Future Makespaces and redistributed manufacturing

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Introduction

This paper sets out some of our vision of future makespaces and redistributed manufacture, a pragmatic future vision, that reflects the state of makespaces now, tests ideas and aspirations of education and circular economy, and uses insights from those studies to imagine a future and its implications.

The context for this future scoping is the Future Makespaces in Redistributed Manufacture (FMs RdM) Engineering and Physical Sciences Research Council (EPSRC) project at the Royal College of Art. Over two years, we will be hosting symposia, funding feasibility studies and undertaking cross cutting research to understand the potential relationship of makespaces to redistributed manufacture and sustainability.

'Re-Distributed Manufacturing', is a term which aims to encapsulate the rapidly changing geographies, organizational structures, value chains and distribution networks associated with new advances in materials sciences, engineering, digital and enabling technologies. It is akin to 'on shoring', but recognizes that the future of manufacturing will operate on a variety of scales according to specialism and material flows.

We consider that redistributed manufacture is a term that should not apply simply to the inevitable future of business as usual. Our framing of redistributed manufacture, taking advantage of ubiquitous computation and distributed infrastructure has the potential to apply to a different future state of production, one which is desirable not inevitable, which responds to the imperatives of our time and builds a production system fit for humans. As Sloan (2015) emphasises in his recent reflection on the sharing economy:

We are alive at a time when huge systems—industrial, infrastructural—are being remade, and I think it's our responsibility as we make choices both commercial and civic…to extrapolate forward, and ask ourselves: Is this a system I want to live inside? Is this a system fit for humans? (Sloan 2015)

Industrial demassification & makespaces

Industrial demassification is changing where and who can make, produce or manufacture. A near future characterised by ubiquitous or distributed production is emerging built upon the communication infrastructure of the Internet but not limited to the Internet as a site of production.

We see makespaces, makers and designers as being part of that emergent system, as nodes within a potentially decentralised network, sites of production and producers that enable new ideas about production and sustainability.

The Chancellor of the Exchequer, George Osborne's 'march of the makers' may be hyperbole (Elliot 2016), but underneath the pufferfish rhetoric about makers and making is an emergent infrastructure and community with real skills, material knowledge and a potentially a real role in producing the goods and services we need and desire.

Over the last twenty years, we have witnessed the early developments of a networked economy that is operated by its interconnected participants. Infrastructural social and political changes have affected both the structural factors of what kind of production is possible and the cultural norms and logics, expectations and desires in relation to production and consumption. As Lomas states "Decentralized information streams and sources have altered people's attention scopes, ambitions and goals and stimulated a more critical and pro-active attitude." (Abel 2011)

The Internet has enabled geographically distributed communities of practice, and enabled new forms of culture and new modes of production and dissemination. The emerging decentralized infrastructure enabling a shift in both information and material flows is often ad-hoc, operating shared principles and protocols.

Makespaces, defined as open access workshops ranging from fablabs to hackerspaces, are an increasing community phenomena (Stokes et al. 2015), in part born from the opportunities of Internet-enabled shared knowledge, community action, collective effort and digital manufacturing tooling, alongside a growing interest in 'making' as opposed to passive consumption.

In talking about Future Makespaces we are specifically referring to potential of these spaces in the near future, when they reach maturity how they may develop in capacity to produce more sophisticated, larger scale and with higher degree of complexity.

New landscape of making and manufacturing

Industrial demassification is not a phenomenon purely enabled by technological progress; it is also a response to increasing resource scarcity, climate threat and geopolitical changes (Moore and Folkerson 2015). For purely the purposes of managing risk and delivering on value creation in the late capitalist sense the sites and approaches of manufacture need to change.

As highlighted in Policy Connect's Industrial Evolution report the current modus operandi of how we make and produce is under threat. Rapid changes in the security of supply chains, demographic shifts and technological opportunities leave manufacturing bare, open to risks and responsible for actions - economically, socially and structurally vulnerable in the face of fundamental shifts in what society expects of it. (Moore and Folkerson 2015)

How we make, produce and manufacture now is affected both by logic or culture of how we make, and also by a series of externalities that are exploited (structural factors). In order to arrive at a more sustainable future, these factors will either have to change or the approach to what constitutes value and the total cost of a product will need recalibrating.

Makespaces are part of an emerging decentralized infrastructure as well as propagating new logics and cultures around production (Dellot 2015). While they are currently prone to being demographically limited and fragile in their organizational and business models, in their future state they have potential to support better decision making at a range of points along the design chain.

