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Designing Garments to Evolve Over Time

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Abstract

This paper proposes a REDO of the current fashion paradigm by investigating how garments might be designed to evolve over time. The purpose is to discuss ways of expanding the traditional role of the designer to include temporal dimensions of creating, producing and using clothes and to suggest a range of potential fashion futures that decouple from declining resources. In the first part literature on 'Past and Present' historical and current aspects of sustainability in fashion and textiles are presented. In the second part, three exploratory case studies are described: Two projects by students and one practice-based experiment by the authors. Finally, we reflect on the insights gathered and suggest a REDO of design education to accommodate a wider territory of emergent sustainability thinking. By providing knowledge about teaching sustainability and technical details the paper contributes to a REDO of design education, to further research and the future fashion and textile industry.

Keywords: Sustainability, design, education, fashion, textiles.

Introduction

Traditional design facilitates the movement of natural resources through the fashion system by transforming raw materials into highly desirable products for sale. In the modern fashion industry, the increasing speed and volume of material product throughput is predicated by the industry's utter dependency upon exponential business growth (Grose 2011). With the now ubiquitous presence of fast fashion, the global fashion system is readily accepted as being an unsustainable and heavy burden on the environment (Fletcher & Grose 2012). The fast pace and sheer scale of raw material extraction at the beginning of the supply chain and product disposal at the end outpace nature's capacity to supply natural resources and its ability to process the waste generated.

In design for sustainability, identified burdens indicate points of creative intervention and potential for innovation. Prolonging the active use of garments by improving physical durability is one such

intervention proposed by researchers (Allwood et al., 2006; WRAP, 2012) and applied in practice by several brands (Patagonia, Eileen Fisher, Jussara Lee). For example a report from The Waste and Resources Action Programme in UK found that:

“....increasing the active life of all clothing by nine months would reduce the annual carbon, water and waste footprints of UK clothing by 20-30% each, and cut resource costs by £5 billion.” (WRAP 2015)

The assumption in this strategy is that better quality fabrics and more robust seaming ensure a garment will last and therefore remain in active use for a longer period of time, thereby reducing the need to extract additional raw materials to produce new items. But focusing entirely on the physical durability of a product in isolation is a flawed concept since studies show that many consumers dispose of garments long before the end of their useful life (Nordic Council of Ministers, 2015). Hence physical durability becomes a liability, not an asset, when garments end up in a landfill or in a natural environment. Moreover, fashion businesses are dependent upon speed of change to ensure new sales and financial growth. Effective fashion sustainability strategies must therefore consider the consumer's use practices and implement new business models that decouple revenue from material throughput in order to achieve any meaningful ecological gains.

PAST PRACTICE

Textiles enable the physical manifestation of garments and changes in fashion are closely linked to shifts in fabric design expressed through fibre, construction, colour and patterns (Hallet & Johnston 2014). Temporal considerations in textiles and clothing were practiced for centuries across many cultures before the industrial revolution, which began in England around 1830. Prior to this time shifts in fashion were slow, and ordinary people valued clothes because they were time consuming to produce. Most households during this period owned a loom and manufactured hand woven fabrics to meet their own family's needs. Similarly, individuals made their own garments and were habituated to caring for, repairing and 'refreshing' them several times through their lifetime. Techniques for refreshing garments included embroidery, and over-dying or printing patterns to hide wear, tear and staining (Lorentzen, 1985; Ploug, 1983). In many villages a local dye/print master provided customized services for the embellishment of these hand made fabrics and garments. At this small scale, these practices were flexible, made optimal use of local resources and produced minimal waste. This prevailing system also allowed for co-creation, providing ample opportunity for the user/wearer to influence the aesthetic expression of the garments, which by necessity and through these treatments, slowly evolved over time. The mechanization of the textile industry and machine-based clothing manufacturing eroded these practices as ever-more efficient mass-production gave rise to changing fashions each season and the current norm of inventing additional seasons to prompt more purchases (Brett, 1992; Forty 1986; Harris, 1993).

