

# EXPLORING THE BRAVE NEW WORLD OF DESIGN AND MANUFACTURING

# IMAGINE



Manufacturing in the Digital Age  
Exploring the Materials of Tomorrow  
Welcome to the Circular Economy



**SPACE10** +

FranklinTill  
Studio



“People have not sufficiently understood the importance of the next 20 years. They are going to be the most decisive two decades in human history.”

**Nicholas Stern**

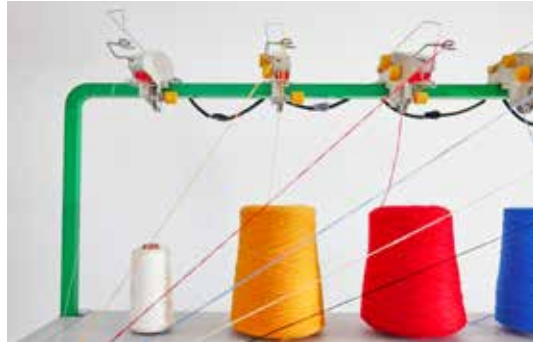
Former chief economist at the World Bank and chair of the London School of Economics' research institute on climate change and the environment



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## Closing the Loop: Welcome to the Circular Economy

**WELCOME**

# **From imagination to reality**

Imagine a different future: a positive one, where the world is a better place because of – not despite – how we design, produce and consume things.

Imagine if products didn't have to be made in factories on the other side of the world, but instead travelled as digital files to be made locally, on demand, only when needed.

Imagine if we didn't have to extract more of our planet's finite resources, but instead started growing materials within our cities.

Imagine if what we treated as waste today could be seen as a resource tomorrow, and systematically became a new raw material.

Imagine if our protocol was "leave things better", not just "do less harm".

We have a responsibility to find better ways to produce and consume things in the future by rethinking how we do things today. This publication is an introduction to some of the trends, weak signals and promising breakthroughs that have captured our imagination.

We hope you enjoy exploring it with us.

Guillaume Charny-Brunet  
Director of Innovation & Strategy,  
SPACE10

SPACE10 is a future-living lab in Copenhagen. Our mission is to explore global challenges, detect potential disruptions and, most importantly, bring together radical thinkers and specialists from around the world to ideate, prototype and design new concepts and business models that enable a better, more sustainable and meaningful way of living. SPACE10 is proudly supported by IKEA, and we share their belief that together we can create a better everyday life for the many people.





# FUTURE LIVING: DARE TO DREAM



We believe there is a world of opportunity to rethink the way we design, make and use things. We aspire to unpick our current “take, make, dispose” economy and transform it into a circular one; one that would not just help reduce the environmental impact of human production and consumption, but also create new opportunities for better business and more equality in the world.

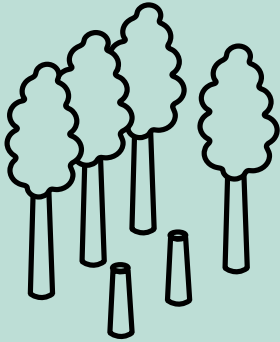
We have produced this magazine to share the trends and technological advances that enable us to envision how to reshape society for the better and celebrate some of the pioneering companies and innovators already breaking new ground.

We are aware that by the time you read this, it may already feel out of date thanks to technological breakthroughs, advances and concepts that are emerging everyday. We also recognise the importance of collaboration in developing this new mindset: please add your comments, input and criticism on our Medium page, so we can take this magazine further together. The world moves quickly, and we need to move faster.

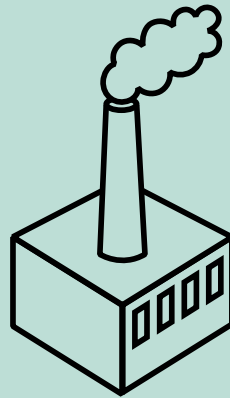
Simon Caspersen  
Director of Communications, SPACE10

For over a century, we have followed a linear model of taking, making, using and disposing. We rely on a supply of raw materials to be extracted from the ground and then shipped to large factories to be turned into products. In turn, these products are shipped around the world, where they are used or consumed before typically ending up as waste.

## Extraction



## Production



This model is reaching its physical limits.

Today, however, several disparate factors are converging that enable us to move beyond that model, and to develop a new one – one that is better for business, people and the planet.

## Distribution



## Consumption



## Disposal





# No time like the present...

Let's start with the facts. Each year, we note the date when humanity exhausts a year's supply of the planet's natural resources. In 2006, that date was in October. In 2016, it was in August. Evidence suggests that if we continue at our current rate, we will soon need a second planet.

The world's population is growing at an unprecedented rate, and with it our demand for natural resources. It is projected that three billion people will climb out of poverty in less than 20 years.

But the prospect is bleak: global consumption will increase dramatically at a time when we need a rapid decline in carbon emissions to stabilise the climate. We are extracting more from the planet than it can sustainably supply, and we are replacing it with enormous quantities of waste and pollution.

What can we do today to ensure change in the right direction?

# Tomorrow, today: A world of opportunity

It's not all bad news, though. We live in a world of constant transition and, with change, comes opportunity. We have identified five factors that together provide us with the impetus and opportunity to influence our society for the better.

01

## THE FLEXIBLE FACTORY

Ongoing developments in technology and digitalisation mean powerful fabrication tools, such as 3D printers, laser cutters and CNC (computer numerically controlled) machines, are increasingly more accessible, cheaper and easier to use.

### **The opportunity?**

The factory of tomorrow could be in our homes or neighbourhoods, allowing us to convert digital designs into physical objects with the click of a mouse.

02

## THE INTERNET

The internet continues to empower us, meeting our desires and capability for greater autonomy over our lives. We can learn and practise new skills, and form networks on both a local and global level.

### **The opportunity?**

We can share knowledge, interests, ideas, opinions, content and consumer goods with one another, instantly, anywhere.

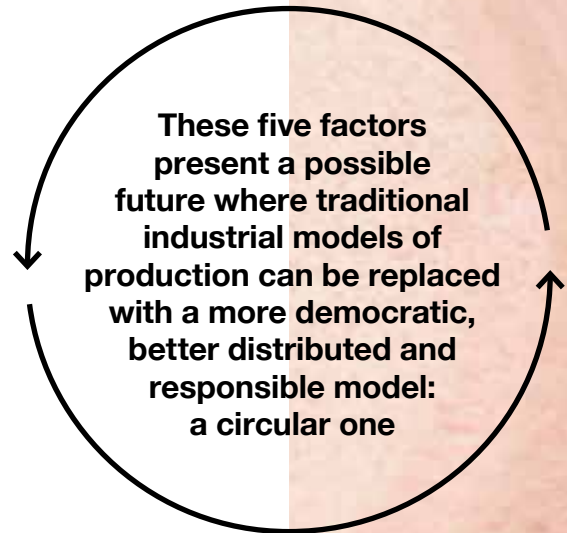
03

## THE MATERIAL WORLD

Innovations in material science and technology are allowing us to rethink how we source materials and design products. New types of material are emerging that are biologically engineered or reclaimed from waste.

### **The opportunity?**

Our systems of production and consumption go beyond “doing less harm” to “leaving things better”.



## 04

### NEW ASPIRATIONS

Our attitudes towards consumption are changing. Instead of discarding, we increasingly seek to buy products that last, and think in terms of conserving, reusing and passing on resources instead of generating waste.

#### **The opportunity?**

Social habits and attitudes towards ownership are being reconfigured: people increasingly share, trade, borrow and rent everything from their homes and their clothing, to their furniture and their vehicles.

## 05

### THE CIRCULAR ECONOMY


The circular economy implies a radical shift in the way we design products, services and businesses towards a regenerative system. It envisions a future that produces little or no waste, and is powered by renewable energy, and where materials can be reused or safely re-enter the biosphere.

#### **The opportunity?**

The significant reduction of both waste and pollution. Economic implications are vast, too: Accenture has estimated that adopting circular economic models could generate as much as \$4.5 trillion in additional economic output as early as 2030.







There are a wide variety of digital fabrication techniques, from 3D printing to CNC milling to laser cutting. These machines all turn digital designs into products.

# PUTTING THE “FAB” IN FABRICATION: MANUFACTURING IN THE DIGITAL AGE

Fifty years ago, printing involved giant presses and specialists to operate them. Today, we have desktop printers in every office and most homes. Could advances in digital fabrication develop in a similar way?

Digital fabrication is based on a simple idea: to design something on a computer before using a digital fabrication tool to physically make or reproduce it. This can be done by adding layers of materials on top of each other (printing), or by cutting, carving and shaping things in ways that would usually require unique manual skills or complex industrial-grade machinery. Very often, 3D printing appears as the figurehead for digital fabrication, but CNC machines and laser cutters, for example, offer a world of possibilities too.



There was a time when digital fabrication tools were so expensive that they were confined to the factory floor, and used for production in large volume. Today, these tools are being democratised in terms of both price and use, empowering people and small shops, enabling entrepreneurs, and fuelling a vision of distributed and collaborative manufacturing.



Shaper Origin is the world's first handheld CNC machine. It is much smaller, cheaper and more mobile than a traditional CNC machine. The robot uses computer vision to let you see exactly what you're cutting, and compensates for any shaky hand movement with automatic stabilisation. If you stray from your design, the Origin can move the spindle independently to continue to follow the path. If you stray beyond its ability to adapt, it will quickly raise the bit so you don't ruin your work. Once you move the Origin back into position, it'll just continue right where it left off. You can even go to another part of the design and it can figure out where it is and what it needs to cut.





3D printing is no longer just a prototyping tool that takes forever to print a brightly coloured plastic sculpture of questionable quality. Today, you can print everything from titanium to cement, metals to polyamides. Researchers have even printed living tissue and predict that internal organs could be printable within a couple of years.

MIT's Self-Assembly Lab worked with US furniture company Steelcase to develop the process of Rapid Liquid Printing, which promises to be a 3D-printing breakthrough by tackling the three main challenges they believe have prevented 3D printing's widespread adoption in manufacturing: speed, scale and material properties.

Rapid Liquid Printing physically draws objects into existence in liquid gel through direct injection, which enables the production of large objects such as chairs in a fraction of the time that regular 3D printers take. In its current iteration, there are no limits to scale – with a large enough tank, the process can create objects of any size.

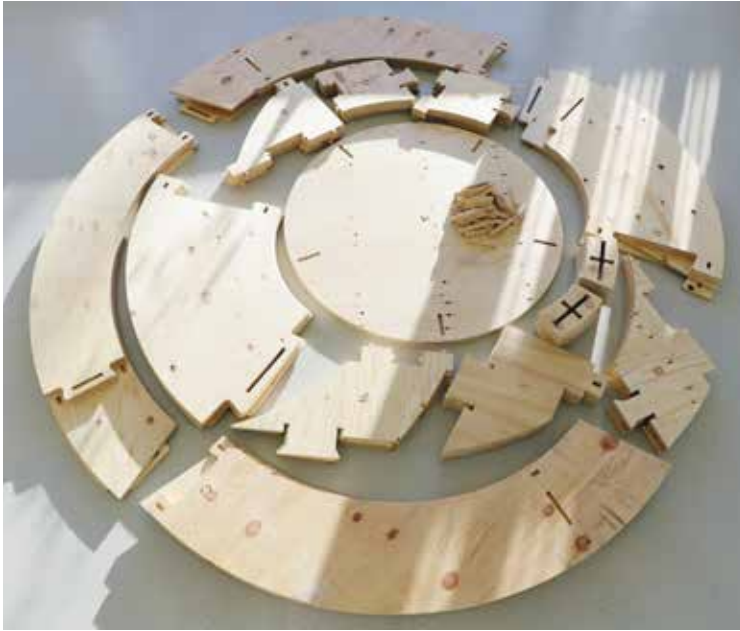
Digital fabrication is still emerging and has yet to fulfil its potential, but that potential is enormous. We have already experienced unthinkable evolutions in computing and communications, and now a similarly transformative revolution could be happening in the physical world, enabled by technology.

Digital fabrication isn't new. The technology has had widespread use in factories over recent decades, with machines controlled by computers that can convert digital designs into physical objects with the click of a mouse.

