

The Textile Reuse Programme: Building macro circular systems for used clothing

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Abstract

Circularity is being touted as the next evolution of the fashion system. The model, if successfully implemented, could radically reduce the draw on virgin resources, reduce carbon impacts, eliminate waste and extract considerably higher value from clothing. To transition from the current linear model to a circular one requires the alignment of multiple factors, from up-stream processing capability, logistics, technology and capital. It also requires a broad, birds eye view and long-term planning to maneuver crucial components and resources into place. The Textile Reuse Programme is one such macro system, V.1. designed and under construction in a geographically contained test market, New Zealand.

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INTRODUCTION

The aim of this research is to socialise crucial lessons gleaned from over ten years of global sustainable textile research and development. And to introduce to the industry under the agenda of Nature - 'Fashion systems for sustainability', new and practising knowledge and technology systems developed within the Textile Reuse Programme. The intent in sharing this knowledge is to advance understanding and accelerate a step change in clothing management towards more resource respectful, circular systems.

There is a growing awareness of the significant impacts of our clothing and textiles. According to the Ellen MacArthur Foundation report 'A New Textiles Economy' "Negative impacts of the textiles industry are set to drastically increase" (EMF, 2017, p21) through resource consumption, the textile industry's share of the carbon budget and microfibre contamination. Globally clothing production has hit an estimated 100 billion units per annum, with less than 1% of material used to produce clothing is recycled into new clothing, representing a loss of more than USD \$100 billion worth of materials each year.

Clothing product has risen rapidly, doubling in the last eighteen years (EMF, 2017) and is out pacing the market for reused clothing and fibres. During the World War Two, vast resources were directed towards the war effort, from the clothing and textile sector demand for uniforms, tents, blankets, sheets, bandages etc meant companies like nylon manufacturer DuPont who prior to the war produced women's stockings, retooled their factories to meet lucrative government contracts, turning to the manufacture of parachutes and rope for the war effort. In the United States, post war, the middle class expanded significantly due in large part to The Servicemen's Readjustment Act of 1944 otherwise known as the G.I. Bill, which offered living expenses and tuition payments for returned servicemen and women (based on ethnicity) to attend high school, university or technical school, plus low interest rate mortgages and cheap loans for starting businesses. According to Bound and Turner (2002) over 2.2 million (one in eight) returned servicemen and women attended college or universities under the G.I. Bill.

With the restrictions on resources removed, resources and workforce that had been redirected to the war effort turned again to refocus on the domestic market. DuPont once again retooled their factories, returning to supplying stockings for the domestic market. Manufacturing steamed ahead supported by an expanded middle class. Marketing academic Levy described the post WW2 social change "There are more people. These people have more of all kinds of things — more leisure, more money, more possessions, more pleasures." (Levy 1959, p 117). After years of making do the world wanted new. Textile Recycling technology stalled at 1940's mechanical recycling.

In the following decades, the pursuit of neoliberal economic policies by successive governments passed the reins of the economy from the public sector into the hands of the private sector and free market conditions. Greatly reducing the role of government and society in the economy. Privatisation, deregulation, free trade and the removal of protectionist regulations and barriers such as import tax and duties has had a significant effect on societies around the world resulting in extreme inequality and unchecked overuse of the world's finite resources. As trade barriers were relaxed and manufacturing migrated to developing nations, globalization and offshoring provided the opportunity to exploit lower wage production. The movement of manufacturing to less regulated locations increased profit margins but also raised environmental and social impacts. With negative manufacturing costs such as pollution and environmental damage externalized amongst the communities in which factories operated, while the privatized profits were returned back to the shareholders, usually in developed nations, away from the pollution, environmental damage and poverty.

With recycling technology lagging behind the 'fast fashion' phenomenon and with higher volumes of clothing consumption and significantly decreased number of wears per item, end-of-life of clothing is becoming increasingly problematic. The Ellen MacArthur Foundation warn the consequences of not addressing clothing waste is the problem could now could be "potentially catastrophic". Demand for clothing is continuing to grow quickly, should growth continue as expected, total clothing sales would reach more than three times today's amount. If the industry continues on its current path, by 2050, it could use more than 26% of the carbon budget associated with a 2°C pathway. Moving away from the current linear and wasteful textiles system is therefore crucial to keeping within reach the 2°C average global warming limit. (EMF 2017, p 21)

Gillespie, (2015, p14) explains "The cheapest manner to dispose of waste has always been at locations close to poorer communities which have less resistance to the waste and some may actually want it because of the economic opportunities it offers. These communities often have lower standards than richer areas. These lower standards are often because they are unaware of the risks, are not in a position to challenge the lower standards, or do not desire to set higher standards for waste management as it is not a pressing issue for them. These poorer communities are commonly dominated by racial and ethnic minorities, foreigners – and within this mix – often possess a strong gender element. Their unifying characteristic is that they are usually all well below the national levels for average income."