PRESENT TRENDS

Today, with increased awareness of the detrimental effects of the current industry and the rise of digital technologies converging, pre industrial practices may be worth re-visiting and viewed through a fresh 21st century lens. This might provide inspiration for re-setting the rate of material flowing through the fashion system, to be more fitting for our time. Shifts away from ubiquitous styling and fast speeds are already evidenced in the resurgence of small-scale spinning mills that produce yarns from local fibres, the return of traditional crafts, which are naturally restrained by the pace of hand-

work and attention to the 'craft of use' (Fletcher 2010; Fletcher 2016). In parallel, digital technologies in communication, design and textile/garment fabrication are bringing flexibility and customization to the forefront once again reducing surpluses in production and offering completely new user experiences (Riisberg, 2006; 2007). For example the London based company Unmade engages the wearer in the design of knitted sweaters, producing each customized piece on site and on demand, completely eliminating the need for inventory necessary for re-stocking traditional retail stores (Durrani, Ravnløkke, Niinimäki, 2016). This concept simultaneously eliminates waste caused when product sales fall below projections and meets the desires of individual wearers to acquire a unique item.

Concurrent to the above, new concepts and frameworks are emerging in the fashion and textile sectors. One of the most influential is the Cradle-to-Cradle framework that focuses on design with positive impact and on reducing the negative impacts of commerce through efficiency (Braungart & McDonough, 2002). The Ellen MacArthur Foundation points to this school of thought as one out of seven supporting 'Circular Economy'; which is: "... restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times." (<https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept>). This strategy is one of the core touchstones in Patagonia's business; the company recently received the Accenture Strategy Award for Circular Economy Multinational at the World Economic Forum in Davos, Switzerland for their concept (Hoang, 2017). Several other businesses have worked to extend the lifetime of products in various ways. High-end fashion designers like Martin Margiella and Christopher Raeburn, for example, have transformed old garments and textiles into new products of high aesthetic value. Social entrepreneur, Nathalie Chanin of Alabama Chanin creates beautifully handcrafted pieces using skills available locally in rural Alabama and the independent fashion label Good One in UK combines new fabrics with textiles reclaimed from large retail brands inventory waste (Fletcher & Grose 2012). More recently, repair services designed to prolong the physical life of existing garments have gained in popularity e.g. Eileen Fisher's Green Eileen, Toad & Co and Renewed Apparel. Leasing concepts have also been established, as exemplified by MUD JEANS, Filippa K, Rent the Runway and VIGGA.us. All these initiatives aim to address the issue of declining resources by maintaining raw materials and energy embedded in garments, in active use for a longer period of time.

In addition, a number of research projects focusing on sustainability in the fashion industry are in progress one of them is the Trash to Cash project which aims: "...to create new regenerated fibres from pre-consumer and post-consumer waste materials" (<http://trash2cashproject.eu>). Another is The Mistra Future Fashion Project that is a cross-disciplinary research program with the vision: "...to close the loop in fashion and clothing – enabling a systemic change in the Swedish fashion industry, leading to a sustainable development of the industry and society." (<http://mistrafuturefashion.com>) As part of this program Dr. Kate Goldsworthy and Professor Rebecca Early from University of the Arts London carry out practice-based research where they have developed prototypes exploring 'designing for cyclability' (Early & Goldworthy, 2015).

Over the last decade, a number of books on designing more sustainable fashion and textiles have also been published (Black & Alexander, 2012; Fletcher, 2008; Fletcher & Grose, 2012; Fletcher & Tham, 2015; Gardetti & Torres 2013; Gwilt & Rissanen, 2011; Niinimäki, 2013). Research on teaching

sustainable design in this field has also been brought into the public domain (DeLong et al., 2017; Grose, 2011; 2013; 2015; Hasling, 2015; Leerberg et al., 2010; Riisberg et al. 2015), along with an increasing volume of material for students and educators made readily accessible on-line (Parker & Dickson, 2009; Ted Ten; Youth Fashion Summit, Forum for the Future, Ethical Fashion Forum).

