RSA
Action and Research Centre

Ours to Master

How makerspaces can help us master technology for a more human end

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About the RSA

The RSA (Royal Society for the encouragement of Arts, Manufactures and Commerce) believes that everyone should have the freedom and power to turn their ideas into reality – we call this the Power to Create. Through our ideas, research and 27,000-strong Fellowship, we seek to realise a society where creative power is distributed, where concentrations of power are confronted, and where creative values are nurtured. The RSA Action and Research Centre combines practical experimentation with rigorous research to achieve these goals.

Acknowledgements

This report is about our relationship with technology, and the potential for makerspaces to deepen this relationship.

Executive summary

Makerspaces are open access workshops hosting a variety of new and old tools – from 3D printers and laser cutters through to sewing machines and potter's wheels. There are now more than 100 sites in the UK that self-identify as makerspaces, and their number continues to grow. What appears to be a relatively simple proposition – people coming together to create, fix and modify objects – has generated excitement among politicians, educators and the media alike. Yet we still know very little about them. Why are makerspaces emerging, and why now? What impact are they having on their users and the communities in which they are based? And is this an enduring trend or a passing fad?

To answer these questions first requires an understanding of the wider maker movement within which makerspaces sit. Broadly speaking, this movement promotes individual acts of making as both intrinsically worthwhile and beneficial to our society and economy. It is difficult to precisely gauge the strength of this phenomenon, but an RSA/YouGov poll commissioned to coincide with our report indicates a nation enthusiastic about making. We found that over a quarter (26 percent) of GB adults regularly make things for their own use, nearly half (49 percent) fix things that are broken and over a fifth (21 percent) modify products to better suit their own needs. We also found that 57 percent of people would like to learn how to make more things that they and their families could use.

A straightforward observation is that the maker movement is a cultural phenomenon. The suggestion here is that making has become fashionable and part of a hobbyist craze that may soon fizzle out. But we propose a more profound analysis: that the maker movement is a reaction to significant technological upheaval and indicative of a desire among people to have more control over their lives. Our survey found that 43 percent of people often feel confused by the pace of technological change and struggle to keep up. We argue that 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. Through novel acts of making we come to understand the workings of complex tools and the make-up of objects.

The maker movement is not the first social response to technological change that has championed making. The Luddite protests were led by skilled workers who sought to defend their livelihoods from the encroachment of new machines, while the Arts and Crafts movement hoped to limit the spread of mass production by stimulating the nation's appetite for handcrafted objects. But what sets the maker movement apart is that it has chosen to embrace new tools rather than shun them. Its conduct and ethos are also more promising. For example, the movement is highly inclusive, meaning there is a strong feeling that everyone should be able to take part regardless of their background or financial circumstance. It is also agenda-less, with every individual able to decide what they want to work on free of judgement from others.

In this report we look at how makerspaces, as the epicentre for this maker movement, can help people to master technology for three ends:

- **Self-fulfilment** – The therapeutic effects of making have been well documented. Multiple studies show that the act of creating and fixing things can stem cognitive decline and help people control their emotions. But the making activity that occurs within makerspaces may also imbue people with a deeper sense of meaning and a feeling of 'being in control' that is elusive within their day to day lives.
- **Learning** – Close to 70 percent of makerspaces are believed to offer formal classes to users, while just over 60 percent have their own school programmes. There are introductions to 3D printing, bootcamps for Arduino, masterclasses in throwing clay and even classes in so-called 'mind hacking'. It is common for makerspace members to find employment as a direct result of the skills they have picked up on site.
- **Enterprise** – Makerspaces can help people turn their ideas into marketable products and in doing so establish viable maker businesses. In most cases, entrepreneurs will use tools to rapidly create prototypes of goods that can be made in bulk elsewhere. Examples of businesses using makerspaces in this way include producers of surgical equipment, boat repair technicians, and camera designers.

Each of these three roles is concerned with solving a given problem with a given solution, for example addressing skills shortages in STEM (Science, Technology, Engineering and Mathematics) subjects with training programmes. Yet makerspaces also have a role to play in changing our broader worldview. Put another way, they are not just sites to craft objects but also places to prototype a new way of living – one that responds to the opportunities and challenges of a world in which technology is ubiquitous. MadLab in Manchester hosts sessions on how to eco-retrofit houses, the ZB45 makerspace in Amsterdam holds monthly meet-ups to talk about technology and surveillance, and the RSA's Great Recovery team in Fab Lab London run workshops introducing people to the principles of a circular economy. Projects like these are being replicated in makerspaces across the UK by people who desire a better kind of economic and social system.

Taken together, there is much to be excited about with the emergence of makerspaces. The question is whether they can break through into the mainstream. After all, our polling found less than 1 percent of the population are currently using makerspaces and that only 4 percent have heard of the term. But our view is that their momentum will continue to gather pace – not least because the public's appetite for making, and to do so in collective workshops, is growing. Around a quarter of the respondents to our survey said they would be interested in using a makerspace in the future. Moreover, making is becoming more accessible thanks to new digital tools. 3D printers, laser cutters and Raspberry Pi computers can all be wielded by novice makers with limited skillsets. A third factor fuelling makerspace activity is the emergence of new 'hardware markets' such as biofabrication and the Internet of Things.

None of this is to say that the success of makerspaces is guaranteed. Just as some are planning to expand into new locations (Makerversity and MAKLab are looking to establish sister sites elsewhere), others are drawing their operations to a close (the Metropolitan Works makerspace recently shut its doors to the public). Many are struggling to balance the books, while others are finding it hard to engage with particular demographic groups, notably women. There are also ethical questions to grapple with, such as how to manage intellectual property rights and how to ensure micro-manufacturing meets expectations over its environmental impact. One solution to these challenges is for makerspaces to become highly professional and formalised, possibly accepting greater funding from corporate backers. But the concern is that this could blunt the movement's radical edge in the process.

The reader may wonder whether words like 'radical' are warranted when discussing makerspaces. What is particularly ground-breaking about people coming together to fiddle with electronics, craft furniture or mend clothing? In a popular *New Yorker* article on making last year, the techno-critic Evgeny Morozov subtly mocked the movement with the subtitle: "Pick up a spot welder and join the revolution." Yet the problem with this interpretation is that it assumes change can only be achieved through grand projects, political or otherwise. While individual acts of making may appear trivial in isolation, the collective outcome of thousands of creative endeavours may be a society that is more self-assured and fulfilled. The work of makerspaces may not always be dramatic and awe-inspiring, but it does amount to an uprising of sorts – what the writer Matt Crawford calls a "stoic revolution" that is "resolutely this-worldly".

Over the coming months the RSA will explore in more detail how makerspaces and the broader maker movement can live up to their potential. We hope this report is the first step in understanding where the opportunities and challenges lie.

Box 1: Key findings from our YouGov survey on making

Our RSA/YouGov poll of 2,034 GB adults online found that:

- 43 percent of people often feel confused by the pace of technological change and struggle to keep up.
- 26 percent regularly make things for their own use, 49 percent fix things that are broken, and 21 percent modify things they have bought to better suit their needs.
- 57 percent would like to learn how to make more things they and their families could use.
- 61 percent would like to have a better understanding of how the things they use work.
- 78 percent think our society is too materialistic and our economy too dependent on consumerism.
- 1 percent currently use a makerspace / hackspace, but an additional 24 percent say they would be interested in doing so.
- 21 percent think capitalism is fundamentally flawed and requires a radical change.

Will technology save us?

The information society has been brought about by the fastest growing technology in history. No previous generation has ever been exposed to such an extraordinary acceleration of technical power over reality, with corresponding social changes and ethical responsibilities.[1]
Luciano Floridi

The rise of the techno-pessimist

For all the talk of a slowdown in innovation, the influence of technology on our lives today is perhaps the greatest it has ever been. Eight general purpose technologies have been invented since 1950, the most profound being computing and the internet.[2] Few areas of our lives have been left untouched by their presence. The way we consume, work and play have all been transformed – and the effects of this new digital age have yet to fully play out. The American economists Andrew McAfee and Erik Brynjolfsson talk of the "second half of the chessboard" and the almost unimaginable outcomes of a continued exponential growth in computer power.[3]

But are these outcomes desirable? The most optimistic commentators believe the new digital age will hand power back to everyday people, enabling them to tackle corruption, manage health conditions, start businesses and forge meaningful connections with others. Though not entirely sanguine about the future, the American scholar Jeremy Rifkin forsees the onset of a third industrial revolution, where internet-enabled devices lead to hyper efficiency and a world of abundancy.[4] Others subscribe to Joseph Schumpeter's doctrine of 'creative destruction', believing that while new innovations may be painful at first their ultimate impact will leave us better off in the long run.

These views, however, are deeply contested. There is a fear among some that many jobs will be automated out of existence owing to relentless improvements in computer power.[5] A widely cited study from the University of Oxford found that 47 percent of occupations could disappear in the next 30 years.[6] Moreover, those jobs that do remain may become highly precarious as so-called sharing economy platforms disrupt

1. Cited in Mason, P. (2015) *PostCapitalism: A Guide to our Future*. Allen Lane.
2. See Marsh, P. (2013) *The New Industrial Revolution*. Yale University Press.
3. Brynjolfsson, E. and McAfee (2014) *The Second Machine Age*. W. W. Norton & Company.
4. Rifkin, J. (2014) *The Zero Marginal Cost Society*. Palgrave Macmillan.
5. See for example Ford, M. (2015) *Rise of the Robots*. Basic Books.
6. Frey, C. B. and Osborne, M. A. (2013) *The Future of Employment: How susceptible are jobs to computerisation?* Oxford Martin School.

more industries. The macro economic ramifications of these changes could be severe. According to Thomas Piketty, capital would become more important as a source of income and inequality would rise as a result.[7] For some like the legal scholar Tim Wu, the concentration of power on the internet means it already resembles a monopoly board.

Yet economics and the future of work are only part of the story. An equally important debate relates to people and society. Does connecting through social networks make us narcissistic? Has the internet made us less empathetic? Academic studies are beginning to explore these questions and their answers can be troubling. A University of Michigan study found that spending time on Facebook makes people feel lonelier, while the psychologist Cass Sunstein argues that, by acting as an echo chamber, the internet may deepen prejudices.[8] We should also be mindful of reports that regular interactions with digital devices can 'rewire' our mode of thinking, making us less attentive and more prone to distractions.[9]

Figure 1: Proportion of people agreeing that they often feel confused by pace of technological change and struggle to keep up
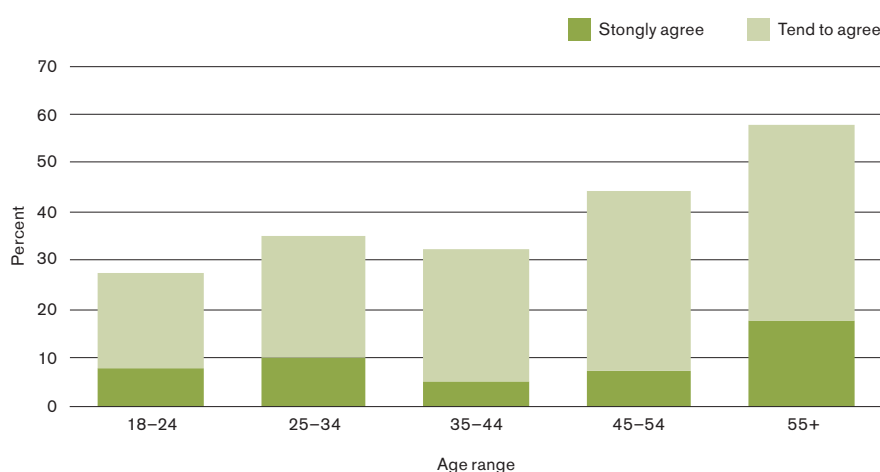
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015)

Sharing the fruits of technology

As the digital age has matured, so too has society's framing of the 'technology problem'. During the first phase the challenge was seen as one of **access**. The aim was to connect more people to the internet and to supply them with personal computing technology. The second phase was concerned with **acumen** – the 'digital literacy' required to operate these new tools. But today the most pressing technological problem relates to **agency**, or the way that people use new tools to respond to the aforementioned challenges. A key issue we are concerned with is whether the onset of a new digital age will strengthen or weaken people's 'power to create'.