Putting used clothes into clothing bins provides charities and private rag trade businesses with tens of millions of dollars of free stock per annum. The majority of this clothing is then on-sold to poor, second-hand clothing traders on foreign shores. The uncontrolled export of waste clothing has decimated textile and clothing industries in countries receiving used clothing exports, resulting in significant social

impacts through the closure of local manufacturers, the loss of skilled jobs and produced negative environmental effects from the dumping of unwanted clothing.

Our clothing is also far from inert, recent studies revealing micro fibres from clothing is so prevalent they are now a common contaminant in our drinking water and food sources. Over 80% of the world's drinking water is contaminated with microplastic fibres from clothing and other plastics. (Carrington, 2017) While domestic clothing consumption is eye watering, commercial textile consumption is estimated to be forty times greater by volume. To protect brand reputation, corporate clothing is landfilled, the majority of corporate clothing is made from polyester, when assigned to landfill it does not break down and is still going to be there for decades even centuries to come, leaving a long legacy for generations to come.

LITERATURE REVIEW

Much of the work in ethics and sustainability in the fashion industry to date has focused on production and supply chain operations. (exploitive and unsafe working conditions) With clothing production continuing to increase, reports of large volumes of unsold and unwanted stock (sometimes referred to as SLOB stock- slow/obsolete) being incinerated or dumped. Scrutiny of industry practices more recently extended to include the upstream impacts, waste and the ethics of communal resource use (such as water). The conversation has broadened to include an extended chain of custody.

Ethical consumption according to Thompson (2012) is a capitalist construct, a fantasy. That in buying into the marketing stories that companies tell of products being 'eco-friendly' or 'fair trade' that people are numbed to the opportunities to act on a macro level. Arguing that framing social and environmental problems as individual problems diverts humanity from any serious critique of the system. Gilbert (2008) also raises this concern, in micro-managing each little detail in our lives distracts us from being able to concentrate on the bigger picture, the broader social and political issues.

Anti-consumerism literature argues that it is both unfair and unreasonable convincing people into believing that they are personally responsible for the state of the environment. This shift of focus the 'individualisation of responsibility' both Sennett (2000) and Bauman (2001) call "far from benign" (Gilbert, 2008). Maniates (2001) argues against ethical consumption as social action, positing that buying fair trade commodities will not save the biosphere. Consumer knowledge of product supply chains cannot address the overconsumption of resources, pollution and power imbalances. Compounding this issue is the world's expanding population. Organisations such as Earth Overshoot measure the short fall of resources in comparison to population, according to their calculation the world

overshot its annual ecological resources by August 1st, 2018 (Earth Overshoot Day, 2018). Exceeding the world's annual available resources in 7 months instead of 12, drawing more from nature than the world can replace in the whole year, leaving the world in a resource deficit.

Hyper-consumerism cannot co-exist in a finite system, the perpetual growth demands of the consumerism model is in opposition to earth's biophysical limits with its finite resources already over extended, these inimical systems create a very real challenge for society. Using material flow data Goodall (2011) contends the United Kingdom has already reached "peak stuff". Cohen (2013) explores the incongruity between the dominant societal construct in Anglo-European countries of consumerism and societal reality of retrenchment due to the global economic collapse. Raising questions about the longevity of a consumerist society, illustrating the progression of society to date through successive macro-economic models, the transition of humanity from agrarianism to industrialisation to consumerism. Presenting an argument that the world is now transitioning into a post-consumerism era, where zero growth economies may be the new reality.

Gilbert (2008) contests that the promotion of 'choice' for consumers between ethical and less ethical products, or preferable and less preferable products is attributable to the dominance of neoliberal concepts in today's market place. Is it not preferable for a company to supply products manufactured to the highest ethical and environmental standards they can achieve, thereby removing the responsibility from individual consumers to have choose between products with complex supply chains and opaque corporate social responsibility reporting Casey (2017). Placing the onus back on businesses to do their best, by the environment, the people they employ, the societies in which they operate and the world in which they live?

