This home is a factory: Implications of the Maker movement on urban environments

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Abstract: This paper considers the matter of sites of production in view of recent technologically enabled trends toward the intersection of designing and making. These changes have been conceptualised as 'open design' or as 'consumer-as-producer' and they are specifically manifest in accessible and inexpensive 3D printing. We argue here that these developments reactivate the Arts and Crafts notion of personalised domestic-scale production in newly technologised and globally connected ways. Akin to the ideals of the 1970s Punk movement, amateurs can become agents of change as the open-source Maker movement provides individuals with the 'source code' to make, adapt and disseminate individualised products via information and communication technology (ICT) channels. This paper discusses the possible impacts of distributed making on our urban landscapes, with the increasing conflation of domestic, industrial and retail zones and what some have described as 'maker-friendly' cities.

Introduction

> We want one man to be always thinking, and another to be always working, and we call one a gentleman, and the other an operative; whereas the workman ought often to be thinking, and the thinker often to be working, and both should be gentlemen, in the best sense. As it is, we make both ungentle, the one envying, the other despising, his brother; and the mass of society is made up of morbid thinkers and miserable workers. Now it is only by labour that thought can be made healthy, and only by thought that labour can be made happy, and the two cannot be separated with impunity. (Ruskin 1903–1912: 201)

This paper considers sites of production in view of recent, technologically enabled trends toward the intersection of designing and making. These changes have been conceptualised as 'open design' (Vallance, Kiani and Nayfeh 2001; Kadushin 2010) or as 'consumer-as-producer' (Gunderson 2004) and they are specifically manifest in accessible and inexpensive three-dimensional (3D) printing (Bowyer 2011).

With strong continuities with the Arts and Crafts movement of the late nineteenth to early twentieth century, particularly William Morris and his Kelmscott Press (Peterson 1991) and, more recently, with user-generated digital media, particularly in the music industry (Gunderson 2004), and the emergent category

of small-press book publishers (Haylock 2011), there is evidence of a rejoining of the roles of designer and producer. Products developed organically in an open-source digital environment and printed by 3D digital fabrication tools can be modified, 'mashed-up', evolved and manufactured within domestic, studio and public environments according to personal needs and taste. The process of independent production figures strongly in all of these examples. On account of developments in FAB tools — small form factor 2D and 3D printers, laser cutters, computer numerical control (CNC) machines and vinyl cutters (Gershenfeld 2005) — small spaces, including domestic environments, can become sites of production. Consequently, factories of the future do not need to be sited in vast industrial parks, but can, to some extent, be distributed across thousands of homes and small, collective workspaces in the urban environment. We are already beginning to see the impact of this new manufacturing on cities: with the revival of the local in new manufacturing communities that utilise global, digitised technology, and with these communities networking in and across zones of production that form nuanced areas of specialisation. In this, we are also seeing the collapsing of industrial and non-industrial spaces, and of sites of leisure, community, design, manufacturing and training.

In Section 1, we outline the rise of 3D printing within the broader context of the Maker movement and open-source file sharing, and its situation in domestic and community spaces. In Section 2, we address the implication of these developments with respect to questions of community and urban space. And in the final section we offer a brief example of such spatial shifts by examining 3D printing and the Maker movement in the city of Detroit in the United States.

Domestic-scale production, Open Design and the Maker movement

A reorganisation of the sites of production can be seen in a range of activities that previously might have been considered separate industries, but are now part of an overarching Maker movement — a broad association of individuals and groups, in the United States and around the world, who are said to 'passionately engage with objects' in making activities that often involve digital tools and new technologies (Dougherty 2012: 12; see also Monitor 2011; Stangler and Maxwell 2012). Foundational in this reorganisation is the ability to translate digital data into physical artefacts. As we discuss, the proliferation of 3D printing demonstrates the effectiveness of the conjoined functions of the 'democratisation of technology' (Burgess 2006) and internet connectivity as a conduit for a new and formidable type of cultural production. It fosters what might be described as utopian impulses engendering a culture of DIY artisans utilising Web 2.0, social media and creative software tools, who are enabled to make and disseminate products outside normal corporate–consumer channels (Gunderson 2004).