7. Piketty, T. (2014) *Capital in the Twenty-First Century*. Belknap Press.
8. Kross, E. et al (2013) *Facebook Use Predicts Declines in Subjective Well-Being in Young Adults*; and Sunstein, C. (2014) 'Pole Positions'. *RSA Journal*, Issue 4 2014.
9. See for example Carr, N. (2011) *The Shallows: What the internet is doing to our brains*. W. W. Norton & Company.

By this we mean the ability to turn our ideas into reality and in doing so become the authors of our own lives. In short: do we have technology, or does technology have us?

The results from our RSA/YouGov poll should give us pause for thought. We found that 43 percent of GB adults often feel confused by technological change and struggle to keep up (see Figure 1). Perhaps unsurprisingly, the figure is highest for the over 55s (58 percent), but still over a quarter (27 percent) of 18–24 year-olds feel this way. A recent segmentation exercise undertaken by the RSA reaffirms previous research showing that the benefits of new technologies are not equally felt among the population.[10] While we identified many 'Confident Creators' who are adept at using new technology, we also found a large group of people who are 'Held Back' by a lack of support. Another group – the 'Safety Firsters' – have yet to recognise the potential of the tools at their disposal. The latter two segments are more likely to be found in poorer social classes (C, D and E) than the Confident Creators.

Yet coping with evermore sophisticated technology is not just a question of empowering individuals. It is also one of reconciling competing objectives between individuals and society at large. A beneficial use of technology for one person or group may be irrelevant or even harmful for other people or groups. For example, while some may welcome the proliferation of Internet of Things devices as a means to monitor their behaviour and the surrounding environment, others may find them an intrusion on their privacy. Similar dilemmas are present in the economic sphere. The rise of sharing economy platforms like Airbnb and Uber have dragged down prices for consumers and opened up opportunities for people seeking extra income. But in the process they have begun to flatten traditional business models and, in some cases, destroy jobs and undermine previously secure, well-paid occupations.

Makerspaces at the frontier

Against this backdrop of upheaval, the central provocation we put forward in this report is that makerspaces can be one means of helping people gain mastery over technology. We use the term mastery in the broadest sense of the word, to encompass both technical prowess (using technology) and a sense of agency (understanding technology). Indeed, this paper will argue that the value of makerspaces may lie not only in the crafting of objects but also the crafting of mindsets, values and a different way of living. Our study is principally interested in how makerspaces, as sites for making, can help people master technology for three ends:

- **Self-fulfilment** – Making to boost personal wellbeing and retrieve a sense of agency.
- **Learning** – Making to gain new skills and knowledge, and to find employment.
- **Enterprise** – Making to create objects to sell to others and bolster financial resilience.

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10. Painter, A. and Bamfield, L. (2015) *The New Digital Learning Age*. London: RSA.

There is no common definition of the term makerspace, but for the purposes of this paper we view them as open access workshops that host a variety of new and old fabrication tools. These include cutting edge 3D printers, laser cutters and CNC milling machines, but also traditional tools such as sewing machines, electronic microcontrollers, lathes, drills and other woodwork and metalwork devices. Being open access means that anyone, regardless of their background or familiarity with technology, can use the tools – sometimes for free but usually for a modest fee. Although makerspaces have been in existence for at least two decades, they have grown considerably in number since the economic downturn. Nesta estimates there are close to a 100 up and running in the UK, and that the pace of their expansion is increasing.[11]

This phenomenon has not gone unnoticed. Makerspaces have received increasing amounts of attention from the media, educators and policymakers – both at a local and national level. President Obama promised in 2012 to introduce makerspaces within 1,000 US schools, while several popular writers have drawn attention to makerspaces within their work, including Chris Anderson and Cory Doctorow.[12] Some of the most prominent champions of makerspaces are to be found in university departments, with University College London, Imperial College London and the University of Kent all having established their own sites on campus. Similarly, local authorities have toyed with the idea of backing makerspaces, and a number of libraries are looking to host workshops on site.

Makerspaces could be dismissed as a passing fad or as curious distractions that will only ever appeal to a certain type of enthusiast – artists, crafts people and those known pejoratively as geeks. Indeed, the term makerspace is seldom recognised among the population at large, and many people are puzzled at first when the concept is explained to them. But what may seem outlandish today – making and fixing objects in communal sites – may eventually become a mainstream activity. The rapid rise of the sharing economy is a case in point. The idea of renting out our cars on an ad hoc basis to strangers, or lending money to other people half way around the world, would have seemed far-fetched at the turn of the century. Yet today this is what hundreds of thousands of people do every day.

So the starting point for this analysis of makerspaces is unashamedly idealistic. At this early stage in their development, we have a window of opportunity to craft a common vision for these spaces and to articulate their potential value based on what we have seen so far. Our belief is that makerspaces can indeed be a means of helping more people to develop a better relationship with technology, and in doing so instil a power to create. Critically, makerspaces are grounded in the belief that technology can be moulded to suit our own ends – a notion that runs counter to the widespread determinist assumption that technology is an immutable force destined to develop on a given path.

11. Sleigh, A., Stewart, H. and Stokes, K. (2015) *Open Dataset of UK Makerspaces*. London: NESTA.
12. Anderson, C. (2012) *Makers: The new industrial revolution*. Crown Business; and Doctorow, C. (2009) *Makers*. Tor Books.

But this progressive project is not guaranteed to succeed. To help it do so requires a better understanding of the origins of makerspaces and of the challenges and opportunities they face. What types of makerspace exist? Why are they emerging in large numbers? What impact are they having – and could they have – on their members and the communities in which they operate? And what might they look like in the future? The purpose of our research has been to unpack these questions and in doing so start a conversation about how makerspaces could live up to their potential. We hope the findings are useful to existing and would-be makerspace directors, as well as to the policymakers, educators and entrepreneurs keen to support them.

Before looking at examples of makerspaces in action today, the next chapter examines the broader 'maker movement' within which makerspaces sit. We argue that this movement is the most promising of a succession of social reactions to technological upheaval.

Box 2: Methodology

The findings documented within this report are derived from desk research, data mining of government datasets, an expert roundtable, semi-structured interviews with stakeholders and visits to 12 makerspaces across the UK. Alongside this we commissioned YouGov to undertake a survey of people's attitudes towards making, makerspaces and the wider economy. 2,034 GB adults completed this survey online between the 22 and 23 September 2015. The figures have been weighted and are representative of all GB adults (aged 18+).

Making, past and present

Introducing the maker movement

Makerspaces are the epicentre for the maker movement. Broadly speaking, this movement champions individual acts of making as both intrinsically worthwhile and beneficial to our society and economy. The term 'movement' is problematic because makers are an amorphous group with different objectives, yet they are united by a common desire to be involved in the production of things – whether that means creating electronic devices, 3D printing objects, crafting furniture or making clothing. Indeed, it is important to emphasise that making encompasses more than just the use of digital tools like 3D printers, Raspberry Pi computers and laser cutters.

But where does making stop? In his TED Talk, Dale Dougherty, founder of *Make:* Magazine, declared that we are all makers at heart.[13] Yet without parameters in place the term becomes so fluid as to be almost meaningless. For the purposes of this report, we define making as the application of technology using one's own *ingenuity* to create, fix or modify something. By ingenuity we mean original insight. Someone who works in a factory to make cars, but who has no say in how the machines are programmed, is therefore not a maker. Neither is someone who assembles flat pack furniture. But the person who designs cars to be made by the same machines, and the person who makes their own furniture based on original designs, are makers. Not every maker is someone who uses their hands, and not every person who uses their hands is a maker.

There is growing evidence of the maker movement's arrival. Aside from the growing number of makerspaces, one indicator is the proliferation of Maker Faires, which see hundreds of electronic and science enthusiasts come together to "show what they have made and share what they have learned". Several books also capture the zeitgeist, such as Chris Anderson's *Makers* and Mark Hatch's *The Maker Movement Manifesto*.[14] Politicians, too, have been caught up in the moment, including the chancellor George Osborne who in 2012 called for a "March of the Makers".[15] But does the enthusiasm for making extend to the population at large? A look at Google's search trends hints this may be the case. Searches for the

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13. See www.ted.com/talks/dale_dougherty_we_are_makers?language=en
14. Anderson, C. (2012) op cit; and Hatch, M. (2013) *The Maker Movement Manifesto*. McGraw-Hill Education.
15. For the full speech see www.telegraph.co.uk/finance/budget/8401022/Budget-2011-Chancellor-George-Osbornes-speech-in-full.html

term 'maker movement' have been growing steadily for the past five years, reaching a peak in October 2014.[16]

Our survey with YouGov similarly shows a nation enthusiastic about making. We found that over a quarter (26 percent) of GB adults regularly make things for their own use, nearly half (49 percent) fix things that are broken, and over a fifth (21 percent) modify products to better suit their needs (see Figure 2). However, these findings only give us a snapshot of what is happening today. The government's Taking Part Survey, which captures people's cultural and recreational habits, is perhaps the best source of insights on how the nation's appetite for making (albeit only one strand of it) has changed over time. Our analysis of this dataset shows that the proportion of people that had undertaken any craft activity in the last 12 months increased from 17.4 percent in 2008/09 to 20.7 percent in 2013/14.[17] The increase is modest but note that the latest figure is the highest ever recorded by the poll.

It is tempting to think of the maker movement as just a cultural phenomenon – a fad that will fade away in due course. However, our belief is that it is an important response to the technological upheaval described in the last chapter. The maker movement helps people gain mastery over technology in two senses. Most obviously, it is concerned with enabling people to **use** technology to produce something useful – whether that is clothing, furniture or an electronic gadget. This is important for self-reliance. But the movement is also about helping people to **understand** technology, by which we mean becoming aware of how it works and what it is capable of. Through novel acts of making we come to understand the workings of tools and the make-up of objects. This gives us a sense of agency but also a greater awareness of technology's externalities, for example on sustainability and matters of privacy. Later in the report we will explore in more detail the connection between making and mastery.

Figure 2: Proportion of people taking part in making activities on a regular basis
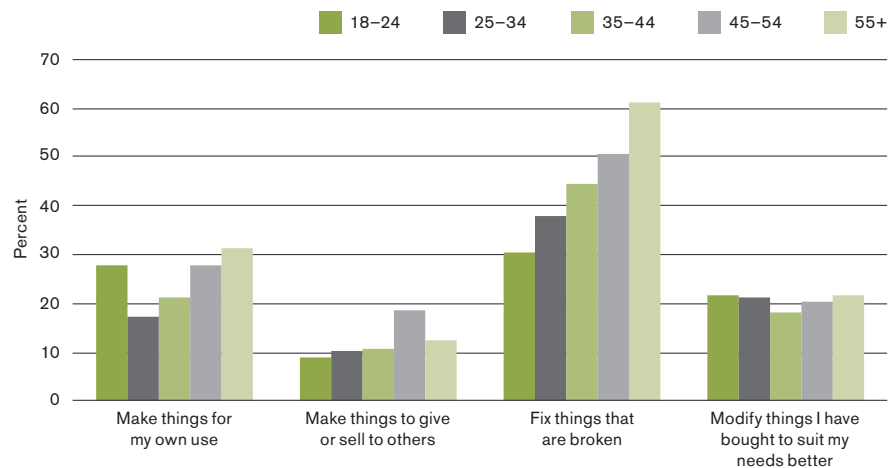
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015)

16. See www.google.com/trends/explore#q=maker%20movement
17. RSA analysis of the Taking Part Survey 2008/09 – 2013/14

Box 3: Four movements championing making

Phase	Response	Driver	Leaders	Faults
Luddite movement	Destroy the tech	Introduction of first automated machines	Workers	Relied on violence and failed to recognise benefits of new tech
Arts and crafts movement	Ignore the tech	Onset of mass production	Intellectuals	Became distracted by nostalgia and lacked broad-based appeal
Hacker movement	Own the tech	Introduction of computing and the internet	Techno-enthusiasts	Lost its emphasis on making and championed consumption over production
Maker movement	Embrace the tech	Technological ubiquity	Leaderless	?