Today, these machines are becoming cheaper, smaller and more user-friendly, and hence increasingly accessible for more of us. Soon our factories could sit in our homes or on street corners. Designs could travel as digital files to be downloaded and made anywhere – reliably, repeatedly and on-demand. Local production could be the new normal.

This means everything from clothing to furniture – even houses – could be downloaded, customised and produced by us, as needed.



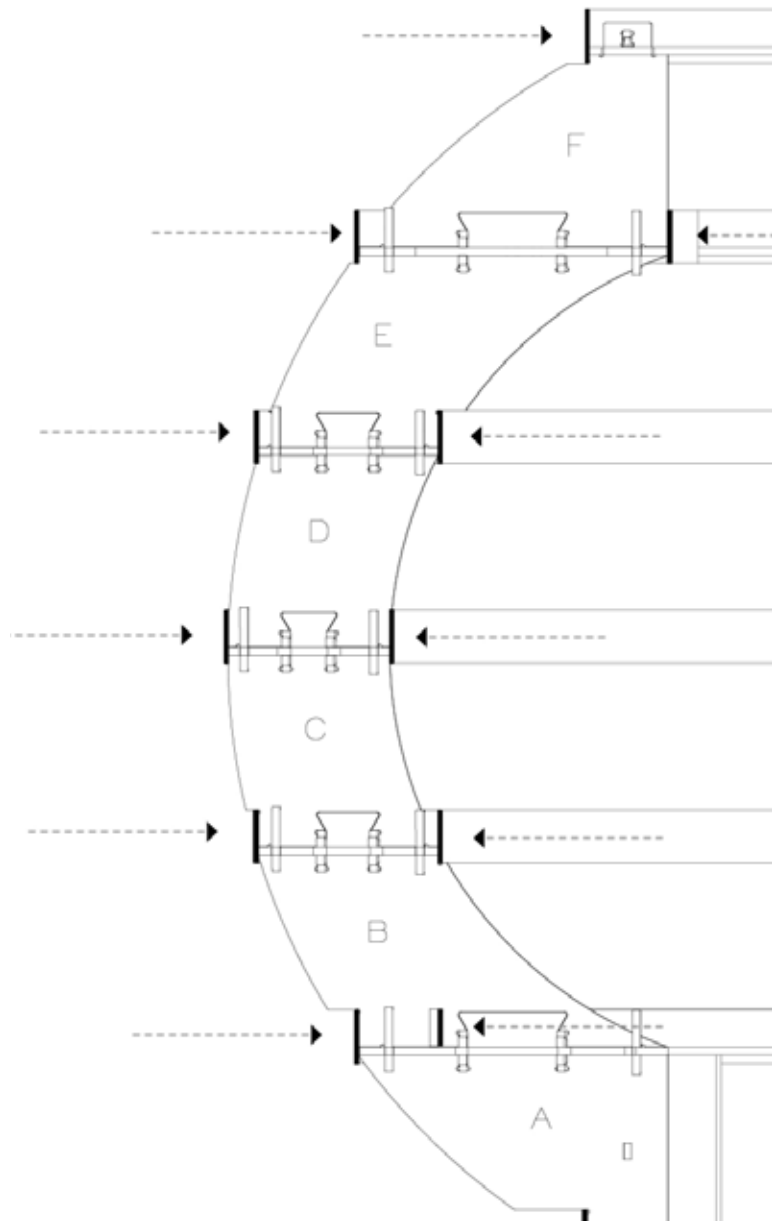


While open source design is still an emerging concept, we are already seeing the first steps in industries such as furniture and housing. SPACE10 launched an open source spherical garden called The Grow-room, together with architects Sine Lindholm and Mads-Ulrik Husum. People can download the design for free and have the components made using a CNC machine or laser cutter. The building process requires no formal skills: numbered pieces are joined together easily. Your new garden can produce food for your neighbourhood within a couple of hours.

## Open source design: What you want, when you want it

Factories of the past cranked out high-volume identical products and shipped them around the world. With powerful, more accessible industrial-grade machines, such as 3D printers, CNC machines and laser cutters, the process of production and supply is turned on its head.

It heralds a new era of decentralisation and efficiency. Instead of shipping physical products in large containers, we can send digital files and have things made locally, wherever and whenever they are needed, with materials that can be sourced, recycled or grown locally and sustainably.

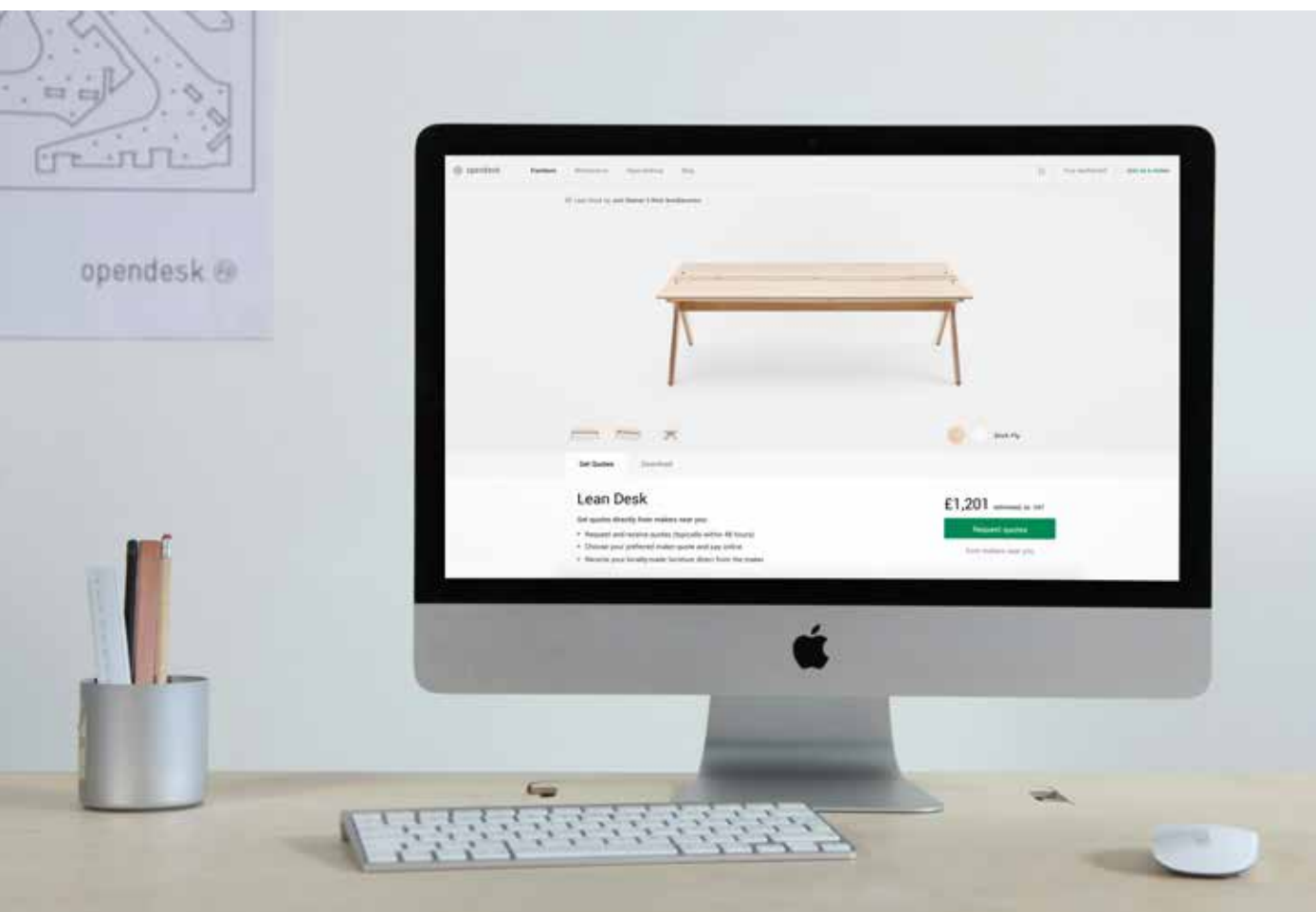








Opendesk is a London-based design company reinventing how furniture is made. All of its furniture is designed to be downloaded via its platform and made locally on a CNC machine.





# Open source furniture: A leaner model

Given that most people don't own or know how to operate a CNC machine, Opendesk has set up a network of independent fabricators spanning most major cities around the world. If you wish to buy a piece of furniture and have it made for you, you simply click a button and get paired with your nearest professional fabricator in Opendesk's network. Opendesk – and the original designer – take a small cut of the fee that is paid to the local fabricator.

Opendesk is pioneering a new form of supply chain and business model, cutting out many of the middlemen and complicated logistics involved in a traditional global supply chain. By democratising the design and manufacturing process, it reduces time-consuming and expensive shipping, as well as the need for storage and showrooms. This benefits all parties involved: the designers, the manufacturers, the clients and the platform.

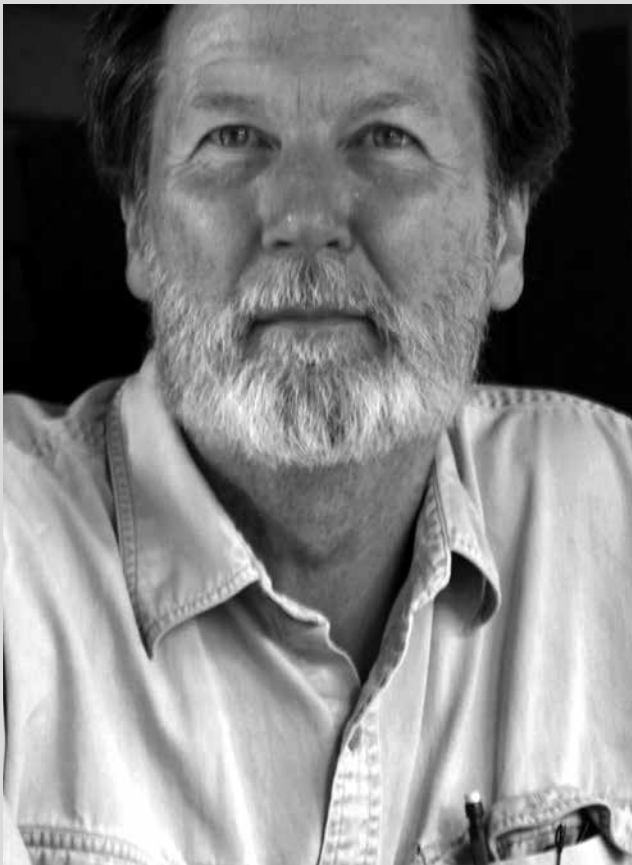
## The facts speak for themselves:

- For each purchase on its site, Opendesk ensures the fair distribution of income between independent designers, the platform and local fabricators.
- Opendesk furniture is made on-demand by local craftsmen, using digital fabrication tools, which simplifies and speeds up production and delivery.
- The price point on Opendesk is close to that of mass-produced goods, because most of the logistics, shipping costs and retail price markup are eliminated.
- Opendesk products are made locally, which supports local economies and reduces the environmental impact of transportation.
- Because the furniture is made on-demand, it can be customised to suit individual taste.



**EXPERT VIEW:**

# **Digital fabrication**



**Ted Hall is founder and CEO of ShopBot Tools, Inc., which he founded 20 years ago to create a digital fabrication tool that was oriented for use by individuals rather than in the industrial production work of then-current CNC machines. Today, there are thousands of ShopBots fabricating away in garage shops, hackerspaces, schools, Fab Labs and manufacturing operations around the world.**



The “new industrial revolution” promises a paradigm shift that can favour the entrepreneurial small manufacturer. This opportunity for the little guy creates an opening for re-establishing manufacturing in our communities. The enabling technology that underlies the opportunity is called digital fabrication.

You probably already know about digital fabrication because of 3D printing. It’s the superstar exemplar of digital fab. But “additive” 3D printing is just one of several digital manufacturing technologies built on this design-to-production continuum. Others include “subtractive” technologies such as CNC machining, plasma cutting and laser cutting, as well as robotic assembly.