We see Future Makespaces as fitting into the emergent landscape of demassified and redistributed future manufacturing. We believe that makespaces exhibit the characteristics of redistributed manufacture as they change the tools, cultures and sites of production (Pearson et al. 2015). We are excited to be looking at sustainability, systematic change and a rethinking of production from the perspective of grassroots innovation and a decentralized adhoc network - not simply from the perspective of a corporation with agency over every aspect of production.

Equally we see industrial demassification and the redistributing properties of the Internet as changing the agency, access and amplification of the decisions available to the individual maker or micro business. When all decisions that influence a product's material footprint in manufacture and capability for future recapture as a resource are considered they can be seen as a 'design chain'. This change in who has access to manufacturing infrastructure, who has the agency to distribute a design or blueprint and the new forms of production network enable a design chain which is dramatically different to what we imagine the design to manufacture process to be.

It can be considered that the majority of the environmental costs of a product are set at the design stage, but this is very difficult to validate, and also implies that design choices are the sole responsibility of the designer (Weaver 2013). Designers play a significant role in determining the sustainability of a product through the choices they make, but design decisions are also made by others within the supply and value chain of the product. There needs to be a shift away from the onus of responsibility for material consequences falling onto the 'consumer' for design chain choices about material, production and lifespan that were made further up the chain.

FMs RdM intends to establish the future place, purpose and philosophy of makespaces within re-distributed manufacturing and investigate key drivers in enabling sustainable re-distributed manufacturing at a grassroots level. If future systems of manufacturing are to move towards a circular economy then the way in which people and organisations make decisions will need to change in the process. We see makespaces and the associated cultures, practices and platforms as being able to enable new logics around production at multiple points within the product ecosystem to enable the necessary change.

It is our premise that the new infrastructure available to us as designers and makers through emergent redistributed manufacturing and makespaces changes how things are amplified along the design chain, with making and distribution increasingly having potential for unintended consequences (Arieff 2015).

Defining Making and Manufacturing

We need to have a sensible conversation about how we could make and produce in the future, in the light of what we now know about the consequences of how we currently make and distribute. In order to do that, we need to ensure we have a shared understanding of the language we are using about making and manufacturing.

For our purposes when talk about 'making' we what we mean is the process by which material is transformed by human endeavour and where this often involves tools and machines as extensions of human capability.

'Making' becomes 'producing' when the outcome satisfies a preconceived set of plans with the intention of value creation.

'Producing' becomes 'manufacturing' when it is conducted in an organized manner and the outcome is created in significant quantities, involving a high degree of standardization.

'Manufacturing' becomes 'distributed' when the production of significant quantities is operated across a number of sites and / or agents, where quality is standardized but the end product potentially bespoke.