A short history of man vs. machine

At this point it is worth considering how the maker movement differs from previous responses to technological upheaval, particularly those that also championed individual acts of making like the Arts and Crafts movement. Why did these prior social movements fail? What suggests that the maker movement will be any different? And is there anything we can learn from past experiences? Box 3 summarises four prominent social phases that capture our troublesome relationship with technology, beginning with the Luddite protests in the early 19th century and leading up to the emergence of the maker movement in the present day.

The first substantial confrontation between society and technology occurred during the 19th century, sparked by the arrival of new machines and fuelled by discontent with factory production. Though the vast majority of the population at this time was bound up in agriculture, hundreds of thousands of skilled workers made a living making clothing, ceramics and other goods using their own tools. Their artisanal means of production were threatened by new machines like the stocking frame, power loom and – somewhat later in the 19th century – the self-acting mule. These new technologies concentrated labour within factories for the first time, and helped to drive productivity to levels that would have been unimaginable only a few decades earlier.[18]

The result was that many self-employed craftsmen were pushed out of business. To add insult to injury, the aggrieved workers were often forced to join the same factories that damaged their livelihoods. For a group of workers in Nottingham, the solution was not so much to own the new means of production but rather to ruin it. The newly formed band of **Luddites**, which enrolled recruits from across the country, proceeded to burn mills, destroy stocking frames and in some cases assault factory owners. Yet as dramatic as the protests were, the Luddite movement was by and large a failure. Within a few years, the ringleaders were rounded up and the machines put back into action. Violence and a blanket repudiation of new tools were not the answers to technological upheaval.

18. Frey, C. B. and Osborne, M. (2015) *Technology at Work*. Oxford Martin School and Citi.

By the late 19th century the circumstances of most workers was much improved, thanks in part to the collective bargaining efforts of trade unions and the fact that advances in manufacturing had brought down the cost of consumer goods. But it was these same consumer goods that in part spurred the second confrontation between society and technology – this time in the form of the **Arts and Crafts movement.** Concerned about the poor quality of factory-made products and the loss of traditional craft skills, several leading intellectuals called for an end to the division of labour and a revival of simpler pre-industrial working practices. This was not just an economic movement but a social one, with British social-ist John Ruskin arguing that making and owning beautiful objects was important to a man's character and a moral imperative.

Measured against its impact on public discourse, the Arts and Crafts movement was moderately successful. Literature, architecture and interior design were all influenced by a new aesthetic impulse, and more than a hundred arts and craft associations took root during its heyday. Yet for the everyday worker, the impact of the Arts and Crafts movement was negligible. Writing in *The New Yorker* magazine, the techno-critic Evgeny Morozov argues that it failed because it lacked a broad-based appeal among the working class.[19] While aesthetes like John Ruskin and William Morris were eulogising about handcrafted objects, the wider labour movement was embroiled in a new battle with Taylorism and scientific management techniques that were designed to further alienate and deskill workers. Nostalgia became a distraction rather than a remedy for techno-logical disruption.

Over the course of the 20th century, innovation continued to mete out new challenges for society. Mass production took root, industry got bigger and the first signs of globalisation came into view. The latter force, fuelled by technological progress in the developing world, brought about industrial strikes on a grand scale. But for the first time, according to the French intellectual André Gorz, it was the sphere beyond work that became the primary battleground in Western society's confrontation with technology.[20] During the 1960s and 1970s a counterculture emerged that championed the notions of domestic self-reliance, anti-authoritarianism and ecological awareness. Few books captured the zeitgeist better than E. F. Schumacher's *Small is Beautiful*, which took issue with mass consump-tion, mass production and an "idolatry of gigantism".[21]

It was during this period that the **hacker movement** arose. What made it different from the preceding movements was that it saw new technology as a force for emancipation, rather than a source of unwanted agitation. The tools in question were personal computers and the protagonists of the movement 'new agers' and electronic enthusiasts. An influential group at the time was the Homebrew Computer Club, a small crowd of early computer hobbyists that met regularly from the mid-1970s onwards to exchange ideas and talk about the latest tools. The club encouraged its members – including Steve Jobs, Steve Wozniak and Lee Felsenstein – to assemble their own computers, such as the build-it-yourself Altair 8800.

19. Morozov, E. (2014) *Making It* [article] *The New Yorker*, 13 January 2014.
20. Cited in Mason, P (2015) op cit.
21. Schumacher, E. F. (1973) *Small is Beautiful*.

Stewart Brand, another iconic figure of the time, saw computers like the Altair as the ideal tool for personal liberation.

The impact of the hacker movement was greater than anyone expected. Personal computers, and soon after the internet, helped to transform the lives of billions of people around the world. However, few have recognised that the original vision of the hacker project fell by the wayside. What began as a movement that encouraged the 'hacking' and repurposing of new technology to challenge hierarchical institutions eventually morphed into a commercial exercise.[22] Stewart Brand turned his attention away from making and towards new forms of consumerism, while Steve Jobs began selling polished products that were – and still are – not designed to be tinkered with. Consumption, rather than production, flourished during this era.

The promise of the maker movement

This very short history of man vs. machine is necessarily simplistic. But the take-home point is that previous reactions to new technologies have not led to mastery over them. All initially sought to champion individual acts of making in the face of upheaval, but what sets the maker movement apart is that it has chosen to embrace new tools rather than shun them, unlike the Luddites and arts and crafts enthusiasts. The hacker movement began promisingly, championing new devices as tools for individual autonomy, but in the end that freedom came to be viewed through the lens of consuming rather than making. To be sure, the hacker movement and its digital devices have had a profound impact on our power to create, enabling us to start businesses, access information instantly and hold the powerful to account. However, the emphasis has always been on owning technology rather than truly understanding it.

We should also recognise that the maker movement stands apart because of its conduct. It is not just what the movement espouses that is important – individual acts of making that embrace new technology – but also the way it does so. There are four distinguishing features of the maker movement that give it a strong note of promise:

- **Agenda-less** – The maker movement does not have an explicit agenda other than the celebration and promotion of making. It is up to every individual to decide what they want to work on, be it for personal or commercial gain. Parts of the maker movement exemplify Manuel Castell's concept of 'individuation', which involves people pursuing their own projects but often with a collective goal or shared ideal, such as protecting the environment.[23] No single person or group leads the movement.
- **Inclusive** – There is a strong feeling that everyone should be able to take part in making, regardless of their financial circumstance or familiarity with technology. Many makers subscribe to the open source ethic, such as the company Adafruit that not only sells DIY electronic kits but publicises how these are made so

22. Levy, S. (1984) *Hackers: Heroes of the Computer Revolution.*
23. Castells, M. (2012) *Networks of Outrage and Hope: Social movements in the Internet Age.* Polity.

people can duplicate them. In the same spirit, most makerspaces have 'taster days' where would-be makers can try machines for free.

- **Instrumental** – The maker movement is about creating useful things that will improve people's lives. Most makers are not idealists with grand political projects – although there are some – but rather realists who want to have an immediate and tangible impact. The author Matthew Crawford calls this a "stoic" revolution that is "resolutely this-worldly".[24] This principle also applies to people running maker businesses, whose aim is to sell objects that are genuinely useful to their customers.

- **Reflexive** – People involved in the maker movement are generally passionate about learning and sharing what they know with others. For some this means mastering their discipline of making, but for many it also means gaining a broader understanding of how the economy functions and where they sit within it. New communication tools – wikis, blogs and other social media platforms – have allowed makers to connect and share these thoughts, feelings and ideas with likeminded others.

In the next chapter we turn our attention back to makerspaces as the epicentre for the maker movement. We consider what they look like in practice – including the tools they stock, the users that visit and the organisational models they run on – and present a number of case studies that demonstrate the community's diversity.

24. Crawford, M. (2010) *Shop Class as Soul Craft*. Penguin Books.

An overview of makerspaces

A typology of makerspaces

Makerspaces are as diverse as the maker community they support. No two are the same, and each is in a constant state of flux. One way makerspaces vary is in terms of their autonomy. While some are supported by institutions such as universities, others are independently managed and financed. Another point of distinction is the emphasis on business. Makerversity, based at Somerset House, is singularly focused on supporting maker start-ups – yet most others err towards hobbyists. Makerspaces also differ by whether their origins are demand-led or supply-led. The former refers to sites that were created in response to existing demand among local makers, whereas the latter were established in a bid to *convert* people into makers.

Despite their differences, it is possible to group makerspaces into several clusters. The following types vary in terms of their tools, users, business models and styles of governance, among other characteristics.

Fab Labs

The first Fab Lab emerged from the MIT's Centre for Bits and Atoms as an outreach initiative designed to open up access to digital fabrication tools. Every Fab Lab must sign up to the Fab Lab Charter and agree to host a set

inventory of tools, as determined by the Fab Foundation. They are also expected to connect with other Fab Labs and share their experiences. It is therefore a relatively structured model of makerspace. There are now over 560 up and running worldwide, with plans to establish a network of 50 in the UK.[25] TechShops are another model of makerspace that closely resemble Fab Labs, although none currently operate within the UK.

Case study
Fab Lab Cockermouth in Cumbria opened in 2014 with the support of Britain's Energy Coast, a business support organisation, and The Sir John Fisher Foundation. Unlike many Fab Labs, the makerspace is situated in a rural area, bringing it both challenges and opportunities. One of the motivations for starting the Fab Lab was to expose more young people to science and engineering, with a view to supporting the nearby nuclear industry. The team runs a free programme for several schools (involving 1,000 pupils so far), organises two annual summer school events and holds monthly 'parents and kids' sessions where parents can come into the Fab Lab and make things with their children. Unusually, the space holds two open access days a week where people can try out the machines and only be charged for the materials they use. In return, visitors are asked to write a blog for the website sharing what they have learned.


Hackspaces

Like Fab Labs, Hackspaces operate under a common umbrella brand, yet their approach is less structured. They are free to determine the tools they stock and the business models they operate with. Although most set a monthly membership fee, there is often a policy of pay-what-you-can, which speaks to their inclusive nature. Hackspaces have a strong counter-cultural atmosphere, and many are hostile to the notion of collaborating with big business. They aim for a distributed model of leadership.

25. www.FabLabsuk.co.uk

Case study

Build Brighton began six years ago as a gathering of electronic enthusiasts who would meet weekly to discuss soldering, robotics and computing. Having started at a co-working space with just a shelf to store their soldering irons, in 2011 the group took the opportunity to move into their own premises spanning 1,600 square feet. Today they have over 100 members, predominantly hobbyists who experiment and play with electronics in their spare time. Like most Hackspaces, the emphasis of Build Brighton is more on learning and socialising than entrepreneurship. Members of the space regularly run outreach classes at local events, with one aim being to encourage people from less affluent backgrounds to sign up. Build Brighton now breaks even after four years of struggling with their finances, during which period members would often dip into their own pockets to keep the site running.

