

# Redirecting Textile Knowledge; An Innovative Approach to Recycling

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## Abstract

This paper identifies an opportunity to design a localised textile waste system in New Zealand which provides the raw material required to develop a value added, closed loop, innovative and sustainable textile product. Sustainability is a key challenge of our time. The mass production processes of the apparel industry create large volumes of waste posing significant sustainability issues at all levels. New Zealand is a wasteful country that has up until recently managed textile waste recycling by exporting or landfilling the problem. Ministry for the Environment records indicate 100 million kilos of textile waste is disposed of into New Zealand's landfill annually. At present options for unwanted textile waste in New Zealand are limited. The emergent crisis of textile waste stream management requires systems change and new forms of collaboration to be researched, designed and actuated. This paper challenges some of the complexities surrounding an unsustainable manufacturing cycle and the associated problems of textile waste. This research directly engages with individual New Zealand companies and re-circuit their waste manufacturing streams. A customised design solution that tangibly maximises the utility of an individual company's textile waste is illustrated. The intervention into the established system reveals itself as a reconfiguration of sustainable practice. The paper explores the nature of new knowledge generation in this area, how it was gained, distributed and deployed. Tacit and experiential materials knowledge about textiles is extended by the designers' phenomenological experience and subsequent knowledge brought about by iterative practice. Design led strategies serve as a platform to demonstrate how to re-design and initiate a new pathway for the New Zealand apparel sectors textile waste, to initiate change.

## Keywords

Textiles; Knowledge; Design futures; Sustainability; Recycling

This paper presents specific findings related to textile knowledge from a recent project 'Transformational Cloth' which intended to understand textile recycling practices and explore innovative approaches to reconfiguring the current linear system into a circular model. Two of the aims of this project, were to re-think and re-value textile waste. To realise this, the designer literally located herself in the process to redefine the status quo and establish an approach of doing and making, thereby focusing on the materiality of the textile waste. This shift in practice enabled a new understanding of the materials and highlighted the potential for re-thinking and re-valuing them. In doing so the research project considers textile waste as the result of a systemic design flaw and as a source of raw material. This paper articulates how tacit knowledge blended with experiential knowledge used in the process of textile recycling can contribute to solving issues of unsustainability.

## Background

For the first time in the history of the earth, we are witness to significant geological changes to our planet caused by a single biological species. Human beings have caused a distinct change to the

physical layer of the Earth's geological strata leading to unprecedented climate change. This is arguably the most important, and existential challenge that humans and non-humans currently face. This period has been termed the Anthropocene: "The formal establishment of an Anthropocene Epoch ... mark[s] a fundamental change in the relationship between humans and the Earth system" (Lewis & Maslin, 2015, p. 171). It is by definition a 'wicked', complex, multidisciplinary problem, which raises the question of how design can be best used to sustain ourselves and others on this planet. Sustainability as a concept is nebulous and complex. It has been defined and deployed in very different and often contradictory ways. Fry suggests "the word 'sustainability' has been evacuated of any substantial meaning it may once have had. It's been appropriated by a ragbag of 'green-washing' market interests, opportunists and political hacks. As a result of this we frequently find ourselves 'sustaining the unsustainable'" (2011, para 1).

In addition, the notion of fashion is the very antithesis of sustainability. There are inherent contradictions in the term sustainable fashion, as fashion is about obsolescence: "its lexicon is new every year, like that of a language which always keeps the same system but suddenly and regularly changes the 'currency' of its words" (Barthes, 1990, p.34). The system of rapid change surrounding the fashion industry, with frequent new seasonal ranges, means constant renewal and the discarding of clothes; a 'wear it today throw it out tomorrow' approach (Blanchard, 2008). Conversely, perceptions of sustainability are associated with preservation and longevity. Herein lies a paradox that has motivated this inquiry. Sustainable fashion design and its associated practices are of current global concern (Fletcher, 2014; Gwilt, 2014; Niinimäki, 2013); the issues are complex, and the possible solutions necessitate continual adjusting and transforming. The principles of sustainable fashion design seem like a moving target that is difficult to work towards. This is due to both a myriad of possible interpretations of the subject and the vastness of the situation, which can seem overwhelming. In this context, the role of the designer as someone who only looks forward in their practice and does not engage with the experience and implications of materials and materialism, requires a recalibration (Fry, 2014). It is this redirection in practice and the subsequent new textile thinking that this paper aims to convey through the mechanism of material recycling.