'Distributed manufacturing' becomes 'redistributed' when the spread of sites and agents operate within a decentralized network, that allows for a high degree of flexibility and responds to ecological imperatives and resource scarcity. Redistributed manufacturing doesn't just redistribute the sites and scales of manufacture it also redistributes and recalibrates value, risk and responsibility.
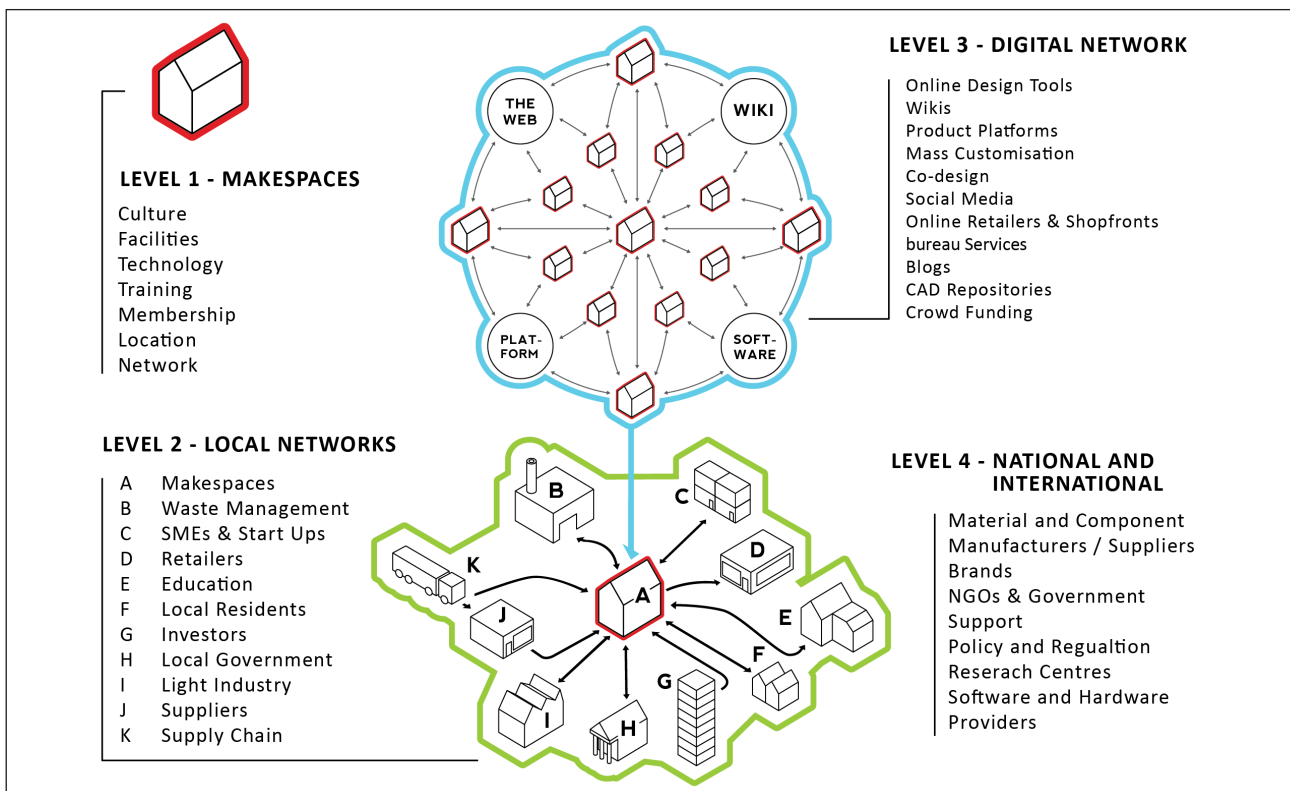
Research program structure

Our project is one of six networks funded by the EPSRC to inform the agenda on where to invest in further research in the next ten years. The EPSRC is aware that the future of manufacturing is going to look very different, based on the 2013 fore site report. EPSRC £3M call for six multidisciplinary "agenda forming" networks to identify the research questions and challenges for re-distributed manufacturing: technology, systems and strategies that will change the economics and organization of manufacturing...particularly with regard to location and scale (Pearson 2013).

We are doing this by looking at four levels or domains where activity takes place and where we can test out hypotheses about role that Future Makespace will play in Redistributed Manufacturing, the type of value that may be created and who will benefit.

The third level is the digital domain and this includes tools and systems that are enabling new ways of working and connecting. Such as social networks and peer-to-peer communities, platforms for sharing and cloud based computational tools, the opportunities and challenges of blockchain technology and how the culture of the digital domain affects our values and how we make and share.

Our fourth level investigates the external factors that influence where and how things are made. This is the domain of national and international policy and global supply chains. This will look at the role that Makespaces will play in a strategy for RdM, where they could operate as sites of production and develop new means of making and ways of creating value.

LEVEL 1 - MAKESPACES
Culture
Facilities
Technology
Training
Membership
Location
Network

LEVEL 2 - LOCAL NETWORKS

A Makespaces
B Waste Management
C SMEs & Start Ups
D Retailers
E Education
F Local Residents
G Investors
H Local Government
I Light Industry
J Suppliers
K Supply Chain

LEVEL 3 - DIGITAL NETWORK

Online Design Tools
Wikis
Product Platforms
Mass Customisation
Co-design
Social Media
Online Retailers & Shopfronts
bureau Services
Blogs
CAD Repositories
Crowd Funding

LEVEL 4 - NATIONAL AND INTERNATIONAL

Material and Component
Manufacturers / Suppliers
Brands
NGOs & Government
Support
Policy and Regualtion
Reserach Centres
Software and Hardware
Providers

Our first level focuses on the domain of the Makespace, which contains the tools, technologies, cultures, knowledge and practices that currently does and potentially could exist to enable RdM.

Our second study level focuses on the areas Makespaces are located in and the role they can play as active participants in their local area to enable local and regional manufacturing.

