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Sustainable Design Futures: An open design vision for the circular economy in fashion and textiles

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Abstract: This paper explores the concept of the circular economy within the context of fashion and textile design in the UK, and does so from the textile and fashion perspectives to explore how this might be achieved. Within the UK alone, we dispose of approximately 10,000 garments every ten minutes (Kerr & Foster, 2011). This project focuses specifically on the practice of textile and fashion design in the UK to consider a more holistic approach for designing and manufacturing within these sectors. Our research aims are to explore the contribution open design can make in implementing the circular economy and thus a more sustainable material future. We ask what are the new models and systems of production that will support a circular economy in textiles? In this work we propose a vision for circular economic models of production in fashion and textiles that adopt open design approaches.

Keywords: circular economy, open design, sustainable design, material futures

1. Introduction

Within the UK textile sector, there is increasing awareness of the requirement for new textile initiatives to be linked with the concept of the circular economy (Goldsworthy and Earley, 2016), but there is a lack of innovation tools, practical knowledge and accessible evidence available to provide support. Conventional methods of dealing with issues of waste, sustainability and resource efficiencies have been citied as being symptoms based; they have not addressed continuous and rising consumption levels. To address this we need to re-imagine production and consumption systems, and develop ways to educate designers and consumers to a more circular way of thinking. Design has a key role to play in this systemic change but needs new strategies and models to help implement it. An Open Design (OD) approach, with its focus on transparent material supply and production process, collaborative nature, free distribution of design data (Tooze et al), and collective action, is well placed to contribute to a new strategy for designing for sustainable futures and the circular economy.

This paper provides a preview of a six-month feasibility study titled '*Re-Mantle and Make'* led by the Glasgow School of Art. This research is funded by a larger project titled 'Future Makespaces in Redistributed Manufacturing', a two-year research project funded by the Engineering and Physical Sciences Research Council (EPSRC). The larger project is led by Baurley, Tooze, Stewart and Hunter (2014-16) from the Royal College of Art, London, and explores the role of maker spaces in redistributed manufacturing (RdM). Our study will be undertaken in partnership with Kalopsia Collective, a micro-manufacturing unit based in Edinburgh, Scotland. Together we will conduct practice-led research to produce a small collection of fashion accessories within a circular economy model. In addition to the collection we will prototype a potential future maker space for circular textile design to scope what tools, techniques, equipment and materials might be required. Currently there are limited practical examples and it is unknown if it is truly possible to implement close loop innovation within the textile sector and on what scale. Our study aims to explore the barriers and opportunities to this closed loop scenario.

Through the research we aim to investigate how we can use maker spaces to cultivate circular thinking for textile designers and provide them with resources to develop circular design knowledge and practice. Re-Mantle and Make was defined as a term by the authors as a provocation to challenge our perceived perception of a finished artefact. This is also a model aiming to demonstrate how future maker spaces could be developed to experiment with strategies for material recovery, repair and reuse on a local scale, providing educational hubs for designers to experiment and learn. This will be achieved through consultation and partnership with textile manufacturers, engagement with higher-education institutions, small to medium enterprises and policy makers to investigate the potential for sustainable, circular design futures in the textile industry.

2. Circular Economy; definitions, theories and opportunities

The Circular Economy according to the Ellen MacArthur Foundation (2013) is a new way to think about our industrial systems of production. In a circular system we would move away from the current linear take, make and dispose system to a system that restores resources and regenerates rather than ultimately disposing of the material resources we use in our daily lives. In circular economic theory 'end-of-life' concepts are replaced with principles of renewal and continued usefulness, where elements of the whole system interact intelligently to prolong life and maximize resource. This systems thinking model goes back further than current society, Von Bertalanffy (1950) noted how systems are characterised by non-linearity between interacting elements, a key principle of this modern thinking about production. A circular economy extols the virtues of renewable energy use, prohibits the use of toxic chemicals that prevent material returning to the 'biosphere', and aims to drastically reduce our waste by application of new design strategies, more carefully considered products, new systems and new business models. At its heart the circular economy is fundamentally a new way to re-imagine our industrial arrangements and the way in which we approach the management of our resources and the design of the things society needs. The theory offers a new outlook for design practice, with new theoretical approaches and strategies to design that support sustainable material futures, yet designers will need to learn how to adopt a more pro-active, systems-based approach that truly 'closes the loop' on our production practices (Goldsworthy, 2014). Research identifies that a key goal in the circular economy is 'to keep valuable materials in circulation' (Hobson, K. 2015). However we will need the tools and methods and evidence to

implement this aspiration. In her recent paper Hobson recognises that, while until now the circular economy has largely been grounded in theoretical systems of recover and reuse, technological advancements, design strategy and recover systems are rendering it a more realistic possibility. Still there is more research needed to understand how we imagine and implement the new circular systems and assess their efficacy.