University-led
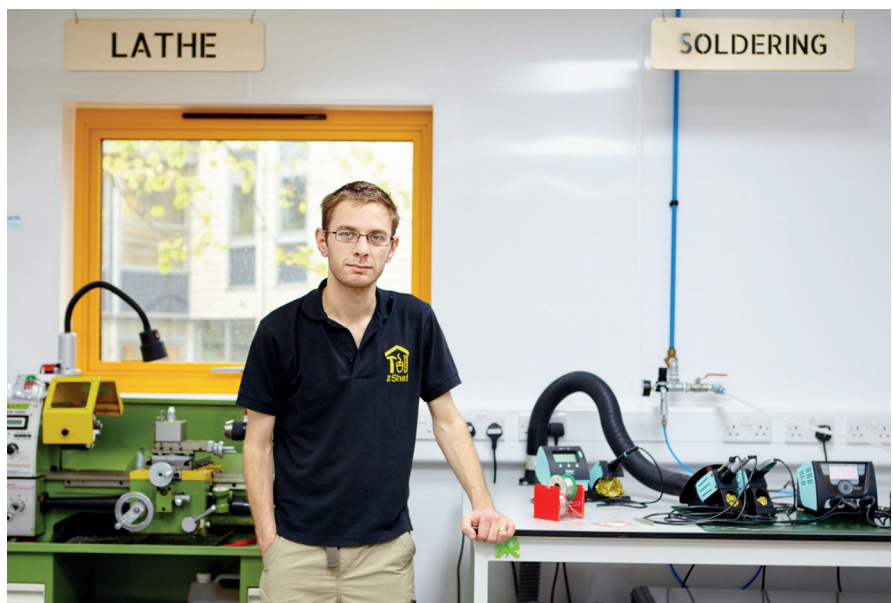
Based in higher education institutions, these makerspaces are well-resourced with existing equipment and expertise, though they are not always financially supported by the university. University-led makerspaces benefit from a ready-made 'market' of makers in the form of their student populations. Many also have passionate academics championing their cause. Because of these characteristics, university-led spaces typically give rise to more sophisticated maker projects.

Case study

The Shed makerspace was established by the University of Kent's School of Computing to provide space for students to work on practical projects. Students and staff of the School can use The Shed not only to build physical devices within taught modules, but also to support and develop their own personal interests and hobbies. A key rationale for creating the space was to expose students to real-world data, which they often struggle to foresee when designing computer programmes in the classroom. The

Shed's activities support new kinds of innovative teaching and learning by taking advantage of the increasing accessibility of electronics and engineering with a rapid prototyping capability. Like most university-led makerspaces, students are not charged for using the machines nor the materials. Such is the popularity of The Shed that the School now sees it as an important part of its offer to prospective students.

Single-discipline

Single-discipline makerspaces focus on one material or technology. Examples include The Kiln Rooms in South London that caters only to ceramicists, and La Paillasse in Paris which is dedicated to biohacking (also known as DIYbio). The advantage of concentrating on a single discipline is that makers have access to more sophisticated machinery and more knowledgeable technicians. The challenge, however, is attracting a critical mass of people interested in the niche domain. These sites belie the common assumption that makerspaces are only about digital fabrication tools like 3D printers.

Case study
The Kiln Rooms is not a stereotypical makerspace as it only focuses on one discipline – ceramics. The idea for the space came from two graduates who met at the RCA, one a ceramicist and the other an expert in arts management. They felt there was an obvious gap in the market for a communal ceramics workshop that would cater to intermediaries who could not afford a fully-fledged studio. However, the founders are keen to pitch their space as a stepping stone where enthusiastic makers can develop their skills with a view to eventually moving into a workshop of their own. In keeping with this mission, The Kiln Rooms offers a "professional development programme" to all members, which involves training, support in developing portfolios, guidance in marketing and the opportunity to hear from visiting artists and expert ceramicists.

Independent

This group captures most of the remaining makerspaces. They are not associated with a particular institution or brand, and each has an idiosyncratic style and membership base. While Makerversity has a focus on supporting maker start-ups, MadLab in Manchester lends greater emphasis to developing the skills of local students and residents. Their independent nature means they are financially self-reliant and usually have multiple income streams – for example from charging members, renting out room space and running training courses.

Case study

Makerversity is one of the best known makerspaces in the UK. It occupies the extensive basement rooms of Somerset House in central London, bringing micro-manufacturing activity to a city that is renowned for its finance and service industries. The space is now home to 55 businesses and 140 members, including fashion designers, textile makers, magazine producers and architects. Yet only three years ago the site of 27,000 square feet was derelict and disused as HMRC's old storage unit. Somerset House, with whom the team has a close relationship, agreed that Makerversity could renovate the space at their own cost and risk, and to use it rent-free until they were fully up and running – as they are today. Looking to the future, the team hope to expand their range of services – including through a new business support programme called MV Works – and to establish sister sites in other city centres.

Box 4: Getting granular

This typology demonstrates the diversity of the makerspace population, but it is also worth considering the aggregate picture. Thanks to Nesta's recent survey of makerspace directors and managers, we now have a more detailed understanding of what these places look like as a whole, the tools they stock and the people who use them:[26]

- **Size** – The average size of a makerspace is 209 square metres. The biggest space is just over 1000 square metres (Building Bloqs), and the smallest is 10 square metres (Goodlife Centre).
- **Tools** – Two-thirds of makerspaces offer more than five different types of tools. 73 percent have digital fabrication tools, 60 percent general hand tools, 60 percent electronics and 52 percent woodwork tools.
- **Users** – 60 percent have 50 members or less, although not all makerspaces are membership organisations. Three-quarters had up to 250 unique visitors in the month of surveying. 80 percent of members are male.
- **User motivations** – 41 percent of makerspaces say at least half their members come to socialise. 35 percent say the same of learning and 33 percent of making.
- **Learning** – 79 percent of makerspaces offer informal help to users, while 68 percent offer formal classes. Less than 10 percent provide no training whatsoever. 63 percent provide educational programmes for schools.
- **Business models** – 55 percent levy a flat monthly or annual fee, 21 percent have a variable fee, and 24 percent have no membership fee. The largest turnover recorded was £350,000.
- **Legal structures** – 55 percent are registered as some form of company, while 12 percent are charities and 10 percent are informal collaborations. Half were founded by informal groups and one third by existing companies or organisations.

26. Sleigh, A., Stewart, H. and Stokes, K. (2015) op cit.

Mastery in the making

At the outset of this report we proposed that makerspaces, as the epi-centre of the maker movement, could play an important role in helping society to master technology. Recall our definition of mastery as being able to use *and* understand technology in such a way that enables people to turn their ideas into reality and lead autonomous lives. Here we explore how makerspaces and the act of making can help people master new and old tools for three ends: self-fulfilment, learning and enterprise.

Self-fulfilment

Makerspaces ostensibly exist to help people make things – and indeed this is an important part of their repertoire. In our visits to sites across the country we met many people who used tools to create objects that were in some way useful to them. This includes a 3D printing enthusiast who made a customised handle grip for his mother's crutch, a sound engineer who adapted an Ethernet cable for work purposes, and an Internet of Things aficionado who created a monitoring device to manage her household energy use. But to focus only on the objects being made would be to ignore the often profound impact that making has on the individuals themselves. Indeed, Nesta's surveying shows most makerspace visitors come to socialise and have fun.[27] For some, it is not so much what they make that gives them satisfaction but rather *who* they make with.

As well as helping people to forge meaningful connections, the making that occurs within makerspaces may also have therapeutic effects on participants. Several studies have found that the repetitive and absorbing nature of certain types of making can ease anxiety, alleviate symptoms of depression and help people manage their emotions.[28] For example, a 2013 survey of 3,500 respondents found that 82 percent felt happier after knitting.[29] Engaging regularly in making may also be an investment in one's physiological health. Yonas Geda, professor of neurology at the Mayo Clinic, believes craft activity can slow cognitive decline because it puts into action multiple areas of the brain that are often unoccupied.[30] Not every act of making will yield the same results, but the general point stands that wellbeing is more likely to be arrived at through living an active life rather than a passive one.

27. Ibid.
28. A short list of academic studies linking craft with wellbeing can be found here: http://craftcouncil.org/post/healing-powers-craft
29. Riley, J., Corkhill, B. and Morris, C. (2013) 'The Benefits of Knitting for Personal and Social Wellbeing in Adulthood: Findings from an International Survey' in *The British Journal of Occupational Therapy* Vol. 76, No. 2.
30. Geda, Y. E. et al (2011) 'Engaging in cognitive activities, aging and mild cognitive impairment: a population-based study' in *The Journal of Neuropsychiatry and Clinical Neurosciences*, Vol. 23, No. 2.

These points – about the relationship between making, community and wellbeing – are well documented. Less considered is the more fundamental impact that making can have on people's sense of agency. In a powerful critique of our consumerist culture, Matthew Crawford argues that today's technologies have been made to disburden us of responsibility.[32] He cites the seemingly trivial examples of dipstick-less cars and handle-less faucets to make a profound point: that as consumers we have fewer chances to be involved in shaping everyday objects. The same 'disburdening' forces are at play within work. Owing to automation and the application of scientific management techniques, many employees have such specialised roles that they rarely see the impact of their actions. Richard Sennett argues that today's managers do not want deep-thinking workers but rather 'fluid' employees that can be moulded to suit any task.[33]

The act of making, fixing and modifying things in makerspaces is arguably one way to retrieve this elusive sense of agency over technology. Crawford believes this is because working with material objects demands not just subjectivity but objectivity. It is possible to know through the 'infallible judgement of reality' whether or not one has succeeded in making. A jeweller can point to a finished necklace, a mechanic to a bike that has been fixed or a ceramicist to a vase that has been fired without cracking. Individually these acts may seem trivial, but the collective outcome of thousands of creative endeavours may be a society that is more self-assured and fulfilled. Many of the makerspace directors we spoke with certainly felt this to be true. One described makerspaces as "all about empowerment", while another said they are one way for people to "deal with the ultra-complexity of modern life".

Learning

The second domain of mastery we are concerned with is learning. Nesta's survey found that 79 percent of makerspaces offer informal help to their users, while 68 percent arrange formal classes. There are introductions to 3D printing, bootcamps for Arduino, masterclasses in throwing clay and even classes in so-called 'mind hacking'.[34] However, the nature of most knowledge exchange is fluid, networked and serendipitous, with many users teaching one another rather than relying on structured lessons. One makerspace manager likened his experience to a "just-in-time software degree", while a member joked that "every day is a school day". Makerspaces have several characteristics that make them ideal learning hubs, but perhaps the most important is their interdisciplinary make-up. Artists mix with carpenters, dressmakers with electronic enthusiasts, and graphic design students with engineers – interactions that may allow for combinatorial learning.

31. For more information see www.rsaacademies.org.uk/projects/a-manual-for-modern-making
32. Crawford, M. (2010) op cit.
33. Sennett, R. (2009) *The Craftsman*. Yale University Press.
34. London Hackspace's Mind Hacking group discusses hypnosis, optical illusions and lucid dreaming.

> **Box 5: A Manual for Modern Making**
>
> In partnership with the Comino Foundation and Black Country Atelier, the RSA's Family of Academy schools have begun a new initiative to raise the quality and relevance of design and technology education.[31] The project will bring together teachers, designers and expert makers to explore the different ways that young people can learn about and work with new digital fabrication tools such as 3D printers. The ultimate objective is to create a Manual for Modern Making, first tested in RSA Academies, which can act as a how-to guide for teachers and schools across the country.

One beneficiary of these opportunities is adult learners. Approximately 38 percent of the UK population engaged in some form of adult learning in 2014.[35] Measuring the impact of makerspace activity on skills development is difficult, not least because most makerspaces are less than a few years old. But nearly all of the directors and managers we spoke with could cite several examples of users who had found a job as a result of their involvement in the makerspace. Two members of DoES Liverpool went on to work with the software company Autodesk, while a regular visitor to the Fab Lab in Cockermouth found a job next door in a business designing radiation detectors. A number of makerspaces have agreed formal partnerships with learning providers, such as MAKLab in Glasgow that will soon be working with the local Jobcentre Plus to train up jobseekers in digital fabrication tools.