CONTEXT

New Zealand as part of the global clothing system consumes an estimated \$5 billion worth of clothing per annum. Local Council's warn of the exponential growth of discarded textile and clothing waste. Auckland Council estimate discarded clothing and textiles is currently approximately 9% of their landfill and is their fastest growing waste stream. Putting used clothes into clothing bins provides free stock to multi-million-dollar businesses which on-sell the majority of this clothing to poor second-hand clothing traders on foreign shores. NZ exports \$14 million in used clothing a year to Papua New Guinea alone. The uncontrolled export of our waste clothing has decimated local textile industries resulting in significant social impacts through the closure of local industries, the loss of skilled jobs and produced negative environmental effects from the dumping of unwanted clothing. The issue is so significant in developing nations that in 2016 a block of East African Governments proposed a ban on the importation

of second-hand clothes. Halling (2016) and Krauß (2018). Off-shoring used garments pushes the associated environmental and social impacts to countries, generally with less infrastructure, social and environmental protections than the originating country. It does not address the volume of textiles we are consuming and also does not meet consumer expectations of resource reuse and environmental stewardship.

Sustainable Textile Research and Development Company The Formary was established in 2008 and works across multiple geographic regions on a range of fibre and textile research and development projects, from post-industrial fibres, post-harvest agricultural fibres and end-of-life clothing and textiles. Their first client, global coffee giant Starbucks, engaged The Formary to develop second generation textile solutions from Starbucks large volume of used coffee sacks. The two-year collaboration produced WoJo® a hard-wearing upholstery fabric made from recycled jute coffee sacks blended with high quality wool, and Juton® a cotton, recycled jute canvas for use in clothing and accessories. The development becoming a global endeavour as the project was moved from the States (due to limited textile processing capability) to Europe in order to access spinning and weaving capability. WoJo® was launched in Starbucks flagship store in Mayfair, London in 2010 winning awards from HRH Prince Charles and sustainable design ambassador Kevin McCloud of 'Grand Designs'.

It was not until after the launch of WoJo® that the development team from The Formary saw one of Starbucks' warehouses, witnessing for the first time the immense scale and volume of coffee sacks generated from their commercial operations. It became clear to The Formary that in order to address the vast amount of textile waste generated, not just by Starbucks but also by industries including fashion, that in order to have any significant impact on the amount of clothing and textiles disposed of each year, that a systems approach was required.

New Zealand has long been known as a known test market for a variety of industries. A small English-speaking country, its ease of doing business, and non-onerous compliancy, has for decades made the country the ideal user-testing market before products and services are released to the commercial market. In 1980's New Zealand's were user-testing the then revolutionary bank method of payment – EFTPOS, since then global companies have been using New Zealand as a test market. Facebook trialled a Snapchat competitor and their new Marketplace function in this small Pacific nation. Microsoft tested website-creator application 'Sway'. Flirty a drone business teamed with Domino's Pizza to trial the first aerial-delivered pizza. An Economist article titled "Kiwis as guinea pigs" (2015) suggests international tech firms use New Zealand to fix bugs, check server capability and test the product in a limited market before global rollout. Taking the lead from tech companies and having

worked on product development in various locations around the world New Zealand seemed to The Formary the ideal market to develop and test a macro circular system for used clothing.

PURPOSE

In 2015, The Formary was approached by New Zealand Post (NZ Post) a state-owned enterprise which operates as a commercial entity offering of a range of business services providing communication and business solutions. The organisation had identified a growing problem with their branded uniforms and textile waste going to landfill, further research revealing that the twenty largest New Zealand organisations use around 860,000 garments a year. NZ Post had created a collaborative project with Wellington organisations Booker Spalding (uniform supplier), Earthlink, (social enterprise, maker) and Massey University. The group established a model to recycle and upcycle old corporate uniform into redesigned clothing. The project highlighted challenges around market demand, processing volume and waste. NZ Post then engaged The Formary to implement a “bigger picture” solution. Drawing on The Formary’s expertise in textile research and development, fibre recovery and reengineering, as well as their proficiency in supply chain building to deliver commercially viable, scalable solutions. Initial funding was provided by NZ Post and Wellington City Council (WCC) Waste Minimisation Fund.

Project Aim.

The aim of the project is to understand the volumes and type of textile waste generated by New Zealand Corporations. To identify existing reprocessing capability in New Zealand and to build the business case to address any gaps in the re-processing supply chain. Enabling the re-processing of corporate clothing and textile waste in New Zealand into second generation products, reducing waste and extracting higher value from textile resources.

