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Circular textile design

Old myths and new models

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INTRODUCTION

The Mistra Future Fashion programme[1] brings together design and sci- entific researchers with industry experts to create new insights based on collective endeavour, focusing on the need to use design to create a cir- cular future through evolving new economic, environmental and social values. Design can work at both micro and macro levels (from materials to products to systems) to avoid the, often unintended, consequences which can come from looking only at parts of the life cycle and value chain, rather than the whole.

Designers need to work with circularity principles within a sustain- ability framework and need to fully understand the technical and bio- logical cycles. Yet innovation in the field has shown us that for textile designers, circular design also needs to consider how these cycles can interconnect; and how understanding the speed of cycles is important too. Inter-disciplinary practice-based textile design research can gener- ate new insights for this emerging design field.

This chapter presents four projects which challenge and provide a basis for different approaches to circularity. In defining circular design in part one, we consider how a polarization of thinking has occurred before we consider how boundaries are blurring between the biological and technical cycles. The practice work in this section addresses design- ing for future material cyclability[2]: the 'Laserline' project shows how a single-fibre property approach combined with laser technology can keep polyester materials pure for future reprocessing.

As our desire for functionality from materials grows – think non-iron shirts, waterproof Teflon or anti-bacterial coatings – keeping these tech- nical and biological cycles separate becomes increasingly complex and new approaches are needed. Part two looks at innovations that are lead- ing the way.

In part three, we question the idea of speeds for circular textile design and we present research that extends these ideas to 'super-slow' and 'ultra-fast'. 'Fast ReFashion' and 'Twice Upcycled' keeps polyester shirts in use for extended periods of time through new business practices and user engagement approaches. A.S.A.P. (paper cloth) experiments with new materials for clothes we don't intend to keep for long, for whatever reasons.

The chapter concludes by applying these insights from original prac- tice-based research to other disciplines to show that textile design has an important role to play in understanding the potential for material flows.

CIRCULAR DESIGN AND MATERIALS

Circular design first became relevant to textile materials through McDonnough & Braungart's *The Hannover Principles* (1992) followed by the more widely cited *Cradle to Cradle* in 2002, where the sixth princi- ple 'eliminate the concept of waste' pointed towards a far more holistic notion of materials recovery as compared to the 'reduce, reuse, recy- cle' mantra. They called for the optimisation of the 'full life cycle of products and processes to emulate the state of natural systems, in which there is no waste', and suggested that current methods perpetuated a cradle-to-grave strategy, which was ultimately linear in nature.

Circular design should not be confused with 'sustainable design', although they undoubtedly overlap in ethos and approach. Circular- ity aims to be sustainable by default but sustainable intentions are not always circular. It is also not just about recycling materials, which can often be a linear process in real terms, ultimately ending up in landfill, albeit a little later in time. In fact, it is not always about closed loops, with materials being directed neatly back to the beginning of the same product life cycle. For design, the key concept is one of systems thinking.

Connected solutions

All too often, approaches to sustainability and even circularity are at odds, with competing strategies almost battling it out for top billing. Yet the potential for circular design is that it 'connects' through holistic relationships, participation and collaboration. Circular systems thinking is built upon the oldest system of all – our ecological system. The model we aspire to is based on a synergistic network of cycles and open loops, which feed each other at multiple scales and speeds. These are complex and sophisticated transformations of materials and living matter. Within this network we will undoubtedly see both old and new technologies and processes contribute to the whole, with hi- and low-technology working together. The same system could include slow garments, upcycled from pre-loved ones or fibres chemically recycled back to virgin quality in a closed-loop system where nothing is lost.

MYTH 1: NATURAL MATERIALS ARE GOOD, SYNTHETIC MATERIALS ARE BAD

In existing versions of circular design – for example models by *Cradle to Cradle* 2002; Ellen MacArthur Foundation 2014; *RSA The Great Recovery* 2014 – there is a polarised view of the material world as either relating to biological or technical nutrients with a suggestion that these two worlds should be kept firmly apart. All technical resources should be recovered through industrial processes and kept in closed loops away from bio- logical systems, where 'natural' materials should be retained. However, this approach can be problematic in an increasingly complex material landscape and it's not always easy to define boundaries so simply. The following examples show work which follows this material division in order to build-in recovery at end-of-life but also examples where bound- aries are more blurred.

