



Sailing towards sustainability: Material-based, practice-led research

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Abstract

In this article, we discuss the experiential learnings from two collaborative research projects exploring the reuse of discarded competitive sails in Aotearoa New Zealand. The visually appealing and composite sail material, which normally goes to landfill because it is difficult to recycle, was the centre of our creative, practice-led and material-based approach, driven by sustainability and reflexivity. To achieve this, we applied environmental, social and economic lenses to our research processes and outcomes. We used two distinct projects as test cases to analyse and reflect on the realities, challenges, limitations and opportunities in the reuse of waste material in object and fashion design, also considering the differences between commercial design contexts and art-based approaches.

In the first project, we aimed for replicable and commercial outcomes, emphasising material efficiency while simultaneously seeking to collaborate with and economically benefit a women-led refugee trust. In the second project, we aimed to create consciousness of the potential uses for discarded material, highlighting the visual aesthetics of the high-tech and historically meaningful sails in the context of Aotearoa New Zealand. We found that, while there were only minor differences in the design process, external conditions like funding agendas and exhibition spaces play an important role in the perception of design outcomes. Furthermore, there are structural barriers to addressing the social dimension of sustainability in commercial projects with not-for-profits, especially in short-term projects.

Keywords

Sails, reuse, upcycling, waste, sustainability, design process,

artistic practice, practice-led research.

Introduction

This study is based on two collaborative creative research projects carried out at Auckland University of Technology in 2017, in which we explored creative avenues for the reuse and upcycling of discarded America's Cup-type sails, made from valuable but currently single-use materials. One project, *Navigator*, aimed to divert commercial waste from landfill by transforming the sail material into commercially viable products. We produced a research report and a range of product designs: a variety of modular lampshades. The other project, *Voyager*, was the design of a piece of wearable art entirely made from the same waste material, made for public display (live shows and exhibition). Both projects investigated the conditions under which material-based, sustainable products using waste materials can be developed successfully.

Through reflexivity and the environmental, economic and social pillars of the triple bottom line of sustainability, our experiments focused on the composite and visually attractive material, following the four-step design process of the double diamond model. While there were minor differences in the design process, the external conditions, briefs and agendas also influenced the perceived results of the respective projects. In the commercially driven project, *Navigator*, we encountered challenges in creating awareness, for some stakeholders, of the importance of experimentation and 'failure' – fundamental to the design process – and about what is considered a 'successful' outcome.

Our experiences, the outcomes and the discussions and reflections from both projects impacted our learnings and conclusions and have influenced our professional practice. We argue for the importance of research-driven and material-based practices that are aligned with a balanced sustainability approach, without privileging economic aspects. Also, in the relationships with industry stakeholders, it is important to be transparent about the challenges and impasses of practice-led research aiming to upcycle and reuse waste material.

Sustainability, waste reuse and upcycling

Sustainability as a topic has permeated education, political, economic and government agendas for decades. Perhaps the most used term is 'sustainable development', defined in the United Nations' Brundtland Report in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," establishing environmental, social and economic dimensions in decision-making. In 2016, the United Nations' Sustainable Development Goals entered into force and were adopted by world leaders working towards ending poverty, tackling inequalities and mitigating climate change by 2030, making sure no one is left behind.

Over the last century, economic and social progress has impacted on the environment, directly degrading and endangering the systems we depend upon for survival and development. Consumption-driven societies produce and consume products with short lifecycles, generating exorbitant amounts of waste. Consequently, waste reduction has been used as a strategy in the production chain to alleviate the problem of pollution and achieve more sustainable product development. In this area,

waste material recycling, reuse and upcycling have been common approaches.

Upcycling encompasses the creation of products made from materials that have been previously used and/or are considered waste, generating a finished product of higher value and quality. While recycling is commonly confused with upcycling, the difference lies in energy consumption, since with the latter the material does not require reprocessing. According to Szaky, upcycling is one of the most sustainable circular solutions amongst waste strategies, positioned between reusing and recycling. There are scale levels of upcycling, such as industrial, medium-scale, small-scale and individual. At the individual level, upcycling has become part of a lifestyle for waste reduction and sustainable consumption. The upcycling lifestyle is part of DIY (do-it-yourself), maker and repair movements aligned with waste reduction, reflected in the increasing number of individuals sharing information, physical resources and spaces, online and offline. These accessible spaces contribute to sharing resources, skills and knowledge on the reuse of waste material and on the fixing and making of products. This contributes to the creation of communities of like-minded individuals with similar values.