Similarly, 3D printing gives designers and makers the ability to produce one-off and limited-run batches of three-dimensional products in domestic locations and studio environments, bypassing the need for the expensive tooling that is used in traditional manufacturing. Sometimes referred to as Additive Manufacturing or Direct Digital Manufacturing, 3D printing is a rapidly maturing industry. With a 29.4 per cent growth in 2011, it eclipsed its own collective historical growth (26.4 per cent) in one year (Wohlers Associates 2012). Many believe that it will transform the future of manufacturing and become an integrated part of everyday life (see for example; Bernard and Fischer 2002; Gershenfeld 2005; Bowyer 2011; *Economist* 2012; Anderson 2012; Quirk 2012). 3D printing technologies are now coming to be widely used for the batch production of parts, which is a radical departure from traditional mass manufacturing. Set-up costs are relatively low, determined primarily by the equipment purchased, and ongoing costs can be minimised due to inexpensive raw materials, easy maintenance, small spatial requirements and limited power usage (Harris 2012).

Since the mid-2000s, technological developments have seen the costs of 3D printing technology reduce and accessibility increase markedly. Importantly, these developments have not come from industry, but stem from the activities of academic researchers and enthusiasts whose primary aims are to democratise technologies for making artefacts. They are based on open-source platforms and designed to be hacked, innovated and distributed by and amongst communities.

Open Source Hardware (OSHW) has sparked the Maker movement, which comprises online communities of individuals who freely exchange information about how to make things (Monitor 2011; Dougherty 2012; Stangler and Maxwell 2012). Akin to the punk movement of the 1970s, which rested on the presumption that amateurs might become agents of change (Hebdige 2002, as cited by Mason 2008), the open-source platfroms of OSHW 3D printers reflect the underpinning of an Open Design methodology — a process where the design information of core constituents of physical artefacts are made accessible to end users regardless of geographic, social and economic standing through internet connectivity (see for example Vallance, Kiani and Nayfeh, 2001; Kadushin 2010; Troxler 2011). It is an adaption of open-source methods which have been used in software development for a number of decades — where the source code of computer software is made freely available for anyone to innovate, modify and improve. This methodology allows designs to rapidly flourish because development is open to a global network of innovators rather than a select few within an organisational structure. It is an intrinsically participatory process, providing the opportunity for designers to maintain a closer relationship with the end user: individuals are given the opportunity to generate content, adapt and personalise products, and be involved in the making process. Since the 'hacking' of 3D printing technology by open-source users, the price of non-open-source, commercially available machines have fallen dramatically, with some available for the price of a mid-range domestic 2D printer.

The practices of distributed manufacturing and the conflation of the roles of designer and maker represent a clear departure from Fordist labour division and mark a progresson on the post-Fordist trajectory of flexible means of production: the distribution of which has moved beyond interconnected organisational structures and into a rhizomic network of globally dispersed individuals. The Maker movement works to collapse the disparate mode of designing and manufacturing, instead returning the role of making to the hands of the designer, and perhaps more importantly, the end user. The designer's role in this case moves away from developing products as singular, finite artefacts, to establishing a meta-system within which the product mutably resides (Saakes 2011; Vasser, Stippers, Kistemaker 2011; De Mul 2011). Further, the trend towards 'consumer-as-producer' (Gunderson 2004) provides a framework for user-generated design, development and production. This new type of actor may or may not be formally trained but has access to a wealth of knowledge and manufacturing precedents via a network of similarly minded individuals, and has access to the tools to produce their designs via shared spaces. These spaces are both online (blogs, wikis and repositories such as SourceForge, Github, Codeplane and Bitbucket) and physical (Fablabs, hackerspaces and 100K Garages).

The notion of the meta-design requires an inherent degree of product incompleteness — i.e., the design itself is never final but becomes one possibility among many in the course of a perpetual development cycle (Garud, Jain and Tuertscher 2008). Designing products for incompleteness also means that they can be retailed in various states of completion and can be customised by the end user when they have the means or inclination to do so. Products can also be updated, reconfigured and upcycled to take on different forms rather than remaining static in their embodiment. In a new, digitally enabled frontier of networked society, 'designs are like dynamic jigsaw puzzles in which multiple actors assemble pieces within templates that change as a result of the actors' engagement' (Garud et al. 2008). Collectively, these design templates and small-scale digital tools, coupled with internet connectivity, mean that sites of production can be situated almost anywhere with internet connection — but most commonly in the home or studio environment: this is sometimes referred to as desktop fabrication, or what is termed in this paper as domestic-scale production.