Besides these commercial and literary examples, the Local Wisdom project directed by Dr. Kate Fletcher provides a model for how academic and practice-based research can be conducted in collaboration with students (Fletcher, 2016). In this particular project, seven design schools from around the world came together to further explore Kate Fletcher's ethnographic research with everyday people on the 'craft of use', which is defined as:

“The Craft of Use aims to challenge the dependency of the fashion industry on increasing material throughput and propose solutions through sustained attention to tending and using garments and not just creating them.”

<http://www.localwisdom.info/about>

The authors of this paper were lead investigators for Local Wisdom and brought this ethnographic research into studio classrooms to challenge conventional methods for teaching design.

Potential Fashion Futures

It is in this social, cultural and technological context of change that business models centred on designing garments that evolve over time can be imagined and explored as potential fashion futures. The aim of the design experiments carried out in the following case studies, is to use design, technology and 'craft of use' to both slow the flow of materials through the fashion system, and to provide new fashion experiences for wearers. In different ways each of the examples provided below investigates how to embed elements of change to satisfy the wearer's desire to 'feel refreshed' as effectively as when they purchase a new item of clothing. A secondary, but no less important purpose is to use these explorations as probes to bring industrial and educational norms to the surface so they can be examined anew in context with the realities of a resource constrained world.

CASE STUDY 1: DESIGN SCHOOL KOLDING

Being part of the Local Wisdom project inspired Design School Kolding to extend and further develop the 3rd year fashion and textile course in sustainable design which build on knowledge and skills previously acquired in 1st and 2nd year. Currently the 3rd year course, entitled *Design for Change - Past, Future and Present*, is a ten weeks full time study divided between teamwork and an individual project. At the beginning of the course we introduce Kate Fletcher's ethnographic research and the methods developed in the Local Wisdom project (Fletcher, 2016). We also present a range of present and future environmental challenges, visionary designers and companies as well as new developments in materials and emergent technologies. The first two weeks of the course are allocated to wide-ranging research starting with a visit to the ethnographic collection at the National Museum. Here the students are asked to document and reflect on sustainable elements in the construction of garments and to identify their specific function. Following this the students conduct a personal and a user centred wardrobe study investigating what elements create emotional value for the wearer (Skjold, 2011, Niinimäki & Koskinen, 2011). Based on the wardrobe studies, the students analyse and reflect on how personal experiences can inform the design process and be integrated

into new clothes for constructed personas. This phase of conceptualising runs parallel to an assignment with 2nd hand clothes, which helps students understand how wear affects garments and textiles. In the workshops the students experiment with 3D form experiments and a range of textile techniques, to give the materials a new life. The simultaneous purpose of these exercises is at the same time to develop student's skills for designing new textiles and clothes. Note, using 2nd hand clothes in the final project are not mandatory. The groups are free to choose materials and techniques that meet the criteria they set up for a sustainable closed loop design concept. The next four weeks students work in mixed teams to realize their future scenario for a sustainable fashion collection, in which textiles and prototypes for three full-scale styles are completed. The remaining four weeks of this course are allocated to individual work adjusting ideas to a present context. In the following we present a group project from 2015, which is the result of the first six weeks work on Past and Future.

Maria Viftrup Cramer, Liv Marie Rømer (textiles) and Marte Heidirdottir and Ragna Hatlan (fashion) developed a concept they call: The Marks of Use. The group described a closed loop scenario for 2025, where they imagine that efficient campaigning has increased knowledge about the lack of global natural resources. In this scenario, product transformation becomes a key element for the clothing industry, which is now dealing with a disrupted supply of raw materials for new textile production. Garments that enable the user to repair and alter them are now a standard requirement, and companies look to develop and monetize systems that support product adaptations.

