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THE NEW DIY
RISE OF THE MAKER CULTURE

IET The Institution of Engineering and Technology

Changing the world one maker at a time

The maker movement has small beginnings but could alter the way we think of mass production
By **Chris Edwards**

IN THE WAKE OF the Fukushima disaster in 2011, a lot of people in Japan felt the government was not giving them enough information about radiation, so many went out and bought their own Geiger counters. Supplies quickly ran dry, so a group gathered in Tokyo's Hackerspace to design and build their own under the name Safecast.

Before they did anything, they consulted the Internet. Joichi Ito, director of the MIT Media Lab and founding member of Safecast, explained at the group's anniversary and conference in March this year: "When we had the earthquake, most of us didn't know about radiation or even starting up communities.

We called out on the Internet, asking: 'Do you know anything about this?' Someone would say 'I know the person who did the monitoring sensors for Three Mile Island'.

"We put together quite a good team having started from zero. We couldn't have designed this as quickly without open hardware or without the help of the Internet. That is a big trend that we are seeing the beginning of."

The result of the hacking project was the bGeigie, a combination of a Geiger counter, GPS receiver and data recorder. Users submit their data to the Safecast database by uploading it from the bGeigie's SD card, usually from a network-enabled computer rather than the device itself.

Ray Ozzie, former chief software architect of Microsoft and the adviser to Safecast, came up with the idea of putting the small initial number of handmade Geiger counters on the outside of car windows, so they could be driven round to maximise the number of

3D printers make manufacturing accessible to local communities
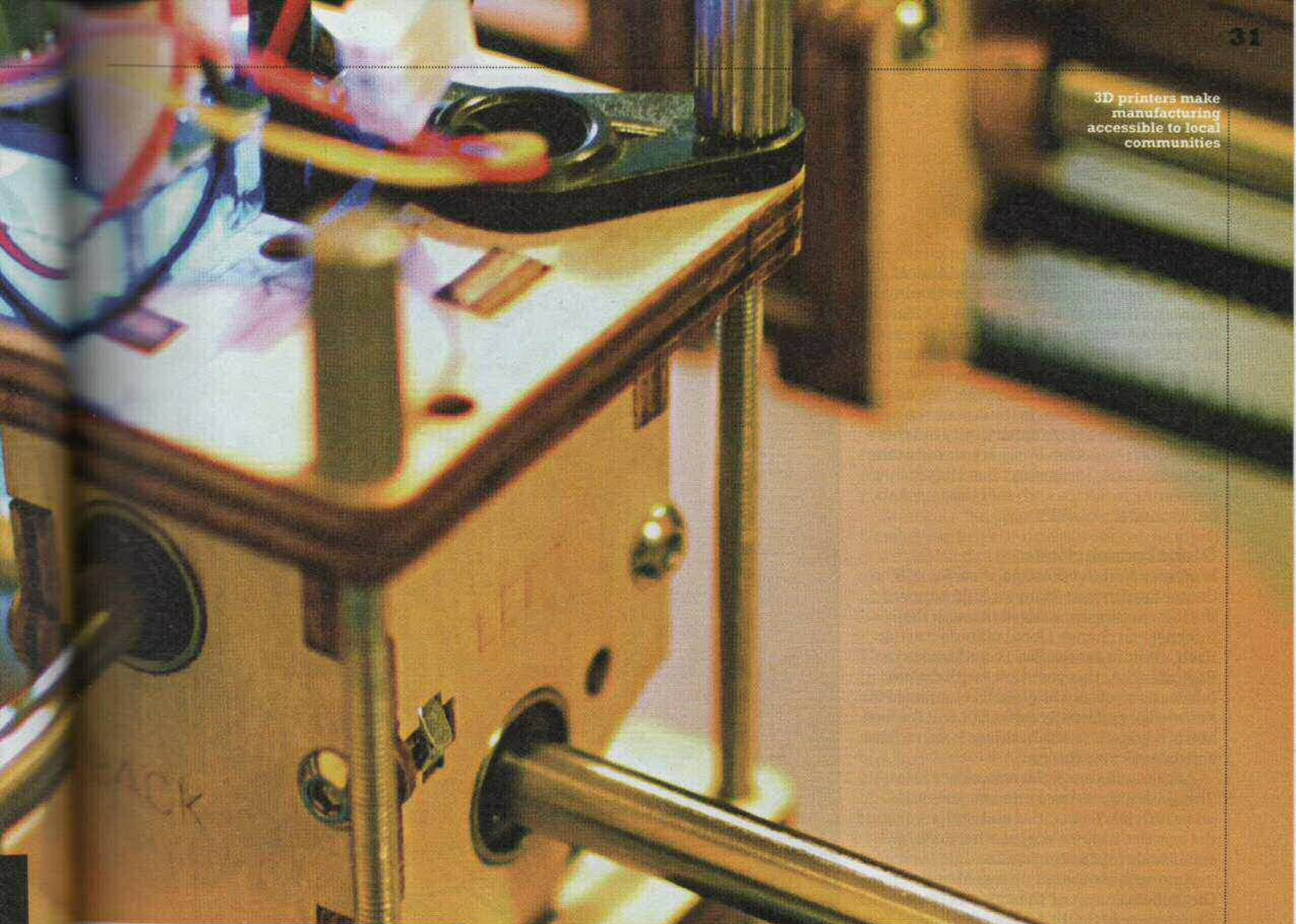
Safecast holds bGeigie building workshops in Japan every couple of months, mainly in Tokyo and Fukushima