This new form of designer-consumer manufacturing has led to the ongoing establishment of networks of distributed, digitally enabled, small-scale producers in domestic, workshop and studio environments. A broad customer or end-user base can be intrinsically involved in the processes of both the design and making of artefacts. As a consequence, feedback loops are both rapid and integrated, thus allowing batch manufacturing of products en masse, but with high levels of potential product variability and the continual updatability of parts and sub-assemblies. Artefacts can also be manufactured on demand in close proximity to the end location of the product, which vastly reduces product

miles. Local materials can be sourced, which can stimulate local revenue streams and create new business opportunities within community groups. The manufacturing workforce is also fluidly variable according to demand.

The precedent for distributed, domestic-scale, digital manufacturing is growing. In 2009, for instance, Makerbot Industries called for community contributions from a global base of home fabricators to manufacture pulleys to be included in 3D printer kits (Pettis 2009). More recently, a request was made for global contributions to a project to manufacture connectors for an open-source geodesic dome (Nirmal 2010). Precedents such as these demonstrate a new way of thinking about the location and operation of production. Rather than relying on single-source manufacturers for sub-assemblies, manufacturing can be undertaken from multiple locations and from a variety of contributors, providing opportunities for siting it in the home.

Impact on urban landscapes: Community and spatial consequences

Our discussion here acknowledges that economic and productive activity is (necessarily but not sufficiently) fundamental to urban development, while allowing for a range of human behaviours and values that determine the dynamics of urban life (see, Scott 2006). With this in mind, perhaps the most obvious shift brought about by the new potential of domestic-scale manufacturing is the return to the co-location of the range of activities associated with manufacturing, drawing them back into the cities, communities and landscapes of consumption. This is in contrast to the twentieth century global approach that sees manufacturing as capable of enormous volumes but that has processes that are fragmented, depersonalised and resource-intensive. With both the 'inputs' and the 'outputs' of domestic-scale distributed manufacturing localised in terms of individuals, resources, customised knowledge and technology, it is arguable that these dynamics have been and will continue to profoundly impact urban life.

These changes are compelling in that, in one sense, they involve a seemingly retrograde move back to a reinstatement of the local, particularly in involving the individual craftsperson or producer situated within a regionally based community. While we acknowledge that more conventional manufacturing and economic activities have always been grounded in the local to some extent, there remains a recent, decided move in post-Fordist global production to the revived phenomenon of co-location (Scott 2006). This type of shift, as demonstrated through Maker culture, can have profound economic and social benefits:

> Economists and others have long realized that the benefits of co-location — when engineering, design, and manufacturing jobs exist in the same geographic place — go well beyond job numbers. Spillovers and returns to proximity matter; moreover, when manufacturing jobs leave, the innovative

> potential of the remaining workers is undermined and, hence, the skills and knowledge level of the surrounding area go untapped. (Strangler and Maxwell 2012)

In this sense, this new wave in manufacturing reinserts the human element into productive enterprises, particularly with its potential to ‘grow’ the urban community. As distinctive relationships are emphasised and technology is democratised, certain populations can more ably choose to 'stay put' rather than uproot in the pursuit of employment. These towns and cities could come to reflect an at least partial restoration of the social grounded in the geographical as an enduring value — what Lipietz (1994) is gesturing to when he says:

> emotional and familial relations are the main component in the conditions for human development and happiness, and they require material conditions: stability of communities, linked to territories. The compromise should therefore embrace not only the ‘right to work’, but also the ‘right to live and work in one's own region’. (Lipietz 1994)

Critically, however, this return to the local is overlaid by a community-governed and digitised 'wiki culture' that makes use of a sophisticated, globalised reservoir of manufacturing and design know-how. Distributed manufacturing relies on a large volume of knowledge transfer across individual, organisational and national boundaries, and thus in the ‘wikinomics’ described by Tapscott and Williams (2006), such economies remain decidedly global in their use of mass collaboration, such as the open-source cooperation outlined above.

This dual process of the personalised local with the digitised global has the potential to breathe some new life into the 'ghost towns' that have been impoverished by industrial collapse, as our example in the next section illustrates. While the impact of this collapse is formidable and not to be underestimated, we can see the creation of some new productivity, creative expression, social economy and urban identity where it was previously waning.