In some cases, the skills being developed are highly sought after by local employers. There is an ongoing debate as to whether arts and crafts occupations will take greater precedence in our economy, but it is indisputable that demand for digitally savvy workers will rise. The RSA's analysis of the government's Business Population Estimates shows that computer programming is the UK's sixth fastest growing sector in terms of job growth.[36] A good example of a makerspace responding to this trend is MadLab in Manchester, which decided to run a Digital Skills for Women project after the arrival of the BBC's Media City in Salford. Makerspaces are also helping to develop skills in science and engineering. The Fab Lab in Cockermouth runs training sessions for apprentices in the nearby nuclear industry, which involves activities such as making drones and building 3D printers from scratch.

The opportunities for learning are not limited to adults. 63 percent of makerspaces have their own school programmes.[37] Makerversity, for example, recently partnered with The Prince's Trust to devise and run a product design course in digital musical instruments. Programmes like these speak to the growing enthusiasm in formal education for so-called service learning, which is predicated on the assumption that learning is a shared experience best practiced in real world settings.[38] The reason makerspaces seem to be popular with children and schools may be down to the poor state of conventional Design and Technology teaching today,

35. Painter, A. and Bamfield, L. (2015) op cit.
36. Dellot, B. (2015) *The Second Age of Small*. London: RSA.
37. Sleigh, A., Stewart, H. and Stokes, K. (2015) op cit.
38. Rifkin, J. (2014) op cit.

which some experts like John Miller see as rigid and formulaic.[39] What makes makerspaces particularly powerful educators is their emphasis on play and experimentation, rather than instruction. Students are presented with problems and they themselves must seek out the knowledge required to solve them. Practice is put before theory in the hope that one leads to the other.

Enterprise

The third domain we are interested in is entrepreneurship. Putting the arts and crafts market to one side, there is a widespread assumption that the UK's manufacturing industry is in a spiral of decline. In 1980 the sector employed one in three workers but today accounts for only one in 10 of the labour force, and makes up just 10 percent of GDP.[40] Yet caution must be taken when interpreting these figures. The economist Ha-Joon Chang makes the point that the state of manufacturing looks worse than it is because machine productivity has increased significantly in recent decades, with attendant falls in prices and required manpower.[41] This in turn has shrunk manufacturing's official share of GDP and employment. The claim that the UK is in a 'post-industrial' era is therefore exaggerated (an issue we pick up again in the next chapter).

But what role could makerspaces play in strengthening our manufacturing base? We know that many are already supporting people to start up in business, providing the tools they need to create marketable products. Makerversity was the first home to an innovative start-up called Knyttan, which makes customised jumpers on site using a modified knitting machine. Many artists also use makerspaces to create one-off pieces, as sculptors do in the London Sculpture Workshop. Yet the reality is that it is currently difficult for most spaces to incubate fully-fledged businesses, primarily because of a lack of space. Where they add greatest value is in enabling people to create prototypes of products that can be manufactured elsewhere – be it in the UK or further afield. Examples of businesses using makerspaces in this way include producers of surgical equipment (Fab Lab London), boat repair technicians (Fab Lab Cockermouth) and camera designers (MAKLab).

This raises an important point about manufacturing: that it is as much about designing products as it is about physically making them. Apple's products are designed in California and made in China, while Dyson's products are designed in Bath but assembled in Malaysia. Before the existence of makerspaces, many designer makers would have had to commission an external agency to create their prototype for them, and wait weeks if not months for it to arrive. But for some makers it is now possible to visit a makerspace and create prototypes themselves, often with the help of a technician. This offers the advantage of a quicker turnaround time and the opportunity to see and physically touch the objects in question. Another benefit is that inventors and entrepreneurs can use makerspace tools on a 'variable cost' basis, meaning they are only charged per hour spent on a 3D printer or half-day on a laser cutter.

39. Miller, J. (2011) *What's wrong with DT?* London: RSA.
40. RSA analysis of ONS National Accounts data on output (GVA), employment and productivity.
41. Chang, H-J (2011) *23 Things They Don't Tell You About Capitalism*. Penguin Books.

The most immediate beneficiary of these manufacturing businesses are the owners and employees. Many of the makerspaces we visited were proud of the fact that some of their members were the main breadwinners in their households. The Labour Force Survey shows that manufacturing employees earn 21 percent more than their counterparts in the service industry.[42] Workers in manufacturing micro-businesses also report higher levels of work satisfaction, scoring better than service micro-businesses on measures such as job security, a sense of achievement, and opportunities for skills development.[43] Tempted by the prospect of rekindling manufacturing in their areas, some local councils and city authorities have taken a keen interest in backing makerspaces. A new housing and commercial development at the Old Vinyl Factory in Hayes will include a makerspace, while a major makerspace called Here East has just been launched in London's Queen Elizabeth Olympic Park.[44]

Prototyping a new way of living

Whether it is creating opportunities for self-fulfilment, enhancing learning and skills development or stimulating manufacturing, makerspaces show promise in helping people to master technology for a more human end. Yet the biggest impact of makerspaces may not lie in helping society solve a given problem with a given solution, but rather in reconfiguring our worldview and way of thinking. Several stakeholders we spoke with cautioned against trying to analyse makerspaces through the lens of existing economic and social structures. As one expert put it: "We need to get beyond the simple substitution argument that says makerspaces will do X instead of another actor doing X. Instead we need to think about how makerspaces might encourage Y instead of X." This could mean championing the notions of self-reliance, data privacy and the ethos of open source knowledge sharing.

But how might makerspaces shape people's worldview? One hypothesis is that the very act of making can change attitudes. The German philosopher Martin Heidegger believed that the only way to understand the world is to understand objects – literally to 'grasp' things. It may be that by giving people the opportunity to confront technology, makerspaces allow them to comprehend the opportunities and dilemmas it presents. Matthew Crawford, for example, believes that people who regularly fix and make things are less given to the "soaring hopes" of consumerism because they have a better understanding of the real value of objects.[45] It is also conceivable that taking things apart makes people more aware of their resource intensity and thus more thoughtful in their purchasing habits. This was one of the rationales for the RSA Great Recovery's workshops on the circular economy, which involved designers and the general public "tearing down" objects including mobile phones, sofas and toys.[46]

A number of the makerspace directors certainly believed their community fostered critical thinking of some kind. Remember that the first spaces to emerge in Germany during the 1990s were partly geared towards

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42. The median manufacturing wage is £564 a week, versus £466 a week in services.
43. RSA analysis of the 2011 Workplace Employment Relations Study.
44. For more information see www.centralresearchlaboratory.com and http://hereeast.com
45. Crawford, M. (2010) op cit.
46. See www.greatrecovery.org.uk

understanding the ethical implications of the internet and personal computing. One of the reasons makerspaces may be ideal catalysts for critical thinking is their inclusive and agenda-less nature, which means they can attract individuals from marginal sections of society and foster challenging subcultures. MadLab in Manchester, for example, is home to many people from the city's transgender and gay community. Another reason why makerspaces are well placed to promote different value sets is that the organisations themselves are sometimes managed in unorthodox ways. It is common, for example, to find spaces that run on a 'pay-what-you-can' model with no hierarchical leadership structure.

But the impact of makerspaces is not limited to direct users. Three years ago the Fab Lab in Barcelona initiated the Smart Citizen project, which involved handing out internet-enabled devices to households so they could monitor local levels of air and noise pollution, and other environmental indicators.[47] The goal was partly to collect information to be crunched by a central team of analysts, but it was also to prompt the city's residents to think differently about their broader ecological footprint. Alongside specific projects like this, the very presence of makerspaces in prominent locations may help to expose local communities to a different way of living. Fab Lab London in Bank is a juxtaposition in the heart of London's financial district, while MAKLab is situated just off the high street in Glasgow.[48] One of our interviewees described these as "islands of production in a sea of consumption". Another made the point that "visibility gives rise to a sense of possibility".

Figure 3: Attitudes towards capitalism[49]
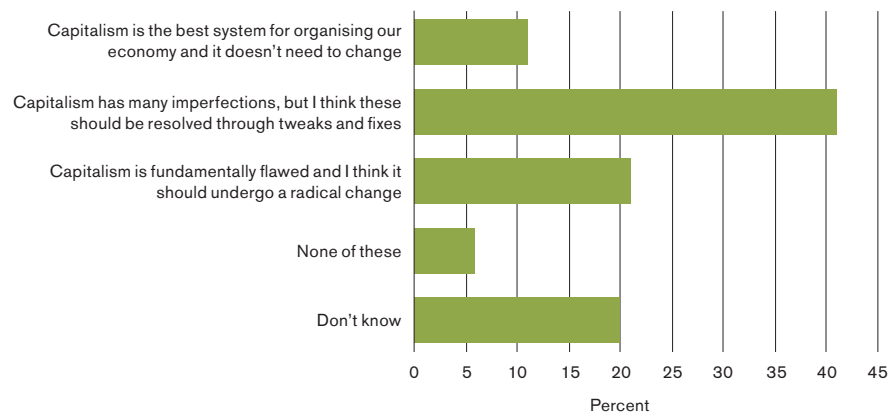
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015)

47. For more information see https://smartcitizen.me/pages/smartcitizen
48. However, it seems likely that the Fab Lab in Bank may soon have to transfer to another location.
49. We gave our respondents the following definition of capitalism: 'Capitalism is a system, such as our own in the UK, where a country's economic activity (ie trade and industry) is driven mostly by private individuals / businesses, who operate for profit in a free market.'

Ours to Master

To be sure, the maker movement and the makerspace community are still marginal features in most people's lives. As our RSA/YouGov poll showed, 4 percent of the GB population have heard of the terms 'makerspace' or 'hackspace'. But their emergence comes at an important time when people are beginning to question the principles of capitalism and look for alternative ways of organising our economy and society. Our survey found that over a fifth of people (21 percent) believe capitalism is fundamentally flawed and should undergo a radical change, and a further 41 percent who think it has imperfections that need to be resolved (see Figure 3). The opportunity for makerspaces is to allow communities to experiment with a different way of living – one that may be based less on consumption and more on production, less on private property and more on shared ownership, and less on being subject to technology and more on being masters of it.

A passing fad or enduring trend?

The last chapter described how makerspaces are helping people to use and understand technology for three purposes: self-fulfilment, learning and enterprise. It was also suggested that makerspace activity could lead to a more fundamental change in people's mindsets and worldview. But we are still unclear as to why makerspaces have grown in number, and why the maker movement more broadly has taken root. Is the desire to create, fix and modify objects, and to do so in collective spaces, a passing fad? Or are there structural causes that indicate this to be an enduring trend? In this chapter we grapple with these questions and conclude that, on balance, makerspaces are being driven by three long term factors:

- **Want to** – More people want to make and view makerspaces as the ideal hubs to do so.
- **Can do** – Making has become easier, cheaper and more joined up thanks to new tools.
- **Asked to** – There is a growing desire for the products and services of makers in the UK.

Want to

Earlier in the paper we noted that the UK is home to millions of DIY aficionados, electronic tinkerers and experienced craftsmen and women. Recall the results of our RSA/YouGov poll showing that over a quarter (26 percent) of the GB population regularly make things for their own use, nearly half (49 percent) fix things that are broken, and over a fifth (21 percent) modify products to better suit their needs. But can these levels be sustained into the future? Promisingly, our survey found that 57 percent of people would like to learn how to make more things that they and their families could use, while over three quarters (77 percent) said that more people in general should be encouraged to make and fix objects, rather than always buy new items (see Figure 4). The difference between these two figures suggests there are many people who value making but who do not want to take part *themselves*. Nevertheless, it is encouraging that over half of the population do want to engage in more making activity in the years to come.