Within each level there are things we have identified that we think are worthy of studies, therefore we conduct a symposium for each to help us draw out and add to these, to baseline what is known about a given territory and to ensure that we and our network have a deeper understanding of the challenges and opportunities that need to be tested.

The aim is that the symposium can ensure that possible feasibility studies have an in-depth understanding of the area - a firm understanding of the state of the present research landscape as well as who the trailblazing organizations, projects or individuals are who are testing the boundaries of what is understood at this level.

In reviewing the studies our primary objective is to make sure that the studies we fund tackle the most pertinent and foundational, as identify what is fundamental to this domain and propose something - a hypothesis - that can be tested to move our understanding forward.

As our mandate from the EPSRC is agenda forming, we have an emphasis on action research. As we believe first hand intervening and testing assumptions - going beyond desk based research and straight observation gives us better understanding and better questions - so we can understand more specifically where the future research focus should be.

Mid Project Insights and Understanding From the Makespace Level

At the time of the Making Futures conference, we had run two events, a symposium for the makespace level at Machines Room in London and the local communities level symposium at the Biospheric Foundation in Salford and had two feasibility studies underway.

Within the makespace level our focus was on cultures, tools, practices and processes that could enable future redistributed manufacture and sustainable practice. Including identifying a vision for the key technologies, people and skills, tools, materials, resources, cultures and methods that are needed in makespaces for them to support redistributed manufacturing and in order to move from linear economy practice to circular economy practice.

We know where the makespaces are, and what the standard range of equipment is (Stokes 2015) - we know and have followed the genealogy of makespaces and the ideology of both hacker culture (Maxigas 2014) and the maker movement. We've a firm understanding and a respect for Britton's (2014) work on the discourse of the maker movement, Corbin's work on materials and community (Corbin 2015), Smith's (2014) work on the experiences and position of the technology networks and grassroots innovation (Smith et al. 2013).

The changing dynamics of work and communities, including the rise in people identifying themselves as makers or using makespaces, has significant implications; digital making and tools can be seen as primary, but what other factors are important if we are to effectively put these tools and spaces to good use?

The studies we selected focused on two of the factors that are fundamental in establishing the velocity and nature of the relationship between RdM and makespaces - education and sustainable practice.

RE:FORM with the Open University and Maklab explores the role future makespaces could play in working with academia and industry to provide training to support the employment needs of redistributed manufacturing. Investigating models of cooperative learning and pedagogy and considering suitable accreditation schemes for makespace learning that are relevant to industry.

Circular Makespaces with Sustain RCA considers how the current opportunity to move to a circular model of production can be achieved with the makespace community at its heart. The exploratory study builds on previous research, exploring assets already in place within existing makespaces – people, culture, facilities, technology, skills and business models – from a circular economy viewpoint.

Together, they test the potential role of makespaces in redistributed manufacture, informing us what the shape and nature of future makespaces could be, particularly in relation to the tools, cultures and practices necessary for tackling both the skills and accreditation needed in this domain, and the culture and practice needed in terms of sustainable production. Recognizing that this demassified production landscape enables 'bad' practices to be amplified and distributed effectively, as much as it does world-enhancing innovation.

The studies we funded tackled issues we considered foundational both to our research and also to a creating a 'terra firma' of insights to inform the design of redistributed manufacturing systems and approaches. Through evaluating and stretching the boundaries of current practices and capacities, they inform our understanding of the implications of that future system of redistributed manufacturing; socially, culturally, economically and politically.

Case Study one: OU/MAKLab reform

Manufacturing is changing. The use of networked technologies by industries to change the nature of their supply chains, requires different skills. Responding to the call for a Level 1 Feasibility Study to explore the landscape around makespaces and redistributed manufacturing, this project chose to focus on the educational role of makespaces.

Government and industry have identified that certain industries are finding a skills deficit in education-leavers. This project team proposed that formal educational institutions such as universities can work with community makespaces to overcome this deficit and nurture future designers and makers better placed to participate in the future employment landscape of redistributed manufacturing; both as employees in established organisations, and as self-employed entrepreneurs in their own right

The Open University and MAKLab's study aimed to:

(1) Understand the key challenges faced by makespaces in providing effective and relevant education and training for redistributed manufacturing in the UK.

(2) Understand the capacity for collaborations between makespaces and educators to fulfil the education and training requirements for effective distributed manufacturing in the UK.