Allen Scott’s description of ‘creative cities’ of the ‘new economy’ was written at the birth of the Maker movement and argued that urbanisation around the world was well and truly on its way to reflecting the productive dynamism described by Florida (2002) of ‘the new creative class’ (Scott 2006: 3–4). Scott argues that the city’s physical make-up has come to reflect new, organic networks of reciprocity that form between producers — both sole operators and corporate operations that have increasingly taken on the new economy’s values: of flexibility, specialisation and rapid adaptiveness (2006: 5). Scott notes that cities have been reforming on the basis of ‘articulation of specialised agglomeration’: both small, niche geographical groupings and larger, more diffuse cities that possess zones of specialised production (2006: 9–10). In the latter, dense local development is likely, but so too is the teasing out of sub-regions across a wide area beyond the boundaries of a central business district. According to Scott, these larger cities have been adopting nuanced distinction of their various ‘mini’-industrial quarters while maintaining overlapping spaces (2006: 9). From this description we might extrapolate a Maker city (such as Detroit, see

Section 3) that has regions of specialisation spread out and away from the CBD and conventional industrial areas, each with a determinable specialisation, with shared spaces among them and perhaps certain continuities in each (distributed domestic-scale facilities in most regions, for example).

Similarly, Dale Dougherty (2012) describes 'maker-friendly cities' whose new style of commerce moves things away from last century's large, centralised shopping/consumption complexes (the city of sensory spectacles described by Debord 1994) towards smaller shops, associations, studios and domestic craftspeople. A culture that is less promoting of passive consumption and activities, like shopping for its own sake (Birtchnell and Urry 2012), and more of active involvement by 'prosumers' in both making and/or customising goods (Toffler 1980) would suggest a decline in demand for public spaces like shopping malls and high streets towards multipurpose sites scattered within and around residential areas that function as manufacturing hubs, print shops and sites of association for networks of micro-communities (Birtchnell and Urry 2012). We could also assume that there would be less need for vast industrial parks and suburbs as retail and manufacturing sites converge.

Scott posits that all new economy cities possess a distinctiveness of identity and output that is a key component of their survival (2006: 9). Communities require more than the mere promise of creative opportunities to ensure their long-term durability, which is his contention regarding Florida's ideas on creative communities, and so a critical aspect of maintaining and growing a citizenry is the city's unique style of material and cultural production. A powerful tool in developing this distinctive identity is the 're-branding' of its architecture as renewed history and identity of place, and with greater optimism on the quality of life in its society (Scott 2006: 9–10). In this light we can see inner-city and inner-suburban industrial spaces that have in the past 30 years been redeveloped as residential dwellings and retail outlets again being activated as sites of production. Thomas Birtchnell and John Urry (2012) describe this blurring of domestic and manufacturing spaces, wherein the suburbs and apartments of cities and towns become productive spaces for the goods consumed in daily life. An example might be retail spaces printing on-the-spot products sourced from a digital repository, rather than customers choosing from off-the-shelf products (see 3D photo booth as a precursor example, Wainwright 2012).

Another important urban feature, according to Scott, is the facilitation of 'the smooth habituation and socialisation of workers, easing their circulation through regional structures of employment and helping to maintain the idiosyncratic advantages of the local production system' (2006: 7). This would require not just a localised production system, but also training and local learning facilities (Scott 2006: 9–10). One of the intrinsic elements of the Maker movement is the notion of collectively run, open workshops akin to the principles of the Fab Lab. These not only provide access to training but are sites of manufacturing, thus again collapsing the space between these activities. Fab labs are often embedded in community settings and, due to the small physical size of the tools and the networked and distributed connectivity, they can be located in domestic and

inner-urban contexts. Two examples of this trend are Hackerspaces and 100K Garages, both of which provide the means to conflate activities associated with labour, community and leisure; i.e., individuals working in a community setting during leisure time on projects that, in many instances, have commercial value. Hackerspaces are a global collective of physical meeting spaces that provide a means for 'creative expression plus community'. The concept, founded by Mitch Altman in 2007 at the Chaos Communication Congress in Berlin, provides spaces around the world for hacking — that is, 'taking what is, improving upon it and then sharing it'. This process involves input from people from all walks of life with the focus on the production of things that perform specific, many and varied functions. Many projects involve electronics and digital fabrication; they are not, however, limited to these processes. Given the initiative's focus on community, the spaces provide free education that is based on peer-to-peer learning, and outcomes that are often open-source in nature. Over 1,100 hackerspaces are now in operation worldwide. (Altman 2012)

100K Garages (Shopbot Tools, Inc. 2012) is a website that connects designers (anyone who has designed something to be made) with fabrication facilities (Fabbers) that are located nearby. As the title suggests, these facilities are sometimes located in domestic environments and include digital manufacturing tools such as 3D printers, CNC machines and laser cutters. Negotiations of price and allocation of tasks — i.e., what contribution the designer makes to the making process — is dealt with on a one-to-one basis.