In enterprises involving diverse stakeholders, like universities and research centres, as well as amongst design students and upcycling practitioners, there is now a shift in focus from individual upcycling towards small- and medium-scale development. While these scalable and replicable initiatives could have long-term impacts, there are challenges and questions to be addressed: for example, can approaches relying on existing consumption-driven paradigms help to address sustainable development for the whole population, not just the privileged?

Integrating upcycling and waste material reuse into the design process

Educators and practitioners are noticing the need to create different design processes and methods to approach upcycling and waste material reuse projects, even proposing this to be integrated into design programmes to address sustainability. Here, it is important to understand the differences between conventional product design processes and design processes where the integration of waste reuse has been contemplated. Frequently, design considers the creation of products based on raw, virgin or recycled materials, rather than reusing and upcycling existing ones. The integration of waste material and upcycling into the design process requires a shift in mindset and an approach primarily towards experimentation and 'trial and error', fundamental to the creative process of upcycling. Also, knowing and recording the stories of the original material or product in the sourcing stage has the potential to add value in the commercial stage.

Upcycling and waste material reuse practices face challenges related to sourcing, transporting, cleaning and storing waste material before it is used in the manufacturing process. At the same time, the design process depends on the type of waste material collected and therefore requires constant adaptation and experimentation. It can be labour intensive and time consuming as it relies heavily on the designer's skills as a creative and maker, and also on the prevailing commercial strategies, issues that are reflected in the pricing. Here, it is necessary to consider whether reliance on the same consumption/market paradigm of commerce catering for high-end markets, which produced the problem in the first instance, can contribute to sustainable goals.

Waste reuse and upcycling for sustainability and the market

Around the world, sustainable waste reuse and upcycling practices address environmental, social and economic challenges. However, the reasons and motivations are different in the Global North and the Global South. Reuse and upcycling in the Global North is almost a lifestyle and often results in small-scale businesses, while in the Global South limited resources and financial restrictions motivate these practices. Hence, it is necessary to contextualise and adapt reuse and upcycling to the conditions of different contexts.

Even though upcycling and waste reuse are common approaches to reach sustainability goals, there are questions about their efficiency. In the 2010 World Economic Forum, it was discussed that the current trends towards sustainability are not sufficient, even inefficient, producing only incremental changes. Achieving the United Nations' Sustainable Development Goals by 2030 calls for radical and transformative practices. Sustainability requires constant examination, evaluation, testing, control and research of current practices, systems and cultures for the generation of new and effective alternatives. This involves transformation at different levels, such as systems, products, infrastructures, organisations, information, relationships, mindsets and praxis. Furthermore, the current economic system based on overconsumption and constant growth needs to change structurally, towards a system that is more ethical and respectful for the environment and societies worldwide.

The research context: Aotearoa New Zealand and the 'City of Sails'

Aotearoa New Zealand has a strong history of sailing, with an outstanding performance on the world stage. Māori arrived from Eastern Polynesia, sailing waka (canoes) in the late thirteenth century, navigating the ocean as their highway that connects places in a "sea of islands." The first Europeans (Dutch) navigated New Zealand waters in 1642, followed by the first longer-term visitors, such as whalers, in 1769 (English) and later colonial settlement.

More recently, Auckland has played an important role in sailing. With the most boats per capita in the world, it has aptly been nicknamed the "City of Sails" (Figure 1). More than 40% of registered sailors and yachtsmen in the country live in the region encompassing Auckland, North Harbour and Waitakere. The first regatta took place in 1850, and is today known as the Auckland Anniversary Regatta, taking place annually. It has been estimated that this regatta draws one of the largest fleets in the world. Auckland has hosted two America's Cup challenges, the oldest international sailing race, and is preparing for a third in 2021. New Zealand's leading-edge yacht designers emerged on the international scene in the 1980s, and sailing material manufacturers supply competitive and leisure sails worldwide. Amongst them, the numerous sailing vessels in Auckland discard a considerable number of used sails, which are dumped or stored as they cannot be recycled.