## Fashion Manufacturing Cycle

With regard to the precept of our fashion system, Niinimäki (2013) maintains that our present-day fashion design, apparel manufacturing systems and economic models have directed us towards an unsustainable level of fashion consumption and its resultant waste stream. The current linear system, commonly referred to as the "take, make and waste model" (The World Economic Forum, n.d.) extracts predominantly virgin fibres for textile manufacturing, produce clothing en masse, have a short use phase and ultimately discard the clothing into landfill (refer to Figure 1, to see how this linear system currently operates).



Fig 1. Current linear take, make and waste model

Along with the loss of materials, we squander their inherent economic value when we discard them. In fact, a recent industry report written by the Global Fashion Agenda, 'Pulse of the fashion industry', estimated that "the overall benefit to the world economy could be about EUR 160 billion (USD 192 billion) in 2030 if the fashion industry were to address the environmental and societal fallout of the current status quo" (as cited in Ellen MacArthur Foundation, 2017, p. 19). The Global Fashion Agenda suggests that it is small to medium-sized producers and manufacturers that have

had the least uptake of sustainable strategies (Global Fashion Agenda, & The Boston Consulting Group, 2017). This highlights that engaging small to medium-sized businesses in sustainable enterprise, would be advantageous as a model to effectively illustrate a sustainable strategy. Fashion industry writers propose that, the solution to the issues raised by this linear system, is the shift towards a circular model (Ellen MacArthur Foundation, 2017; Global Fashion Agenda, & The Boston Consulting Group, 2017; McDonough, & Braungart, 2012). The 'New Textiles Economy' report 2017 positions "low levels of recycling, the current wasteful, linear system [as] the root cause of this massive and ever-expanding pressure on resources" (Ellen MacArthur Foundation, 2017, p. 20).

### ***Barriers to a Circular Systemic Approach***

One possible way to engage industry lies in the reframing of sustainable fashion and textile systems as 'positive feedback loops' with a potential to make change through knowledge growth and alteration of practice (Fletcher, 2014). Tackling multiple smaller problems cumulatively could have a big impact on consumer behaviour. Peter Senge's 'Systems Thinking' approach (1990) describes reinforcing loops as being a fundamental function of a modern organisation and suggests how to run a more efficient and effective management system that has evolved from the quality control circle style of organisational behaviour. He defines complete systems holistically with positive impact that transforms little cycles within a system; when analysed and palpated they flow in a harmonious manner. He proposes that this shift in organisational behaviour requires a quantum leap of leadership in all tiers of management and labour, not just the top and not just the bottom. He advocates a need for all levels to 'buy in' to the concept of wholeness and engagement, and apply strategic goals. When you apply the principles of what he terms 'leverage,' "actions and changes in structures can lead to significant, enduring improvements" (Senge, 1990, p. 104) in business growth, capacity and culture. In theory, this establishes a concept that is very applicable to an existing organisation and suggests that drivers towards sustainability could be applied to it in a reinforcing and positive way, one step at a time. However, these admirable shifts in occupational culture rely on 'buy in' from all tiers within the organisation. This is problematic until corporate perceptions around waste management shift away from that of concealment and move into a more transparent mode. Whilst there are still negative perceptions towards waste management and a direct resistance to change we will continue to encounter challenges as companies prefer to send their waste to landfill rather than have the details of their waste recorded. This denial of access would be detrimental to any pragmatic solution of leverage being actionable within a system.

### ***Design Futuring***

Fry's design philosophy proposes a pathology that is reinventive in nature, and suggests a redirective premise of design, 'design futuring' that is anchored in practice. He argues that the status quo of design is engaged in the act of unsustainable 'de-futuring' and details 'a new design intelligence' which is focused on the being of a designer and the world we live in now (Fry, 2014). He suggests designers need to make fundamental changes in their own being, that are not only involved in materiality but also have a new awareness of what is being designed and what the implications are of that design, in a world that has finite resources. This re-imaged design ontology promotes singular transdisciplinary practice as a mode of operation as "by its very character, redirective practice can never be universally or theoretically generalised - it can only ever be situated and circumstantially reactive" (Fry, 2014, p.10). This presents an opportunity for a redirected, action style of materials research with a designed sustainable outcome.