What might lie behind this heightened yearn to create, fix and modify things? One hypothesis is that it is a reaction to the economic downturn and a stagnation in wages. With little disposable income, people may have been forced to make their own furniture or clothing, and to fix broken household objects that they would have otherwise disposed of. If this is true, then we should expect making activity to shrink as real wages

increase. However, there is sparse evidence of a widespread revival in such 'make do and mend' attitudes. Indeed, one of the barriers to making is the cost involved, with it often being cheaper to buy a new toaster, radio or clock than to repair one. This may be one reason why our survey showed that people in the top half of socio-economic groups (ABC1) are slightly more likely than those in the bottom half (C2DE) to take part in making things for their own use (28 percent vs 25 percent) and to fix things that are broken (50 percent vs 47 percent).

Figure 4: Attitudes towards making and consumption
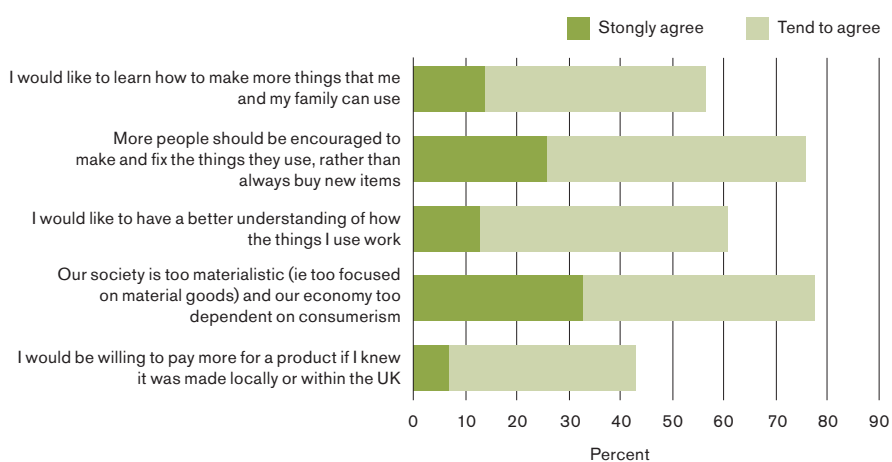
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015))

Another explanation is that making has been caught up in the cycles of fashion, which again if correct would mean that the burgeoning appetite for it would soon tail off. There is no doubt some truth in this theory, with knitting and other types of craft activity now closely associated with hipster culture and a back-to-the-land trend. However, the fact that making activity has risen among every demographic group – each with their own cultural domain – suggests there are other factors at play.[50] Our belief is that the uptick in making may be part of a deeper and longer term reaction to society's increasing exposure to technology, which has fuelled a desire among people to have more of a handle on it. Verifying whether such a link exists is very difficult and not something for this report to unpack, but it is telling that 61 percent of those surveyed in our poll said they want to have a better understanding of how the things they use work (see Figure 4 above).

Matthew Crawford, who explores the connection in his writing, has this to say:

"Both as workers and as consumers, we feel we move in channels that have been projected from afar by vast impersonal forces. We worry that we are

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50. RSA analysis of the Taking Part survey shows there had been an increase in the proportion of all age groups who had taken part in 'any craft activity' between 2008/09 and 2013/14.

becoming stupider, and begin to wonder if getting an adequate grasp on the world, intellectually, depends on getting a handle on it in some literal and active sense."[51]

Taken together, it seems likely that making activity will remain popular, and possibly become more so in the future. But an important question remains: why are people convening in makerspaces when they could make things elsewhere? One reason is practical. While the cost of tools has fallen and will continue to do so, it is still likely to be a long time before their prices are fully within reach of the average maker. The full inventory of tools that every Fab Lab is obliged to hold costs in excess of £65,000.[52] It therefore makes sense to pool resources, especially when new machines like 3D printers are constantly being upgraded and made obsolete. Regardless of the reason, the concept of working together in a makerspace appears to strike a chord with people. Our survey found that almost a quarter of the population (24 percent) would be interested in using one, a very high figure relative to the 1 percent who currently do so (see Figure 5).

Figure 5: Desire among makers and non-makers to use makerspaces[53]
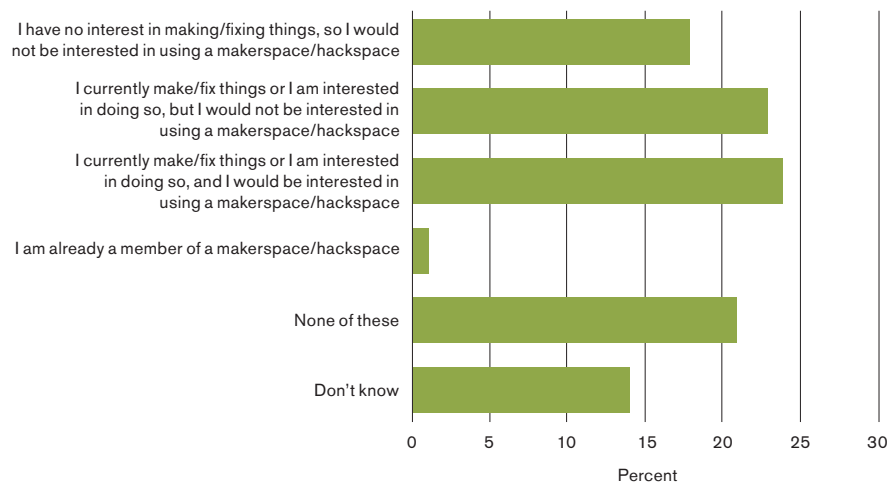
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015)

Can do

At the same time as making is becoming popular, it is also becoming easier. Owing to the advent of computing, tools that would have once taken years to master can now be wielded by fledgling makers with limited skillsets. A good example is of Computer Numerical Controlled

51. Crawford, M. (2010) op cit.
52. See www.fabfoundation.org/fab-labs/setting-up-a-fab-lab
53. We gave our survey respondents the following explanation of makerspaces: *Makerspaces/hackspaces are community workshops where people can use new and old tools to make, tweak and fix anything – from clothing and furniture to electronics. They often run courses in how to make things and encourage members to support one another.*

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(CNC) Milling Machines, which can be instructed to make intricate carvings into wood, metal and other materials. In the field of electronics, the arrival of Arduino (a micro controller) and Raspberry Pi (a credit card-sized computer) has been transformative. Both can be used easily for a variety of purposes, including to connect everyday objects to the internet and to monitor the use of devices like home appliances. Approximately 5m Raspberry Pi units were sold between 2012 and 2015.[54] Even in the complex domains of biology and chemistry, new software has simplified processes and broken down the barriers to entry.

Thanks to the internet and its multiple platforms, it is also easier to learn how to use new tools, or to deepen one's expertise in an existing craft. YouTube is home to thousands of instruction videos that span nearly every discipline and which are free to view. There are videos documenting how to make dresses, how to fix motorbikes, how to throw clay and how to programme Raspberry Pi computers. *Make:* magazine, a publication for maker enthusiasts, has its own YouTube channel of instruction videos with just over a million subscribers. Those seeking a more structured learning format can sign up to 'Massive Open Online Courses' (MOOCs), many of which cater to makers seeking to hone their skills. Although it is difficult to calculate the number of people taking courses in 'making', one estimate suggests that 4.5 percent of all online courses are in art and design, 5.2 percent are in engineering and 16 percent are in computer science and programming.[55]

Another factor behind the democratisation of tools is falling prices. 3D printers have been in use since the 1980s, but for the most part were only accessible to large-scale manufacturers who had the resources to invest in this expensive and unproven technology. Today, however, a good quality 3D printer can be bought for as little as £1,000 – considerably less than the £20,000 it cost for a Stratasys 3D printer in the early 2000s.[56] Other industries have felt the same deflationary forces. Monitoring chips required for internet-enabled devices now cost just a few pence each. Moreover, these and other widgets have become more accessible thanks to new online marketplaces like Seeed Studio that help people find the parts they need.[57] The impact of the open-source movement has been equally important. Linux, the programming software for many hardware projects, is freely accessible, and so too is Autodesk's modelling software for 3D printers.

To focus only on the tools of production, however, would be to ignore the wider infrastructure that has grown up around makers. Crowdfunding platforms like Kickstarter and Indiegogo have helped many people raise the money necessary for their projects. This includes the Pebble watch, Zano drone and Nebia showerhead, which have won backing from thousands of supporters. At the same time, new manufacturing connectors like Just Got Made and Make Works are now linking designers and makers directly to companies that can provide raw materials or manufacturing support. At the other end of the production journey, e-commerce

54. See www.raspberrypi.org/blog/five-million-sold
55. Shah, D. (2014) *MOOCs in 2014: Breaking down the numbers* [article] edSurge: 26 December 2014.
56. Rifkin, J. (2014) op cit.
57. See www.seeedstudio.com/depot

marketplaces have emerged to help makers sell finished goods to buyers around the world. One such platform is Etsy, which has over 1.4 million active sellers of crafts and vintage goods. A third of the Etsy makers we surveyed in 2014 said they would not have been able to get their business off the ground were it not for platforms like it.[58]

Just as digital communication tools have enabled more people to fund projects and find buyers, so too have they helped makers to connect with one another – first online and then offline. Without the ability to communicate and find likeminded others through the internet, some makerspaces would never have been established and many would struggle to find a critical mass of members to remain sustainable. It is conceivable that in the pre-internet age there were hundreds of makers in a given area who would have liked to have met others but had little means of forming these connections. A final point to note is that communication tools have helped to pool learning among makerspace directors and founders. Many write blogs about their experiences and document their lessons via wikis. London Hackspace in Hackney goes as far as to display a breakdown of their finances.[59]

Asked to

A third force fuelling the activity of makerspaces is the growing demand for the products and services of UK makers. As noted in the last chapter, there is a common assumption that our manufacturing industry is in terminal decline and that the sector cannot compete with the low labour costs of developing economies. However, the latest data collected by government surveys suggests it may be turning a corner. The sharp decline in manufacturing output has halted, productivity is growing slowly but surely, and the composition of the sector is tilting towards higher value activities such as pharmaceuticals.[60] Moreover, micro-manufacturing businesses are becoming more prominent. The number of one-person manufacturing firms grew by a quarter over the past five years, compared with a decrease in the populations of all other manufacturing firm sizes (see Figure 6). This is important because these businesses are potential users of makerspaces.

Makerspaces are proving to be hotspots of activity for a number of fast growing industries. The emerging market for Internet of Things (IoT) goods – otherwise known as internet-enabled devices – has opened up new opportunities for electronic enthusiasts, many of whom have used the cheap computing kit within makerspaces to create marketable gadgets. The DoES Liverpool makerspace specialises in supporting IoT projects, such as WhereDial, a device that monitors the location of family members. Biofabrication is another up and coming market where makerspaces appear to have a foothold. Forma Labs is a 'biomakerspace' in Cork whose members work on projects in the budding areas of human prosthetics, basic genetic sequencing and food microbiology. A good example of a biofabrication start-up is Pili, which makes eco-friendly dyes

58. Dellot, B. (2014) *Breaking the Mould*. London: RSA.
59. See https://london.hackspace.org.uk/cost-of-hacking
60. The RSA recently analysed a number of government datasets to assess the state of the UK's manufacturing industry. For a summary of our findings see Dellot, B. (2015) *Reports of manufacturing's demise are greatly exaggerated* [blog] 27 July 2015.

for pens, printers and textiles. Another is Muufri, a producer of artificial milk that is free from lactose and cholesterol.