Competitive sails as waste

Starting in 2016, our team of three design practitioners and researchers began to investigate waste streams for a funded research project. We focused on the sailing sector due to its popularity and size in New Zealand, particularly in Auckland. In high-stake races, competitive sails are commonly used only a few times, since their performance and reliability quickly diminish after exposure to extreme forces, abrasion and UV light. High-end and high-priced



Figure 1: Auckland's main marina and images of competition sails. Photographs by the authors.

sails have been made in New Zealand since the early 1980s, but an increasing number are acquired from China. Regardless of the country of origin, the high number of regattas in New Zealand results in large stockpiles of used sails still in reasonable working condition.

During our search, we found a company that specialised in America's Cup sailing experiences for the tourist industry. This company has between 50 and 60 used competitive sails stored in containers, some 15 to 20 years old. There are two main reasons for storing these used sails and not disposing of them: first, their size and weight makes it too expensive to throw them away; and second, the initial cost and perceived value of the sails is too high. The competitive sails we sourced were made from carbon fibre and Kevlar fibre strands, providing flexibility and stretch resistance. The strands are laid out in a specific pattern and are held in place between two layers of Mylar, which is a translucent foil made from PET. Due to its material and fabrication, this type of sail is considered a composite material, mostly non-recyclable. There is no official information related to the environmental impact of these sails and their components, and unwanted sails are classified as 'unknown' due to their composition and thus discarded along with other non-recycled household waste.

Commercially reused sails

The reuse and upcycling of sailcloth material to create new products is not a new concept. There are several businesses around the world that trade this type of product, many on platforms like Etsy, where people offer one-off, handmade designs. We identified four key challenges for businesses commercialising recycled sailcloth: 1. A

lack of continuous flow of sail material for production; 2. Intensive craft-type/hand labour to produce upcycled objects, increasing retail prices; 3. Difficulty in maintaining a consistent supply chain to retailers; and 4. A focus on niche markets, like high-end stores and galleries of art-objects. The latter creates a dependency on one or more of three aspects: 1. Environmentally conscious consumers; 2. The name of the creator-artist as an important asset; and 3. The cultural capital the sails' provenance may provide.

Design process and reflexivity towards sustainable change

The blurred boundaries of art, design and craft

Differences between art, design and craft were constant topics of discussion during the research. In conventional design education, the distinctions between design and art and craft are emphasised to establish, in simple terms, that art focuses on personal expression, design on fulfilling business-oriented briefs, and craft on objects predominantly made by hand. As design practitioners and researchers we beg to differ, particularly in the light of a recent publication of one of the authors on decolonising design.

The tensions between the creative fields have been discussed by many authors over time. Shiner claims there are "blurred boundaries" between craft and art, while Greenhalgh considers crafts to exist on the border between design and art economies. Despite the questioning of the boundaries between art, design and craft, hierarchies are still present in their perception, value and consumption.

Considering the similarity of our design education and our focus on collaboration, we agreed to use a familiar design process as a guide and point of reference to compare the two material-based projects with a sustainability focus: the double diamond model.

The double diamond design process

The double diamond design process is a model launched by the British Design Council in 2004 as an innovation framework for designers and non-designers to address "complex social, economic and environmental problems." The reasons to use this approach were: 1. That it is directly linked to the divergence-convergence model and creativity, common in art, design and craft; 2. That it is an established design process in academia; and 3. That the authors had previous experience applying and teaching the model. Each diamond represents a different stage in divergent and convergent thinking as a process of exploration followed by action. The double diamond design process is divided into four stages: Discover, Define, Develop and Deliver. The first half of the first diamond (divergence) represents Discover, a stage where understanding of a problem is pursued, and the second half (convergence) constitutes Define, where insights are gathered and opportunities defined. The second diamond, another cycle of divergence and convergence, starts with Develop to explore potential answers or solutions, followed by a Deliver phase in which different solutions are tested and a final solution is delivered (Figure 2). Collaborating in the Discover and Define phases mainly consisted of allocating specific research tasks to the individuals, and conducting field research as a team, with regular team meetings. Storyboards and mood boards were significant tools to unpack ideas and narratives, and to visualise a certain 'look and feel.'