Supplementary to this, Kane and Philpott propose a heuristic style of interdisciplinary practice, seated in textiles and sustainability that they call 'textile thinking'. They propose that "until recently this knowledge or way of thinking - 'textile thinking' - has remained largely unarticulated" (Kane & Philpott, 2013, p.1). They suggest practitioners working directly with textiles hold a 'specific blend' of materials' knowledge essential for developing sustainable solutions. They state that "hand-making and craftsmanship are key processes used by textile practitioners to develop understanding of both materiality and concept" (Kane & Philpott, 2013, p.5). Their

acknowledgement of mastery and a heightened metacognitive state are relevant to this research as it suggests that *techne* is a vital component and goes hand in hand with design principles in the emerging field of sustainable textile creation. Doing and making, bound together with the craft knowledge generated through material practice uses a physical approach. Cameron Tonkinwise describes this relationship of design practice as one where "designing involves the tacit discernment of aesthetics, a prejudicial yet flexible analogue of ethical hermeneutics [where] there is clearly an art and craft to the science of practicing design" (Tonkinwise, 2003).

A useful tool to reconfigure sustainable design is to embrace Fry's (2014) premise of redirecting practice, where the emphasis shifts away from blue sky ideals and holistic systems into an actionable approach that is reflexive to circumstance. As two of the aims of this project, were to re-think and re-value textile waste, the designer adopted Fry's theory and literally located herself in the process to redefine the status quo and establish an approach of doing and making, thereby focusing on the materiality of the textile waste. This shift in practice enabled a new understanding of the materials and highlighted the potential for re-thinking and re-valuing them. In doing so the researcher became aware of the textiles potential as a raw material.

### ***The Role of the Design and the Designer***

Designers often turn to theorising about design in a departure from the practice of design. Banerjee, suggests design researchers should stay connected by operating in a mode that accommodates both theory and practice (2008). The worldwide problem of textile waste offered this research tangible context. It was critical that the research practice was undertaken using genuine textile waste from industrial streams. It was also paramount in working towards another one of the project's aims, to develop a model where the scale of textile waste is matched with the scale of intervention, that the textile waste was processed on available machinery that could offer scalability and repeatability. This approach to knowledge generation has at its core, values anchored in sustainable practice.

### **Research Approach**

The project was situated in New Zealand and was localised to the Auckland area. It should be noted that at the time this research was conducted there was no significant civic infrastructure to recycle textile waste. Throughout the design led project the textile designer, collected and redirected several streams of industrial textile waste, diverting it from the expected linear route to landfill and explored ways to reanimate the fibres into new textile outcomes. The project involved working with: industrial partners to gain their trust to work with their materials, different processing plants in different locations to recycle the materials and multiple material specialists with unique fibre knowledge. In this process the designer/researcher utilised existing infrastructure and specialists that were not previously known to each other or connected in any way. Building these new pathways meant that the designer needed to manage each interaction with boutique machinery operators, consider fibre specialist knowledge and develop new process centric terminologies (refer to Figure 2).

Whilst collecting the textile waste new methods of gathering and recording the data were developed. Quantitative and qualitative data was harvested and recorded in new material libraries of knowledge. The qualitative mapping included methods, such as grading the fibre compositions and fabric structures, colour categorising and evaluating the potential recyclability. The agency of these methods was founded on not only expert technical advice on possible machine capabilities, but also the researcher's tacit knowledge blended with thinking about what was possible. Fry (2014) recognises tacit knowledge as being a product of skilled practice. Polanyi, who introduced the notion of tacit knowledge, suggests that this type of knowledge "cannot be told" (2009, p.4). Fry fuses this understanding with the explicit knowledge of technical mastery as one of the foundations of 're-futuring design' as a redirective methodology (Fry, 2014).