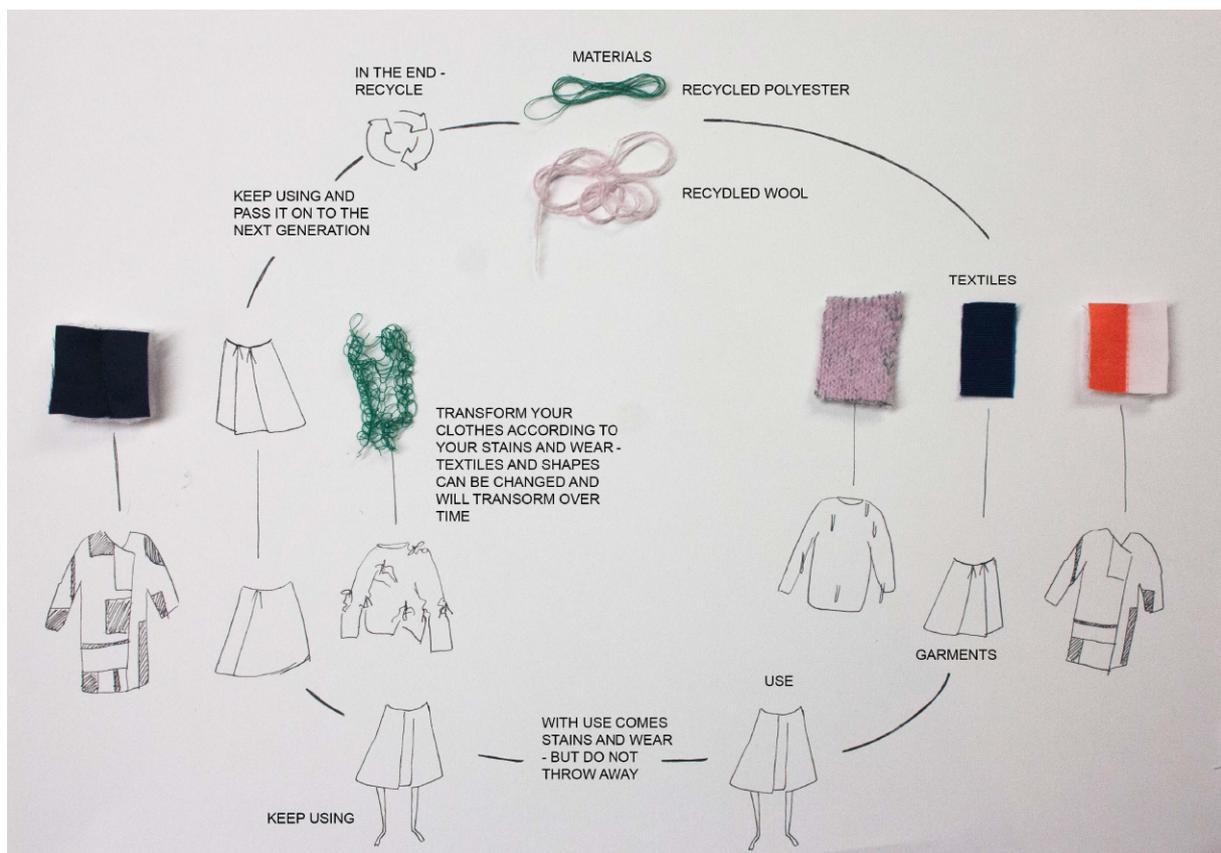


Figure 1. Marks of Use - Closed loop concept developed by Cramer, Rømer, Heidirdottir and Hatlan 2015. Photo by Students

Based on this scenario the students investigated how to create garments that change in form and material, whilst harnessing the skills and interactions of the user during the products lifetime. During

the process decisions were taken collaboratively. Finally the group printed and knitted the textiles and tailored a prototype of one outfit: a skirt, a sweater and a coat, designed for various user interactions.



Figure 2. Skirt, sweater and coat designed by Cramer, Rømer, Heidirdottir and Hatlan 2015. Photos by Jens Christian Hansen

The skirt – made of regenerated cellulose - is double-faced, constructed with ties and printed with three large colour blocks in light grey, blue and green. The colours can be arranged differently by using the ties to create a one-colour effect or different combinations of the three colours. The sweater also features easily adjusted ties and is knitted using two different colours and yarns – a light rose wool and a strong green polyester yarn. Over time the sweater will change from rose to green as the 'patina of use' leaves its marks. The quilted coat is 100% polyester with a print design added by heat transfer. A set of coloured heat transfer papers accompanies the product so that the user by ironing can apply surface prints for themselves over time to cover stains or change the appearance. Students also designed a user guide for each garment with instructions on how to use and care for the garments as well as what to do with it at the end of its active life.