Detroit 2.0 (Or Lemonade Detroit)[1]

An obvious case in point is the city of Detroit, Michigan in the United States, the largest boomtown in North American history that has, in recent decades, been crippled by its self-declared financial emergency of widespread poverty, high unemployment and evacuation of the city's downtown and expansive industrial zones (two-thirds of the city is classified as industrial) (Proulx 2013). Some estimations are that up to 80,000 buildings have been abandoned (Dawkins 2011). This has largely been due to the collapse of the automobile industry and, therefore the economy of the 'Motor City'. More recently, however, there has arisen a strong subculture of artist, maker and entrepreneurial networks that have reclaimed the abandoned spaces of the city's industrial past, with a new emphasis on collaborative reuse (see for example Ryzik 2010; Dougherty 2010; Dawkins 2011). These micro-enterprises are occupying the architectural symbols of twentieth century megalith industry and other social relics and have converted them into sites of technologically advanced, yet decidedly human, mico-enterprises plugged into an expansive network of like-minded enterprises (see also, Dawkins 2011). While the extent of the economic and political potential

1 The title is taken from Erik Prouxl's independent film *Lemonade: Detroit*, online at http ://www.lemonadedetroit.com/.

of these communities, which often present optimistic, even utopian messages, is complex (see, Dawkins 2011), their presence is nonetheless significant in Detroit.

For example, Dearborn in Detroit's metropolitan area was the nucleus of the automotive manufacturing industry and notably the Ford Motor Company's manufacturing sites and suppliers. In the industrial premises adjacent to Ford's product development campus, the fabrication workshop, TechShop, has opened:

> a prototyping studio on a mission to democratize access to the tools of innovation [with] cutting-edge tools, equipment, and computers loaded with design software featuring the Autodesk Design Suite. Most importantly, TechShop offers space to make, and the support and camaraderie of a community of makers … (TechShop 2013)

Ford actively encourages its employees to use these facilities while seeking to forge commercial relationships with makers in general (see, TechShop 2013). The once-industrial giant says it hopes to 'spark imagination that could be the solution to problems that we couldn't solve before, or develop all new ideas that are answers to questions we weren't even asking …' (Coughlin, cited in Gansky 2012)

Closer to the centre of town in Near-East Detroit, a growing community of artists, urban farmers, teachers, activists and builders has taken over abandoned buildings for communal activities such as gardening, sidewalk stalls, art installations and theatre performances (for example, see the Yes Farm website 2013). In the same region is a fab lab and training facility, the Mt. Elliott Makerspace (MEM). The MEM operates out of a nineteenth century Episcopalian church to provide workshop facilities and training for carpentry, electronics, crafting and knitting, among other activities (MEM website 2013). The area presents a good example of a dense residential and semi-corporate sub-region that collapses studio, leisure, retail, training and manufacturing sites.

The 'granddaddy' of these activities is the Midwest Maker Faire in Detroit, the largest of a range of craft and maker fairs in the city, which is held in the Henry Ford exhibition centre in Dearborn in the heart of the old automotive manufacturing precinct. Since it began in 2010, the Faire has drawn 65,000 DIY enthusiasts: crafters, tinkerers and hackers sharing their projects (Hass 2013). At a Maker Faire event in 2010, K. Venkatesh Prasad, senior engineer with the Ford Motor Company, described the potential of the new movement in this way:

> What if Detroit's capacity of factory spaces, automobile proving grounds, specialized manufacturing equipment and enormous intellectual concentration could get re-purposed and re-wired and be made available to auto 'makers', not just the Big-3 or the Big-6, but the 'Small Millions'? … Detroit 2.0 is the re-making of the Motor City to become the cradle of a new generation of creativity built on shared space, shared toolkits, shared platforms and most importantly shared human intelligence, energy and zeal to create … (Hass 2013)