(3) Investigate the role of accreditation in supporting career trajectories in redistributed

The project saw makespaces as having the potential to act as a central mediating space for enabling the education of a future generation of 'employees' in professions associated with redistributed manufacturing. By 'employees' they were referring to former learners both as employees in established organisations, and as self-employed entrepreneurs in their own right. A range of educational institutions could work alongside makespaces to provide training, including Further Education and Higher Education providers, and industries offering apprenticeships. On going conversations with makespaces' existing networks (including industry partners, SME's, start-ups, and independent designers and makers) can ensure the training provided is relevant to the needs of redistributed manufacturing.

This project is explored the rich territory around networked learning of a very embodied, practical making skill: this allowed the OU to consider how to support networked learning which moves beyond paper based learning, and for MAKLab it was an opportunity to think about the challenges of learning via networks (rather than face to face) and at scale.

Despite using a low-fi approach and all the communication happening via forum posts, it proved a rich medium with over eighty posts in the busiest thread between pairs (several hundred posts in all). It is an authentic learning exercise which is getting both sets of learners to think about their partner's requirements and put themselves in their shoes, giving them experience of not only having to learn the technical skills (2D CAD drawing, prototyping using CNC routers and 12mm ply at real scale) but the communication skills and strategies required.

There is a lot of territory to cover in the future around networked learning distributed across the UK and around scaling this work. MAKLab is already working with their local universities in Glasgow and the project shows that collaborative working between makerspaces and universities may be a very feasible way of supporting learning in different localities and also providing support for learners' transitions – from formal to informal, informal to formal, and through career trajectories.

Case Study two: Sustain RCA

While there is a presumption that makespaces are intrinsically engaged in a vision for redistributed manufacturing and the creation of a circular economy practice, there is no empirical evidence to support this, this project sought to explore this link more fully.

If community based digital fabrication workshops, or makespaces are anticipated to be the hothouse for this new era of localised production they may be a key to future sustainable design and manufacturing practices. The concept of the circular economy (CE) conceptualises the move from a linear economy of takemakewaste to a system (Macarthur 2013) through repair, remanufacturing, refurbishment and recycling, which maintain materials and resources in a closed cycle. Despite the clear interplay between RdM and CE, there is limited research exploring this relationship.

In light of these interconnected developments, the aim of this project was to explore the role of makespaces in contributing to a circular economy through redistributed manufacturing activities.

The overarching aim of this research is to explore the role of makespaces in contributing to a circular economy through redistributed manufacturing activities. The project sought to uncover triggers for circular practices in order to do this they defined the following three objectives:

(1) To build understanding of how makespaces can be purpose focused, seeing themselves to be creators of sustainable cultures and society as well as simply makers of stuff.

(2) Identify the challenges to the uptake of circular practices.

(3) To set out a roadmap from this initial research, outlining gaps, opportunities and needs of the makespace community.

Circular Makespaces considered that was a need for simple tools and applicable material knowledge that can be embedded into the culture of makespaces – not another toolkit that can sit on a shelf and demands additional of the scare resource of money and time.

This research is taking an exploratory approach using semistructured interviews and actionled workshops underpinned by a literature review. The research findings uncover the overlaps between CE and RdM, identify barriers and opportunities to both CE and RdM practices, and identifies a range of future research directions that can support the coming together of these areas.

These two studies at the time of presentation were on-going, they will publish in their own right and with us, condensing their learning into actionable research findings to steer future research investment and current practice.

Conclusion

It's early days for the research of the Future Makespaces in Redistributed Manufacturing project, but there is a breadth of current research in this space and a few thousand years of material and resource management to draw upon.

We are not promising a refined utopian vision of future makers enabled by a technological panacea, nor are we promising the overthrow of exploitative capitalism by the 'March of the makers' (Elliot 2016) or any similarly alliterative movement or empire.

Instead we are offering a pragmatic vision of the future of manufacturing - a future vision that reflects the state of makespaces now, tests ideas and aspirations of education and circular economy, and uses insights from those studies to imagine a future and its implications.

From the RE:FORM study we see that there is space for educating for industrial scale redistributed manufacturing, with this initial small scale and low fi twelve week case study proving that there is value and material awareness in an approach to education that integrates the methodology of a distributed mook and local makespaces.

From Circular Makespaces we see where best to intervene within makespaces culture and practices, to enable appropriate material knowledge of both good practice and also resource imperatives to best embed circular economy principles in makespaces and redistributed manufacturing.