"A 'circular economy' (CE) is an approach that would transform the function of resources in the economy. Waste from factories would become a valuable input to another process – and products could be repaired, reused or upgraded instead of thrown away." (Preston, 2012, pg.1)

Aspirations like that of Preston (2012) are laudable and offer us a vision for what we 'should' do but not necessarily 'how' we should do it. As Ghisellini et al discuss in their research:

"The implementation of CE worldwide still seems in the early stages, mainly focused on recycle rather than reuse." (Ghisellini, et al, 2016, pg.1)

There is a way to go before circular economy principles are broadly adopted, as different goods will require different ways of thinking about how best to keep the materials needed to produce them in the loop. There will be no 'one size fits all' approach and so there is an opportunity to develop new models for design and production of specific categories of goods at the local level that can scale laterally to propagate circular thinking throughout industry and consumers.

3. Open Design; Key theories, literatures, and applications

Open Design is a term that has emerged in recent years and is associated with a re-thinking of product development processes. In the field of knowledge, culture and software 'open' is a fairly mature and understood term (Bretthauer, 2001) (Madey et al, 2002) (Oreilly, 1999), yet applied to hardware, such as fashion items, it is something that is still misunderstood and often misrepresented among the design profession and wider industrial practices. Most recently the term has associated itself with social forms of design activity aimed at bypassing traditional forms of design and production and extolling more collaborative lateral practices. For us it is these forms and theories of open design that are of most interest. We recognise that the term is ambiguous, and therefore for the purposes of this paper needs some definition and some examples of application that represent what we see as the most relevant to our research. In Abel's work Open Design Now (2011) open design is explicated as a phenomenon that 'covers an extensive area and its contours are not yet clearly defined, making it difficult for designers to come to grips with' (van Abel, 2011). In previous research Smith (2008) describes 'openness' as when designs and instructions to create real physical objects are feely shared. This definition foregrounds the open availability of design data as open design, it does not require a design process itself to be open. We find this distinction between the design process and the design objet particularly useful when looking at open design practice. Tooze et al (2014) in their paper on open design classification based on real applications talk of open design inputs and open design outputs, or the contrasting closed versions, to define open design. The open knowledge foundation (Open Knowledge Foundation, 2013) set out their definition of open design as work that satisfies certain criteria. This criteria sates designs are open if they are: accessible in a way that is convenient for users to access; the designs can be redistributed and there are no restriction from selling or giving away the work; the designs are reusable so the design object must allow for any modifications and derivative works, and the work must avoid any technical restriction or technical obstacles that restrict the access, redistribution or reuse. In their recent paper on collaborative commons, Smith and Mortati (2016) refer to open hardware as a movement that

'allows a lateral network of developers to collaborate on the design and manufacture of real world goods'. One of the benefits to an open design approach is that a lateral network of individuals can work on the development of goods and their manufacture can happen locally. Innovation can happen frequently due to the quick propagation of a design through a network. Getting 'closer' to the production of an artefact and producing something on demand can respond to local conditions in a way that a closed design cannot. Research suggests that a diverse population of contributors can be more capable than a few experts and open input to the design process from a variety of backgrounds might offer a perspective on an issue that other wise might be missed (Poetz and Schreier, 2012). In their work Aitamurto et al (2015) articulate OD as a contingent process that provides public access to both the design object and the means to add to the design object, thus opening the process. It extols the virtue of accessible data that includes technical data and other data gathered during the process, for example life cycle analysis. Open technical data combined with open process data and accessible data will be central to our model for circular textiles. Atkinson & Cruikshank (2014) offer a number of perspectives on the ways in which open design is impacting on design as a practice and wider industrial practices. In their analysis of open design applications and theories they highlight that distributed design is one such effects. The distribution of design data coupled with accessible technology is a driving force behind truly open design processes. For example open knit are developing the open source digital knitting machine that can at low cost 'knit' open source digital patterns (openknit.org, 2016), and software like Valentina (Valentina, 2016) are creating open source software that can digitally create patterns for digital production. The convergence of these technological developments enables the true opening up of design and production, where accessible technology to produce meets open design data. Fab textiles (Fab Textiles, 2016) is an open source textiles project based at fab lab Barcelona, they are changing the way textiles are designed, distributed and produced using the fab open platform and distributed manufacturing to provide fashion items. They work locally and make connections through networks globally. Open Textiles based at Santiago Fab Lab (Open Textiles, 2016) is a further example of an open design data project coupling means to design with accessible data, they invite collaboration on projects that produce new textile products and knowledge about them that they freely distribute.

