mode (which lets some outside noise through), eight on-board microphones feed into a system that can optimise output hundreds of times a second – six capture the surroundings and two what the user is hearing. Processing is done via ten audio cores in two on-board H1s, one in each cup.

A spatial audio feature can then be used for video offering a well-rated conversion of Dolby 5.1, 7.1 and Atmos soundtracks into a three-dimensional rather than solely horizontal spread.

Performance is also highly rated across the full dynamic range with any of these features – or a further Adaptive EQ – turned off. The sound itself is delivered by two 40mm Apple-designed dynamic drivers.

On comfort, the Max weighs roughly 100g more than premium rivals at 384.8g. Apple has sought to mitigate wearer fatigue by giving the canopy a lightweight stainless-steel frame and a breathable knitted mesh headband as well as balancing weight across the two cups.

An iFixit teardown highlights the canopy design. "Any capable headphone headband has to tilt, spin, and connect the ear cups together, but no other headphone does it quite like this. Apple's electromechanical hinge hardware is both intricate and overbuilt, and might make the AirPods Max's price tag a little easier to swallow," iFixit found.

"This hinge needs to provide a sturdy but comfortable connection for the headband, while also reliably passing a power connection through from the battery. Apple uses a wraparound flex cable in the rotating portion of the joint, with some clever routing and built-in

strain relief – then switches over to spring contacts for the connection to the headband. What a flex."

As its teardown team explains, these things do matter: "The two points in any headphone where the headband meets the ear cup are paramount for comfort. The joint needs to move with multiple degrees of freedom to sit comfortably on the wearer's head, and be sturdy enough to be yanked around a bit during the putting-on and resizing process.

"Additionally, headphones are little pockets of pure vibration. Inside both ear cups, the drivers vibrate rapidly for extended periods of time to create sound for your earholes. So any joint hardware inside the ear cup needs to be pretty robust."

Meanwhile, though not signalled in the marketing, Apple has included a further feature that allows a user (or, more likely for now, a repair engineer) to

insert a SIM pin into a small hole and detach the canopy

After so many earbud teardowns where partial replaceability and repairability have been disregarded, Air Pods Max reverses the trend.

The ear cushions, the most vulnerable spots for wear and tear, are held in place by smart magnets and are user replaceable (albeit at £75 a pair).

Access to the ear cups is mostly a case of removing screws, although there are some pentalobe and very small (down to T1) Torx screws as well as a modest amount of glue. Once inside, battery and driver removal and replacement is relatively straightforward. For iFixit, the main issue then became the sheer range of screws used: "You'll need an extensive tool kit, even by our standards."

At this price, you suspect that the bill of materials for such a sculpted and unique design has made Apple not merely more repair-friendly but also wary of the costs it could face for replacements.

You cannot get away from the fact that the AirPods Max are on every level a beautifully designed product (once out of the case). But you equally cannot get away from wondering if, notwithstanding Apple's massive brand power, a price tag around £200 more than comparable headphones from Bose and Sony would have been asking a lot at the best of times. *

KEY COMPONENTS APPLE AIRPODS MAX

Part	Supplier	Comments
Processor	Apple	H1, 10 audio cores, Bluetooth 5.0
Battery	Sunwoda	Two cells, total ratings: 664mAh, 2.53Wh
Accelerometer	Bosch Sensortec	3-axis
Microcontroller	STMicroelectronics	32-bit, ARM, STM32L496QG
Audio codec and amplifier	Cirrus Logic	(Likely)
Memory	Winbond	256Mb, serial flash
FPGA	Lattice Semiconductor	MachX02, LCMX02-2000ZE
Op Amp, Comparator, Converter	Texas Instruments	Op Amp: TLV341. Comparator: TLV3691. Converter: TPS62743 (300mA step-down DC-DC)

Note: the components listed here are not exhaustive but restricted to key parts whose suppliers and function could be identified.

Source: iFixit

Air pollution is one of the biggest environmental threats we face today and one of the most significant causes of premature death. Author **Chris Woodford** discusses the science and statistics.

Book Interview

By Nick Smith



Bad breath of life

ALTHOUGH IT'S tempting to think that air quality in the 21st century is poor, it's important to realise, says Chris Woodford, that "pretty much ever since humans discovered fire, air pollution has been an issue". If you go back through history you could argue that it's always been the case, says the author of 'Breathless', a book in the popular science genre that examines, in the words of its subtitle, 'why air pollution matters – and how it affects you'.

How much of an issue air pollution has been over the centuries depends on how you quantify it. "In terms of deaths we're talking about possibly as many as ten million annually worldwide," with the UK responsible for around 30,000 of

those. "That's frightening. When you think that coronavirus has passed 100,000 here in the UK. Well, air pollution notches up 30,000 a year. Year after year." And if you look at the statistics for the past decade, "we're not actually making any progress in bringing that number down". You can measure the impact in other ways – such as the type of airborne contaminants – but how many people die as a result of that pollution "is a meaningful way to look at the problem".

Top-line findings in 'Breathless' make for grim reading. Together, indoor and outdoor air pollution present a greater health risk than anything other than high blood pressure. It is implicated in six

of the top ten causes of death worldwide, including lung cancer, heart disease, stroke and dementia. Air pollution is one of the most significant causes of premature death worldwide. The ten million casualties represent five times as many deaths as there are in road traffic accidents, three times more than tobacco smoking, 15 times more than all wars and other violence put together, and more than malaria and AIDS combined. The financial cost is staggering: the \$5tn annually lost to the world's economies could triple the global defence spend.