Designing for the technical cycle

In the fashion and textiles industry, one of the most prominent techni- cal fibres – polyester – represents over 48 percent of total global fibre production (The Fiber Year, 2013, p. 101). As fibre-to-fibre polyester recovery comes closer to commercialisation (first industrialised by Tei- jin with Eco-Circle[3] in 2006) then designing production processes to fit with this recovery system becomes vital. One approach is to design mate- rials which fit within the constraints of this system, i.e. are monomaterial in content to enable efficient recovery with minimum waste.

LaserLine (2011) (Figure 17.1), developed by Goldsworthy as part of a doctoral project (2012), was focused on this challenge. Research identi- fied monomateriality (sometimes also called 'unimateriality') as the key to designing polyester fabrics for chemical recyclability and a new laser- based technology was developed as an alternative to existing finishing techniques which often rendered materials unrecyclable. Rapid advances in chemical fibre-to-fibre recovery are being made which save not only resources but also chemical and energy use when compared to virgin materials; companies such as Worn Again,[4] Renewcell[5] and Evrnu[6] and researchers at VTT[7] Aalto Chem,[8] RiSE[9] and Swerea IVF[10] lead the way in this area. Projects like Trash-2-Cash[11] – an EU-funded Horizon 2020 venture – is bringing some these researchers together to join up the approaches by striving for Design-Driven Material Innovation (DDMI).

Figure 1. 'Seamsdress' (Goldsworthy & Telfer 2014), evolved from the 2011 'LaserLine' work. Photo by Philip Kroll *(left)*

Designing for the biological cycle

Perhaps with more obvious links to sustainability principles, new materi- als from the biological cycle represent a fast-growing area of innovation. Materials such as organic cotton or hemp are well established alterna- tives to traditional fibres, but a new material world is opening up by utilising the waste streams found in agriculture and the food industry.

Materials made from food waste streams are an exciting way to link up industries which can benefit from each other's waste. Pinatex[12] is a vegetable leather produced from agricultural waste from the pineapple industry; Grape Leather[13] is made from the waste materials in wine pro- duction; Manure Couture[14] even uses the cellulose in cow dung to cre- ate a bio-fabric like viscose. The important factor here is that *all* aspects of the materials and processing must be biocompatible to ensure safe return to the environment.

Blurring material boundaries

Keeping these material ‘opposites’ apart is sometimes problematic. Often we need properties from both natural and synthetic materials in order to produce the most functional fabrics (polycotton is a common blend often used for its easy-care properties and durability). It is also often difficult to firmly place materials into either the biological or syn- thetic cycle. Raw materials of natural origin can be processed to produce at least semi-synthetic materials (for example bamboo becomes viscose, corn becomes polyester, etc.); whilst experimental material innova- tions often prove that even synthetic materials can be transformed back across the divide into bio-nutrients. Fungi Cutlery[15] uses mycelium fungi to create plastic cutlery; at Exeter University, the e-coli bacteria has been engineered to produce a renewable propane biofuel (Howard et al., 2013). CiCIO[16] technology allows plastic-based fibres like polyester to degrade more like natural fibres in landfill conditions. If we are to cre- ate a truly ‘networked’ ecology of future materials, designers need to understand these continually blurring boundaries and material stories and adapt the design of products accordingly.

MYTH 2: SLOW FASHION IS GOOD, FAST IS BAD

Design and production has changed to meet the need for speed, grow- ing populations and the cultivated fast fashion appetite. Conversely, the idea of designing durable and long-lasting fashion textiles has been a part of the fashion industry from the outset – long before product obso- lescence had been dreamt up in the 1950’s, yet the idea of slow fashion has been promoted in recent years as a new counter approach to *fast fashion*.

The concepts of fast and slow fashion (Tham, 2012) have gained increased attention during recent years since Fletcher & Tham first published around clothing *rhythms* (*Lifetimes*, 2004). This may in part be due to a renewed and intensified media coverage of the unwanted implications of the fast fashion industry, which can be seen on a local, regional and worldwide scale (including water, air and soil pollution, climate impact, shortage of arable land, harmful and unsafe working conditions and poor worker’s rights’, etc.). In addition, slow fashion, coined by Fletcher (2010), has been promoted by NGOs and other devoted individuals for the last decade, and is growing stronger. Slow living, spanning from food to fashion to other daily practices, is now an established phenomenon of the Western world – as an antidote to the fast-paced living that dominates our societies.