Project Objective:

Through the reuse of clothing resources, the Textile Reuse Programme intention is:

- Diversion from landfill – aim for zero waste.

- Reduce carbon emissions.
- Reduce reliance on virgin resources
- Extract the greatest value from garments.
- Create economic and social development through new jobs.
- Create shared value for both community and business.
- Provide higher visibility and traceability through local processing.
- Brand protection and reputation management.
- Inform the front-end design of garments creating efficiencies over the whole life-cycle of the product.

METHODOLOGY

The Formary reviewed the initial NZ Post upcycling project Whitty (2015) and Whitty & McQuillan (2015). This was followed by an investigation of systemic approaches through product design development across a range of industries and disciplines. Transition Design fosters design-led societal transformation, a proactive conscious approach to the planetary limitations. Hargraves (undated) suggests that “In mattering, design transitions from a capacity to induce change, produce artefacts, or to work the materials of communication, industrial or interaction design. Design becomes a mode of participation” Cohen (2013) challenges scholars and others to begin working on what a post-consumerist system might look like, with the aim of aiding humanity’s transition from the current but unsustainable consumerist economic model to an unknown but feasible post-consumer model of the future. The current linear clothing system is clearly failing, Tonkinwise (2016) posits failures have an affective force and the creativity of designers is catalysed by the failure of products and services.

The Programme adopted the Sustainability Business Council’s Value Chain thinking framework, the framework is designed to deliver the following benefits:

- Reduce resource consumption and waste.

- Realise opportunities for innovation.
- Create shared value with communities (enhancing social licence to operate).
- Improve relationships and resilience through greater security of supply.
- Enhance stakeholder relationships through better understanding.
- Lower operational, reputational and regulatory risks to business.
- Fuel top-line growth and enhance productivity through efficiencies.
- Create new markets for products or services.
- Improve access to finance and lower-cost insurance.
- Provide a point of difference and competitive advantage.

The Framework included:

1. Value Chain mapping
2. Identifying risks and opportunities
3. Assessing priorities
4. Identifying solutions
5. Developing a project plan
6. Creating a new 'business as usual'

The areas of focus for the project plan were:

- Procurement & Disposal – analysis of how much & what type of garments are being purchased; how are the garments being managed and disposed of.
- Reprocessing (current solutions) – research what processing options exist now, and how might these be best utilised in the short to mid-term.
- Reprocessing (emerging technology) – research what processing technologies are emerging from the emphasis on resource efficiency and circular economies and how these might fit into the NZ marketplace to provide mid-to-long term solutions.

- System design, economics, implementation and funding.

In order to support a commercial re-processing supply-chain in market and to fund the research and development, The Formary recommended a collaboration of corporations, inviting Air New Zealand, Fonterra, SkyCity, and The Warehouse Group into the project titled the 'Textile Reuse Programme'. The aim of Programme being to build an integrated and scalable system for the management and re-use of end-of-life garments.

Funding was provided by the initial Programme Partners: New Zealand Post, Fonterra, Air New Zealand, SkyCity, The Warehouse Group and also provided by Wellington City Council, Alsco NZ and Wellington Zoo as they subsequently joined the Programme. The New Zealand Ministry for the Environment also provided funding for the Feasibility stage of the Programme.

FINDINGS

General observations and statements:

Currently there are limited immediate local solutions for textile waste. The solutions that are available are either very small scale, costly to tap into, or at current capacity. Upcycling globally only addresses approximately 1% of the waste stream and cannot scale to meet the size of the issue. (MacArthur, 2017)

The sorting required to re-engineer garments pushes the price point up for upcycled garments, reducing market demand. There is considerable wastage where fabric is worn, sweat stained, pilled, damaged; and, the integrity of the upcycled garment can be compromised as the fabric is often degraded and already a reasonable way through its useable life. While re-engineering of garments may extend the life of a garment for a period, it does not address its end-of-life. Corporate fabric choices and colourways do not align well for re-engineered clothing.

The charity resell option does not align well to corporate textile waste, corporate organisations do not want their uniforms re-worn by the public. The public are generally not attracted to and unwilling to purchase used corporate wear. Charity stores face issues of high volume of low-quality clothing resulting in increasing waste disposal costs running into thousands of dollars per month.