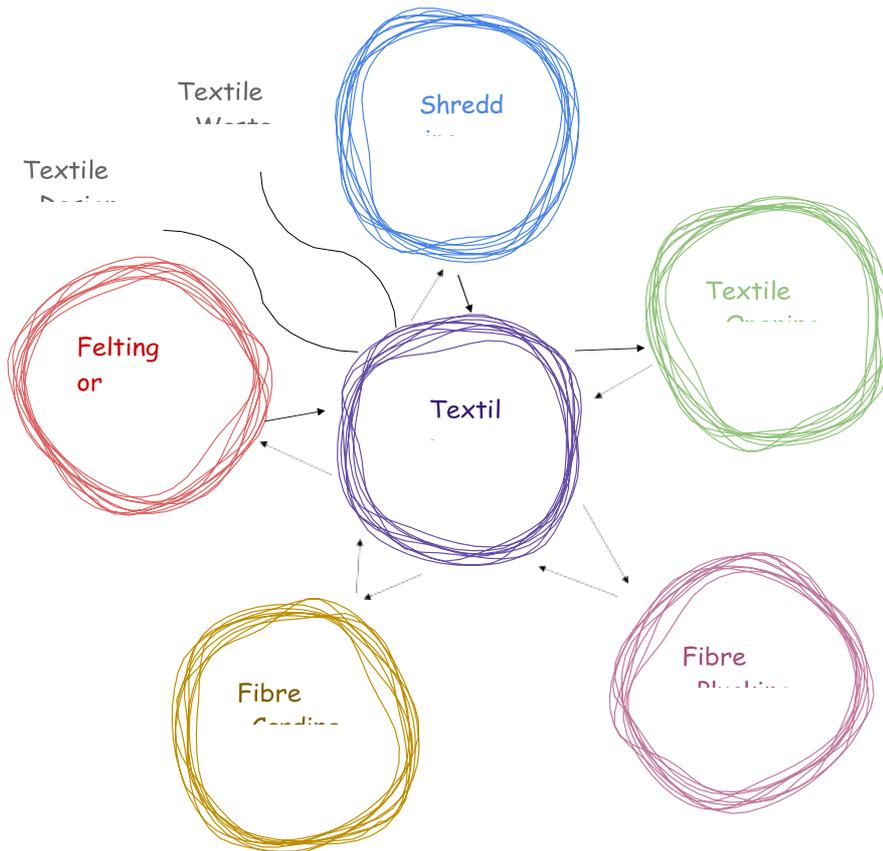


Fig 2. The design-centred system showing how the materials move through different mechanized processes.

This combination of materials knowledge influenced the choice of methods used and their application. These initial mapping methods considered the inherent value of the fibres and the possible synthesis that could further add value. Of the collected waste streams the one that affected the designer the most was from an academic regalia hire company. The textiles that had the biggest impact on the designer's experience with the materials were the black trenchers and gowns. These items required considerable disassembly by the researcher before being able to recover recyclable textile materials. During this time the materials shifted the designer's perspective on textile recycling from small pieces of post-consumer textile waste into powerful pieces of transformational cloth.

### ***Knowledge through Disassembly – Black Trencher***

This section discusses the disassembly of a particular item of academic regalia and the phenomenological experience the designer had when stripping them for salvageable material. When disassembling an academic black trencher, the initial approach was to apply the minimum number of cuts required to take the components apart. This gave a production-type imperative to the work. The workflow proceeded from a careful dissection into seven definitive and repeatable steps (refer to Figure 3).



Fig 3. The stages of disassembling an academic black trencher.

1. Make a circular cut around the base of the skull cap detaching the mortarboard
2. Turn the trencher over and remove the button
3. Separate the tassel from the button.
4. Make four diagonal cuts away from the centre making sure you slice around the button.
5. Remove the cardboard inner
6. Remove the binding off the skull cap
7. Remove all the labels

Each of these steps was repeated 590 times (refer to Figure 4 and 5). This gave the researcher ample time to develop a technique, becoming very efficient with the disassembly. The process changed from initially taking nearly five minutes, to only taking three minutes towards the end of the disassembly phase. This freshly acquired autodidactic skill set became second nature. Fry recognises the value of such skills gained through practice, stating “it is this condition that provides the ground for the ability to innovate, create, exploit and critically deploy the capability gained” (2014, p.19). This building block of new habitual practice allowed a deeper understanding of the world of the textile processing labourer, which is one of repetition and specialisation (Hawley, 2006). This was a very new mode for the researcher and gave not only a new appreciation of the materials but also transformed the identity of the designer. This translation of agency was important to this project as it augmented the relationship the researcher had with the materials and their inherent qualities. This was a compound of iterative practice and handling the materials while manually manipulating them. Through processing the trenchers, the researcher began to be able to sense small variations in each item without having to look closely.



Fig 4. A pile of button componentry from the academic trencher.