readings around Japan that the team could record.

The arrival of the third-generation bGeigie has seen the number of counters in active use around the world rise to more than 500. Those units have collected 30 million recordings. Some of the sensors have made it inside the Fukushima and Chernobyl compounds and Safecast intends to install 25 permanently close to the Fukushima reactor. The group is now expanding development work to look at other kinds of sensors, with the aim of building an environmental and pollution global database for crowdsourced science.

Ozzie said at a panel session on the second anniversary: "It's interesting to see what parts of the environment we as citizens choose to measure. Some may do it for subversive reasons, some may do it for local reasons. What Safecast is doing is paving the way for many future projects, whether it's air quality, water quality or so on."

According to Sean Bonner, co-founder and global director of Safecast, crowdsourcing environmental data with the help of self-made hardware has helped push government sources into publishing their own data. Although some of the data was meant to be available, the Safecast group found that it was not, in fact, publicly accessible.

"In Washington DC, on one day there was no publicly available data. Twenty-four hours later a handful of us walked around with stuff and published some 48,000 data points. Shortly thereafter the government published their data," Bonner claims.

Aid organisations USAID and Unicef have adopted the idea of mass-deployed sensors developed by the maker movement to try to improve society's understanding of what is happening in the underdeveloped nations, where there are very few environmental sensor networks in existence. In May, Unicef launched a competition with ARM and Frog Design to try to find a new generation of wearable devices that could help women and children.

Blair Palmer, Unicef's Innovation Labs lead, says the work initiated by the competition could let the organisation "really look at how mobile technology can be an enabler in these communities".

The winning design need not rely on electronics. One group of finalists from India and Korea came up with a pen-shaped bar of soap, wrapped in tightly rolled paper, designed to encourage hand washing among children, reducing the spread of diseases by contact. Like a crayon, as the paper is rolled away it exposes more soap.

Another group from India has developed a concept based around an ear-worn sensor with a target cost of $25 that streams data on respiration rate, heart rate and body temperature over Bluetooth to a mobile >

Workers in Kenya dismantle unwanted products for potential re-use

< phone or medical recorder.

Over the longer term, ARM and Unicef intend to carry out research in developing countries that they hope will provide ideas for new business and technologies. "We aim to bring ideas to investors and help them grow and go worldwide," said Ian Drew, executive vice president of ARM. "We as an industry need to listen to the rest of the world. There is a huge opportunity out there. But it won't be driven by where we are at the moment. Those ideas won't just shape what's happening in Africa and emerging markets, but around the world."