There is a risk is that current options do not necessarily guarantee security of brand / iconic textile, they (often) do not guarantee a reprocessing option, they have limited capacity (and sporadic supply of textile does not facilitate this capacity growing), and they do not provide an auditable trail of the garment reuse.

The manufacturing options that are available require a known supply of fibre to operate most efficiently (otherwise each supply becomes a one-off transaction which continually has one-off overheads).

There is considerable R&D happening in this area, particularly in chemical technology solutions i.e. breaking down the garment to its constituent fibre parts for reuse by a chemical process (predominantly for polyester).

The model employed through this Programme needs to be implemented in stages to test the process, identifying and addressing issues before any significant waste stream volumes are diverted to it. A staged transition will avoid overwhelming the system. This provides the opportunity to actively manage any problems or risks before full implementation.

Polyester which constitutes much of corporate clothing, can take hundreds of years to break down in landfill. Polyester and polyester blend uniforms assigned to landfill have a long legacy with significant volumes compounding the issue.

Using only the textile disposal costs to evaluate the business case for diversion does not take into account the socialised environmental cost of landfilling. Companies like Hugo Boss are starting to assign dollar values to their environmental impacts (where previously it was calculated as a carbon and / or water usage but was never quantifiable in an economic dollar sense). This is starting to provide a clearer picture of the full costs of disposal (both privatised and socialised).

Consumers have been donating used clothing to charity for a couple of hundred years. Clothing as a valued resource is well imbedded in society and consumers will make the effort to travel to charity shops or clothing donation bins rather than simply placing their old clothes in the rubbish. They now expect similar, or better, from commercial companies – landfilling end-of-life textiles does not meet with consumer expectation.

Some organisations have little oversight of where branded garments are going. Seepage and disposal of garments at worker's homes is a common phenomenon. High profile cases like Qantas

first class pyjamas being worn in a terrorist video and Kathmandu employees destroying clothing in a public car park can cause considerable damage to brand reputation.

Disposal of slow and obsolete clothing stock has created public debate on the management of clothing resources, ethics and responsibility.

While working with commercial organisations to develop scalable, financially and environmentally sustainable systems for end-of-life clothing, the need to acknowledge and address immediate challenges of decommissioning garments was also an important factor. As a result the Programme organically split into a tri-form strategy based on the short, medium and long term timeframes in order to meet partner's needs. Being responsive to partner's requests for immediate solutions was valuable to the project as it built relationships with reprocessing companies, enabling awareness of their capabilities and understanding of their requirements, it also informed how the proposed model might facilitate these companies to continue to take textile waste, and potentially increase their use of used clothing fibres.

SOLUTIONS:

Short Term

Short term solutions available in the immediacy are focused on reuse within the community. Employing minimum intervention to contain resource use and environmental impacts while extending the life of garments.

Charity stores receive donated clothing and on sell the donations as revenue generation for their operations, the priority is not necessarily to supply those in need with clothing. This leads to a disconnect where those in need cannot access clothing resources. If you cannot afford food you cannot afford to purchase clothing, even through charity stores. Through the Textile Reuse Programme good quality decommissioned clothing was diverted directly to communities in need, at no cost to the community.

WRAP UK calculate that "Extending the life of clothes by just nine extra months of active use would reduce carbon, water and waste footprints by around 20-30% each." (WRAP, 2006) Connecting appropriate organizational decommissioned clothing to communities in need serves both organisational and community needs.

The Formary distilled the exercise of decommissioning Wellington Zoo's uniforms into a Case Study (Example 1) This case study is being presented by Wellington Zoo to the World Association of Zoo's and Aquariums Sustainability Strategy Writing Team as an example of the United Nation's Sustainable Development Goal 17 - Partnerships. The aim is to include it as an exemplar in the strategy. The strategy is then going to be written over the coming year for launch at 2019 World Association of Zoo's and Aquariums Conference in Buenos Aires, Argentina.

WELLINGTON

ZOO

NZ TEXTILE REUSE PROGRAMME

Uniform Reuse

Wellington Zoo is nestled in the green belt of Wellington, New Zealand. Now over 100 years old, it was the country's first zoo and has 13-hectare (32-acre) dedicated to over 100 species of fauna from across the globe. Wellington Zoo is a significant contributor to conservation efforts including breeding programs for endangered species, as well as spreading conservation and sustainability messages to the wider community.

Wellington Zoo Chief Executive, Karen Fifield, has been selected to lead the team to develop a sustainability framework for progressive zoos and aquariums throughout the world.