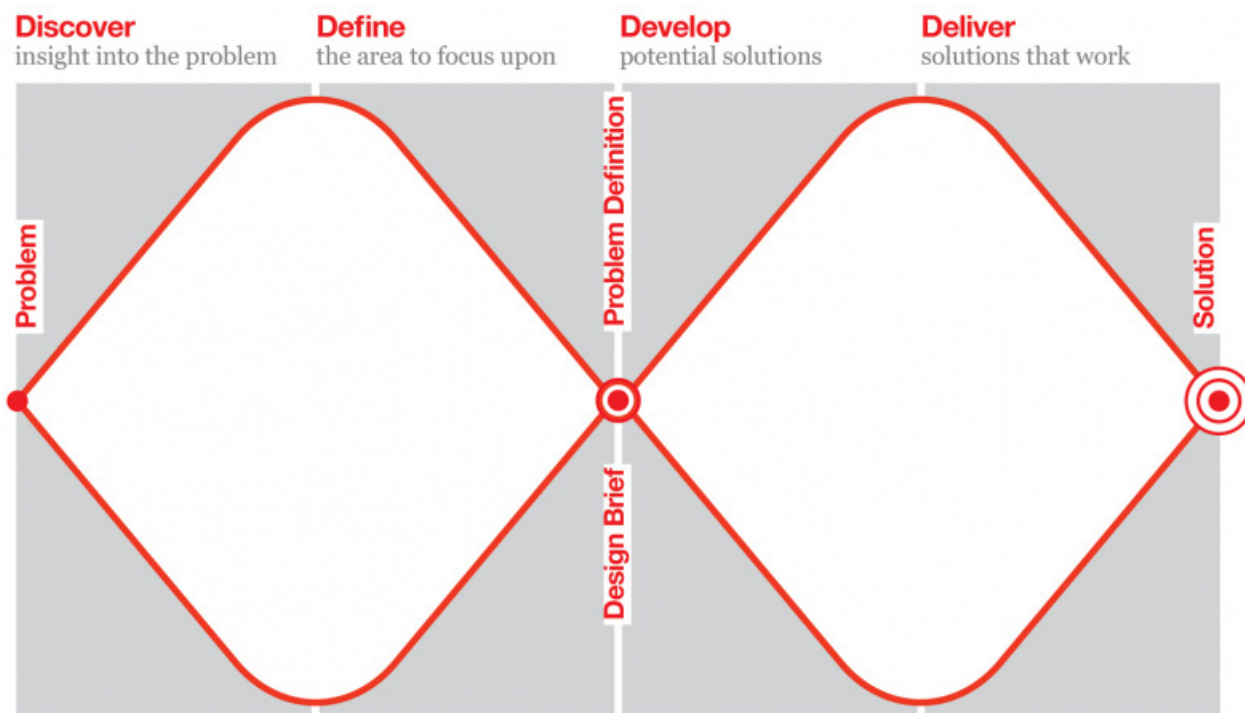


Figure 2: Double diamond, created in 2004 by Design Council. Visual courtesy of Design Council.

After going through the phases of the first diamond, for both projects, we had a clear idea of the problem and the opportunity we wanted to pursue.

In the Develop and Deliver phases, we did extensive material experimentation, idea exploration and model making, where similarities helped us to reach common agreements. We had a couple of iterations of the Develop and Deliver phases for further concept and prototype development, to improve functionality, proportions, details and overall aesthetics in order to deliver high-quality working art-objects for both the *Navigator* and *Voyager* projects.