Global connections

Professor Neil Gershenfeld, director of The Center for Bits and Atoms at MIT, believes the information exchanged through the Internet can change global manufacturing itself, claiming at the Fab 11 conference in Boston earlier this year that "with digital fabrication you can be globally connected for knowledge and locally self-sufficient for food and products. It is where things become data and data become things."

At the conference, the researcher into 'things that think' recruited mayors and other officials from cities and regions around the world to become part of a network of small-scale fabrication centres.

Among those to sign up was Mondli Gungubele, mayor of the new city of Ekurhuleni in South Africa – the combination of nine towns that lie around the Oliver Tambo airport. "We are building our city around that busy airport, developing a 30-year master plan. Our city must be a different city altogether by 2032. Where do we get the capacity to take it forward? We realised that R&D will be key."

Rather than building a few centralised labs, Gungubele sees the fab-lab idea as more promising. "We realised we needed a hub of fabrication labs to unleash the energies of as many South Africans as possible, seeing young people put the products of their mind through the fab lab."

Irakli Kashibadze, chairman of Georgia's innovation and technology agency, sees his entire country adopting the fab-lab idea: "We are going to create 500 community innovation centres with maker spaces across the whole country. The challenge is to become a self-sustainable country: produce everything the country needs."

The fab-lab network being built in South Africa and Georgia among others will be the result of top-down planning to try to invigorate an economy through individual effort. A group of makers in Togo did not wait. In the WoeLab maker centre in the capital Lomé, maker Afate Gnikou used e-waste to form the guts of the 3D printer that carries his name. A board made by Arduino, a popular choice among makers, controls the motors and nozzles. The W.Afate design won first prize of the Global Fab Award at last year's Fab 10 conference in Barcelona.

"The idea is to use e-waste and dead machines to build new machines," says Woelab founder Sénamé Agbodjinou. "We have a lot of e-waste dumps in Africa. In

Amanat Anand, Junho Byun, Shubham Issar and Yogita Agrawal are finalists in Unicef's 'Wearables for Good' challenge. The design of their SoaPen, a wearable soap crayon for children, was to be revealed on 12 November.

Ghana, there is the biggest e-waste dump in the world. We are trying to see how we can manage this problem."

Woelab wants to seed the W.Afate printer across a network of cybercafes around the city of Lomé and further into Togo and Africa. "Our objective is to put the printer into everyone's hands and they will find what to do with this machine," Agbodjinou adds.

A project launched by UK charity Techfortrade aims to extend the reach of 3D printing further around the world. Technical director Matt Rogge developed the core of a software package that can build plans to convert pieces of e-waste into the insides of a 3D printer, publishing the software at open-source community site Wevolver. The software takes the dimensions of a discarded chassis and provides the design changes need to build a functional printer.

Katherine Hughes, communications officer of Techfortrade, says the aim of the charity is to use the printer design to help build social businesses based on local manufacture. Versions of the printer are used in projects with groups such as Nairobi-based AB3D, STIC Lab in Tanzania and FabLab Oaxaca in Mexico.

Roy Ombatti, who heads up the Happy Feet project at AB3D, uses 3D printing to make customised shoes for people whose feet have been deformed by sand-fly infection. "We launched the plans for the Retr3d printer in September. We are already seeing great improvements in the design. It's an open-source design to encourage people to come up with improvements.