Fig 5. A pile of black tassels from the academic trencher

This cognitive shift happened in tandem with a shift from being regimented and goal-oriented to being in a creative-thinking mode, that was temporally emergent. This thinking was flexible and opened up the researcher's mind to a discourse centred around the possibilities. Kane and Philpott describe this internal dialogue as being a usual state of mind that develops from both a sensitivity towards the materials and an elastic cognitive process which reveals itself as "a pliable style of thought that twists, turns, stretches and folds in on itself" (2013, p. 6). The purpose of extracting squares of fabric to obtain a maximum yield of recoverable fibres gave way to the possibilities of the componentry and an awareness that the materials held stories and had a presence of their own. The researcher's thoughts moved from thinking about how dusty and dirty the materials were and what they were constructed of, to thinking about all the people who had worn the trenchers and the challenges they would have overcome to be in a position to have worn the trencher. The wear of the trenchers was subtle and unique for each item, such as slightly worn on the front corner perhaps from constant readjusting on the head or the faint indentation left on the cap from the hairpins used to hold it in place (refer to Figure 6).



Fig 6. Slightly worn front corner on the academic trencher perhaps from a constant readjusting on the head

These traces humanised each trencher as each imprint revealed itself. This experience affected the researcher by introducing a new narrative. Carole Hunt, describes this mnemonic phenomenon as "the capacity of textiles to retain and communicate memory, both privately and publicly" (Hunt, 2014 p.207). Hunt's described phenomena materialised in this research project while the researcher was engaged in repetitive processes; in turn, this stimulated reflective practice. This determined the direction the researcher took when making decisions about the textile outcomes. It also created a new sense of knowledge and a desire to value the fibres. The effect of this experience and reflection was to transform the researcher's mindset from using the materials to being used by them. The materials, through the agency of disassembly, revealed themselves not only as having new material potential but also as a form of material memory bank. The researcher considered whether the fibres themselves could hold memories (Hunt, 2014). With the action of disassembling each trencher, new abstract and tangible stories unfolded. The researcher became conscious of the need to save the fibres from an impoverished destiny as waste, and instead celebrate their individuality and potential. These insights into previous use and wear were gained from unconsciously reading clues and impressions transferred onto the textile by its past users (Hunt, 2014). This experience reconnected the researcher with the vitality and value of the fibres and the need to re-future them (Fry, 2009). This ignited a new appreciation for not only the trenchers as objects that contained narrative, but also the energy involved in manufacturing them. The origins of the fibres were unclear, but there was no doubt that extensive energy had gone into the life of the fibres and this would be squandered when sent to landfill. The disassembly, grading and cutting had a significant phenomenological outcome where touch and sense triggered cognitive resonance and a change in direction.

In other words, by handling the materials, the designer, began to understand their composition,

and allowed the senses of touch, smell, seeing and feeling, to guide the making and innovative decisions about the design. This is often a less acknowledged aspect of decision making within a textile designer's role. The resulting 'textile thinking' had a cognitive elasticity that provided new experience for the researcher. In this way, cognitive models can command methodology through the premise of 'textile thinking' (Kane and Philpott, 2013).

This mode promotes a re-directed textile narrative that explores the advantages of what Kane and Philpott describe as 'sack' and 'box' thinking (2013). This premise, informed by the writings of Gilles Deleuze (2003), presents 'box' thinking as a structured, rigid system that is determinate and leaves no room for conjecture. When this is applied to processes that have clearly defined boundaries, it is "measurable, amenable to precise mathematical prediction and practically applicable" (Kane and Philpott, 2013, p.6). On the other hand, 'sack' thinking offers a realm where quantification is less specific and the results are range based; in that, the model "does not replicate, in detail, the particular outcome that occurs in reality" (Kane and Philpott, 2013, p.6). The recognition that working with textiles involves indeterminate complexity due to their nature led this research to seek and deploy modes of operation that valued "the malleability of textiles and textile modes of thinking... creating an approach where connectivity and continuity are key to the development of novel and innovative ideas" (Kane and Philpott, 2013, p.6). This metaphysical approach produced a new sentience that affected the researcher's vision of what the practice was achieving and informed how best to unfurl the new knowledge generated within the world it operates in.

The predetermined design outcomes the researcher had initially held shifted, as the physical handling of the materials evoked a deeper connection with the history of the fibres and the inherent knowledge they held. This interdependence of process and understanding became a key lens through which the designer could inform the re-animation of the recycled fibre.