We consider regular team meetings a fundamental part of our process to discuss cultural backgrounds, narrative proposals and specific aspects to include in the outcome. These sessions were often playful and fun without personal attachment to any particular outcome, where key aspects were respect and positive feedback without judgement or negative language. This does not mean tension was not present at times, but focusing on care and connection supported our journey. Collaborating as a team made us achieve more than we could have individually, getting us to a better outcome, but it also made working on the projects a lot more enjoyable. Our regular conversations allowed us to not only unpack the design process but to have open reflections on the challenges around design, funding, relationships with stakeholders and sustainability, in other words, individual and collective reflexivity.

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Reflexivity for sustainability

Reflexivity as a research approach has been extensively used in social science research, and is gaining attention in other fields. "Reflexivity involves a process of on-going mutual shaping between researcher and research," where our design experience and practice-led research involve extensive, individual and collective reflexive practice. This approach has also been used in sustainability, and in particular in its connection to design and art.

There are different links between art and design, sustainability, and reflexive practices. Sustainability needs deep changes in our attitudes and ways of living, requiring creative thinking and open minds to adapt to changing conditions, the "art of being different." In this sense, it is a "more than rational" process, involving identities, emotions, lifestyles, desires and fears, rather than goals. Here, connections to art and design become evident, since they relate to creativity, exploration, testing to transform, and a process of inquiry by creating. Designers and artists (craftspeople included) engage in creativity, divergent and convergent thinking and intuition to address specific topics and challenges.

Since sustainability is a process of change and exploration, reflexive practices in practice-led research support the integration of individual and collective reflections, feeding the research and design process. At the same time, the researchers transform their views as a result of their investigations, and this influences their practice. We consider this approach fundamental as designers and researchers, and it has impacted our current perspectives.

Sailing-inspired, practice-led research projects

The background stories

Differences between art, design and craft were constant topics of discussion during . The *Navigator* project was organised by an external funder with a six-month duration. Out of 32 applicants submitting a research proposal, five groups of designers were selected to investigate waste streams, find specific producers of waste, and design and make new products using the selected waste. Through the design of viable commercial outcomes, the project also aimed to enable community enterprises to integrate the social aspect of sustainability. As one of the team members had an existing relationship with a women-led refugee trust, we saw the potential, in their involvement, for them to become ongoing producers of the upcycled products, perhaps creating a revenue opportunity for them.

The World of WearableArt (WoW) is an internationally renowned design competition attracting entries from over 40 countries for over 30 years: "Anything that is wearable art can find a place on the stage, if it is original, innovative and well executed."¹ For

three weeks every year, WoW showcases the best of these wearable creations in a spectacular stage show in Wellington, visited by around 60,000 people. After obtaining a university's research grant, we entered the competition with the *Voyager* project, aiming to explore the application of the discarded sail material, generating awareness of waste issues and adding value to the material and stories behind it. WoW's brief was clear with no major constraints, and we took the opportunity to approach this as an art-based project, enabling us to explore beyond commercial product constraints.

Navigator: Product design with a commercial brief

Participating in this funded research project appealed to us because of the opportunity for it to have a tangible impact; adding value to waste materials and reducing waste quantities, as well as involving community enterprises to support the project and vice versa. Our initial approach to the project was to investigate local waste streams. We found large amounts of waste materials, mainly discarded products and packaging, but none seemed to have been designed with reuse in mind. Some did have recycling as a consideration, but we found that the recycling process is generally quite involved, with high energy consumption. We became most interested in developing new designs and systems that would eliminate waste in the first place, but the organiser insisted that we focus on the reuse of waste materials.

We approached the sailing industry, finding stockpiles of worn and outdated America's Cup sails stored in containers on Auckland's waterfront. These sails were huge, heavy, cumbersome, dirty, smelly, hard to cut due to the strong fibres used, and quite worn in places. Nevertheless, this once valuable and high-tech material was instantly appealing.

Our material exploration was extensive and thorough. We explored a multitude of product options, by means of collages, mood boards, sketches, and prototypes of products such as bags, pouches, cushion covers, hampers, lamp shades, bean bags, shade sails and outdoor swing pods, to name a few (Figure 3).

Figure 3: Creative exploration, *Navigator* project.
Photographs by the authors.