This project demonstrates how design students are able to reason through a range of sustainability constraints, whilst meeting wearer's desire for changing the look of an outfit. Through prototyping new garments they also prototype new visions for a 'sustainable' future. In this way, far from narrowing and stifling creativity, these constraints engage the students in highly creative and multi dimensional processes of thinking. Through the concept development, they demonstrate new systems of dressing; systems, which can, in fact, be readily deployed today, as an on-demand, limited editions or even larger scale production. Yet in demonstrating such a strong and practical idea, Marks of Use makes us recognize the current fashion sector and its utter dependence on the wearer buying

and discarding pieces at faster speeds and increasing volumes. Indeed, it also helps us see the same dependencies in all business and in our global economy.

CASE STUDY 2: CALIFORNIA COLLEGE OF THE ARTS

As an extension of the Local Wisdom research project, undergraduate students at California College of the Arts, San Francisco were asked to take the research on the craft of use as a starting point for their creative process. This marked a departure from the traditional surface/visual research and inspiration typically developed in industry and fashion design education. The studio application of Local Wisdom research engaged students at junior level (third year in the US system), exploring themes of sustainability practice in the studio class: *Fashion Design 4: Ecologies of Desire*. In the US a semester comprises fifteen weeks with each studio class meeting for one six-hour session per week. The *Fashion Design 4: Ecologies of Desire* class is usually arranged around four projects, running from concept to delivered prototype. For this reason, the Local Wisdom research was conducted during the summer break prior to the start of the academic semester to enable additional time for active research and reflection before starting design development. Since students are still building skills in undergraduate fashion design courses, the abstract nature of Craft of Use as a creative starting point was a challenge for many. Nonetheless, several creative strategies emerged from the project, fusing tacit knowledge of garment construction, making methods and wearer use practices. Ultimately, the Craft of Use project broadened the scope and dimension of student thinking and deepened their design thinking and development in other classes.

One resulting concept from the Craft of Use is 'Bespoke for the Masses' (Fletcher, 2016), which features a jacket designed by Jeff Pacis.



Figure 3. Design and photo by Jeff Pacis.



Design by Jeff Pacis photo by Agnes Lloyd-Platt

This designer was initially inspired by the complex interfacing used in men's suit jackets to achieve quality fit and was particularly intrigued by horsehair interfacing, which is malleable and readily moulds to the wearer's body. Working with mid-weight cotton canvas and silk lining, the designer deployed horsehair interfacing throughout a simple jacket so that, over time, and through use, the garment shapes a silhouette specific to each wearer.

In this 'fit for all' concept the flat patterning remains simple and constant. There are no additional demands on the patternmaker to develop complicated constructions or expectations on the wearer to change their behaviour or adjust the garment. Customized fit is achieved simply through wear and is facilitated by the users body, through consistent and prolonged use. In this way, the embedded material choices, craft of making, design sensibility and sustainability intent are amplified and intensified over time.

REFLECTION ON TEACHING FASHION AND SUSTAINABILITY

Both projects described above introduce the next generation of designers to a new set of values situating sustainability at the core of creativity. The projects example a REDO of fashion and fashion design education in that they go beyond teaching the skills of practice for the fashion industry as it is today (e.g.: choosing fabric, colour, construction, style). Rather they identify familiar and accepted skills of practice and deploy them to prototype 'new ways' for the fashion sector. Essentially, they 'bend' traditional modes of teaching (studio making) to meet sustainability goals: showing how slowing the flow of natural resources through the fashion system can simultaneously meet the desires of the wearer.

Because these inquiries are explored through their own sphere of knowledge - making and development - students are naturally more readily drawn into larger social and cultural issues; resource depletion, deskilled consumers, human needs, economies of desire and consumption. By asking the wearer to engage differently with their clothing, and by providing a wide range of opportunities to do so, students also probe new fashion systems where both designers and wearers are more actively engaged. In short, they are inspired to imagine what the fashion sector could become in a resource-constrained world.