### ***Overcoming Perceived Barriers in the Processing of Textile Waste***

Engaging commercial entities with the view of processing the textile waste was often difficult. The vendors who had the machinery to shred, card or spin the recycled fibres had their own ideals around the scale, quality and value of processing recycled textile waste. These were based on their depth of technical experience, their specific machine knowledge and their preconceived ideas on the advantages of recycling textile fibres, specifically using a mechanical process. For example, the companies that were approached with regard to spinning the fibres considered the fibres would be too short to spin as they had been mechanically shredded and opened. Previous experience and technical knowledge had led to a negative opinion surrounding the commercial value of re-claiming the short recycled fibres. This precept was based on technical considerations about the strength of any yarn produced from mechanically recycled fibres (Langley, Kim, & Lewis, 2000). A limitation revealed during this research was the commercial spinners' ingrained ideas around the outcome of spinning the fibres.

### ***Fibre Recycling Narrative***

To facilitate the logistics of the recycled fibre processing system the researcher needed to communicate with the vendors, often face to face. Each of these commercial enterprises required forms of information and language specific to their individual conditions. For example, when discussing the fibres with a small customised service provider, such as a local carding mill, colloquial language was used to label each waste stream. This approach was not acceptable when dealing with a larger productivity-driven company, such as industrial textile waste shredders, where a formal description using numerical data was considered appropriate. However, regardless of which service provider it was imperative that the incorporeal value and future possibilities of the fibres were given a positive narrative. Portraying the journey of the fibres and acknowledging their inherent value became a prerogative of the research in communicating with the vendors about processing the fibres. Positive language was used to communicate with each of the vendors about their machinery and the nature of the textiles involved in this project.

New terminology evolved to enable the researcher and the vendors to communicate about how the fibres behaved through their machinery. Not only had some of the vendors not put recycled textiles

through their machinery before but they had often never put that type of fibre even in a virgin state through their machine before. One of the mills who carded the fibres for this research had previously only put virgin wool and alpaca through their machine. Carding shorter recycled textiles was a first, as was attempting to card possum or polyester blends, virgin or recycled.



Fig 7. The mixed composition recycled materials being carded on a wool carding machine.



Fig 8 and 9. The fibres were blended with other recycled fibres from other waste streams, re-carded and felted.

When a complication did arise, as was the case when the black polyester waste from the academic trenchers, fell through the carder, it was important to use positive language about the textile waste to change ingrained perceptions around the value of fibres. Using terminology that referred to the origin of the fibres such as 'academic fibres', when discussing the textiles rather than demoting them using terms like 'black shoddy' encouraged a shift in revaluing the fibres. In addition, the focus moved from merely the technical to advocating ways to recycle the fibres and save them from their predestined pathway to landfill. This approach allowed the researcher and expert to engage in an exchange of knowledge around the future possibilities of the fibres rather than dismissing the fibres as technically unsatisfactory. This knowledge informed a new cycle of fibre experimentation which explored blending the fibres and re-carding them. By giving the fibres a hero status, the vendors underwent a transformation in attitude and willingness to work with this project to re-future (Fry, 2014) the recycled materials.

### ***Re-thinking the Textile Waste***

It was imperative to gain buy-in from the vendors as processing textile waste of this type was new to them. Empathy combined with data and samples were key factors in persuading vendors to convert their lines to process the fibres. For some, the shift from high production into a pattern of sampling for research practice meant extending machinery and service to meet the needs of this research project. The vendors' expert opinions about particular plant and its operation, was essential knowledge that the researcher used to re-configure practice while minimising the impact on commercial operations.



Fig 10. A stool designed and made using reanimated academic fibres felted into new materials

## Conclusion

This project embraced the premise of utilising mixed methods with the aim of creating a platform to effect change that is supportive of this paradigm shift. This seats the designer as an agent of change, and the methods selected as agencies that support this aim. The resulting gestalt of cognition, methodology, framework, and practice indicates a type of strategic behaviour needed by the designer to operate as a change maker. Design culture, positioned between the sciences and humanities, encourages interdisciplinary practice. At a macro level this is realised by the building of a theoretical platform that could inform future research or be enacted by others. Throughout this project the designer also operated at a micro level of practice by changing modes from designer to manual labourer, as well as researcher. This research demonstrates the experiential nature of textile materiality and the impact this could have on designers operating in an ever-changing materials environment. Handling the materials and sensing their inherent knowledge has the potential to reimagine what the fibres can become. In this way designers have the ability to re-think and re-value recycled textiles therefore driving systems change.