Wellington Zoo's sustainable journey started more than ten years ago and since then has achieved its carboNZero certification for the fifth year running, added a 100% electric vehicle to its fleet, installed 48 solar panels, transitioned to an ethical uniform supplier and an ethical textile disposal organisation, increased the eco-sourced and sustainable products in the Wellington Zoo Shop, and switched to a CarboNZero certified electricity retailer.

"Reducing the Zoo's carbon emissions and impact on the environment is important to our goal of saving animals in the wild. Sustainability is a journey, it never ends, and we're proud to be leading the way in this area and showcasing our environmentally conscious practices. We hope by sharing our journey with the zoo and aquarium profession and other organisations, we will spark the conversation about what other people can do to reduce their impact on the planet."

Karen Fifield, Chief Executive, Wellington Zoo.

THE CHALLENGE

New Zealand churns through about \$4 billion worth of clothing a year. Auckland Council estimate discarded textile and clothing waste at about 9% of landfill and is their fastest growing waste stream. Putting used clothes into clothing bins provides free stock to multi-million dollar businesses which on-sell the majority of this clothing to poor second-hand clothing traders on foreign shores. NZ exports \$14 million in used clothing a year to Papua New Guinea alone. The uncontrolled export of our waste clothing has decimated local textile industries resulting in significant social impacts through the closure of local industries, the loss of skilled jobs and produced negative environmental effects from the dumping of unwanted clothing. The issue is so significant that in 2016 a block of East African Governments proposed a ban on the importation of second-hand clothes.

Our clothing is also far from inert, recent studies revealing micro fibres from clothing is so prevalent they are now a common contaminant in our drinking water and food sources. Over 80% of the worlds drinking water is contaminated with microplastic fibres from clothing and other plastics.

While our domestic clothing consumption is eye watering, commercial textile consumption is estimated to be 40 times greater by volume. To protect brands corporate clothing is landfilled, the majority of corporate clothing is made from polyester, when assigned to landfill it does not break down and is still going to be there in 100-500 years-time, leaving a long legacy for generations to come.

Where our clothes end up is as important as where they come from.

THE CHALLENGE

Independent research organisation the Ellen MacArthur Foundation warn the consequences of not addressing clothing waste is the problem could now could be *“potentially catastrophic”*. Demand for clothing is continuing to grow quickly, should growth continue as expected, total clothing sales would reach more than three times today’s amount – *“If the industry continues on its current path, by 2050, it could use more than 26% of the carbon budget associated with a 2°C pathway. Moving away from the current linear and wasteful textiles system is therefore crucial to keeping within reach the 2°C average global warming limit.”*

All uniforms become obsolete at some stage of their lives whether they are worn or not. A company’s decision to rebrand or revise their uniforms up until now has never really taken into consideration what happens to the old uniforms.

Organisations invest considerable amounts of money into their brands including branded garments, security and reputation management are key considerations. However most sustainability reporting omits reporting on the impacts of organisational clothing and textile consumption.

Wellington Zoo had recently changed their uniforms and uniform supplier and wanted to investigate alternatives to landfilling their decommissioned old uniforms.

WHY THE FORMARY?

The Formary is an award winning Sustainable Textile Research and Development company and a global leader in textile fibre redesign. The Formary works with businesses and organisations worldwide, transforming textile and clothing waste into valued products.

The NZ Textile Reuse Programme developed from NZ Post requesting The Formary's assistance to develop a scalable system to manage and divert their end-of-life textiles from landfill. The Formary proposed taking a systems approach to the issue, inviting in a small group of likeminded corporates to form a collaboration to design and implement a scalable system to provide optimal end-of-life solutions for textile waste. This led to an initial collaboration of five of NZ's largest corporations – NZ Post, Air NZ, Fonterra, SKY CITY, and The Warehouse Group. With Alsco NZ, Wellington City Council and Wellington Zoo subsequently joining. The programme was overseen by a Steering Group comprising one representative from each organisation. Taking a staged approach to developing the system for scaling reuse of garments that incorporates community needs, conversion to industrial inputs and the inclusion of new processing technologies to extract higher value from clothing resources.

According to the Ellen Mac Arthur Foundation *“Increasing the average number of times clothes are worn is the most direct lever to capture value and design out waste and pollution in the textiles system.”*

WRAP UK calculate that *“Extending the life of clothes by just nine extra months of active use would reduce carbon, water and waste footprints by around 20-30% each.”*

THE SOLUTION

The Formary worked with Wellington Zoo to sort and record each decommissioned garment – fibre type, current state of the garment and reuse pathway.