For at least some types of manufactured goods, digital fabrication leapfrogs the current stalwart of centralised mass production and promises to make small, clean, fulfilling, local manufacturing competitive again.

Complexity and precision are a feature of digital fabrication; and they come with little or no added cost. Today, the ability to produce features that once required capital-intensive specialised equipment, expensive labour, challenging assembly, or extensive time and effort – if even possible – comes virtually free.

Since complexity comes free, employing it affords new ways to manufacture, new ways to assemble, new usages and new processes that would not have been previously possible. Digital fab can thus favour small agile producers who are quick to assimilate new production options and use them to their advantage.

Using digital fabrication, the lack of an incremental cost for producing complex quality components provides small manufacturers with new competitive opportunities that can be enhanced by their particular capabilities, energy and agility. It could now give us the new industrial revolution.

**“Using digital fabrication, the lack of an incremental cost for producing complex quality components provides small manufacturers with new competitive opportunities”**

# Open source cities: Resilient growth

The demand for affordable housing is one of the more pressing issues in cities today. The majority of new urban areas are not glittering skyscrapers, they are “self-made cities” such as favelas, townships and slums.

Predictions estimate that urban populations will increase from four billion to almost seven billion within the next few decades. To house

them all, we will need to build a city the size of New York every other month for the next 35 years. Architecture’s traditional business model – beyond the reach of 95 percent of the global population – is not viable. We have neither the time nor the money to conventionally produce the required buildings and infrastructure.











circle shaped window without frame  
200mm diameter

custom glued circle  
shaped window without frame  
200mm diameter



# Open source architecture: Building better

Imagine if we could make low cost, effective, adaptable, sustainable solutions and tackle the challenge of rapid urbanisation through open source design. Once released, a design would be in the public domain and anyone could use it. Over time, this could empower people to build better living conditions for themselves, relieve some of the pressure on cities dealing with the unprecedented flow of migrants, and hopefully contribute to addressing other challenges such as sanitation, water supply and off-grid energy. We are still in the early days of experimenting – but it's a reality that is plausible and vital.

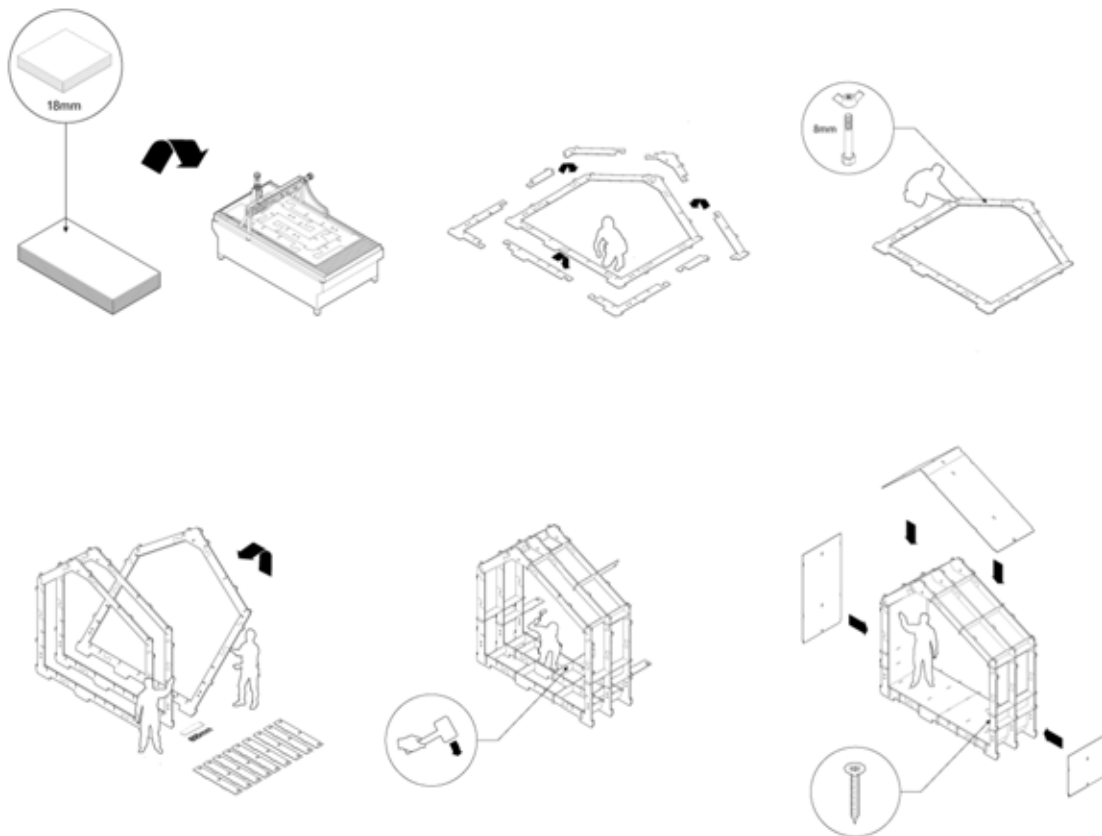
raw concrete surface



aped  
diameter

Paperhouses, founded by Joana Pacheco, is an open source platform that brings world-class architecture to the general public for free. Respected architectural firms all offer designed plans that can be downloaded and adapted. They are not site-specific and can be modified easily for scale and climate, thanks to a flexible construction system. All project maps and drawings are available for PDF download, including a file for digital manufacturing.

Photos: Sporaarchitects



WikiHouse is an open source construction system, downloadable for free, providing CNC machine-cut wood panels to build homes and other structures. People can effectively print out a kit of parts in structural plywood and assemble them in a similar way to an IKEA product. The houses can be put together without the need for traditional construction skills or power tools. The designs use wedge and peg connections, using mallets which are also part of the printed kit. A team of two or three people can build a small house in about a day.



# Print your next home

The potential to use large-scale industrial 3D printing to build inexpensive and environmentally friendly houses is already on the horizon. Though large-scale industrial 3D printing has only existed for a few years, several houses and larger architectural structures have been printed and are standing strong around the world. In 2016, the first house was made in Russia, using mobile 3D-printing technology. With the project led by Apis Cor and PIK, the house was printed in a day and cost \$10,134, which included all the work and materials for

the construction of the foundation, roof, exterior and interior finishing works, as well as the installation of heat insulation in the walls, windows, floors and ceilings.

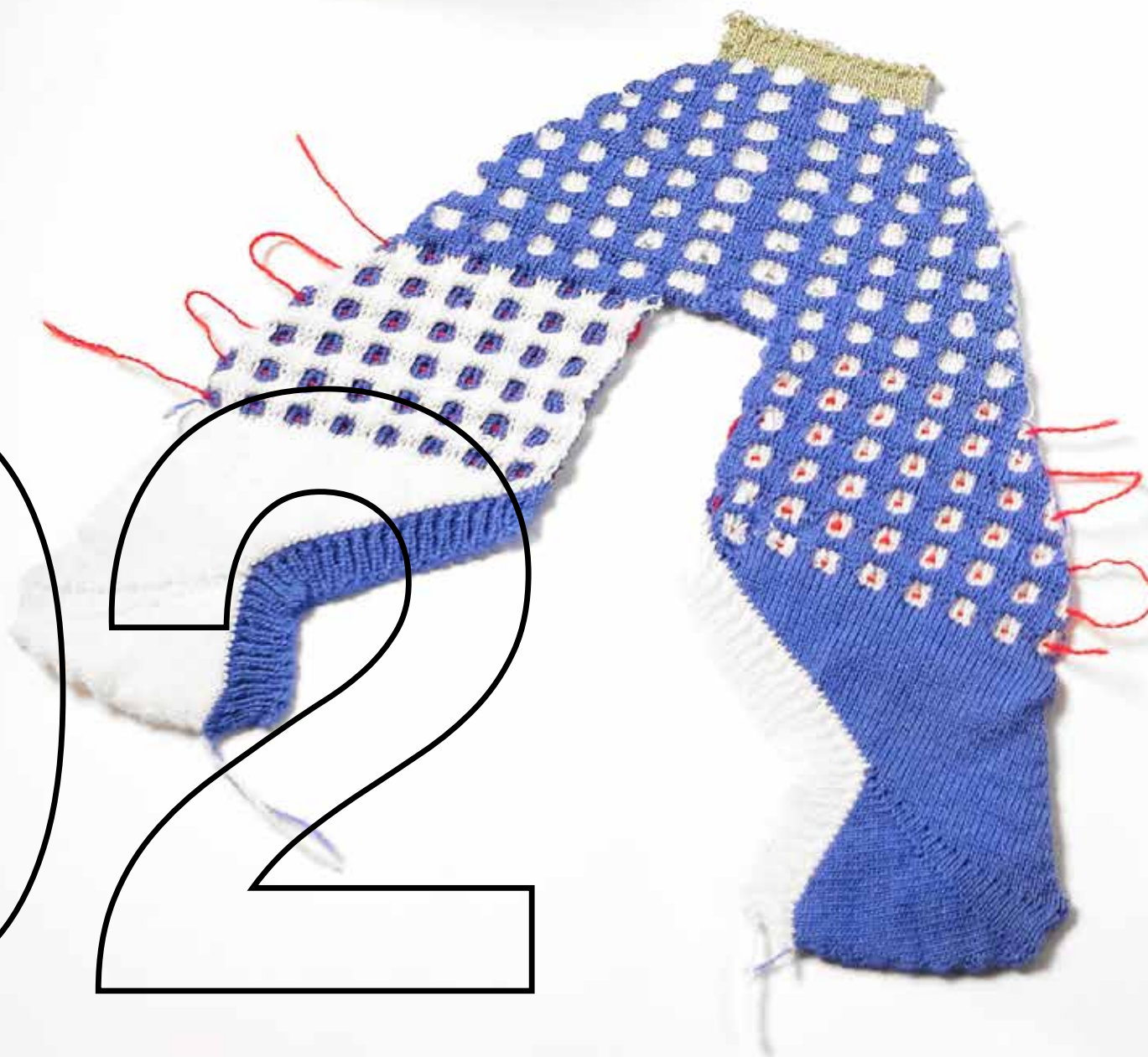
The potential of large-scale industrial 3D printing is enormous, and not just in terms of access, speed and cost. Large-scale 3D printing also allows us to more effectively reuse waste materials such as concrete and plastic collected from the ocean, as well to build with natural materials such as clay.



Dutch studio DUS Architects has 3D-printed an eight-square-metre cabin in Amsterdam using sustainable bio-plastic. When the cabin is no longer needed, it can be destroyed and the materials can be reused.

Photo: Sophia van den Hoek





02

# DEMOCRATISING DESIGN: THE RISE OF MASS CUSTOMISATION



Henry Ford said customers could choose any colour of car they liked, as long as it was black. Life's a bit brighter today. With the current trend of automation, data exchange and the computerisation of manufacturing comes the rise of the "smart factory". Increasingly, people will have the opportunity to take part in the design process, and to buy products that have been personalised to their liking.

People no longer have to select only from what's available on shop shelves; today, they can choose the materials, customise and personalise the design before it's purchased, and make products on-demand. Though this is complex and costly within our current manufacturing system and supply chain, digital fabrication opens up all sorts of opportunities.