Figure 6: Growth in manufacturing businesses by firm size
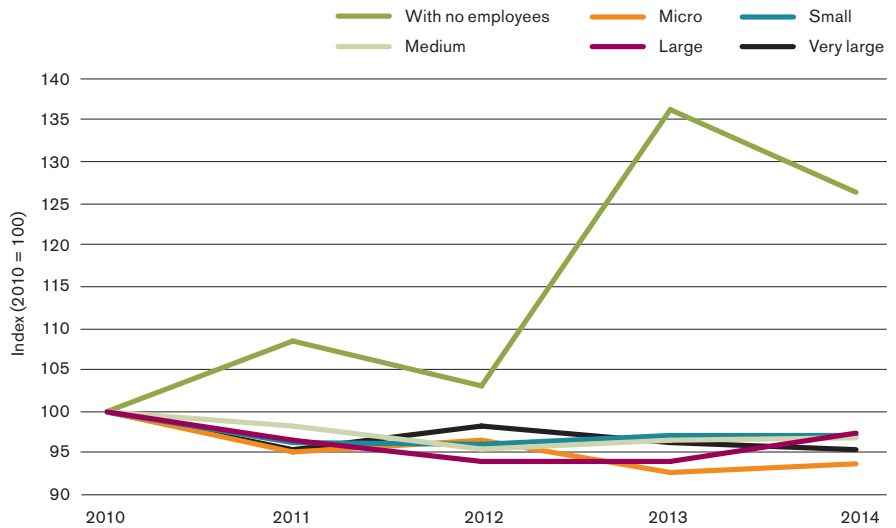
Source: Business Population Estimates 2014

The notion that individuals or small groups of makers can compete with large manufacturers may sound surprising. How can the likes of Pili and the makers of WhereDial keep pace with the research and development teams of Unilever, Proctor and Gamble, Intel and Microsoft? One reason is that smaller outfits perform better in highly niche fields. A related explanation lies in what Harvard Professor Clayton Christensen calls the "Innovator's Dilemma". The term refers to the difficulties that very large businesses have in identifying and breaking into emerging markets, which are often too small to satisfy their growth targets. The answer for some is to buy-out maker start-ups for their ideas and talent. Google's entry into the Internet of Things market only came after it bought the small home appliance maker Nest in 2014.

The interest in makers is owed not just to what they make but also to *how* they do so. There is a strong, and possibly growing, appetite among consumers for objects that are made with a personal touch and which have a compelling backstory. The success of e-commerce websites like Etsy, DaWanda and Folksy speaks to the value that people place on authenticity. Consumers also put a premium on goods that are manufactured nearby. According to our RSA/YouGov poll, 43 percent of people would be willing to pay more for a product if they knew it was made locally or within the UK (see Figure 4). This is partly grounded in a desire to support home grown businesses, but it may also be driven by sustainable values. Many consumers appear to be believe that locally made goods are better for the environment (although as we shall see in the next chapter, the reality is not so clear cut).

The reason for detailing these consumer habits is to show that if the appetite for the products and services of UK makers is growing, then it is

possible the demand for makerspaces will increase in tandem. Yet there is another trend in manufacturing that could have an impact on makerspaces: the growing enthusiasm for circular economy principles.[61] Advocates of the circular economy call for an end to the linear manufacturing process of 'take, make and waste', and champion a more sustainable system where materials are applied sparingly and reused wherever possible – whether that means fixing household appliances that would have otherwise been thrown away, or disassembling old mobile phones and channelling their parts back into the manufacturing cycle. Should policymakers and large manufacturers sign up to this vision, makerspaces could conceivably find themselves becoming community hubs of circular economy activity, possibly organising the collection of old appliances or teaching local residents how to fix objects.

Box 6: The Great Recovery

The RSA's Great Recovery project questions the current system of 'take, make, waste' manufacturing and aims to equip the UK's design community with the knowledge to support the development of a circular economy. Supported by Innovate UK, the team regularly organise 'tear down' workshops where designers are invited to take apart everyday objects – including mobile phones, furniture and toys. The Great Recovery's most recent report, *Rearranging the Furniture*, put forward several ideas for introducing circular economy principles into the manufacture of furniture, of which the UK throws out 1.6m tonnes a year.[60]

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61. The Young Foundation recently published a report looking at the future of manufacturing and good supply chain management. See Johar, I., Lipparini, F. and Addarii, F. (2015) *Making Good Our Future*. London: Young Foundation.

62. Chamberlin, L. and Thomas, S. (2015) *Rearranging the Furniture*. London: RSA.

Future fault lines

Makerspaces at a crossroads

Imagine for a moment a society where most people have a hand in creating, fixing and modifying the objects they use. Large chunks of manufacturing activity have reshored to the UK, makerspaces are to be found in every neighbourhood, and towns and cities across the country have become enthusiastic champions of self-reliance. This vision is not an impossibility – the last chapter listed several forces pushing forward the maker movement and makerspaces – but any attempt to realise it will be beset by multiple challenges. Just as some sites are devising plans to expand into new locations (MAKLab is setting up satellite spaces across Scotland), others are drawing their operations to a close (the Metropolitan Works makerspace recently shut its doors to the public). One of our experts described the current period as "a wild west moment" for makerspaces.

Critically, our measure of success should not just be whether makerspaces survive and grow in number, but rather whether they can do so while retaining their ethos. Recall at the outset of this report the promising characteristics of the maker movement; its inclusive, agenda-less, instrumental and reflexive nature make it the ideal vehicle for helping society to master technology for a more human end. The question is whether makerspaces can continue adhering to these tenets while bringing in enough revenue to keep the doors open and the organisation functional. Makerspaces must grapple with several dilemmas that pull them between idealistic and pragmatic poles. For example:

- Should they seek funding from external parties, even if it means losing some autonomy?
- Can they retain a commitment to the spirit of the 'creative commons' in the face of members who may want to protect their inventions through IP?
- Will most continue to avoid an explicit agenda knowing that a clearer purpose could lead to a greater immediate impact?
- Should they hold onto their egalitarian mode of decision-making when hierarchical governance could speed up progress?

The rest of this chapter looks at four major fault lines facing makerspaces: governance, finance, membership and ethics. It is not for this report to lay out the answers to these problems, but instead to make tensions more explicit and highlight the different ways makerspaces have approached them.

Governance

Every makerspace has a unique approach to governance, grounded in its history and suited to its particular context. But a common trait among those we visited was the involvement of members and users in decision-making. Many view this as the fairest way of running the organisation and the best means of reaching decisions in the interests of the whole community. Yet being leaderless brings its own problems. Reaching a consensus can take weeks if not months and deliberation-fatigue is common. Moreover, the most difficult and undesirable tasks – collecting membership dues and circulating newsletters, for example – will often fall to two or three of the most diligent members. This does not mean that switching to a hierarchical governance model is the solution. With formalisation and structure, makerspaces may inadvertently erode their sense of community and create a transactional relationship where makers are less willing to chip in and help.

Faced with this dilemma, makerspaces have sought to find the delicate middle ground between the two opposing poles of hierarchical and distributed governance. "Loose rules", "loose codes of conduct" and "loose hierarchies" are all terms that came up in our conversations with managers and members. The founders of MadLab in Manchester talked of having "neither a democracy, nor a dictatorship". For fizzPOP in Birmingham, this meant scrapping its model of direct democracy – everyone having a say – and establishing an elected board whose members take decisions on behalf of the community. Other spaces like MadLab do have managing directors tasked with the running of the organisation, but they sound out key decisions with the community through social media, allowing for rapid feedback. DoES Liverpool sets 'collective to-do lists' for members using an online platform called GitHub, with tasks ranging from mending the laser cutter to organising a baby-friendly co-working day.[63]

Some makerspaces have found it useful to connect with other sites and share their collective wisdom. The Open Workshop Network in London, created by Liz Corbin from the Institute of Making, regularly brings makerspace managers in the city together to air challenges and pitch resolutions.[64] Critically, the network takes an inclusive approach and invites representatives from unorthodox and specialised makerspaces, such as Made By Ore (jewellery) and the London Centre for Book Arts (bookmaking). Meanwhile, a number of makerspace managers have taken to the web to share their experiences of running a space, including through wikis and forums such as Hackerspaces.org. For any of this information to be useful requires makerspace managers and members to be willing to change course and experiment with different organisational models.[65] Pivoting in this way is particularly important for spaces that are experiencing rapid growth and playing host to activities they may not have envisioned at the outset.

63. See https://github.com/DoESLiverpool/somebody-should/issues
64. See http://openworkshopnetwork.com
65. For a useful overview of new thinking on organisational management see Laloux, F. (2014) *Reinventing Organisations*. Nelson Parker. Laloux's talk at the RSA can be found here: www.youtube.com/watch?v=QA9J-aKkOAI

Finance

Regardless of whether they are a limited company, charity or informal grouping, makerspaces have considerable start-up and running costs that must be met. This includes expenditure on tools, marketing, staff time, insurance and rent payments. Most of the sites we visited expressed unease with their financial situation, and though nearly all were solvent they were clearly only just so. London Hackspace, for example, scraped by in September 2015 with monthly outgoings of £11,185 and an income of £11,700. It is common for groups of maker enthusiasts to secure the money necessary to establish a makerspace, only to find themselves struggling to keep up with running costs months down the line. A major problem, particularly for makerspaces in London, is exorbitant rent payments, which can account for more than half of their expenditure.

One answer is to approach foundations or local authorities for support, or to seek rent subsidies from landlords. But several of the managers we spoke with were reluctant to do so for fear of the strings that may be attached. One director even said he was "anti-funding". Another option is to seek sponsorship from corporate backers. Intel, Microsoft and Google have all given grants to makerspaces in the UK. In the US, Chevron donated $10m to Fab Labs, while DARPA – the defence agency – gave $3.5m to TechShops. Each agreement must be judged on its own merits, but there are valid concerns that too much involvement from big business might affect the independence of spaces. Recall our earlier argument that makerspaces could play a role in championing a different kind of capitalism – one based on open-source, circular and distributed principles. Yet these may run counter to the interests of some companies.

Is there a way of retaining independence while staying in the black? A handful of makerspaces have chosen to defy logic by focusing more on community and less on business. The rationale is that users with an emotional stake in the organisation and who feel part of a community are likely to contribute more to keep the organisation running. The 'pay what you can' model operated by London Hackspace, MadLab and others should in theory generate less income, but in practice many users decide to dig deeper than usual, with some paying over a £100 a month for membership that warrants £20. In contrast, makerspaces that are purely business minded tend to attract transactional users who pay as little as possible and stay only for the duration of a given project. Such is the power of community that maker enthusiasts have begun using crowdfunding websites like Kickstarter to raise investment for makerspaces.[66]

Irrespective of where a space sits on the spectrum between business and community, there is an emerging consensus that having multiple income streams can aid financial resilience. Many of the spaces we visited drew income from a mix of user fees, training classes, events space hire, open-ended grants and sponsorship for discreet projects. An example of the latter is MadLab's Arts+Tech accelerator, which was supported by Arts Council England and Innovate UK.[67] In the words of one of our

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66. There is now a Kickstarter page dedicated to raising money for makerspaces.
See www.kickstarter.com/discover/categories/makerspaces

67. For more information see http://accelerator.madlab.org.uk

interviewees, relying solely on one source of income, particularly charitable donations, "keeps makerspaces on an IV drip".

Membership

The third fault line relates to the number and make-up of users. In the last chapter we noted that only 1 percent of the population currently attend makerspaces, yet over a quarter (26 percent) have an appetite to do so. Converting just a fraction of these into users would transform makerspaces into mainstream hubs of making, learning and enterprise. The good news is that many of our makerspace managers said they were attracting people beyond the usual suspects. However, it is obvious that makerspaces struggle to connect with particular groups – most notably women. Nesta's survey of makerspaces found that only 18 percent had a membership base with more women than men.[68] Our own RSA/YouGov poll found that women were less likely to have heard of maker-related terms such as 3D printing, the Internet of Things and open source technology (see Figure 7).