We gained a lot of knowledge from our different experimenting processes, for example: we were able to heat-mould, but not fuse layers of the material; since the sails are not UV-resistant, direct sun damaged the material; and friction and abrasion rapidly deteriorated the material. It became clear the sails were designed to be lightweight, but were not fit for long-term use or constant handling. From our experiments, we found that the heat-resistant properties, the visual qualities and the semi-transparency of the material highlighted its suitability for lighting products. Luminaires are not physically handled very often and are not exposed to much UV light, so the rather delicate material of the sails would have a longer lifespan. Lighting products can also achieve a relatively high mark-up and retail price, a necessity for creating a commercially viable product with this waste material, due to the high production costs associated with the labour-intensive craftsmanship.

We had now defined our opportunity, and moved on to the 'second diamond', the Develop and Deliver phases. Following extensive luminaire design exploration and prototyping, we settled on connecting triangular pieces of sail material, forming a variety of shade shapes and sizes that are flat-packable and reconfigurable.

Our final design outcome is called *Navigator*, referring to the use of stars while sailing to new lands. The product is intended to be shipped to the consumer flat-packed, in a small cardboard box containing a stack of triangles with connecting magnets and a metal clamp to hold the lampshade in place on the electrical cord of an existing ceiling pendant. Assembly is done by the consumer, which reduces manufacturing costs and shipping volumes, helping in turn with the commercial viability of the product. Self-assembly was also chosen because a product that incorporates a creative or 'making' component promotes a greater emotional attachment, adding to its longevity. The triangular pieces can be arranged into different shapes, and single pieces can be replaced if necessary, also adding to the lifespan of the product (Figure 4).



Figure 4: Final design outcome, *Navigator* project. Photographs by Cornelius Geraets.

Aiming to investigate all three pillars of sustainability – the environmental, economic and social factors – we collaborated with a women-led refugee trust to explore how a sustainable business model could be created to support their growth. However, challenges to establish long-term work emerged, as it would require our full-time involvement and the creation of a social enterprise for the reuse of waste materials. We realised that in order to create a successful business model and take products to market, enterprises require a proactive and entrepreneurial mindset. Another concern was ethical, that of engaging vulnerable communities to 'solve' problems mindlessly created by the elite.

We were selected as finalists in the New Zealand Best Design Awards in the Sustainability category, but despite this success the project stayed in the prototype phase and was never commercially realised. Some of the reasons behind this were: 1. Once we understood the labour-intensive process of reusing the material, we realised it would be very hard to make this economically viable; 2. The commercialisation of the lamp would not qualify as academic research; 3. We have no expertise in marketing, distribution or selling of products; and 4. We felt that the social business model needed to be explored further, as we wanted the project to be socially beneficial. The insights we gained, partially through failure, were not seen as acceptable research outcomes by the project organiser.

Our key insights from this project were, first, that we found it extremely hard to commercially use this type of waste material where the end-of-life or reuse options had not been taken into consideration when originally manufactured. The waste stage must be factored into a material or product from the start, especially for a composite material. Second, we found it greatly ethically concerning to rely on vulnerable communities to offset the cost of privileged and/or commercial activities that lack regard for their environmental consequences.

Voyager: Wearable art for public exhibit

With our already acquired expertise, aiming to further explore applications of discarded sail material and determined to make a positive impact by creating awareness about waste and highlighting its value, we decided to enter the World of WearableArts competition, in the Aotearoa section. Our outfit, *Voyager*, was inspired by the sea and its creatures, as well as the sailing traditions from Polynesian and European cultures, both prominent in Aotearoa New Zealand. The guidelines of the competition were clear in their requirements and limitations: the garment had to be worn by a certain-sized person and delivered to Wellington. We also addressed the criteria of WoW's Sustainability Award by crafting a "garment designed to maximise use of discarded materials and made from at least 85% post-consumer and/or post-industrial repurposed materials." With an art-based approach in mind and without substantial garment-making experience or skills, developing this piece was a playful process, free of preconceptions of costume or garment design. We tested several techniques, such as using our bodies and dolls, making drawings and collages, as well as making full-scale prototypes (Figure 5).