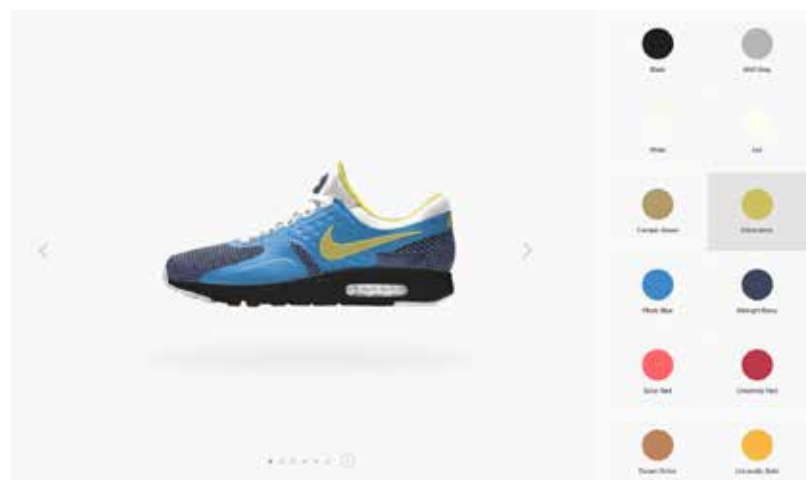
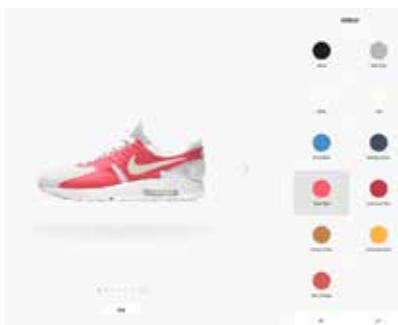


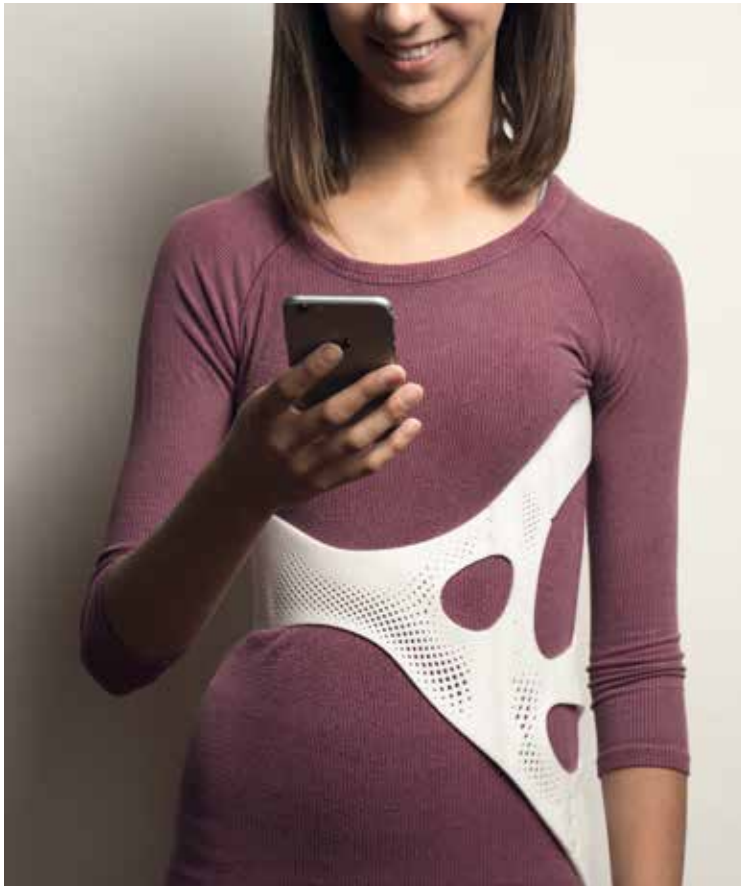




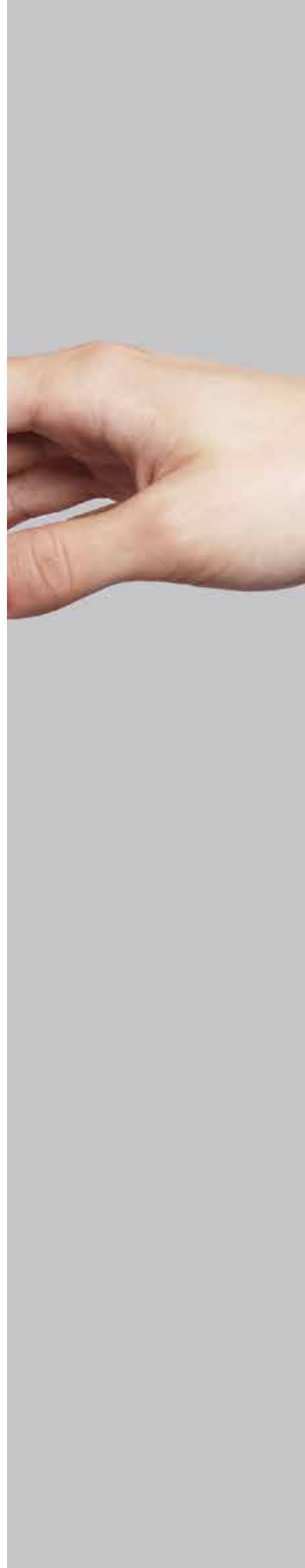
Several brands are already experimenting with mass customisation by handing over a degree of decision-making to buyers. The result is that we have a greater attachment to the things we buy if we feel we have been a part of their production. If they are made by us, or just for us, it is likely that we will look after them better, too.

Nike allows its customers to design their own shoes, trainers and bags. People select a sport, colour and style, and use the NIKEiD builder to customise their purchase.





Studio Bitonti has designed a stylish, “breathable” and personal back-brace for the millions of people around the world diagnosed with scoliosis, the abnormal twisting of the spine. The Boston Brace is a lightweight 3D-printed brace that uses 75 percent less material than its predecessor, can be personalised and provides the necessary support, more comfort and better manoeuvrability to people with scoliosis.







The Post-Couture Collective by Martijn van Strien enables people to adjust their garment designs online to the exact size and length specifications before it is downloaded and cut locally.

# Manufacturing services: Design democracy

**You don't need to be a designer today to create your own furniture or clothing. An increasing number of us have access to the requisite knowledge and tools to design our own objects – and, if you want to have it made, an increasing number of companies offer customisable manufacturing as a service.**

Sculpteo is a digital manufacturing factory that developed the first metal 3D-printing service, presenting a fully functional 3D-printed bike at CES 2017. Developments in 3D printing mean it is easy to imagine a wide range of consumer goods being 3D-printed locally in the future, saving time, energy and money.





i.materialise is an online 3D-printing service that allows people to upload their designs and have them printed in anything from titanium to colourful ceramics, polyamide to 18K gold. This 3D-printed award-winning lamp was designed by Janne Kytta-  
nen and received a Red Dot Design Award in 2005. It is part of the permanent collection at the Museum of Arts and Design in New York.



Production is no longer in the hands of big organisations, behind closed doors, away from customers. Multiple companies offer manufacturing as a service. Some companies service amateurs and makers, some target design professionals, while others prototype, product engineer and manufacture for Fortune 500 companies. What unifies them is that they turn ideas into physical products as a service.



Adidas opened a pop-up shop in Berlin where people could walk in, get a 3D body scan, and have a merino-wool sweater knitted to their size and colour specifications, and washed, dried and ready to go, for €200.







# The shop as a factory: In store, on demand



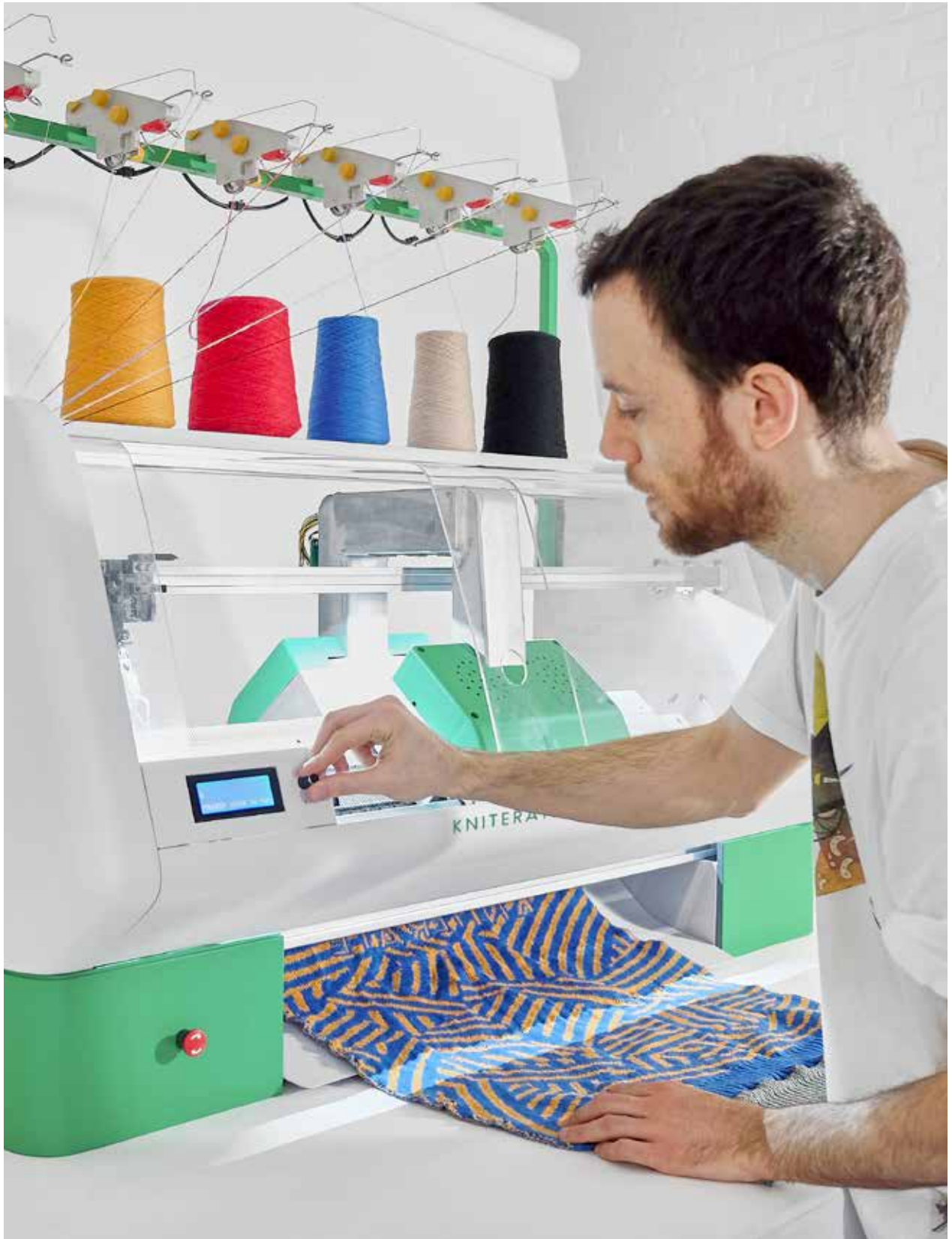
Existing brands and new businesses are bringing production to the retail space, creating in-store micro-factories, where products can be made on-demand. This enables them to make exactly what's wanted, when it's wanted. It reduces waste materials and stock, costs for transport, storage and shipping, and consequent carbon emissions, too.



Unto This Last is a contemporary workshop in London that sells furniture made using computer-controlled cutting tools. Shifting the economic model of scale, it uses digital fabrication to allow local craftsmen to produce made-to-measure, hand-finished furniture at mass-production prices.







Kniterate is a compact digital knitting machine that brings fashion fabrication into small businesses and design studios, workshops, makerspaces and schools. At the click of a button, it allows users to take a digital design and knit it into a wearable fabric.



**EXPERT VIEW:**

# **Democratising Design**



**Mickey McManus is a pioneer in the fields of collaborative innovation, pervasive computing, human-centred design and education. He is a principal of MAYA Design and a visiting research fellow at the Autodesk multinational design, engineering and entertainment software corporation.**

Connectivity is getting cheaper and computing is getting cheaper to embed. A 12-year-old can design a circuit and make something run virtually on a web page. Until recently, only big companies could do this. Similarly, only big companies could make a mould or use a computer to CNC materials, too. Today, students and startups have access to tools that used to cost tens of thousands of dollars, the same tools used by people who design Tesla cars and Nike shoes. You don't need 10,000 engineers any more. Historically, only very few large companies were able to deal with complex systems; now, individuals can make complex projects. This is enabling not only the maker movement but also the connected maker movement.

Against this backdrop, there is a lot of corporate inertia and past dependency: "We've done it this way for so long." It's hard to unlearn things, and any change is hard for big companies; it feels safer to stand on the sidelines and watch with the attitude: "I'll get in when everyone else figures it out." We all need to get in now and be part of the flow: it's hard to learn from the sidelines.