Wellington Zoo's priorities for the decommissioned uniforms were:

- Diversion from landfill
- Support local communities
- Extract the greatest value from the garments

Garments were identified in the following categories:

1. Community reuse as garments
2. Reuse in second generation product
3. Return to supplier (faulty/not fit for purpose)
4. Waste

Unclean reuseable garments were sent to be professionally laundered.

Reuseable garments were sent to embroiderers to have logo covered/secured.

Garments were then dispatched to the following community groups in need of clothing:

Workerbee Oasis & Kaicycle, Common Unity, Kiwi Community Assist for dispatch to: Wellington Night Shelter, Taeaomanino Trust, The Free Store, Capital and Coast Health, and Te Waka Whaiora Trust.

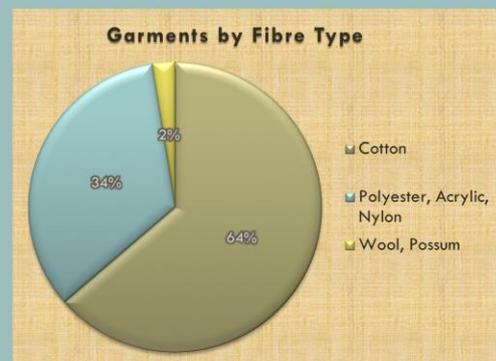
Pathways for garments into second generation products were:

Processed into moving blankets. Made into chew toys for SPCA and shopping bags (as a team building exercise at Ministry for the Environment). To Clyde Quay School, Wellington as an educational fundraising project.

SOLUTION — BRANDING REMOVAL FOR COMMUNITY REUSE



Fabric	kg	%
Cotton	321	64%
Polyester, Acrylic, Nylon	171	34%
Wool, Possum	13	2%
Other	<1	<1%
	505 kg	



WELLINGTON ZOO

Uniform Reuse

WELLINGTON ZOO — UNIFORM REUSE

Number of Garments Decommissioned	1642
Total Weight	505 kg

Environmental Impact	
Water – H₂O	1,037,000 litres
Carbon Dioxide – CO₂	13,157 kg



Calculations based on WRAP UK report titled "Valuing Our Clothes" (2012 updated 2017)
 see http://www.wrap.org.uk/sites/files/wrap/VoC_FINAL_online_2012_07_11.pdf

	No. of garments	Weight (kg)	Carbon CO₂ (kg)	Water ('000 l)
Reuse within community	479	208	5419	427
For reuse in 2 nd generation product	750	164	4272	337
Not fit for purpose – returned to supplier	204	45	1174	92
Waste – too degraded for reuse	209	88	-2,292	-181
Totals	1642	505 kg	8,573 kg conserved	856,000 litres conserved

LESSONS — TAKE OUTS

To lower environmental impact delay rebranding exercises, look at ways to potentially slow consumption e.g. consider what the Zoo's position could be on mending uniforms.

For optimal maintenance of garments provide staff a best practice sheet for laundering uniforms.

Some garments are branded in several places, at decommissioning this increases the cost of removal — extra branding can be a barrier to reuse.

Encourage improved alignment of clothing design and recycling processes by including consideration of design for end-of-life in Request For Proposals (RFPs).

Encourage Extended Producer Responsibility (EPR) by requesting an end-of-life plan including costs in RFPs.

Small/medium organisations often do not have the clothing expertise to de-risk uniform procurement. In this case working with a new uniform supplier unaccustomed to the requirements of Zoo clothing resulted in garments which were not fit for purpose. Smaller organisations could benefit from contracting in garment expertise to assist in the often complex navigation of clothing procurement.

SORTING UNIFORMS — WELLINGTON ZOO + THE FORMARY STAFF



Example 1. Case Study, Wellington Zoo

Medium Term:

A pragmatic approach incorporates current market capability and how these can be leveraged to develop new second generation uses for used clothing resources. Research investigates potential stretch in product applications, followed by product development trials. Working in the commercial sector scale is a priority, industrial applications offer scale and transactional value, designer product applications can offer higher value individual returns but lower volumes are unlikely to support reprocessing supply-chains. Current shredding capability limits the quality of the fibre extracted from processing, but does however remove issues such as security (for banks, aviation, military, police etc) It also protects brands and manages organizational reputation by reducing brand imagery and iconic patterns down to fibre state.