We aimed at incorporating all elements of the sail, such as sailcloth, rope and rigging, achieving this goal by making our entire garment from one former America's Cup sail. Its style elements are inspired by the ocean and its flora and fauna, as well as by Māori and Pākehā (European descendants) travelling to Aotearoa New Zealand in different historical periods. Out of many international submissions,

Figure 5: Creative exploration, *Navigator* project.
Photographs by the authors.

our entry was selected for the World of WearableArt shows in Wellington, at a later stage to be exhibited in the WoW museum in Nelson (Figure 6).



Figure 6: Final design outcome, *Voyager* project.
Photographs by Cornelius Geraets.

Since no one in our team was of Māori descent, we were careful to balance both cultural inputs and made no claim that our design was Māori. We also consulted with Māori scholars about respectful approaches on the matter. However, in the show, our garment

was showcased with a performance using Māori elements and movements such as pūkana without our knowledge or consent. Concerns about misrepresentation and cultural appropriation emerged after seeing the performance, especially in relation to the staging of the show section in which our garment was a part. This experience made us realise the limited control designers have over their creations in relation to perception, placement and promotion, decisions frequently made by funders and organisers (Figure 7).

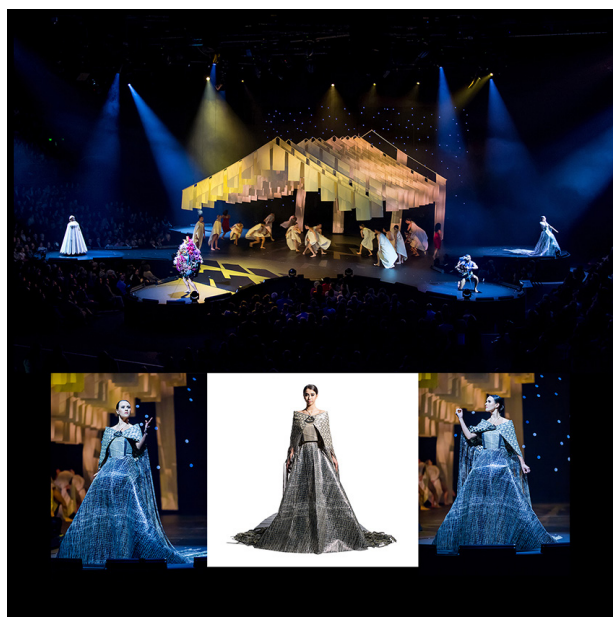


Figure 7: 2017 World of WearableArt Awards Show, Aotearoa section and catalogue image. Photographs courtesy of World of WearableArt Ltd.

The comparison

The *Navigator* and *Voyager* material-based designs had many things in common, like the reuse of discarded sails for sustainability, but our experiences working on both projects were different. Using the double diamond design model as reference, we made a comparison of the design process, organiser requirements, circumstances and experiences, for a holistic approach and to analyse why and how the differences came to be. We concluded that external factors were the main drivers, issues over which we had little or no influence (Figure 8).

Navigator, although presented as a research project, was really a commercial project where the organiser expected a return of investment, which was not clear to us at the outset. Also, this project had a limited timeframe in comparison to common research approaches in academia. We realised that the involvement and direction of the project originator, who had secured funding, directly influenced the outcome. Our project was perceived as 'unsuccessful' because it did not achieve the commercial gain aspect. Commercial product outcomes are hard to achieve when there are not established businesses involved in the projects. The challenges and requirements of using discarded material added complexity to the matter, and especially with the inclusion of organisations

that function as charities (not-for-profit) as opposed to commercial enterprises.