When the internet revolution happened, people tried pilots and the value of learning was immeasurable – it was done so fast. Cheap, fast learning has a huge influence. Today, manufacturers will realise it's not about making money but about having influence tomorrow. Our mission is to run right over the horizon and see how it looks: but not to run on our own, to run with other people. And from that place, we think and learn: What can we put in place to make it easier to get to this beautiful future?

**"Today, students and startups have access to tools that used to cost tens of thousands of dollars, the same tools used by people who design Tesla cars and Nike shoes"**

03





# POWER TO THE PEOPLE: THE IRRESISTIBLE RISE OF THE MAKER MOVEMENT

There was a time when, for good reasons, industrial-grade machines could be found only in professional workshops and factories. That game has changed in the past decade with the rapid expansion of open workshops around the world. These spaces offer people access to software, technical support, education, shared learning and advanced state-of-the-art machinery. Whether called makerspaces, Fab Labs or hackerspaces, they increasingly enable almost anyone to make almost anything.

While DIY (Do-It-Yourself) culture has long been an option for the thrifty, the emergence of user-friendly 3D-design software and digital fabrication tools has taken “making” to a whole new level.



The so-called maker movement is an umbrella term for a new generation of hackers, artisans, designers, artists and entrepreneurs, who are all part of the rise of a worldwide technology-enabled extension of DIY culture. Makers are now empowered to entirely design, model and fabricate what they want themselves.

The maker movement is in full swing and goes far beyond the physical world, fostering thriving online communities. Instructables.com, for example, is one of the larger maker communities online, attracting 30 million people every month. Makers organise physical fairs and maker events: Maker Faire launched in 2006 in San Mateo, California, and has attracted 2.3 million attendees. There are now over 150 Maker Faires around the world.



According to a Royal Society of Arts report, the increased popularity of maker-spaces, physical and digital, goes deeper than making simply being currently “in fashion” or down to economic necessity: “The maker movement is a reaction to significant technological upheaval and indicative of a desire among people to have more control over their lives – as workers, consumers and citizens. The act of making is one means of regaining mastery over technology – not just because it enables us to be more self-reliant but also because it can boost our sense of agency.”









**“Small and medium-size enterprises will flourish in this new era of manufacturing, and global companies will increasingly metamorphose from primary producers and distributors to aggregators. In the new economic era, their role will be to coordinate and manage the multiple networks that move commerce and trade across the value chain”**

Jeremy Rifkin, Economist

# Designer, maker, retailer: A coherent chain

In the overall industrial landscape, the impact of the maker movement is still very marginal. But as new technologies, new funding mechanisms and new distribution platforms become more and more accessible, and more and more efficient, its potential increases as fast as the movement grows. Digital fabrication is opening the doors of manufacturing to almost everyone, and increasing the possibility for goods to be produced locally by people themselves or local makers. It also enables small agile companies to move into areas of production that were previously the exclusive domain of large corporations.

The world is “on the verge of a consumer-driven entrepreneurial revolution that could provide as many relative benefits as the industrial revolution did in the 19th century,” says Iain Murray of the Competitive Enterprise Institute.

The internet has dramatically shortened the distance from producer to consumer, making it feasible to connect them directly and sell small-batch, locally produced items online. This means individuals and

small companies today can prototype, design, make, market and connect directly with customers. We are starting to see how these new technologies could disrupt top-down business models by transforming the way we make and distribute goods.

Even funding product development and setting up production is being disrupted by crowdfunding platforms such as Kickstarter, Indiegogo, GoFundMe and RocketHub. Small players get proof-of-concept and pre-production financing directly from prospective buyers, making it possible to enter the field, sometimes with nothing more than a good idea.



# The Fab City movement: Connected and self-sufficient

Fabrication laboratories (Fab Labs) are similar to makerspaces with one significant difference: they are connected and share the same space requirements, tools, software and curriculum, creating a standardised global community. The programme is building a connected laboratory across the planet for research and invention.

There are today about 1,200 Fab Labs located in more than 80 countries. Initiatives include developing solar- and wind-powered turbines, thin-client computers and wireless data networks, analytical instrumentation for agriculture and healthcare, custom housing, and rapid prototyping of rapid-prototyping machines. From community-based labs to advanced research centres, Fab Labs share the goal of democratising access to the tools of technical invention. This community is simultaneously a manufacturing network, a distributed technical education campus and a distributed research laboratory working to digitise fabrication, inventing the next generation of manufacturing and personal fabrication.

“Fab Labs are the cultural agents that will help transform the industrial and fabrication industry. The Fab City project challenges cities and

regions to start building the infrastructure to be locally productive and globally connected. It is not just a city full of Fab Labs. It’s an ecosystem that is varied and coherent,” says Tomas Diez, director of the Fab City Research Lab and Fab Lab Barcelona.

Diez and the Fab City Foundation are spearheading a new urban model, where citizens are not just perceived as consumers but as producers, empowered through technological breakthroughs and access to knowledge and tools, in order to reclaim some means of production and bring manufacturing back to our cities.

The Fab City vision extends beyond industrial production to renewed capacity for cities to feed themselves and produce energy and new materials. It nurtures the idea of locally productive ecosystems, where local communities could fuel a more circular economy towards self-sufficiency.

“We see more than a thousand Fab Labs in almost every major city as a Trojan horse for the circular economy. This taps into the open source movement and is basically transforming everything,” says Diez.







## LET'S BREAK IT DOWN:

The vision is to create a global network of cities that share knowledge and best practices on urban solutions emerging from citizens, companies, educational institutions and governments. It encompasses various strategies, including:

- **An advanced manufacturing ecosystem of local networks of Fab Labs and mid-scale production centres connected to the larger global network of supply chains, sharing knowledge, best practices and projects.**
- **A distributed production of clean energy, in which households and businesses contribute to generate and share power and resources.**
- **An urban network of local food-producing infrastructures at domestic, neighbourhood and city scales, to create a closed-loop system for food production, harvesting and distribution.**
- **A strong emphasis on learning-by-doing and engagements at all levels of education in creating solutions for local needs, through digital fabrication, that can be shared with the global network.**
- **A step into a more circular economy, by reducing the amount of imported goods, and instead increasing the use of recycled raw materials for the local production of objects in cities.**

The Fab City takes the ideals of the Fab Lab – connectivity, culture and creativity – and scales it to the city. It promotes an ecological system of more empowered citizens, where the need for raw materials, the consumption of energy and related carbon emissions is drastically reduced. In order for this to be possible, the city must become locally productive and globally connected. In 2014, Barcelona was the first city to officially commit to becoming self-sufficient within the next 40 years. Today, 12 major cities (including Amsterdam, Boston and Paris) and two countries (Bhutan and Georgia) have made the same commitment by joining the Fab City initiative.



## **The Made Again Challenge: The first Fab City prototype**

SPACE10's mission to investigate new models of circular societies and enable a better life for the many people quickly led us to explore more sustainable alternatives for production and consumption. Inspired by recent developments in digital fabrication, the rise of the maker movement and the vision of self-sufficient cities, we joined forces with the Fab City Research Laboratory and IKEA to conduct an ambitious experiment in Barcelona. Together, in the summer of 2016, we created the largest Fab City prototype to date.

For the Made Again Challenge, we turned the Poblenou district into a one-square-kilometre testbed to explore the potential of making and remaking products collectively, self-sufficiently and within a productive ecosystem of people, places, machines and materials.





Inspired by the local “scrapping” community – people who collect metal scraps from the streets of Barcelona and sell it to be melted down – one group of designers created the Scrap Lab, a new business model under which “scrappers” would collect a wider range of materials and bring them to places where they could get paid.

Despite the model’s marginal value, it represents what the circular economy should be: a local attempt to constantly collect and recycle all materials – some of which are almost cheaper to extract from the trash than from the ground.

As Tomas Diez puts it: “If you have the capacity, skills and infrastructure to make things locally, then you don’t need to have cargo ships delivering materials around the world.” Svend Jacob Pedersen, co-founder of design, architecture and innovation office Spacon & X, adds: “What they’re doing is what the rest of us should learn from.”



We wanted to explore hands-on how to rethink and re-engineer a production system, away from one where we import most things into our cities and export our waste. We wanted to test a more circular model, where all resources flow in a closed-loop system.

We invited biologists, tech professionals, local makers, craftsmen, IKEA designers and other trailblazers from around the world to participate in the Made Again Challenge.





One team sought inspiration from an old Japanese craft and showed how to restore value to damaged furniture. Instead of binding the broken pieces with gold – as was traditionally done with broken plates in Japan – they used sheets of recycled plastic.

They began by creating a model using the broken pieces of a mirror, before producing the shape with a CNC machine, and then joining the pieces together to make a unique product – in this case, new furniture – and demonstrating how waste might become “the raw material of tomorrow”.



The leftover plastic materials from the CNC cutting was collected and reused to create a new chair.



We connected Fab Labs, workspaces and workshops in the same neighbourhood. Digital fabrication tools such as CNC milling machines, 3D printers and laser cutters were made available, together with plastic-recycling stations, wood-working and metalworking tools, a biohacking laboratory, and textile and electronics stations. We collected rubbish, discarded materials and broken furniture from the streets of Barcelona. We gathered inspiring materials – like bioplastics, local wool and bio-resins, and recycled plastic sheets from Smile Plastics – and unique textiles such as Ecoalf, made from plastic found along the Spanish coast, and Piñatex, a leather-like material made from discarded pineapple leaves.

Over the course of five days, the teams worked together, within the boundaries of Poblenou, to give another chance to products and materials that were on their way to the landfill. Much more than an exercise in recycling or upcycling, it turned out to be an exercise in system thinking. During the five days, the participants in the Made Again Challenge operated the first Fab City prototype to demonstrate how productive a neighbourhood can become when its inhabitants are empowered by the knowledge, tools and infrastructure necessary to make and remake products locally and sustainably.



A group of biologists, fungi fanatics, fashion designers and makers created what they called a “bio lab, a bio factory to make biological materials”. The group cultivated living organisms that can digest and biodegrade materials that would otherwise end up in landfill, meaning they could be the basis of new products instead of becoming waste. In theory, local bio-labs could be implemented in individual neighbourhoods and also produce new building materials such as mycelium.



As Ronald Postma, a web designer and entrepreneur at design studio Mamotok, explains: “By integrating bacteria and fungi and insects and plants, we can create a park that decomposes waste and, by choosing the right plants, we have the raw materials for the next products.”

**EXPERT VIEW:**

# Making good



**Ravi Naidoo is the founder and managing director of Interactive Africa, a multidisciplinary Cape Town company that works on projects to promote South Africa. He established Design Indaba, which is recognised as one of the world's leading design platforms, with the flagship Design Indaba Conference and Festival held annually in Cape Town.**



Africans have been making stuff for ever. It's how people live. We had a workshop recently with IKEA and African designers, and we were talking about how this is not a hipster movement here, it's a way of life. You can't get by unless you have the ability to make. Upcycling is standard procedure. Necessity is the mother of invention, and most designers are firmly ensconced in what others would call the maker space.

We don't have heavy-duty manufacturing here. Even pre-eminent designers are not trained to create products that come off a production line. Like Piet Hein Eek in Eindhoven or Tom Dixon in London, these aren't designers working in a studio, but designers on the factory floor, in the workshop, involved in everything from designing to making to distributing to selling. This is increasingly going to be the model for the 21st century: design will not be about getting a commission from a big international company, but about working in the community and taking responsibility for your own projects.

3D printing and rapid prototyping are giving us more scope: they make sophisticated manufacturing more accessible, they bring it to the desktop. All kinds of people here are in the advance guard of using these new skills, from a jewellery designer doing short runs in Cape Town to the makers of components for motor manufacturing. It gives a lot of power to the designer – and managing the whole value chain also gives power to

consumers. These are exciting times: we are looking at seismic change, products going straight from designer to consumer, losing wholesale, retail, all those steps that just add more cost, not more value to the product.

I like the whole fixing movement; I'm particularly fond of Daniel Charny's Fixperts. We are realising we need to fix the old rather than only making the new. One of the most exciting parts of this is that it comes with humility. Designers don't necessarily want to put their fingerprints on projects as star designers: they have realised existing things need new purpose, utility and meaning.