However, if we are to look to nature’s systems as a blueprint for cir- cularity, there are examples of all speeds in the natural world which point towards positive appropriation of both fast and slow systems. We see the same positive examples of fast in food, fashion and architecture. Perhaps slowing down is not the only solution to the environmental challenges we face. Rather than pursue a polarised approach to viewing ‘speed of use’ (which often limits attention to a small part of the whole life cycle), we would argue that a more nuanced method of analysing speed is needed which acknowledges the entire life cycle of a product. We should in fact be considering the right speed for each garment within specific life cycle stages.

Our research intends to move the discourse on from simply fast and slow, to a level where multiple and proportionate speeds can be both understood, tested via life cycle analysis (LCA) and ultimately engi- neered, to improve the circular efficiency of a product. The idea pre- sented here is that both long-life (slow) *and* short-life (fast) can both be models for clothing to suit a broad range of user contexts – different needs, tastes, incomes and styles.

Designing super-slow

Examples of slow (and circular) design can be seen in the *Textile Toolbox* (Earley & Goldsworthy 2014) exhibition, in the project *Fast ReFashion* (Figure 17.2) and the Top 100[17] project work, *Twice Upcycled* (Figure 17.3) where the retention of products in 'super-slow' use results in product longevity. The approach is to transform the industry through designing fashion services which extend a product's useful lifespan, rather than solely the creation and sale of new products. This is about design inter- ventions or facilitated consumer instructions that can inspire designers and consumers to engage with materials and products towards closed- loop thinking and action.

In *Fast Refashion* (Earley, 2013), users are encouraged to create a monomaterial refashioned garment for themselves, using readily avail- able tools and resources like irons, paper and dry foods. This project references the speed of high street trends, but draws consumers back to their wardrobes or a second-hand shop for the garment that will begin the fashion process – the material and the personal transformation.

In *Twice Upcycled*, (Earley and Goldsworthy, 2008) the original shirt has been bought and worn by a consumer, and then handed on to a second-hand or charity shop, with the first upcycling occurring through reshaping and overprinting by the upcycling SME. On resale of the gar- ment, the consumer agrees to return the shirt at a later date. Follow- ing a period of wear by the same or next consumer, the shirt can be returned to the SME and its third life can be created. In this case, the shirt becomes a quilted waistcoat, where it has been recut and lined in recycled polyester fleece, using an innovative laser-welding process. Upcycling is achieved without any material resources and the resulting product retains its inherent recyclability for another lifetime.


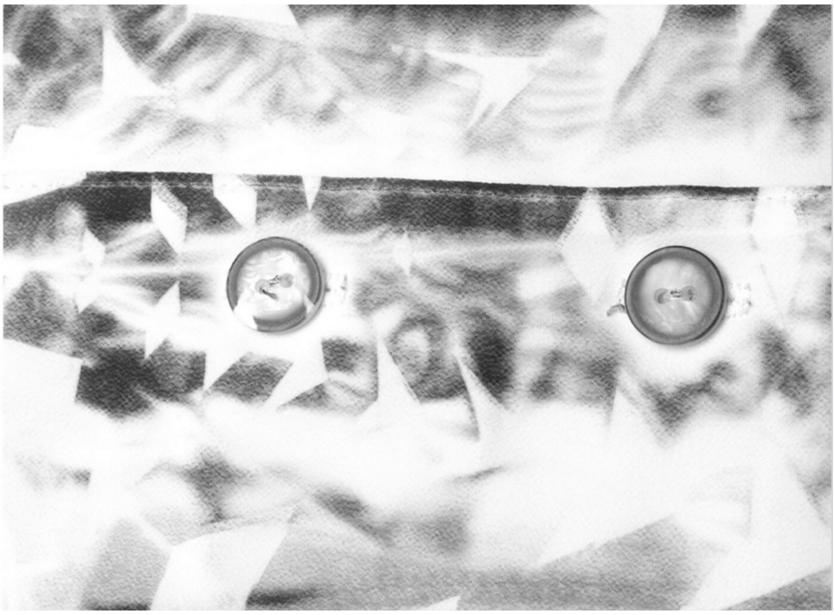

*Figure 2. '*Fast ReFashion' shirt (Earley 2013). Photo by Philip Kroll *(left)*

Figure 3. 'Twice Upcycled' (Earley & Goldsworthy 2008). Photo by Oliver Reed *(left)*