PROJECT COMPARISON				
		Concept	Reflections - Navigator project	Reflections - Voyager project
Organiser requirements	Physical object	Material research	Yes. Extensive	Little. Had already been done in Navigator project
		Commercial outcome	Yes. Long life-cycle intended	Not for design outcome, but 'yes' for shows & exhibit.
		Unique piece	No. Replicability intended. Long life cycle.	Yes. Short life cycle.
	Process report		Yes. Part of project outcome.	No.
	Exhibition		Yes. Our project was not selected though.	Yes.
Circumstances	Brief	Objective/subjective	Brief was subjective and open to interpretation.	Brief was objective.
		Clarity	Unclear.	Clear.
		Constrained or open	Constrained.	Open. Few constraints.
	Funder/organiser	Type	Small, at early stages .	Big. Income from shows, merchandising & exhibition.
		Attitude	Very engaged with researchers.	Autonomous. Not engaged in early stages.
Research funding	Received from:	Project organiser.	External funds obtained.	
Internal design process	Material	Waste stream research	Yes. Extensive.	No.
		Research	Yes.	Yes.
		Exploration	Yes.	Yes.
	Concept	Proposal and exploration	Yes. Sailing based concept inspired by material.	Yes. Sailing based concept inspired by material.
		Sketching	Yes.	Yes.
		Physical models	Yes.	Yes.
		Detailing, refinement	Yes.	Yes.
	Production of final prototype	Craft based by team	-	Yes.
		Prototype by team	Yes. Production intended by a social enterpriser.	

Figure 8: Comparison of the *Navigator* and *Voyager* projects. Visual by the authors.

The *Voyager* project presented different challenges in comparison to *Navigator*. For example, the garment was a unique piece without the intention of being replicated, a common approach in art-based projects. While we achieved entering the WoW show and participated in the exhibition, creating awareness around the reuse and value of waste materials, we could not measure the impact of this approach.

Reflexive conclusions

Our experiences and reflexive practice working on the *Navigator* and *Voyager* practice-led research projects allowed us to have a better understanding of the challenges in the reuse of waste material for sustainability. Even though both projects had a similar design approach through the double diamond model, external factors influenced the perceptions of and the learnings from each project, aspects to take into consideration for further research.

It is important to understand the difference between research projects and short-term projects that aim for commercial outcomes. Academic research needs long-term commitment and funding that is not attached to commercial gains. Particularly, design research and processes require extensive experimentation and testing, where failure is necessary and a fundamental part of the process and learnings. Therefore, relationships with funders, academic organisations and stakeholders can generate challenges when briefs and expectations are not clearly stated during initial discussions. The aim of the *Navigator* project was to find ways to repurpose the valuable, visually appealing and unrecyclable sail material and, through this, have a positive impact on environmental, social and economic issues. We concluded that the reuse of materials for

commercially viable products is challenging, especially for complex composite materials like competitive sails. The costs of sourcing, transporting, storing and cleaning the material, and the labour-intensive process of manufacturing and crafting, would result in unviable design solutions long term or, at best, in small-scale craft outcomes. Waste responses must be designed into the original material or product where reuse is not a viable option, especially for complex and/or composite materials. Finally, the intention of engaging with not-for-profits to alleviate waste issues, mindlessly created through activities for the privileged, undesirably places the burden of the 'costs' onto vulnerable communities.

The *Voyager* project aimed to bring attention and generate public awareness about the wastefulness of this short-term use but high-tech, high-value material. However, the impact of our project is hard to measure. While, according to the WoW organisation, 60,000 people saw our outfit in the live shows, and up to 40,000 people saw it in the exhibition, we had limited time and influence to implement measuring mechanisms. In this project, the challenges revolved around misrepresentation and perception, where the performance added cultural elements we had consciously avoided, possibly leading to perceptions of cultural appropriation.

We also concluded that, despite the difference in design and art-based approaches, there are common challenges around the limited control creators have over the outcomes of their creations once they are delivered. For example, decisions around representation, placement and promotion are commonly made by organisers and funders, and could change the final perception of the projects. Therefore, external factors need to be considered and clarified in advance. Also, due to the subjective nature of design and art disciplines, perceptions around failure and success need to be discussed in early stages so as to have a common understanding and expectations.

Even now we still have unanswered questions: Have the projects made any difference on an environmental, social or economic level? Did they create awareness around competitive sail waste issues, or waste problems in general? Creating awareness through art and design projects is hard to measure, despite the large audiences the projects can sometimes reach. However, it seems this approach is more common than systematically using waste material in commercial projects, perhaps due to the complexities in commercial projects regarding funding, resources, larger teams and time constraints. Although both projects were enjoyable and had satisfying results, the most useful outcome has been the conclusions we were able to draw from our lived experiences, and the insights we have taken from each project.

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