Alejandro Aravena won a standing ovation at Design Indaba: his idea was that people only need half a house, they can complete the other half themselves when resources allow. He took the view that people are essentially makers – how can we help them? There are just not enough resources to go round in places like Africa, India and South America, so you are conservative with those resources. Scarcity is the primary issue here – and, as Alejandro Aravena says, scarcity is a wonderful antidote to arbitrariness.

“Design will not be about  
getting a commission from a big  
international company, but about  
working in the community”

04

# LIVING IN A MATERIAL WORLD: RETHINKING THE BUILDING BLOCKS OF TOMORROW

It's quite simple: the more materials we extract, the fewer are left. Today, we use more materials than the planet can sustainably offer, which means that the supply of raw materials is associated with increasing risks – tied to factors such as price volatility, availability and import dependency.

Researchers and a new generation of innovative companies are bringing solutions and inspiring materials to the market that could rebalance things in the future. Those emerging materials, whether biologically engineered or reclaimed from waste, represent environmentally friendly alternatives to our current supply. The building blocks of design are being rethought.



The Berlin-based studio Crafting Plastics launched an eyewear series called Collection 1. It is made from a plant-based plastic that is strong enough for day-to-day use but will biodegrade safely back to nature when discarded.



# Biodegradable objects: Back to nature

Humans are the only species on Earth that produces waste. Everywhere else in nature a material that has served its purpose – be it from a plant or an animal – decomposes and transforms into nutrients that can be used as building blocks for new plants and animals.

Most man-made products, however, don't work this way. Future archaeologists would discover one massive dumpsite after another filled with plastic and metal objects, electronics, synthetic textiles and other waste materials of our time.

If the twentieth century was the century of physics, the twenty-first century could be the century of biology. Biological technologies are advancing rapidly, and several companies are starting to add principles of nature to the way they design products.

We would never inherit a toothbrush from our parents, but still most toothbrushes are made from a material that lasts 12 generations before it degrades. Plastic has become the workhorse material of the modern economy, because of its unmatched functionality and low cost. We use it to make everything from single-use cups to fast-food containers to toilet brushes. Bogobrush has introduced a biodegradable toothbrush that you can throw on your compost pile after it has worn out. It is made of plant-based bioplastic that will safely return to nature.



# BIO DEGRAD ABLES

Kuskua Bi is a 100 percent bioplastic chair made by Jean Louis Iratzoki for Alki. The goal was to create a comfortable chair without using traditional, environmentally polluting materials. Made of polymers similar to plastic, bioplastic is made from 100 percent plant-based renewable resources such as corn starch, sugarcane and beets. Fully recyclable, it doesn't leave a heavy footprint on the planet and is biodegradable.





# Waste as a resource: Good from bad

Most of the materials we use can actually be mined from what we have already disposed of. A growing number of forward-thinking companies and designers are taking “recycling” to another level. They have embraced the idea of stepping away from mining the planet of its depleting resources, and have instead found ways of mining our waste to recreate the raw material they need. Whether for environmental reasons or because it has already become cheaper to do so for some materials, it is more than just recycling. It is about designing products in different ways, and designing supply chains that can support more ecological industries. And we have plenty of materials, if we can figure out how to harness those resources at larger scales.

IKEA's 2017 line of no-waste products includes seating, vases and kitchen cabinets, all made of recycled materials. Materials include recycled plastic bottles, wood and glass. The brand hopes people will come to see waste "not as garbage, but as just another material that can be used in creating new and beautiful things". IKEA's aim is that all materials in its furniture, including packaging, will be made from renewable, recyclable or recycled materials.





Piñatex by Ananas Anam is a sustainable alternative to leather made from pineapple leaf fibres. Piñatex fibres are the by-product of the pineapple harvest, which means no extra land, water, fertilisers or pesticides are required to produce the raw material. Given the extensive environmental and ethical concerns about cattle farming and leather tanning, there is an enormous opening in the market for alternative materials, which to date have tended to be filled by plastics and synthetic textiles. With Piñatex, Ananas Anam aims to create closed-loop processes in which natural waste serves as an input, with a positive environmental and social impact.



Solid Textile Board is a high-density material made from end-of-life textiles and cut-offs from Kvadrat. The board is designed to replace or even add to existing material offerings and to prolong the lifespan of textile resources by using materials that would otherwise be thrown out.



Adidas has teamed up with environmental organisation Parley for the Oceans to transform the oceans' plastic waste into running shoes. Each pair of shoes contains the plastic of 11 bottles.



**EXPERT VIEW:**

# **Embedded sustainability**



**Nanette Weisdal is the  
manager of the Sustainability  
Range at IKEA.**



We have some unique opportunities as a large company to drive change. It has always been important for us not only to minimise waste but also to use it as a resource. Our founder, Ingvar Kamprad, wrote back in 1976 that “wasting resources is one of the greatest diseases of mankind”, so we see sustainability both as a matter of responsibility and as a good business opportunity.

This is one of the main reasons why IKEA is so successful today. We started with a vision of creating a well-designed life for everyone, not just those who could afford designer furniture. This meant we had to reduce costs at every turn to make our products affordable for as many people as possible. A key component in keeping prices down was to make the best use of resources, which means we have always had a relentless focus on being innovative when it comes to sustainability.

We have the muscles to drive change in our entire supply chain. We don't just close our eyes and ask no questions – we are right down there with our suppliers on the factory floor, and each year we make plans together to improve. We have the expertise and the power to push for change towards more and more sustainable production and material use.

Today, 100 percent of IKEA cotton comes from sustainable sources, which has been a huge accomplishment. Cotton is a very thirsty crop, often grown in water-scarce areas. We use a lot of cotton, so 10 years ago we began teaching farmers how to reduce the amount of water they use, as well as reducing fertilisers and pesticides, which were not only bad for the environment, but also very expensive for the farmers. Together with WWF and others, we developed the

Better Cotton Initiative, setting international standards for sustainable cotton, and our large scale has again been the enabler to make this change which has impacted the whole industry.

We can really make a change. IKEA is obviously deeply indebted to wood, and today we use almost 1 percent of all commercial wood in the world – yet IKEA will have an overall positive effect on the world's forests, by growing more trees than we use by 2020. IKEA has invested over \$2bn in solar- and wind-energy projects, in order to tackle climate change by producing more clean energy than we use.

We are taking it one step further by taking the lead in developing and promoting products and solutions that help people save or generate energy, reduce or sort waste, use less water or recycle it: all at the lowest possible price. Take the LED light bulb as an example. We invested in LED lighting technology when it was three times more expensive than incandescent or fluorescent bulbs – but because of our size, resources and knowledge, we could make LED just as affordable as any other light source. Then we switched our entire lighting range to energy-efficient LED bulbs, and sold 79 million of them in one year. If each bulb replaced an existing incandescent one, it would save enough energy to power almost 650,000 households.

It is the small decisions throughout the design process and in production that make a big impact in the long run. Making the decision to choose colours for prints that are least environmentally damaging, and eliminating the use of chemical brighteners, can still mean a bright future ahead!

**“It is the small decisions  
throughout the design process  
and in production that make a big  
impact in the long run”**

One of the research initiatives pioneering this innovation is the Growing Lab, headed by Maurizio Montalti / Officina Corpuscoli. It is an ongoing design-research project, actively engaging in exploring and assessing methodologies for the implementation of mycelium as the main agent for the development of novel materials, processes and products.



# Magic mushrooms: A natural alternative

Even if we recycled 100 percent of today's waste, given our projected population growth, we would still need to extract the same amount of finite materials in the next decade. We are forced to find new types of more sustainable materials.

One of the most promising hopes in the sustainability field is artificial biosynthesis, a process whereby living organisms, such as bacteria, fungi or plants, are used to create fuels, chemicals and other materials.

Mushroom "roots" – better known as mycelium – may prove to be crucial for mankind. Indeed, mycelium could become one of the innovative building blocks of tomorrow. It is an attractive alternative to current materials because mushrooms are fast growing, high performing and cost competitive, while the material is energy efficient, rapidly renewable and 100 percent organic, and can be stronger than concrete. Moreover, mycelium-based materials are fully compostable and can be freely disposed in nature, easily breaking down into nutrients that in turn offer new life for materials.

Researchers, startups and large companies are exploring how mycelium can become the design and building material of tomorrow, potentially replacing everything from cups and containers at fast-food restaurants to leather goods, packaging, furniture, tableware and maybe even entire buildings.



Ecovative is a company pioneering mycelium technology, by growing high-performance, award-winning biomaterials out of mushrooms. The materials are safe, healthy and certified sustainable.

Packaging is a necessary evil in many consumer categories, but Ecovative has designed a new form of packaging in mycelium. It offers an alternative to traditional plastics and synthetic packaging, and is cheap, plentiful and easy to grow.



Ecovative has introduced a “mushroom material” that looks like any other particle board, but is cheaper, lighter, stronger and 100 percent organic, and compostable when it reaches the end of its life.



#### LET'S BREAK IT DOWN:

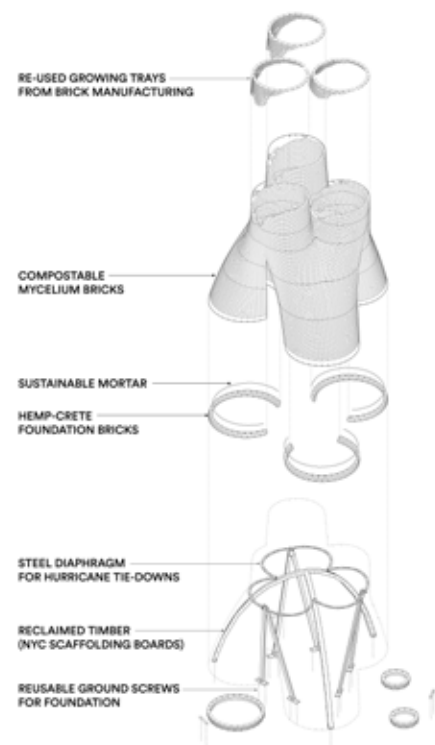
- Mushroom “roots” are made of mycelium, a fungus that wraps itself extremely tightly around anything that gets in its way.
- Inject it into any crop waste, such as rice husks or corn stalks, and it quickly digests any available lignin and anything else left over.
- The outcome is a strong, novel material that is high-performing, cost-competitive and 100 percent biodegradable.
- Mycelium grows underground in the absence of light, which means it requires no external energy source to work its magic.





Ecovative helped build the winning entry for the MoMA PS1 Young Architects Program in 2014. The Tower was designed by David Benjamin, principal of The Living, using low-value farm-crop waste, which was packed into moulds and injected with mycelium. This created light-weight, low-cost organic bricks that grew in five days, with no waste, no input of energy and no carbon emissions. The resulting pavilion was entirely compostable.

Ecovative has also developed an insulation material that outperforms traditional fibreglass. It can be injected between an interior and an exterior wall, where it will grow silently in the dark and become so strong that the wall will need no internal metal or wooden studs to support it. If that weren't enough, mycelium is also water-resistant, mould-resistant and fire-resistant. It can even be engineered to repel or destroy invasive pests such as carpenter ants, fire ants and termites.



**EXPERT VIEW:**

# **Biomaterials**



**Philip Ross is the cofounder and CTO of MycoWorks, a San Francisco-based company that grows leather-like biomaterials out of mycelium. He is an artist, inventor and entrepreneur, and visiting scholar at Stanford University.**



The majority of our material-generating complex industry is dependent on petroleum as an energy source, as well as the means of material production: plastics, synthetic polymers, all sorts of things. The price of this is not tenable to support how we're living. That's the bottom line.

As energy becomes more expensive, materials will become more expensive. This will not go away, so we have to create commodities that are not based on a fluctuating variable. How do we continue to create cheap resources that can supply everybody on the planet?

This is where mushrooms come in. They work through decomposition; there is continual generation of organic matter. We can guarantee it. We can look at that and call it garbage, but it is a resource that can provide for us: it is potentially your food, your house, even your jacket. There is not so much a crisis of materials, but of how we think about them, organise them and use them. We grow corn but we only eat 3 to 10 percent of the plant we've grown. Why not use that other 90 percent?