Because air pollution is global, "talking about it as a single entity often isn't all that useful", says Woodford, a prolific author of several

best-selling science and technology titles as well as being founder of the Explain That Stuff website currently boasting more than 100 million pages. "If you look at Asia, where it is substantially an indoor issue, the problem is more to do with people cooking and heating their homes with biomass and wood fuels. But if you come over to the UK, the emphasis is on entirely different things such as urban traffic." All of which means that "despite my book being about 'air pollution' as a whole, it's not sensible to talk about its causes and solutions in a monolithic way".

If you were to ask someone for a spontaneous description of what air pollution is, what's most likely to spring to mind is

‘Even theoretically credible pieces of air-cleaning technology won’t be able to solve the problem’

Chris Woodford



Causes of UK air pollution have changed markedly since the smogs that affected cities like London in the mid-20th century



“an image of dirty old factories, smokestacks, drifting black clouds across urban London. Which is understandable,” says Woodford, “because this was probably what it was like back in Dickensian times, or during the Great Smog of the 1950s that killed thousands of people.” The problems back then were, as this image illustrates: dirty power plants and factories, domestic coal burning. “But today the picture is different because that was an obvious problem to focus on and clean up.” This means that the blame has shifted to areas such as agriculture, traffic, and domestic wood burning.

Engineers working in industry can give themselves a pat on the back, says Woodford, because “these areas in the UK have got

WE READ IT FOR YOU

‘BREATHLESS: WHY AIR POLLUTION MATTERS – AND HOW IT AFFECTS YOU’

We take a deep breath 20,000 times a day, assuming that the air we breathe is life-sustaining. It’s an assumption questioned and examined with both science and statistics by Chris Woodford in his latest book ‘Breathless.’ In Delhi, toxic smog is so bad for you that you might as well be smoking 50 cigarettes a day. There are 15 cities globally where if you were to exercise outdoors, you’d be doing yourself more harm than good because of the air pollution. Even in cities such as Paris, London or Rome exposure to ‘fresh air’ is the equivalent of two or three gaspers. Air pollution, says Woodford, is a much bigger issue than most of us think. ‘Breathless’ provides the facts about air pollution in our everyday lives: its causes, effects and, crucially, what can be done about it both at individual and national levels.

CHRIS WOODFORD
BREATHLESS



WHY AIR POLLUTION MATTERS – AND HOW IT AFFECTS YOU

their act together quite well and are no longer the bugbear they used to be”.

When it comes to alleviating air pollution, one of the biggest challenges is simply the fact that people don’t realise the scale of the problem, says Woodford, who thinks that this deficiency in awareness stems from a “basic lack of education on the subject”.

In terms of technical solutions, the starting point has to be monitoring air quality, “so that we can make it more obvious to people what pollution they are experiencing”. For the government, having targets for specific pollutants and having plans for achieving them is the way forward, although “linking air pollution to climate change and understanding that they are two sides of the same coin is also vital. So too are cost-benefit analyses. I think if governments invested in such activities for say, improving air quality in Birmingham, then they would find that this is a much better use of public money than big infrastructure projects.”

While researching ‘Breathless’, Woodford carried air-monitoring equipment with him, for no other reason than to focus on the topic. In his mind, he’d be using the sensor when

looking for traffic hotspots in order to see what the levels of pollution were. “So, for example I spent a whole afternoon walking around Birmingham looking for traffic hotspots – and I couldn’t find any. I thought I’d wasted my time. But when I got to the train station, the readings went off the scale because of all the diesel trains sitting there.

That was a real surprise,” says Woodford, who thinks that this type of casual observation would help others to understand. “You have all these assumptions about where pollution is, but you can’t quantify it. Whereas I could take readings, and I found it shocking. And the problem in some places is that even theoretically credible pieces of air-cleaning technology won’t be able to solve the problem. It’s that big.”

Woodford is optimistic that having studied the problem it can be solved. “I’ve looked at this in a logical way and I can see what the problems and solutions are. But you need political will and public pressure to create change. And so, I’m optimistic in that sense, but also pessimistic due to the scale of the problem.” *
‘Breathless: Why Air Pollution Matters – and How it Affects You’ by Chris Woodford, Icon Books, £14.99

EXTRACT

TAKE A DEEP BREATH

The history of air pollution includes plenty of denial that it was ever really a problem. Back in the 1880s, Chicago coal magnate Colonel W P Rend proudly boasted: ‘Smoke is the incense burning on the altars of industry. It’s beautiful to me... you can’t stop it.’

A century later, US President Ronald Reagan mounted a robust defence of the right to pollute in the name of economic progress: ‘Approximately 80 per cent of our air pollution comes from hydrocarbons released by vegetation, so let’s not go overboard in setting and enforcing tough emission standards from manmade sources.’ At best, that’s a non sequitur: Reagan was right that trees pollute, but wrong to conclude it grants us a licence to pollute as well. Trees can’t help themselves; we can. If money is your measure and you think pollution a price worth paying for progress, which is what Reagan was really arguing, you need to consider the World Bank’s finding that dirty air costs the planet \$5tn a year, including \$225bn in lost work days. That’s about a third of the total cost of the financial crash of 2008 each year. In the UK, pollution costs £6-50bn annually; in the US, estimates range from \$45-120bn. Globally, pollution chops 6 per cent off GDP – to put that in context, the world spends 2.2 per cent of GDP on defence and 4.8 per cent on education.

Reagan died of dementia – a progressive condition increasingly correlated with pollution. If Reagan had known that, would he still have defended the toxic clouds coughed out by cars and power plants? Supposing his dementia had anything to do with pollution, had it dulled his brain to an argument that might have helped save him? Are we all in the same leaky boat now?

Edited extract from ‘Breathless: Why Air Pollution Matters – and How it Affects You’ by Chris Woodford, reproduced with permission.