Conclusion

The developments in design and manufacturing practices examined here recombine the roles of designer and maker, which have been mostly separated for more than a century by the industrial organisation of production. Recent moves in post-Fordism to highly distributed, small-batch and one-off production, enabled by new manufacturing technologies, will have a discernible impact on urban life with potential economic and social benefits. This has importantly involved a revived notion of co-location and the conflation of labour roles, and sites of production. We draw on Scott's view of 'creative cities' in the early twenty-first century, and changes taking place currently in Detroit in the United States (among other cities), to argue that alternative Maker networks, which form in sub-regions spread throughout urban populations, are taking up and transforming the architecture of industrial-era corporatism to reflect a new wave of maker values. These values incorporate virtual collaboration, open-source knowledge sharing, material reuse and, in some cases, more durable artefacts.

Emergent developments in 3D printing represent a democratisation of technology and the production of objects. Despite requiring qualification, not least because there are still some financial barriers to entry (an egalitarian ideal of designing-making cannot yet be celebrated), much significance can be ascribed to developments in open innovation. OSHW stands to positively affect the richness of collective knowledge-building and sharing, whilst also driving the cost of technology to a more accessible price point. Significantly, these enabling technologies provide new means for shifting practices of making from the domains of industrial parks and locations around the globe to the homes, studios and fablabs of designers and end users. This has the capacity to in part reinvigorate cities suffering economic and industrial slow-downs and, further, that by dispersing sites of creative production throughout the community, greater amenity and resilience can be achieved.

Future research in this area might address the particular benefits of these emergent practices with respect to education — either higher education or community education programs. Further, much might be learned from empirical sociological analyses of communities of designer-maker-users, or from design practice-based research in this area, which might be concerned with technical innovation, or with systems of community-building.

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References

Altman, M. 2012, 'The Hackerspace Movement', presentation, Tedx Brussels 2012, http://www.tedxbrussels.eu/2012/speakers/mitch_altman.php.

Anderson, C. 2009, *The Long Tail*, London: Random House Business Books

—— 2012, *Makers*, New York: Random House.

Bernard, A. & Fischer, A. 2002, 'New trends in rapid product development', *CIRP Annals—Manufacturing Technology*, vol. 51, no. 2, pp. 635–52.

Bowyer, A. 2011, 'Rewriting history', on *Reprap: Blog*, 18 April, viewed 19 July 2012, http://blog.reprap.org/2011_04_01_archive.html.

Birtchnell, T. & Urry, J. 2012, 'Four ways 3D printing could change the world', *Technology Spectator*, 30 Nov. http://www.businessspectator.com.au/article/2012/11/30/technology/four-ways-3d-printing-could-change-world#ixzz2RqfiKPVV.

Burgess, J. 2006,, 'Hearing ordinary voices: Cultural studies, vernacular creativity and digital storytelling, *Continuum: Journal of Media and Cultural Studies*, vol. 20, no. 2, pp. 201–14.

Dawkins, N. 2011, 'Do-it-yourself: The precarious work and postfeminist politics of handmaking', *Utopian Studies*, vol. 20, no. 2, pp. 261–85.

Debord, G. 1994 [1967], *The Society of the Spectacle*, Donald Nicholson-Smith (trans.), New York: Zone Books.

Dougherty, D. 2010, 'Making Detroit: Changing the story', *Make: Blog*, 22 July, http://blog.makezine.com/making-detroit.

—— 2012, 'The maker movement', *Innovations*, vol. 7, no. 3, pp. 11–14.

Economist, 2012, 'Solid print: Making things with a 3D printer changes the rules of manufacturing', special report, 21 April, viewed 22 July 2012, www.economist.com/node/21552892.

Florida, R. 2002. *The rise of the creative class*. New York: Basic Books.

Gansky, L. 2012, 'The maker movement is upon us', *Shareable: Life & Art*, 18 May, http://www.shareable.net/blog/the-maker-movement-is-upon-us.

Garud, R., Jain, S. & Tuertscher, P. 2008, 'Incomplete by design and designing for incompleteness', *Organisational Studies*, vol. 29, no. 3.

Gershenfeld, N. 2005, *FAB: The coming revolution on your desktop — from personal computers to personal fabrication*, New York, Basic Books.