This is being taken seriously at the highest levels of academia and government: we can make more, and use less material, and recycle. All the pieces are in place. Making mushroom-generated materials is not so very different from growing food, and the

processes we use, such as pasteurisation, are globally distributed. People grow crops all over the planet, people grow mushrooms all over the planet.

You hear a lot about ideas that might happen in 10 years' time but this stuff is here – it can grow now. At least three other companies have already started up around the planet and there will be others – this is part of a wave.

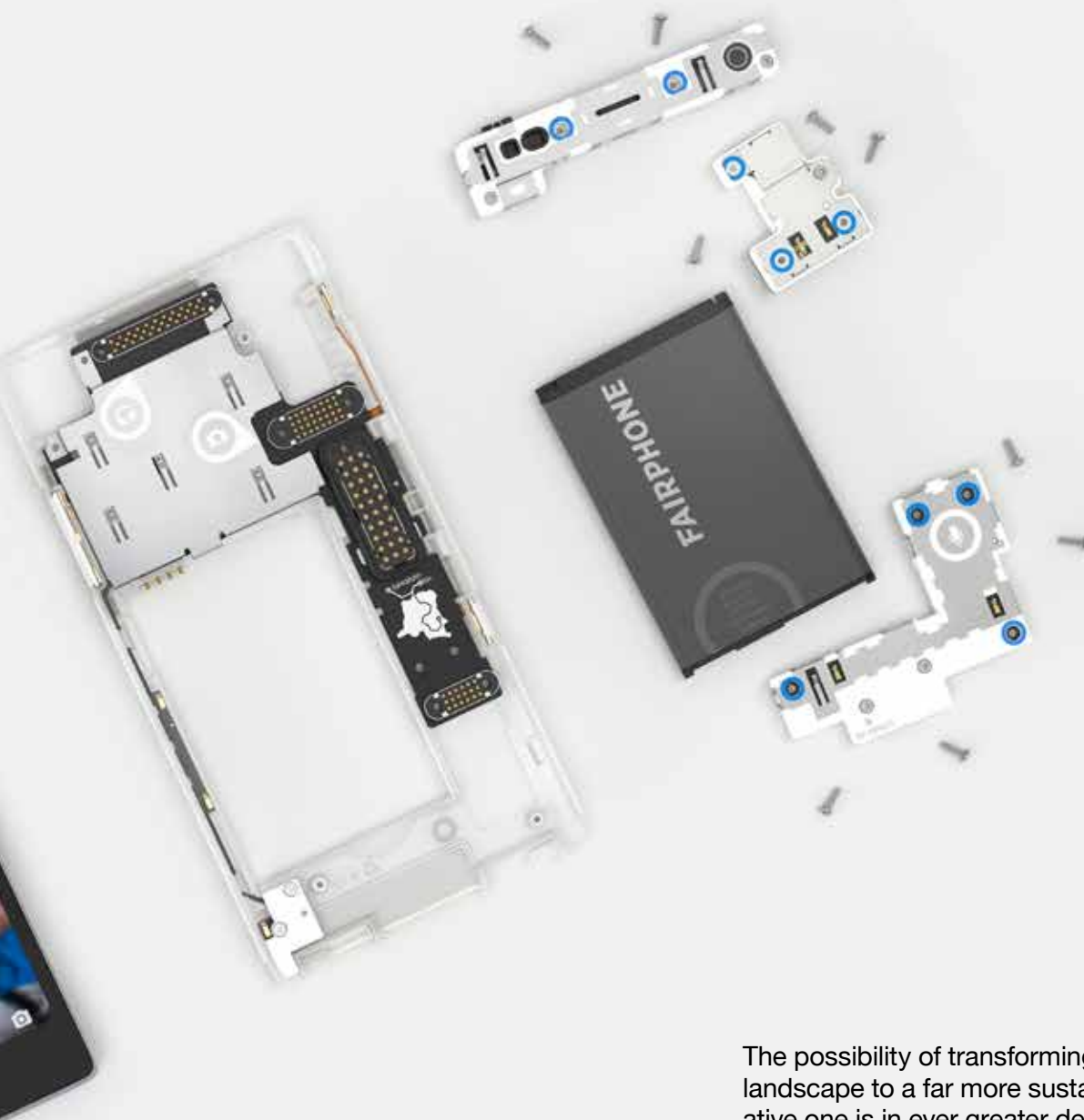
The biggest restrictions are not technical; they are financial and legal. Petroleum byproducts are underwritten by huge investments, so there's no way a small startup can compete in that arena. There is no replacement for polystyrene in terms of cost, for example. However, when restrictions are put on materials known to be toxic and they are banned, businesses respond very rapidly because they can't sell their products. So they find alternatives. Northern Europe has active laws about materials that are organic and recyclable; companies have developed new technologies and are in a great position to sell them to the rest of the world. We need to set the course of how to be right. Then industry will fall into line.

“There is not so much a crisis of materials, but of how we think about them, organise them and use them”

# THE BUSINESS OF TOMORROW: LEADING BY EXAMPLE

05





Fairphone is on a mission to open up the smartphone supply chain and trace materials back to their source. It launched an ethically minded device in 2013, and keeps pushing for a truly fair-trade smartphone. Its latest Fairphone is built around an innovative modular architecture that enables subsystems to be easily repaired and replaced. That allows the company to make phones that last longer and provide a much stronger sense of ownership.

The possibility of transforming our production landscape to a far more sustainable and restorative one is in ever greater demand. A rising number of people aspire to consume differently and wish to drive positive change through their purchases. Still more are embracing a new role as custodians – buying into products that last, and thinking in terms of conserving, husbanding, upcycling, reusing and passing resources on. Mindsets around ownership are shifting, too.

Brands driven by purpose and values stand out today, and people increasingly tend to reward the purveyors of ethically, socially and environmentally sound brands with loyalty. In response, this is fostering a new generation of companies with concepts that favour longer product life, less ownership, more sharing and increased opportunities for “second life” through repair and resale.





Patagonia is one example of a brand that has built its reputation on high-quality, sustainably produced outdoor gear: “We have found, as we invest in sustainability, that we are rewarded by our customers, who continue to support the brand sufficiently that we continue to be very healthy as a business,” says Rick Ridgeway, vice president of public engagement.

**“There is an increased knowledge that we need to make our things last longer in order to reduce material consumption”**

**Per Bolund, Sweden’s Minister  
for Financial Markets and  
Consumer Affairs**

## Repairability: Good for business

The assumption has been floating around for a while that many items are deliberately conceived with built-in obsolescence, encouraging us to replace them. Whether this is the case or whether it is more a natural consequence of a fast-paced consumption pattern is difficult to answer. In any case, more brands and retailers are introducing a more circular approach by providing increased opportunities for repair.

While designing for repair has historically come naturally to some industries (such as automotives), other industries such as electronics have a hazier approach. iFixit’s repairability score indicates how well a

given electronics product lends itself to being repaired – and it varies greatly across the industry, even within individual brands’ product ranges.

There is a business opportunity here. Companies that focus on product-life extension can create new revenue streams through repair, modularity, upgrade and maintenance services.

In certain countries, repairability is becoming a matter of public policy. In France, manufacturers not only have to indicate how long appliances should last, they also have to tell customers how long spare parts will be available for. Similarly, Sweden has implemented a law that ensures tax breaks on repairs to various goods.

#### FAIRPHONE 2.0

Modular components which can be removed with one screwdriver. Disassembly instructions are printed on the phone, making this the high scorer.

HIGH  
REPAIRABILITY  
SCORE

iFixit rates phones based on how easily they can be taken apart. Points are added for modular designs, removable batteries, standard screw types and easy-to-replace screens. Points are docked for excessive adhesive, soldered components and complex opening procedures.



10



#### LG G5

A user-removable battery and modular components make this one of the most repairable phones.

8



#### APPLE IPHONE 7 / PLUS

Battery and screen replacements are straightforward, but taking apart the iPhone 7 requires four different screwdrivers.

7



#### GOOGLE PIXEL/XL

Most internal components are modular, but the phones are difficult to open without breaking them.

7



#### SAMSUNG GALAXY S8+

Some modular components, but the phone is a glass and glue sandwich – making opening and repair very difficult.

4



#### AMAZON FIRE

Getting inside is straightforward, but it lacks modularity and its cameras are encased in glue.

2



#### HTC ONE

The solid external construction increases durability, but it's impossible to open without breaking, and the battery is inaccessible.

1

LOW  
REPAIRABILITY  
SCORE





**“Repair is a radical act. We work hard to make high-quality, responsibly sourced clothing that lasts for years and can be repaired – and we guarantee it for life. We operate the largest garment repair facility in North America and we’ve trained our retail staff to handle the simple repair jobs... We ask our customers to use the tools we provide to decrease the environmental impact of their stuff over time by repairing it, finding ways to reuse it, recycling it when it’s truly ready”**

Rose Marcario, CEO of Patagonia

## **Goods that last: Repair is a radical act**

It may seem like an unlikely policy for manufacturers whose main aim is to sell products. But studies verify that it makes commercial sense in terms of attracting interest, customer loyalty, consumer confidence and word-of-mouth recommendations.

Buymeonce.com taps into the desire both for manufacturers that can be trusted and for products that last. It recommends items such as clothing, homewares and toys that “don’t break the bank, don’t break the planet... that don’t break at all! We also challenge manufacturers to break their habits and build stuff that really lasts – we know they can.”

Businesses that favour a longer product life and offer products labelled as long-lasting enjoy a significant boost in sales:

41%

Smartphones

70%

Printers

128%

Luggage







# Second life: Taking and giving back

H&M was the first fashion company to launch a garment collection initiative and has, since 2013, gathered over 25,000 tonnes of garments. Some are repurposed or recycled, while others are sold as second-hand clothes. For World Recycle Week in April 2016 alone, the company aimed to gather 1,000 tonnes of second-hand items.

Take-back strategies, recycling and giving a second life to products that otherwise would be wasted enables companies to sell the same product again and again. It's a way of gaining new resources and offering new repairs, upgrades and maintenance services to create additional value out of products that have already been sold. This is good both for businesses and for the planet.



**EXPERT VIEW:**

# **Designs for many lives**



**Rebecca Earley is professor of sustainable textile and fashion design at Chelsea College of Arts and director of the Textile Futures Research Centre at University of the Arts London.**

People understand recycling. It's easy to respond to. The barrier used to be technology and material flow – literally nothing changed in recycling for about 100 years. There were no new developments, no new service methods, simply shoddy down-cycling or incineration. Now there's a flood of entrepreneurialism around it, driven by the rise in cotton and oil prices.

The next big opportunity is bringing the consumer in. Without consumers, the circular economy can't work: we need people not only to buy, but to bring back. They have to understand that circular works for them. What we need to start doing with communications in brands, and more broadly in media, is designing and visualising a different cycle. People can still have products, but we need more services to achieve a coherent, circular flow.

The biggest opportunity is to enable people to be part of building or rebuilding their own economy locally. The growth in the maker economy, and more localised, democratic processes, means we can have local regeneration and manufacturing hubs that will bring local benefits: not shipping stuff to China to be reprocessed, and then buying it back.

It could be part of our weekly routine to send our stuff somewhere that benefits us locally, whether that's through remanufacturing, repurposing or recycling. I believe the future lies in helping develop products, mindsets and services that will make us more self-sufficient. Behaviours, mindsets and habits will be the most radical part of the

circular economy: people will become both happier and richer when they are involved in recycling. We'll see the Airbnb equivalent for wardrobes, repair cafés will grow, as will fashion libraries, mending services, making services. These circular behaviours will save money, we'll have original products, and it will make us feel good. Some of the most exciting research is on our brains: recycling and reclaiming are correlated with a sense of wellbeing.

For high-volume high-street stores, as well as recycled fibres, bring-back centres would be one way to go. You go out with a bag as well as coming back with one! And perhaps come back with fewer but more considered items, and keep stuff moving instead of hoarding.

I can see us living differently in 10 years' time, but at the moment, the intention-behaviour gap is huge. Until we see some well-priced alternatives, economic and time pressures mean people won't change their buying habits. Incentives and legality are the biggest behaviour changers: you either encourage something or you ban it.