4. Re-Mantle and Make; *the concept*

Re-Mantle and Make is an exploratory model designed to pilot a new approach for trialling a circular fashion system on a local scale contextualised within Scotland's textile sector. It is important to acknowledge that this feasibility study is currently within the early stages and in order to flourish partnerships, prototypes and pilots will be integral.

Our approach is to pilot a range of different approaches for repurposing textile waste within a future maker space. However, to align to the principals of the circular economy we will endeavour to preserve and enhance natural capital, optimise the use of resources and foster system effectiveness by designing out wastefulness. This will require collaboration and a range of manufacturers have generously agreed to provide access to their textile waste. Three designers have been commissioned to produce circular archetypes in response to a design challenge and the archetypes will be presented and the textile techniques will be demonstrated within design jam events to orchestrate further ideas for circular innovation. The Re-Mantle and Make model aims to prototype a long-life, circular archetype that has the potential to be transformed within a maker space to enable the archetype to evolve through different design loops. The market place may be positioned somewhere in between the high street and luxury retail.

A design brief was written (see below) which provides an overview of a circular fashion archetype. Three textile designers have been commissioned to conduct research and development to produce a concept, demonstrated through a prototype and presented as an open source package for others to replicate or modify. The maker space facilities will be available to support sampling and production and at least one of the materials need to be included.

4.1 The Design Brief: Circular Collar

'Fashion clothes capture a moment in time and are as quickly forgotten. But what if that moment was not one but many moments... a process of transformation?' (Earley & Fletcher, 2003).

Design Challenge: To prototype a circular design concept for a collar that can be worn with existing garments. This project aims to shift our perception of fashion archetypes and the collar needs to be open source, the original conception of a collar can be hacked or modified to produce a hybrid concept. This must apply a modular design approach and consider how to sustain a long-life. The collar will be initially produced within a maker space and this can be used to provide a range of different services to support transformation through workshops or a menu of tailored options.

Facilities: 3-D Printer, Digital Textile Printer, Digital Embroidery Machine, hand stitching and embroidery, screen printing

Materials: leather, lace and cashmere

Inspiration: The following open source fashion archetypes are available to reference; the Uniform Project (ref), Smock Shop (ref), SHOW studios Design Download project (2009 - ongoing) provides downloadable fashion garment patterns from previous catwalk collectives from several high profile fashion designers (McQueen, Galliano, Pugh, Yamamoto, Watanabe, Price and Margiela, 2009). Each of these projects utalise social media to adopt an open source approach for distributing patterns and downloadable templates.

A panel of specialists across the supply chain will review the concepts and be invited to make recommendations on feasibility and the most viable concepts will be produced within the Kalopsia micro-manufacturing unit. A short film will be produced to document each stage and this will be showcased alongside a Pop Up exhibition.

4.2 Re-Mantle Re-Make-a-thons

To explore the possibilities for a circular economy in textiles we hosted two design Re-Make-A-Thons. These are one-day, rapid, hands-on design events where we would conceive and prototype new garment designs using surplus materials that would challenge our conception of current models of production.

Both events set about exploring the challenges and opportunities for establishing a circular economy in the Scottish textile industry. The participating designers were set the challenging brief of using only surplus materials from local textile manufacturers in the West of Scotland, and transforming them into a prototype circular collar that can be worn with existing garments. The collar needed to be open source, where the original conception can be hacked or modified to produce a hybrid concept. As it was the first Re-Make-A-Thon, this event focussed more on exploring the possibilities with the surplus material and making facilities provided.

Except for some thread and buttons, all the material we used for the Re-Make-A-Thon was surplus textiles sourced from Scottish textile manufacturers. The Glasgow event supplied the designers with bags of material including luxurient cashmere selvedges from Begg and Company, leather off-cuts

from The Scottish Leather Group, and varieties of lace from MYB Textiles. Participants also made full use of the technical capability of MakLab, such as 3-D printing, digital textile printing, digital embroidery and laser cutting, alongside more traditional sewing and embroidery equipment.