Figure 7: Awareness of maker-related terms among males and females[69]
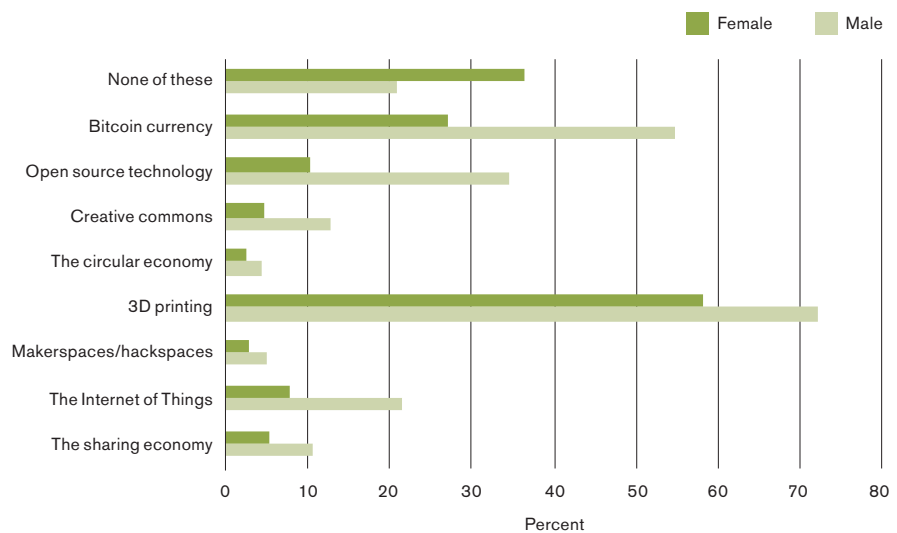
Source: RSA/YouGov poll of 2,034 GB adults online (22–23 September 2015)

Recognising underrepresentation as a distinct challenge, some makerspaces have expended a great deal of energy ensuring their spaces are accessible to particular groups. MAKLab in Glasgow has sought to recruit female technicians, while Makerversity has set aside free working space for under 25s. Outreach projects are also common, from Made by Ore running a jewellery pop-up workshop at a local music festival, to MadLab linking up with Longsight Library on a project to boost the digital skills of refugee women. Whether it is to attract specific groups or the general population at large, some makerspaces have also chosen to

68. Sleigh, A., Stewart, H. and Stokes, K. (2015) op cit.
69. We asked our respondents to only confirm terms they knew the meaning of, not just ones they had heard of.

form strategic partnerships with other organisations. Fab Lab London has agreed a deal with the University of the Arts London (UAL) whereby students are allowed to use their machines for one day a week. In the same vein, East London Printmakers and the London Centre for Book Arts have struck a partnership so their members can use one another's tools.

It is too much, however, to expect a makerspace to cater to the needs of every individual. Indeed, the broader the remit of a space, the shallower the possibilities are for making. This is particularly true for small spaces that can only hold a modest inventory of equipment. The answer for some makerspaces is to settle on a particular niche (even if they are still open to makers of any discipline). DoES Liverpool specialises in the Internet of Things, Makerversity only accepts people starting businesses, and Forma Labs in Cork focuses on biofabrication. Specialising in this way can give makerspaces greater appeal among particular communities, while providing makers with tools that are more sophisticated, technicians that are more knowledgeable and other users that share more similar interests.

For a significant minority of makerspaces, the challenge is less one of having too few members but rather of having too many. According to Nesta's survey, a fifth of makerspaces have over 250 unique visitors a month, with the most enthusiastic members visiting several times a week. Not only do booming populations put pressure on technicians and create waiting times for machines, they also risk destabilising the often carefully crafted culture of a space. One of our interviewees highlighted the research of Robin Dunbar, an anthropologist who claims that communities tend to fracture when they grow beyond 150 people.[70] Faced with this prospect, a number of makerspaces have decided to splinter their operations. MAKLab in Glasgow is now split between two locations, with one site hosting so-called 'clean' tools and another 'dirty' ones. Meanwhile, London Hackspace has helped a group of members break away into a nearby satellite hub that is dedicated to music technology.[71]

Box 7: The Making It Inclusive SDA brief

The RSA's Student Design Awards is a 91-year-old competition challenging students and recent graduates to tackle social, environmental and economic issues through design thinking.[68] One of the briefs in our 2015/16 competition is called Making it Inclusive and asks students to think about how the benefits of making could be opened up to more people – either as makers or consumers. An example entry might be a reimagination of the way D&T is taught in the classroom, a new take on craft apprenticeships or a service linking makerspaces with their local communities. The competition opened in September 2015 and the winners will be announced in the summer of 2016.

Ethics

While makerspaces may empower people to master technology, there is no guarantee it will be used for a benign purpose. Speaking at the 2015 Conference on World Affairs, the futurist Jamais Cascio argued that our moral and ethical framework has not kept pace with the maker movement, and that we do not have "the wisdom to know what to make and

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70. Dunbar, R. (2010) *How many friends does one person need? Dunbar's number and other evolutionary quirks*. Harvard University Press.
71. For more information see http://sda.thersa.org/en

what not to make".[72] The manufacture of a 3D printed gun is the most extreme example of the risks posed by new tools. Yet equal attention should be paid to everyday making activities that carry the same ethical implications. For example, the manufacture of internet-enabled devices that monitor people's feelings and behaviours could eventually spell the end of privacy as we know it. There are also valid concerns about the trend for DIY synthetic biology, which allows people to play with DNA and assemble new gene combinations with only basic equipment.

From a legal perspective, there is also a battle in the offing between proponents of the creative commons (eg Jeremy Rifkin) and advocates of intellectual property rights (eg Chris Anderson). Although the capability of 3D printers is still limited, some experts foresee a future where people will be able to 'scan' consumer goods and have them fabricated on-demand. The result would be to open up hardware to the same disruptive forces of copying, sharing and piracy that have overhauled software and so-called 'info-goods' like music and film. Another legal question to contend with is who should take responsibility when the objects made in makerspaces lead to accidents and injuries. In the case of 3D printed objects, should the product designer be culpable, the person using the printer, or the makerspace that owns the machinery?

Then there are ethical dilemmas that relate to sustainability.[73] It is widely assumed that making products for oneself leaves a lighter environmental footprint than buying objects anew, and that small-scale local manufacturing (aka 'redistributed manufacturing') is more sustainable than a system of mass production where goods are shipped all over the world. Yet the reality of making is not so black and white. Crafting a single item of furniture, for instance, may demand more energy and generate more waste than buying a chair from Ikea that was manufactured en masse in China. One of the problems is that the parts people use to make objects, in particular electronic gadgets, are unobtainable in the UK and must be transported from thousands of miles away before they can be assembled. Every makerspace is different in their approach, but one of our interviewees lamented that the community as a whole "pays lip service to sustainability".

Whether it is experiments in synthetic biology, the legal tussle between IP and the creative commons, or the environmental realities of small-scale manufacturing, the ethical dilemmas that maker activities give rise to will present makerspaces with both a challenge and an opportunity. On the one hand, makerspaces could propel dangerous activities by blindly encouraging experimentation and championing making of any kind, regardless of the fallout. On the other hand, they could be sites that provoke thoughtful deliberation and a progressive debate among members about how making can best serve the interests of society. It is the RSA's view that makerspaces have the characteristics, ethos and – in the words of one makerspace director – "moral compass" necessary to fulfil the latter role. But we also recognise that sound ethical judgements are not inevitable and that strong collective leadership is required to steer activities in the right direction.

72. Cited in Tierney, J. (2015) 'The Dilemmas of Maker Culture' [article] *The Atlantic*, 20 April 2015.
73. See Smith, A. et al (2013) *Grassroots digital fabrication and makerspaces: reconfiguring, relocating and recalibrating innovation?* [Working paper] Science Policy Research Unit at the University of Sussex.

Ours to Master

Conclusion

We began this report with a weighty provocation: that makerspaces can help people to master technology for a more human end. In practice, this means enabling people to make and fix objects in order to regain a sense of agency, learn new skills and find employment, or start maker businesses. We also argued that makerspaces may be able to reshape people's broader worldview, for example by championing notions of self-reliance, data privacy and the ethos of open source knowledge sharing. A case in point is the eco-retrofit workshops that MadLab hosts with the Carbon Co-op, with local residents being taught how to refurbish their homes in order to cut back on their energy use. Another example is the sessions that Fab Lab London runs in partnership with the RSA's Great Recovery project, whereby designers, entrepreneurs and makers are introduced to circular economy principles.

At their most powerful, makerspaces may therefore be thought of as a new institution through which to reimagine capitalism. Recall our RSA/YouGov survey finding that over a fifth (21 percent) of GB adults feel our economic system is fundamentally flawed and should undergo a radical change. In 2011 we saw a dramatic manifestation of this discontent in the form of the Occupy movement, with thousands of people taking to the streets to demand a fairer society. But ultimately the protests fizzled out, in part because the movement was largely expressive, calling for change rather than acting on it.[74] In contrast, the maker movement is about individuals taking matters into their own hands, working on practical projects that lead to a tangible impact on their lives and those of others around them. The activity that occurs within makerspaces may appear trivial, but to those involved it is often of great consequence.

We have argued that people's desire to make, and to do so in makerspaces, is unlikely to fade in the foreseeable future. Our survey found that 57 percent of the nation want to learn how to make more things that they and their families can use. But makerspaces undoubtedly face challenges – particularly in the domains of governance, finance, members and ethics – and many will be torn between pragmatic and idealistic poles as they seek to grapple with these. Should they seek external funding if it means sacrificing some of their independence? Can those that have a distributed model of governance continue to heavily involve members in decision-making without the organisation becoming dysfunctional? And how can makerspaces ensure their makers abide by high standards of ethics and sustainability, without being intrusive and interfering?

It is up to the managers and directors of makerspaces to answer these questions. But there are actions that other stakeholders can take

74. Castells, M. (2012) op cit.

to ease their burden. Educators within universities and schools could reach out to form learning partnerships, while local authorities and property developers could offer rent and business rate discounts in acknowledgment of their community impact. At a national level, there is an argument for diverting to makerspaces some of the government funding that goes into manufacturing schemes. There are also significant policy ideas afoot that could serve to boost maker activity, including proposals for Individual Learning Accounts, a Citizens Income and a Cities of Learning initiative.[75] Finally, we should be mindful of the role large institutions could play, for instance the Post Office and the BBC. Both could feasibly signpost people to makerspaces and perhaps provide helpful materials to makers.

The RSA, with its 260-year-old history of supporting manufacturing, invention and acts of individual ingenuity, is keen to ensure that makerspaces live up to their full potential as sites of mass creativity. Therefore in the coming months we will work with our Fellows – some of whom are makerspace directors – on new research projects to explore this phenomenon in more depth. We are particularly interested in understanding the extent to which makerspaces could strengthen manufacturing activity, as well as the role they could play in boosting skills development and employment opportunities within STEM subjects – always being mindful not to pigeon-hole makerspaces in the process. In keeping with our emphasis on practical activity, the RSA will also consider the scope for new events, networks and learning materials that may be of use to those starting and growing makerspaces.

To find out more about the research, please email Benedict Dellot at benedict.dellot@rsa.org.uk

75. For more information on the Cities of Learning initiative, see Painter, A. and Bamfield, L. (2015) op cit.

The RSA (Royal Society for the encouragement of Arts, Manufactures and Commerce) believes that everyone should have the freedom and power to turn their ideas into reality – we call this the Power to Create. Through our ideas, research and 27,000-strong Fellowship, we seek to realise a society where creative power is distributed, where concentrations of power are confronted, and where creative values are nurtured. The RSA Action and Research Centre combines practical experimentation with rigorous research to achieve these goals.

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