"What is interesting with this style of printer is that being made from e-waste that's locally sourced, it's much easier and cheaper to repair than if you place a commercial printer in the country. If people are building them, they will know how to fix them. It makes them more of a community creation. If you have the tools to make it, you can decide what you need to do," Hughes adds,
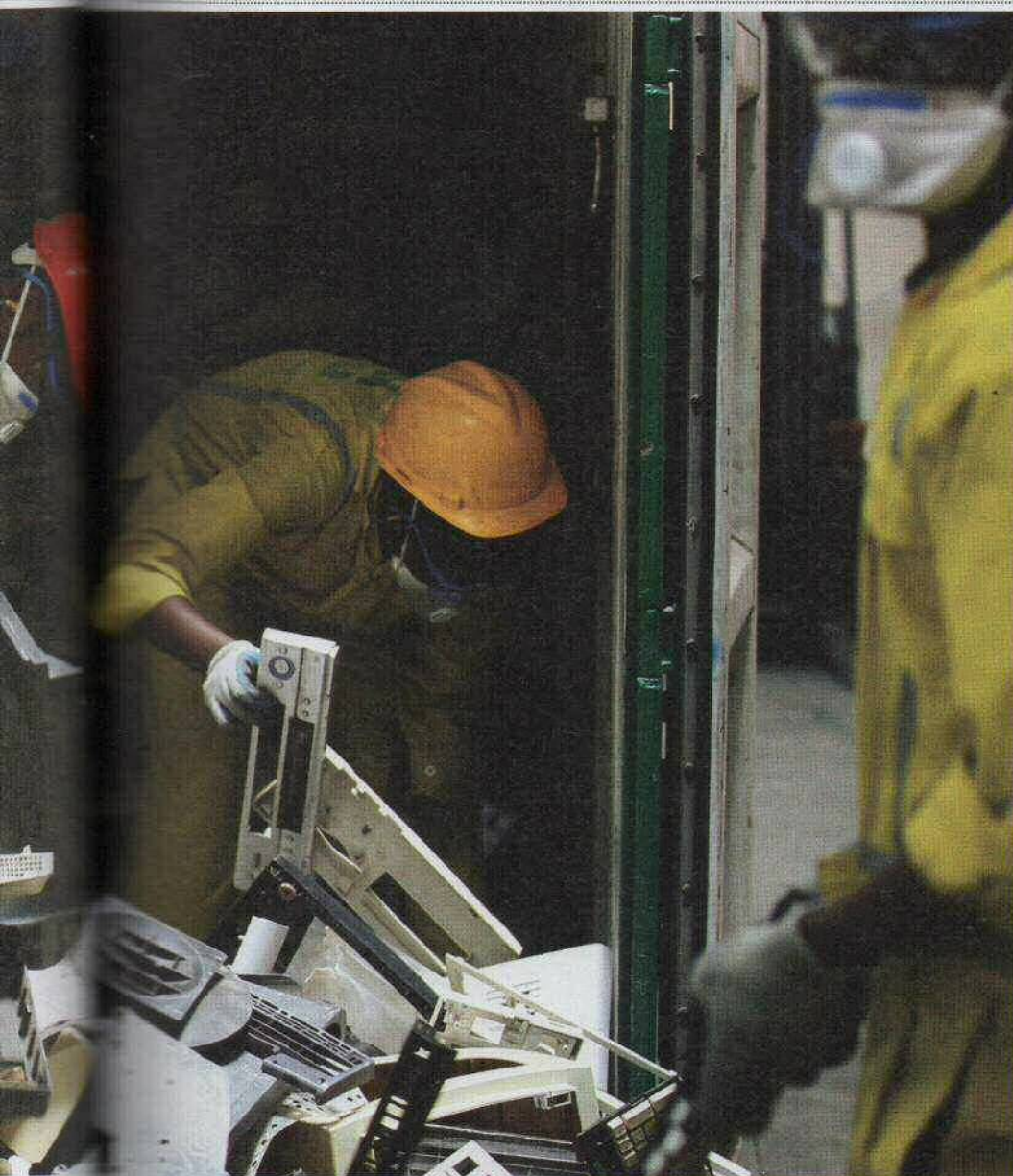
'The idea is to use e-waste and dead machines to build new machines'
Sénamé Agbodjinou, Woelab

...ting to use of 3D printers in Haiti in the ...ars after the devastating 2010 hurricane.