Using the full diversity of materials and flexible making facilities, designs quickly came to life with lots of great collaboration and sharing of skills. It was truly a collective effort. Among the unique, yet remarkably simple, collars different concepts emerged; plaited and braided selvedge, pungent interlocking laser cut leather panels, customisable layers of ruffles and folds, decorative shoulder pads and all manner of ways to revive seemingly lifeless materials. To produce a collection prototypes such as; hooded collars fashioned by simple folds and darts, cashmere fabric designs made adaptable in its processes of production, patchwork pattern garments and even utilising smaller off-cuts as padding for modular garments.

At the end of each event we assembled our initial observations and participant responses, to critically evaluate the prototype designs we produced, and gather some initial learning for our research. To interrogate the final prototype designs in terms of how they responded to the circular economy principles, we designed a life cycle analysis tool to drive our discussions and tease out the challenges and opportunities for embedding circular thinking into the design phase of production and the impact on the wider system.

Through our reflections and initial critical evaluation, we have developed some initial findings. The learning we have so far is presented here as some initial themes that we feel are significant to our research questions, or pose some significant interest to the broader issues of the circular economy and the future role of Makespaces.

Agency and structure: the interplay between the structure of current production models on the agency of design, and the impact embedding circular design thinking into products can have on the wider system. Who and what needs to be taken into consideration to make systemic changes to the textile industry.

Makespaces: are sites for experimentation and taking ideas to the next level of scale and feasibility: as well as being places of physical means, Makespaces are also places where ideas and thoughts can take shape and sites for social interaction that can further new ideas out of the space.

Making things simple: there are barriers for designers engaging with the circular economy especially around surplus material becoming a viable supply. There are issues around categorization, articulating material properties, cost/benefit for using surplus.

Moving from consumers to custodians: to make significant change then all stakeholders need to contribute. Designer can control the design, suppliers can control the supply, but consumers also have a responsibility. How can we make it easier for consumers to make a shift and be ‘ethical’ consumers?

Multiple engagements vs individual engagements: as emerging context for participant data.

Categories of materials: working with surplus is currently an informal process, there is no consistency with supply, designers need to know the material they are working with, provenance.

DIY: as an act of empowerment supported by Makespaces and open source designs, people can make for themselves, this could be an important role for Makespaces in empowering citizens to contribute to a circular economy, theories of product attachment and longer lifetimes.

5. Open Design Model

Our research aims are to explore the contribution open design and the circular economy can make in implementing a more sustainable material future. We ask what are the new open models and systems of production that will support a circular economy in textiles?

Based on our early research into the key principles and possibilities around the circular economy we are proposing a new vision for a circular model in textiles. The approach calls on the key attributes in open design theory of distribution and derivation to design a model that can scale laterally and work at the local level to extend material lifespans Our model is underpinned by the key aim of the circular economy that is to 'keep valuable materials in circulation' (Hobson, K. 2015). We propose a future system whereby waste material from local sources can be coupled with open source design data and accessible production hardware to manufacture fashion items designed collaboratively with circular principles in mind, considering material supply of various types. The model promotes innovation through open access to information and freely available knowledge of extending the flow of materials through re-design and re-use which often required testing and sampling The open model will produce design recommendations around zero-waste design, production, re-design and identify sustainable design strategies for reclaiming first life materials for second life and so forth.

The model we propose could in the near future link with accessible technology in the home, such as evolutions of technology like open knit and advances in 3D printed textiles. In the immediate future our model would put open access studios such as Maker Spaces at the technological centre as sites for design, production and research. Figure 1 illustrates our open design model for the circular economy in textiles. Open source data and patterns for garments are available to access through digital networks. The designs are based on local waste streams from textile manufacturers, designed in collaborations between designers and suppliers based in Maker Spaces near by to the waste supplier, and designed according to circular principles. Distributed with the design data are associated accessible data that details the materials used, their source, the circular economy principles adopted in the design and a lifecycle analysis including options for reuse (technical or bio cycles). Items are made locally in the original Maker Space and any derivatives are opened up to the network with the same 'data bundle' as the source data (design data and accessible data). Other Maker Spaces apply the same model to their local economy, resourcing waste materials, designing new garments in collaborations, conducting lifecycle analysis and opening the designs up as an open data bundle. Our vision is that once a critical mass of designs is reached then designers (individuals or groups) can take designs from the network that either: match with their local material supply and technology provision so that no or minor changes are necessary to produce; or offer opportunities to experiment with new material supplies or technologies.