It is intended this research project could be used to inform future initiatives to enable New Zealand to achieve waste reduction goals in the future. It is envisaged that the outcomes of the project could be grafted with or onto existing or emerging textile waste management initiatives and offer a fresh perspective on materials knowledge. There is future research potential in establishing a network sharing knowledge between the suppliers, producers, service providers and artisans, where new sustainable strategies could be trialed and new ways of engaging with sustainability considered. This research project, showed that textile waste recovered from industry can be considered a valuable resource to feed circular systems. Future research needs to be undertaken to shift industry perceptions around textile waste recycling, specifically in New Zealand where it has been identified that scale is a problem. This research demonstrated the possibilities of operating with commercial partners to change a system, this could be taken further and translated into the wider industry.

## References

- Banerjee, B. (2008). *Designer as agent of change*. In *Changing the change*. Retrieved from <https://changelabs.stanford.edu/sites/default/files/Banny%20Banerjee-Designer%20as%20Agent%20of%20Change.pdf>
- Barthes, R. (1990). *The Fashion System*. California, USA: California University Press Blanchard,
- T. (2008). *Green is the new black*. London, UK: Hodder & Stoughton
- Deleuze, G. (2003). *The fold: Leibniz and the Baroque* (T. Conley, Trans.). London: Continuum
- Ellen MacArthur Foundation, *A new textiles economy: Redesigning fashion's future*, (2017, retrieved from <http://www.ellenmacarthurfoundation.org/publications>)
- Fletcher, K. (2014). *Sustainable fashion and textiles: Design journeys* (2nd ed.).
- Fry, T. (2009). *Sustainability: Inefficiency or Insufficiency?* *Design Philosophy Papers*, 7(1), 25-37. doi:10.2752/144871309x13968682694830
- Fry, T. (2011, May 3). *Sustainability is meaningless - it's time for a new Enlightenment*. *The Conversation*
- Fry, T. (2014). *Design futuring: Sustainability, ethics and new practice*. London: Bloomsbury Academic.
- Global Fashion Agenda, & Boston Consulting Group. (2017). *Pulse of the fashion industry*.
- Gwilt, A. (2014). *A practical guide to sustainable fashion*. London: Bloomsbury.
- Hawley, J. (2006). *Textile recycling: A systems perspective*. *Recycling in textiles*. Retrieved from <http://krex.k-state.edu/dspace/handle/2097/595>

Hunt, C. (2014). Worn clothes and textiles as archives of memory. *Critical Studies in Fashion & Beauty* 5(2), 207-232. doi:[10.1386/csfb.5.2.207\\_1](https://doi.org/10.1386/csfb.5.2.207_1).

Kane, F., & Philpott, R. (2013, September). *Textile thinking for sustainable materials*. Paper presented at Making Futures, Plymouth.

Langley, Kenneth D. (2000). *Recycling and reuse of mixed-fiber fabric remnants: (spandex, cotton & polyester)* (17). Retrieved from UMass Lowell, Chelsea Center for Recycling and Economic Development website: <http://www.chelseacenter.org/pdfs/TechReport17.pdf>

Lewis, S. L., & Maslin, M. A. (2015). A transparent framework for defining the Anthropocene Epoch. *Nature*, 519(2), 171-180. doi:[10.1177/2053019615588792](https://doi.org/10.1177/2053019615588792)

McDonough, W., & Braungart, M. (2012). *The upcycle: Beyond sustainability - designing for abundance*. New York: North Point Press.

Niinimäki, K. (2013). *Sustainable fashion: New approaches*. Retrieved from <https://shop.aalto.fi/media/attachments/1ee80/SustainableFashion.pdf>

Polanyi, M. (2009). *The tacit dimension*. Gloucester, MA: PeterSmith.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday/Currency.

The World Economic Forum. (n.d.). Retrieved from <http://www.weforum.org/>

Tonkinwise, C. (2011). Only a God Can Save Us - Or at Least a Good Story. *Design Philosophy Papers*, 9(2), 69-80. Retrieved from <http://www.tandfonline.com/doi/pdf/10.2752/144871311X13968752924554>

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