Due to propriety considerations and contractual obligations, medium term applications being developed within the Textile Reuse Programme can be described as falling broadly into the following categories:

- Known applications - such as insulation
- New industrial products - such as geo-textiles
- Research stretch products

New Zealand Regional Councils and the Ministry for the Environment have highlighted challenges in the under reporting of waste categories, including those of textile and clothing, and as a result under examination of the waste streams and their impacts. To ensure transparency and traceability blockchain technology is being applied to the system, providing tracing capability of used clothing, oversight of material flows and the capture and dissemination of data on associated impacts. Enabling the participants to include material impact data into their organizational environmental reporting. Extended oversight over products will drive the reuse and recovery of resources. It also informs product design and materials selection, steering products towards compatibility with end-of-life solutions, reducing waste and environmental impacts.

Long Term:

With the macro system in place aggregating used clothing, the technology system recording the flow of materials and industrial reuse solutions operating, higher value solutions can be plugged into the system as they are developed and commercialized. An example of this higher value system is fibre to fibre technology. The Textile Reuse Programme has trialed one such system developed in the United States by Ambercycle.

Ambercycle was founded by University of California, Davis alumni Akshay Sethi and Mubasher Ahmed and is now located at Bioscience Laboratories, a tech incubator in San Francisco. The team has developed a process to convert polyester from post-consumer textile feedstock into raw material chemicals, which can then be used to make new polyester, without a loss in quality. Employing *E. coli* bacteria to consume polyethylene terephthalate (PET) plastic as a carbon source and breaking it down into terephthalic acid and ethylene glycol. The ethylene glycol can be fed back into the reaction, leaving terephthalic acid as a raw material that can be sold back to plastic producers. Ambercycle were recipients of the Global Change Award (annual innovation challenge for circular fashion, initiated by the non-profit H&M Conscious Foundation) the funding from which is enabling the commercialisation of their polyester digester.

The Formary worked with Ambercycle to trial the system using decommissioned clothing sourced from Textile Reuse Programme Partner, Air New Zealand. Polyester cabin crew uniforms were processed through Ambercycle's enzymatic system, converting the garments from woven textile form to an extruded pellet form that could then be re-extruded into yarns or molded plastic products.

IMPLICATIONS

Conglomerate funded brands and their return on investment priorities dominate the fashion industry. This has radically altered the fashion landscape, increasing the speed of production and consumption, the waste and resource use. Recently the issue of over production and unwanted stock has repeatedly hit the news in high profile cases, raising the debate over use of global resources and extended producer responsibility over the garments brought to market.

Mankind has the innate ability to address failures, from product failures through to macro system failures, in an ever-evolving environment of design and development. Challenges in the industrialised clothing system require acknowledgment of the common interests in global resources and the interconnectedness of social, economic, political and natural systems. Prof Michael Braungart co-author of Cradle to Cradle declares "Waste is a threat to mankind" To stay within the ecological boundaries of the planet there must be a radical reduction in the draw on virgin resources, a reduction in carbon generated by the clothing industry, an elimination of waste and the extraction of considerably higher value from clothing.

Cradle to cradle, clothing-to-clothing system that loops resources from used clothing back into the beginning of the supply chain is no longer just an ideal, each day researchers are getting closer and closer to commercialising and implementing such technologies. From a systems perspective connecting

the used resource back into the beginning of the value chain requires that either production is relocated closer to where clothing is disposed of, or the logistics of moving end-of-life clothing from end market regions back to producer regions for reprocessing becomes economically viable.

Either way, alignment of capability and investment is required to close the loop, connecting supply-chains from end to end. In the mean-time there are valid second-generation applications that will reduce clothing to landfill/incinerator and extract higher value and usage from clothing resources. Exploring and implementing these solutions is a crucial next phase in reducing waste and transitioning the fashion industry to more efficient systems. In-market closed loop systems make take years to be a financially viable option. In regions like New Zealand closed loop systems may not prove to be economically viable due to market size, geographic remoteness or level of investment required. However, improvements can be made that lower current volumes of clothing waste and associated environmental impacts.

The Textile Reuse Programme is a pragmatic, holistic system designed to accommodate defined immediate needs with planned inclusivity of emerging technologies. It is a replicable eco-system for the evolving translation of design and technology, transitioning the current failing linear system to essential circularity of clothing resources.

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