The charity 3DPforHealth, now part of ...eld Ready, initially proposed fabricating ...edical devices such as umbilical cord clips ...d prostheses. However, the applications ...panded to making spare parts for other ...quipment, even buckets. It was quicker to ...ake the buckets locally than to wait for ...ipments to arrive.

...eld Ready proposes using 3D printing ...re widely for relief efforts. It says ...encies spend up to 80 per cent of their ...come on logistics, and claims that local ...anufacture could cut costs by 40 per cent.

Turning waste into raw materials

...-waste can provide not only the core of 3D ...inters for local maker projects, but the raw ...aterial for making products.

...echfortrade is cooperating with other ...oups to develop not only the printers, but ...ays to recycle the large quantities of plastic ...aste dumped in Africa to create raw ...aterials for manufacture. The polyethylene ...ed in bottles is highly suitable for many ...-printed parts, but the process for ...nverting the waste into spools of filament ...far from straightforward.

"Our partners in Oaxaca [Mexico] are ...rking on this. But it's a gradual learning ...rve. If you could speed up the process of

making the filament, it would help a great deal. So we are interested in finding partners, such as materials companies who can help develop techniques for making the polymer filament," says Hughes. "The shared learning is important."

"There are health issues regarding the collection of e-waste. So part of the plans on Wevolver cover aspects such as safe collection," Hughes adds. "There is always a risk with this kind of work but the e-waste is there. If you can find a constructive use for it, if the parts have real value, it's better they can be reused."

E-waste also provided the materials that Kelvin Doe from Freetown, Sierra Leone, used to build the equipment he needed to support his ambitions as a radio broadcaster, in the process creating generators and other devices for family and neighbours to keep their homes lit at night. Doe has become part of a campaign launched by start-up Kano to provide young people who have little access to conventional education with a path into technology that co-founder and CEO Yonaton

Raz-Fridman hopes will lead them into engineering careers. "He is helping us figure out how to empower millions of Kelvins around the world. There is increasing youth unemployment around the world. [With this, they] share with the world around them. They don't have to wait until they are grown-ups or get certificates. They can be more creative than any of us will ever be."

On the back of a $100,000 Kickstarter fundraiser that wound up 15 times oversubscribed, Kano has made and delivered 20,000 computer kits.

Ito argues the practical experience derived from trying to make things work can be much more productive than sitting in classrooms absorbing the theory first: "Don't let the lack of theory stop from you trying things. Because you can get the theory later."

Empowering consumers

In the developed world, companies such as National Instruments and German electronic component distributor Conrad see the combination of Internet cooperation and easy access to 3D printing and low-cost electronic subsystems as providing a way of making consumers more active, turning them into producers.

National Instruments president James Truchard claimed at the company's 2015 conference in Austin, Texas that "the consumer is going to be king. In the old days only kings could have custom door knobs. With 3D printers, everybody will be a king. The consumer will be a major factor in manufacturing [providing] a mass market of one, with the consumer really driving the product and demanding very fast and rapid changes in what they expect."

Conrad recently launched its "Everyone's a techie" campaign and is experimenting with ways to bring consumers' designs to market, such as the Arduino-compatible Controllino module, developed by a customer based in Austria. Melanie Lauer, director of international marketing for the B2B division at Conrad, says: "Makers provide the link between our B2B and B2C businesses. Supporting them is a must for us."

To make 3D printing more accessible, the company is experimenting with an in-store machine, using one designed by its own engineering team which is also sold from its catalogue. Conrad installed the machine at its Munich store in the summer to let customers print out their own designs.

Professor Gershenfeld says widespread adoption of 3D printing and other maker tools means "the end of fab labs. They will disappear along with the ultimate transformation of the economy. Instead of doing something you don't want to do to get money to buy stuff you want, why don't you just make the stuff you want?"

It's a remarkably similar vision to the one Mahatma Gandhi presented more than a century ago. Although it started as a boycott of British mass-produced goods, Gandhi turned the idea of 'swadeshi' into a vision of local, self-sufficient production. The maker movement, assisted by 3D printing, may make it happen. *