Together, and informed by our cross-cutting research we consider that the current demassification of the landscape of manufacture, alongside the emergence of makespaces and the associated culture of open resources and practices has potential to play a role in future manufacturing.

We are still evolving that vision based on the evidence of what is happening now. From our cross-cutting research we can see that the implications and amplifications of how we design has changed, and even fractured, with a material choice for a product designed in one place potentially having resource implications on the other side of the world through the affordances on pan-geographic infrastructures, networks and platforms.

In this landscape of distributed production, supply and design chain changes - gaps in material literacy start to have fundamental ramifications.

We are not imagining that the production of 3D printed Yodas in and of itself will shift how and where we as a society make things. However, we can evidence that how and where decisions about what is made, by whom, and to whose benefit are changing. The value system of making has rapidly changed. That encompasses access and ownership, risk and responsibility, amplifications and implications – it is our job to find the challenges and barriers that are squeezing those shifts into negative patterns with unfortunate consequences, it is our job to consider the role of makespaces and redistributed manufacturing in a production system fit for humans.

As we continue with these studies and make sense of their findings we need to hang these visions of the future in pragmatic terms that reflect the urgency of our current position. What do these projects and the emerging role of makespaces in redistributed manufacturing tell us about the inevitable future of business as usual? The potential future if we recalibrate the logic of how and what we make? Or crucially the desirable future - the future production ecosystem we aspire to live within?

References

Abel, B. (2011). Open design now. Amsterdam, The Netherlands: BIS Publishers.

Arieff, A. (2014). Yes We Can. But Should We? — re:form. [online] Medium. Available at: https://medium.com/re-form/just-because-you-can-doesnt-mean-you-should-252fdbcf76c8#.1fbr23a3o

Britton, L. (2014). Examining the maker movement through discourse analysis: An introduction | Technology & Social Change Group. [online] Tascha.uw.edu. Available at: http://tascha.uw.edu/2014/07/examining-the-maker-movement-through-discourse-analysis-an-introduction/.

Corbin, E. (2015). Manufacturing Futures: The role of 'open-access' making.

Dellot, B. (2015). Ours to Master: How makerspaces can help us master technology for a more human end. [online] London: RSA. Available at: https://www.thersa.org/discover/publications-and-articles/reports/ours-to-master/.

Elliott, L. (2016). March of the makers remains a figment of Osborne's imagination. [online] the Guardian. Available at: http://www.theguardian.com/business/2016/jan/12/march-of-the-makers-osbornes-economy-manufacturing-output.

Foresight, (2013). The Future of Manufacturing: A new era of opportunity and challenge for the UK Summary Report. Foresight. [online] London: The Government Office for Science. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/255923/13-810-future-manufacturing-summary-report.pdf.

Pearson, H., Noble, G. and Hawkins, J. (2013). Re-Distributed Manufacturing Workshop. [online]

Epsrc.ac.uk. Available at: https://www.epsrc.ac.uk/newsevents/pubs/re-distributed-manufacturing-workshop-report/

Policy Connect, (2015). Industrial Evolution, making British manufacturing sustainable, Manufacturing Commission. [online] London: Policy Connect. Available at: http://www.policyconnect.org.uk/apmg/sites/site_apmg/files/industrial_evolution_final_single-paged.pdf

Sloan, R. (2015). Why I quit ordering from Uber-for-food start-ups. [online] The Atlantic. Available at: http://www.theatlantic.com/technology/archive/2015/11/the-food-delivery-start-up-you-havent-heard-of/414540/?utm_content=bufferf1367&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

Smith, A. (2014). Technology networks for socially useful production. Journal of Peer production, [online] 5. Available at: http://sro.sussex.ac.uk/53574/2/Smith_2014_Technology_Networks_JPP_final.pdf

Stokes, K., Stewart, H. and Sleigh, A. (2015). Top findings from the open dataset of UK makerspaces | Nesta. [online] Nesta.org.uk. Available at: http://www.nesta.org.uk/blog/top-findings-open-dataset-uk-makerspaces

The Center for a Stateless Society (C4SS),(2015). Industrial Policy: New Wine in Old Bottles. http://c4ss.org/wp-content/uploads/2009/01/industrialpolicycarson0109.pdf
Wever, R. (2013). Is 80% of environmental impact determined during the design phase,.... [online] Researchgate.net. Available at: https://www.researchgate.net/post/Is_80_of_environmental_impact_determined_during_the_design_phase_or_not