CASE STUDY 3: THE 'REFRESHMENT' EXPERIMENT BY THE AUTHORS

Inspired by practices of the past, as described previously in this paper, and in order to investigate further the challenges and possibilities of designing for extended lifetimes and use, the authors carried out a 'refreshment' experiment using white cotton shirts and digital printing. Our purpose was to explore design concepts, which de-couple from declining material resources (specifically cotton) and to use the process as a form finding method for an emergent '21st century' sustainability aesthetic. Furthermore we wanted to investigate how digital technology may be merged with 'wisdom' of the past, and hence exemplify emergent ideas as teaching 'tools' for the classroom. To guide the experiment we pursued the following four questions:

1. Can white dress shirts be disassembled and overprinted to create newly desirable products?
2. Can existing digital printing equipment be used to positive effect?
3. What practical challenges emerge to designing shirts for extended and multiple lives?
4. What new technologies might further enable disassembly of garments?

METHOD AND PROCESS

The methods we employed fall in the category of research by design that:

“...produces forms of output and discourse proper to disciplinary practice, verbal and non-verbal that make it discussable, accessible and useful to peers and others.”
(Hauberg, 2011: 51)

White dress shirts purchased at Goodwill were selected for their most common traditional features; details such as stand collars, formal cuffs, plackets and shoulder yokes. Our preferred fabric content was 100% cotton, for two practical reasons:

1. Studies indicate that virgin cotton cultivation is in long-term decline in part due to impacts associated with global warming, as irregular precipitation patterns disrupt crop yields globally. We therefore anticipate that cotton is likely to become a highly coveted fibre and that re-use of cotton is likely to be a future necessity (Grose, 2011).
2. To ensure compatibility of the garments with fibre reactive dyes used in the digital printing process. This print technology was chosen for its production flexibility, artistic freedom and for its low environmental impact.

Each garment was first disassembled into its component parts to allow the separate pattern pieces to be flattened, taped to a worktable and prepared for digital printing. Next all pieces were treated with a compound of alginate thickener and alkaline chemicals to aid fixation of the reactive printing ink to the fabric and to minimize colour losses in washing. Taping the pattern pieces flat was critical to reduce potential for fabric bubbling and buckling during the alginate compound application, which could create surface glitches when printing.



Figure 4. The 'Refreshment' experiment by the authors.



Photos by Lynda Grose

Once dry, the prepared pieces were transferred to paper and taped flat a second time to ensure successful passage through the digital printer. The printed motive was created by manipulating a

photographic image in Photoshop and was then communicated to the digital printer¹. Once activated, the ink jet printer head coursed across the whole width of the machine, distributing ink through tiny nozzles and building the print pattern across the taped garment pieces as well as the paper background. After printing the fabric was steamed,² washed, dried and ironed and finally sewn into a new shirt.³

GLITCHES AND INSIGHTS

Deconstructing shirts with robust French seams, proved particularly laborious and time-consuming. Seams stitched by over-locking also proved highly inefficient for disassembly, since they necessitated two passes to rip both the main seam and the over-locked edges. We therefore cut alongside the seams for some of the shirts, which created rough edges on the re-assembled printed garment. Additionally, sewn-on placket constructions at centre front and cuffs create a 'lip', which trips the printer head midstream, requiring emergency taping of plackets during printing and thus causing white sections within the pattern⁴. In future experiments the reactive dyes could be substituted with pigment inks, which do not require pre treatment and where post treatment is less complicated. Other types of digital printers that might be better suited for the job could also be tested. Similarly, precise engineered prints developed for each garment piece would save ink, which in this experiment was wasted on the paper background.

We expected that traditional garment constructions would be time consuming and ill suited to disassembly, but the experiment served to investigate if the cotton fabric was worthwhile up-cycling and how a fabric laundered many times would react to digital printing. The experiment showed positive results to both of these concerns. One strategy that can be deployed to address some of the obstacles described above is using chain stitched seaming to enable swift garment deconstruction. A second strategy is to use the newly developed technology Wear2; which is a thread designed to be durable in use and to decompose when exposed to microwaves (<http://wear2.com>). Wear2 technology therefore enables the rapid separation of seams and removal of tags, labels, zips and buttons, so garments may be disassembled quickly into separate pieces for 'refreshment' or to enter various recycling processes. This would allow for planning patterns and motives to be layered over time, offering a more complex aesthetic with each additional 'refreshment' without any additional base material through put.