Gunderson, P. 2004, 'Danger Mouse's Grey Album, mash-ups, and the age of composition', *Postmodern Culture*, vol. 15, no. 1, Sept.

Harris, I.D. 2012, 'Additive manufacturing: A transformational advanced manufacturing technology, *Advanced Materials and Processes*, vol. 170, no. 5, May, pp. 25–29, viewed 17 July 2012, http://www.asminternational.org/portal/site/www/AsmStore/ProductDetails/?vgnextoid=6b912e00f2d07310VgnVCM100000621e010aRCRD.

Hebdige, D. 2002, *Subculture: The meaning of style*, London: Routledge & New York: Taylor & Francis e-Library.

Hass, Kristine 2013, 'Looking ahead: Maker Faire 2013', *Maker Faire Detroit*, 16 Jan, http://www.makerfairedetroit.com/2013/01/16/looking-ahead-maker-faire-detroit-2013.

Kadushin, R. 2010, 'Open Design Manifesto', *Ronan Kadushin Design*, viewed 18 July 2012, http://www.ronen-kadushin.com/Open_Design.asp.

Lipietz, A. 1994, 'Post-Fordism and democracy', in A. Amin. (ed.) *Post-Fordism: A reader*, Oxford: Blackwell Publishers, pp. 338–57.

MEM, 2013, Mt. Elliott Makerspace, http://www.mtelliottmakerspace.com/

Monitor, 2011, 'More than just digital quilting', *Technology Quarterly: Q4 2011*, viewed 17 July 2011, http://www.economist.com/node/21540392.

Nirmal, 2010, 'Raising the dome', Makerbot News, *Makerbot Industries*, 1 June, viewed 20 July 2012, http://www.makerbot.com/blog/2010/06/01/raising-the-dome/.

Peterson, W. 1991, *The Kelmscott Press: A history of William Morris's typographical adventure*, Oxford University Press.

Pettis, B. 2009, 'Pulleys: Help needed!', Makerbot News, *Makerbot Industries*, 28 Sept. 28, viewed 20 July 2012, http://www.makerbot.com/blog/2009/09/28/pulleys-help-needed/.

Quirk, V. 2012, 'How 3D printing will change our world', *Arch Daily*, viewed 22 July 2012, http://www.archdaily.com/253380.

Ruskin, J. 1903–1912, *The Works of John Ruskin*, E.T. Cook & Alexander Wedderburn (eds), vol. 10, George Allen.

Ryzik, M. 2010, 'Wringing art out of the rubble in Detroit', *New York Times*, 4 Aug.

Saakes, D. 2011, 'Ikea hackers: The Lampan — opportunities for "new" designers bring challenges for "old" designers', *Open Design Now*, p. 223.

Scott, A. (2006) 'Creative cities: Conceptual issues and policy questions', *Journal of Urban Affairs*, vol. 28, no. 1, pp. 1–17.

Shopbot Tools, Inc. 2012, 100K Garages.com: Connect, Collaborate, Create, www.http://www.100kgarages.com.

Strangler, D. & Maxwell, K. 2012, 'DIY Producer Society', *Innovations*, vol. 7, no. 3, pp. 11–14.

TechShop, 2013, website, http://www.techshop.ws/ts_detroit.html.

Troxler, P. 2011, 'The beginning of the beginning of the beginning of a trend', *Open Design Now*, pp. 108–15.

Vallance, R., Kiani, S. & Nayfeh, S. 2001, 'Open design of manufacturing equipment', proceedings of the CHIRP 1st International Conference on Agile, Reconfigurable Manufacturing, viewed 8 Mar. 2009, www.opendesign.org/CHIRP_Open_Design_Mfg_Equipment.pdf.

Wohlers Associates, 2012, 'Wohlers Associates publishes 2012 report on additive manufacturing and 3D printing: Industry study shows annual growth of nearly 30%, media release, viewed 19 July 2012, http://wohlersassociates.com/press56.htm.

Wainwright, O. 2012, Print yourself: The rise of the 3D photo booth', Architecture and Design Blog, *Guardian*, 23 Nov, http://www.guardian.co.uk/artanddesign/architecture-design-blog/2012/nov/23/print-yourself-3d-photo-booth.

Yes Farm, 2013, website, http://www.theyesfarm.blogspot.com.au.