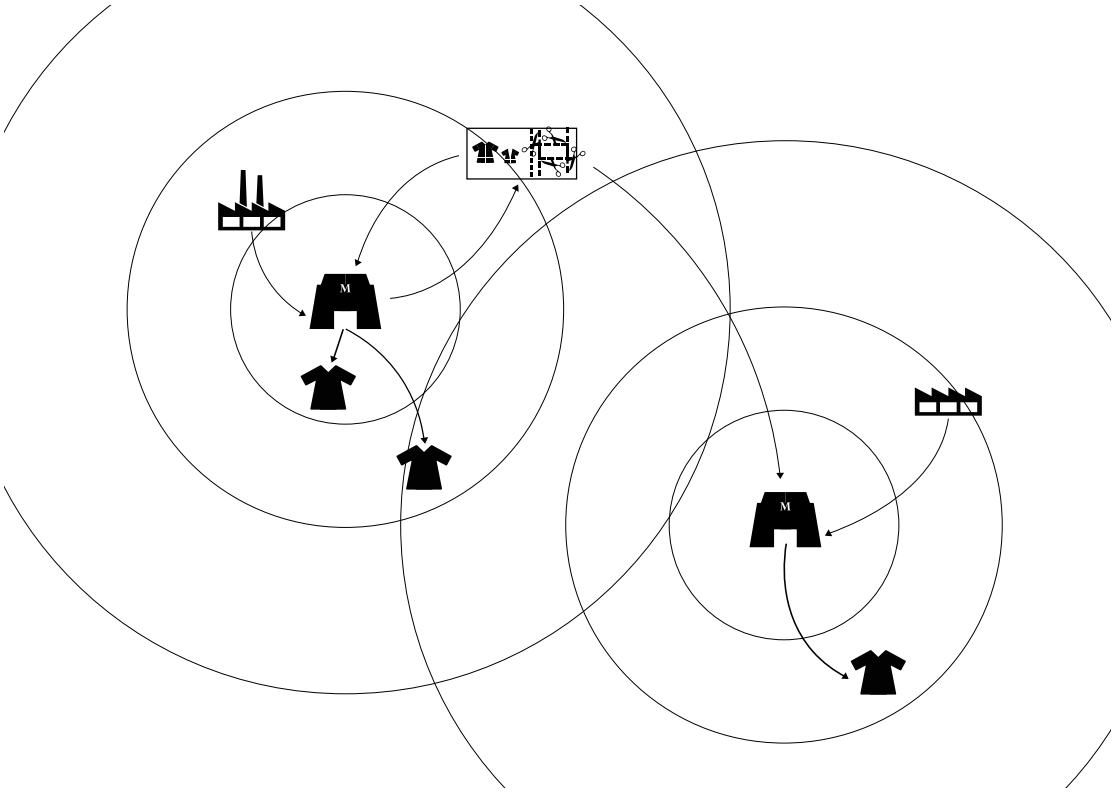

Figure 1: open circular design model

6. Discussion

So far, the findings have identified that there is a large cohort of highly innovative independent textile designers based in Scotland who are growing frustrated with the lack of support available to enable them to design and manufacture on a local scale. Some of the challenges include: being unable to access innovative new materials due to a minimum order requirement; onshore manufacture is too expensive and unequipped to support small orders; and finally business support programs within public sector agencies are tailored to high growth businesses within the textile sector.

The open design model framed within a circular economy can provide a new lens to preview how we as designers would like to experience fashion. Research and development is beginning to help design and the textile industry to understand the value, viability, scalability and role of circular approaches in the future (DeCastro, 2014). By engaging education institutions in the research, we will develop resources for circular design thinking and explore the role maker spaces can play in future learning experiences for students around sustainability in design and circular economy.

This feasibility study provides an opportunity for textile designers and students to experience the concept of the circular economy through participating within a practical intervention. Discussion will be facilitated to challenge existing perceptions and prompt conversation around circular innovation to re-think design, production and use.

The next step will be to develop our understanding of these themes and their impact on the circular economy through discussions at a round table event where we will present our work for debate to designers, suppliers, manufacturers, academics, policy, and advocacy groups.

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