As described above, to design effectively for extended lifetime through digital printing it is key to develop new construction principles so that disassembly is easy or even avoided. However, through our research, we identified that the main requirement of this method of product life extension is to simply enable the garment to lie flat to accommodate digital printing. 'Design to enable flatness' is the key re-entry point for further design intervention. This line of inquiry deviates from traditional western methods of pattern cutting, construction and sewing. We therefore see great potential in

¹ The image was then exported to the program Ergosoft, which is designed to communicate with digital printers such as the MIMAKI Textile jet TX 2-1600.

² The printed pieces were steamed at 0,5 atmosphere pressure and 200 degrees for 10 minutes.

³ In this experiment we only had access to equipment using reactive inks. The advantages of reactive inks are wash fastness and a large colour palette; the disadvantages are higher consumption of water and energy and time consuming pre- and post treatment.

⁴ As a side, conversely, glitches also present an opportunity to expand the designers 'aesthetic latitude' beyond expected norms, by explicitly indicating points for creative responses - decorative counter stitching placed to balance white taped areas, for example, or leaving them alone, to provide points of discussion and sharing ideas with others.

Zero - waste pattern construction - a technique pioneered by Timo Rissanen and Holly McQuillan (Gwilt, & Rissanen 2011), which is more open and flexible to displacing conventional seaming and developing completely new methods of 'assembly-to-enable-flatness for printing'.

The 'refreshment' experiment is an example of research by design and related to, but also distinct from Professor Rebecca Early's pioneering work, which investigates a craft based strategy for extending the lifetime of polyester shirts/blouses using heat transfer printing to create a new look (Clarke & O'Mahony, 2005; <http://www.beckyearley.com>). We share the same intentions as presented by Early & Goldworthy; to reduce environmental impact by up-cycling materials (Early & Goldworthy, 2015). However we focus on cotton garments, for reasons stated earlier, and we prioritize innovation at the beginning of the garments life; design to enable extended lives. Essentially we seek to REDO methods of designing and constructing garments to imagine a potential fashion future, rather than addressing waste in the fashion industry as it is now.

CONCLUDING REMARKS

In this paper we have proposed ways for a REDO of the current fashion paradigm by investigating how garments might be designed to evolve over time. The purpose was to discuss ways of expanding the traditional role of the designer to include temporal dimensions of creating, producing and using clothes and to suggest a range of potential fashion futures that decouple from declining resources.. As stated by Hauberg: "...research is systematic inquiry whose goal is communicable knowledge (Hauberg, 2011). In line with this the aim of the paper has been to provide new knowledge to provoke further research and to inspire the fashion industry. We therefore provide technical details for practitioners and researchers to further build upon our work. Our dual aim was to articulate an underpinning philosophy and intent for teaching design for sustainability. The global community of educators teaching this subject is growing rapidly, along with new Internet platforms providing educational material. This interconnected global community of educators and practitioners has great potential and we fully support its growth. Concurrently, as mentioned earlier in this paper, there is a substantial amount of research going on in the field. Yet we see that design for multiple lives and design for easy repair remain in the margins of business and in our experience such aspects are still not sufficiently integrated into design education. Practice-based research is valuable in that it brings theoretical ideas into forms that provide 'proofs of concept' that may stimulate and inspire REDO in design education and business. In a fast paced industry, where fashion practitioners barely have time to design, it is incumbent upon design educators to investigate how we might reference both historical examples and new technologies to re-align the fashion industry's needs more closely with the natural metabolism of earths systems.

As a bi-product of this research we see that through a practice-based line of inquiry, well-conceived and visually compelling speculative projects become in themselves educational tools. They challenge the tradition of design practice, support and fuel a consumer economy and culture. By doing so such projects start to example as well as prototype new methods for a transitional economy. They also demand and exercise multi-dimensional thinking in the next generation of designers, a skill which is critical to meeting the demands of sustainability. Ultimately for a REDO of fashion, we see design research through practice and design education situated at the centre of sustainability; and sustainability situated at the centre of design and design education.

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