**“Behaviours, mindsets and habits will be the most radical part of the circular economy: people will become both happier and richer when they are involved in recycling”**





An aerial photograph of a vast tea plantation. The tea bushes are planted in dense, concentric, wavy rows that follow the contours of the land, creating a hypnotic, maze-like pattern. The color of the tea leaves is a deep, vibrant green. In the lower-left corner, a small cluster of trees and a dirt path are visible, providing a sense of scale. The overall image conveys a sense of harmony and sustainable land use.

# CLOSING THE LOOP: WELCOME TO THE CIRCULAR ECONOMY

Our current industrial system was developed when humans had a very different sense of the world. A world of “unlimited” natural resources, fuelled by cheap energy and sustained by easy transportation. We remained ignorant of the impact of our ways of production and consumption on climate change. But as we realise the real price of that model and its threat to life on Earth, we are forced to recognise that our industrial system is reaching its physical limits.

## Circular economy

The idea of the circular economy is gaining a lot of traction. It has many different aspects, but each one promotes a radical shift in how we consider and use materials, design products and conduct business. The circular economy promotes a production system as an ecosphere that can run indefinitely, because all our goods are perceived as nutrients that can be fed back into the cycle instead of becoming waste. Instead of taking more than we have, we would give more than we need.

The backbone of the system is a renewable energy supply because it powers everything. Products would be designed in a way so that they are “made to be made again”, or can

safely re-enter the biosphere and become nutrients for new products.

As a result, companies would be less vulnerable to risks involved in acquiring raw materials. They would drive greater resource productivity, be energy independent and reduce waste. The result is that we could position our economy to better address emerging resource security and tackle climate change significantly at the same time.

**“The driver of the circular economy isn’t scarcity, it’s opportunity. By keeping resources economically productive for as long as possible, companies can achieve greater growth. Most companies have waste hotwired into their existing ways of doing business, and it will take many steps for most to turn waste into wealth. But those who get there first will achieve circular advantage that differentiates them in their market”**

Peter Lacy, managing director for growth, strategy and sustainability, Accenture Strategy



## LET'S BREAK IT DOWN:

1

A circular supply chain allows materials to be sourced over and over, either being fully renewable, recyclable or disassembled and easily re-used with a different purpose. This saves money and protects companies from the volatility of raw materials prices.

2

Sharing platforms maximise the use of underused assets and enable companies to create additional value out of products that have already been sold.

3

Replacing ownership-based models with lease or pay-for-use arrangements can increase margins, enable new revenue streams and make a product more accessible for more people. We can recapture residual value at the end of a product's life and make it a good business to design quality products that last longer.

4

Recovery and recycling leverages technological innovations and capabilities to recover and reuse waste to turn it into resources. Some major companies already reuse 100 percent of waste at certain manufacturing sites.

5

Giving a second life to products that would otherwise be wasted enables companies to sell the same product again and again, or to offer new repair, upgrade and maintenance services.



# Bye-bye buying: Why own when you can lease?



VIGGA is a Danish brand that enables parents to lease organic maternity and children's wear. The business idea is based on a need that most people recognise – that babies quickly outgrow their clothes, which is both expensive and a huge waste of resources. With VIGGA, parents receive a bag of clothes a week before their baby's birth, and when the clothes become too small they are sent back to VIGGA, and a new collection in the next size up arrives. This saves time, money and resources.





Thousands of buildings in the Netherlands lie vacant. Some remain empty for weeks, months, even years. At the Venice Architecture Biennale 2010, the Netherlands Architecture Institute and RAAAF highlighted the huge potential of temporarily unoccupied buildings in Amsterdam, with a strikingly visual foam installation.

# Idle resources: Maximising what is already there

People across the world are choosing to share, trade or lease everything from homes and vehicles to finance and skills, using the internet as a platform to connect with peers. Agile new companies find novel ways to create tremendous value out of things that have already been made and sold. These are business models that don't depend on finite resources. The so-called "sharing" economy is projected to be worth \$335bn by 2025, including peer-to-peer lending and crowdfunding, online staffing, car sharing and peer-to-peer accommodation.



Besides household names such as Uber and Airbnb, the so-called “sharing” economy landscape is blooming with services across many walks of life, each maximising the use of space and goods that are already there. When SPACE10 organised a pop-up in New York, we used Appear Here – an online marketplace for short-term rentals of vacant stores and spaces.

Appear Here connects commercial landlords who temporarily have space available, with brands, retailers and entrepreneurs who want to hire retail space for short-term projects such as pop-up shops, product launches and brand showcases. It helps bring empty pockets of our cities back to life.



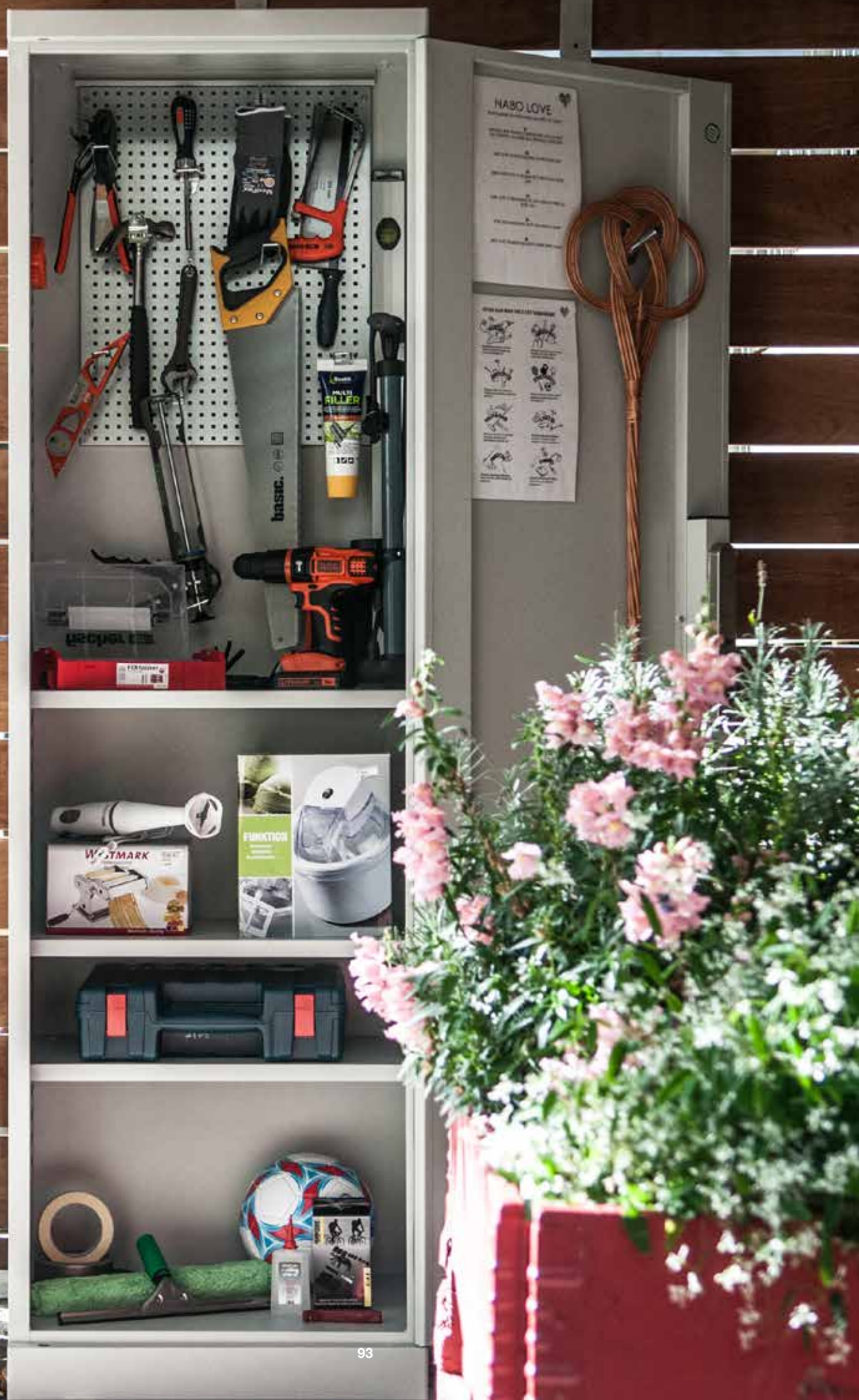
Popping up in several countries, tool libraries are places where you can borrow an extensive range of everyday and specialist tools rather than have your own dust-covered drill for that once-a-year job.

Sharing can make life more affordable, but thrift is not the only factor. Sharing allows us to forge new relationships across both physical and digital communities. It promotes a collaborative “we”-based culture over a “me”-based culture. Sharing connects people on all levels, from local individuals to the wider neighbourhood, and between different communities across the world, too.

Fon is the world's largest Wi-Fi-sharing network. The premise is pretty straightforward: with a compatible router, you can share your connectivity with others and, in exchange, receive access to Wi-Fi when you're out and about. This brings digital connectivity to locations all over the world.









**EXPERT VIEW:**

# **The circular economy**



**Joe Murphy manages the Circular Economy 100 business network at the Ellen MacArthur Foundation, which works with businesses, governments and academia to accelerate the transition towards the circular economy.**

The circular model is not just an idea or a nice story, it's backed up by hard analytics: the World Economic Forum and the United Nations have already picked this up, and we have worked with the likes of McKinsey. The economic narrative differentiates the circular model from other sustainability models: it has to pay, otherwise it will never take off.

This isn't about altruism. Let's suppose you are a textile manager, for example. You have to buy materials and dyes. You put your products on the shelf and sell them. Suppose you implement a take-back scheme and get back a bunch of textiles. If you can feed those back into your supply chain, you don't need to buy as much virgin material, you can sell your product again and generate more revenue from the same material.

In principle the idea is simple. The reality of the way we live, work, make and use things is really complex: our economy is a complex system. Shifting some of those simple principles into the real world requires innovation, creativity, new ways of solving problems, new ways of thinking about problems and new ways of working.

Big businesses are highly optimised and organised to deliver on their goals of producing and selling a product or service. There is a legacy of materials and technology that have been invested in, and also the way the business is structured and organised. Shifting that structure is not easy; you can't just drop tools, there has to be a transition element.

Relying on users of products – on consumers – to solve this problem through their purchasing power or purchasing decisions in my opinion is not the right way. It's very difficult to change or incentivise people's behaviour to effect systemic change. You need to design the system around people to be more effective in the way that system operates.

A more attractive proposition would be to rely on the business to look at how it creates and perceives value. For example: the opportunities to create a longer-term relationship with customers. It requires taking a holistic view of how you perceive value, a long-term view – thinking about your role as a business and not fixating on the traditional way of earning revenue, which is selling products to customers.

**“You need to design the system around people to be more effective in the way that system operates”**

## FINAL THOUGHT

# Imagination and action: Where do we go from here?

We know that transforming our consumption-oriented economic system into a self-sustaining society is one of the biggest creative challenges of our time. It requires a lot of innovation and commitment from a lot of people. This is not going to happen overnight.

There is significant evidence to suggest that if we transform our production system to a circular one, the benefits would be far-reaching in so many ways. We would not only help reduce the environmental impact of our production and consumption, but also create new opportunities for businesses, jobs and economic growth. We could reduce our dependence on the global movement of materials and products, and reduce our reliance on dirty energy. Sustainable materials could be grown and produced locally. Products could be made within our cities, which would encourage community-focused neighbourhoods.

The combined results would position our world economy to better address climate change and our increasing lack of natural resources. As with any system that relies on experimentation to find solutions, an enormous number of unforeseen challenges are inevitable, but the pioneers of today will be the market leaders of tomorrow.

This exciting new future of fabrication won't come into full force tomorrow, or next week, or even next year. But with imagination, ambition and collaboration, there are opportunities ahead of us to rebalance our relationship with our planet and reshape our global society, and to create a better future.





**“The need for true innovation has never been more profound than now. We are capable of creating high-quality circular alternatives which are beneficial for humans and nature. If the future can be positive, why choose differently?”**

Michael Braungart, CEO and scientific  
director of EPEA Internationale Umweltforschung



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