Designing ultra-fast-forward

ASAP (paper cloth) (Figure 17.4) is designed to be 'ultra-fast' but also to enable material longevity through efficient recovery at its end-of-life. The collection made from a wearable, non-woven material developed for the Mistra Future Fashion work in a collaborative project between CCD and Innventia[18] (part of RiSE,[19] a world-leading Swedish research institute). The premise for the project acknowledges the consumer's many reasons for buying clothes and addresses the damage caused by fast fashion by creating materials appropriate for this market. It enables the prevailing 'disposable' culture in fashion to be transformed by the development of inexpensive, bio-based 'recoverable' garments with sustainable credentials. It also aims to eliminate the 'consumer wash- ing' phase and therefore remove its large carbon footprint. Through the collaboration of designers and scientists, this collection relies on the mass production of various blends of wood fibres and polylactose acetate (PLA) fibres, which can be recovered to break new ground in cyclability. Raw materials are developed to offer alternative, renewable qualities as a complement to the resilience and durability of an existing, classic wardrobe.

Figure 4. 'ASAP' (Politowicz, Goldsworthy, Granberg, MacLennan & Telfer, 2014). Photo by Philip Kroll *(left)*

More agile and adaptable business and production models are key to this area. Automated and hi-tech production can be used to enable more responsive (redistributed) manufacturing tailored to the individ- ual whilst reducing associated impacts. Unmade[20] (UK) enable bespoke knitwear products to be manufactured at an industrial scale whilst responding to individual needs; Dyecoo[21] have led the way in water-free and process chemical-free dyeing; the Post Couture Collective[22] designs clothing based on open-source principles to provide a blueprint service for the maker movement generation.

CONCLUSION

In conclusion, we can draw some insights around the principles for cir- cularity from this review of practice and find strategies for impacting our future design decisions; the beginnings of a manifesto for circular design.

- *Circular resources* can be designed with recovery in mind at the outset or upcycled from existing waste streams to retain their value in use.
- *Circular material flows* are not only based upon industrial systems (even when they relate to the 'technical cycle') but need to be part of the ecosystem as a whole. Anything which escapes an industrial cycle should aim not only to do no harm but to be an active nutrient in the biosphere.
- In a *connected system* it is possible to see seemingly polarised approaches exist in balance; old and new, fast and slow, natural and synthetic, large and small working together.
- Whilst there is often an argument for designing for purely biological or technical cycles, in order to enable forward recyclability, there are also materials and processes which *blur the boundaries* and in doing so also enable circularity through new material networks.
- *Circular system opportunities* can often be found outside of industry boundaries. Food waste streams into textile fibres point to open not closed loops.
- *Speed of cycle* is an important and under-explored consideration for circularity. The speed of raw material creation, fibre through to garment production and use-phase need to be considered along with ease of recovery in order to make appropriate design choices.

There are many challenges ahead in the move towards a circular industry; improving technology, economic and political pressures, finding and moving towards new untested models, overcoming misun- derstandings and myths, accurately understanding the impacts we are having (across the whole system). These are complex and wicked prob- lems but many brands and researchers are putting enormous efforts into resolving these challenges.

NOTES

1 http://www.mistrafuturefashion.com/
2 'Cyclability' is a term which describes something that can be recycled (the term originates from the development of recycled batteries) and which Goldsworthy used as a conceptual framework in her PhD thesis (Goldswor- thy 2012).
3 Teijin, *Eco-Circle,* http://www2.teijin-frontier.com/english/sozai/specifics/ ecopet-plus.html
4 WornAgain,http://wornagain.info/
5 Renewcell,http://renewcell.se/
6 Evrnu,www.evrnu.com/

7 VTT,www.vttresearch.com
8 AaltoChem,http://chem.aalto.fi/en/
9 RiSE,www.ri.se/en
10 SwereaIVF,www.swerea.se/en/ivf
11 Trash-2-Cash,www.trash2cashproject.eu/
12 Pinatex,www.ananas-anam.com/pinatex/
13 GrapeLeather,www.youtube.com/watch?v=mGCLIJxdYXc
14 ManureCouture,JalilaEssaïdi,www.youtube.com/watch?v=OuhMIMs1gJs
15 Fungi Cutlery, by Livin Studio and Utrecht University, www.livinstudio.com/fungi-cutlery
16 www.ciclotextiles.com
17 Top100,www.upcyclingtextiles.net/
18 Innventia,www.innventia.com/en/
19 RiSE,www.ri.se/en
20 Unmade,www.unmade.com/
21 Dyecoo,www.dyecoo.com/
22 PostCoutureCollective,www.postcouture.cc/

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