In Conversation with Wool:

A Place-based Approach to Re-imagining Materials Innovation in Aotearoa through Talanoa and Science and Design in Partnership

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Master of Design

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A thesis presented in partial fulfilment of the requirements for a Master in Design at Massey University, Wellington, New Zealand

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POSITIONALITY STATEMENT

Talofa.

O lo'u igoa o Charlie.

O lo'u tina ole Samoa e sau mai le nuu
o Nofoali'i ma Mulifanua i Upolu.

A'o lo'u tamā ole Siamani,
ile nuu o Sieboldshausen.

Na ou fanau i Siamani, ae ua 10 tausaga
talu ona ou aumau i Niusila nei.

I totonu o lenei sueusega, ua ou faatāua ai sosaiete
o tagata Pasefika i totonu o Niusila.

O lenei suesuega e manatua faapitoa ai nai o'u augatamā
aemaise augatupulaga ole Pasefika ile lumanai.

Oute faafetai i nai tuaa ua mavae mo le
asaina mai o lenei faigamalaga.

Faafetai.

Kia ora.

My name is Charlie.

On my mother's side, I come from the villages of
Nofoali'i and Mulifanua in Upolu, Samoa.

On my father's side, I come from the village of
Sieboldshausen in Germany.

I grew up in Germany and have lived in New Zealand
for the last 10 years.

Through my research, I want to uplift the Pasifika
community in New Zealand and in the islands.

This research is for my ancestors, our Pacific communities
today, and our Pacific communities in the future.

I give thanks to my ancestors for guiding me on this journey.

Thank you.

This body of work transcends its academic purpose. It embodies the voyage toward untangling my place in different spaces and navigating them respectfully while recognising the limits to my knowledge and continuously striving to learn and unlearn. Woven into this process is my ongoing endeavour to reconnect with my Sāmoan heritage and ancestors. Therefore, it has my extended community at its heart.

I acknowledge the Tangata Whenua of the Wellington Harbour area - Te Āti Awa - as the rightful custodians of this land and want to contribute to existing efforts toward strengthening the vā between Māori and Pasifika communities.

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To Deb for nurturing our cohort and ensuring we looked after ourselves, and to my Master's cohort for repeatedly listening to the same dilemmas - Tia, Lucy, Gen, Katie, and Tracey,

To Caitlin, Mike, Uli and Saskia for all the moral, academic, and technical support in the world, and to Karl for sneaking me into the building early,

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To Derelee and other wool industry members for offering advice and new insights,

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To the Kafa Kollective, MAPS and Massey's student community - Joe, Tui, Khushboo, Fina, Karl, Avril, Mana, Sherridan, Mia, Sam, George, Hanne, Lottie and Elena - for taking me in and making me feel at home in the fale,

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To Lisa for checking in from the other side of the world and for our long friendship that has carried me through this,

To my German family, Anke, Helmut, Katja, Steffen, Jette, Johann, Martina, Christiane, Kirsten, Marlis, and children for raising me,

To my Aotearoa-based ‘aiga - the Soo-Choon's, Tapili’s and Tavite’s for reminding me of my roots,

To my parents, Malia and Ekkehardt, my siblings, partners and niece, Farida, for offering comfort, realness, jokes, tight hugs, and love to name a few that have spilled over into every bit of this project and beyond,

To my grandparents for showing true strength this year with everything you have endured while remaining firmly anchored by my side,

And lastly to my darling Jonathan for holding me, for your love, and for cheering me on everyday.

Fig. 1 Bubbly wool-based film

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↘ Fig. 2 Left: wool-based filmanet

↘ Fig. 3 Scrunched wool-based film

Abstract

As the world is engulfed in ever-increasing human-made mass, there is a need to shift present-day assumptions around innovation and progress toward more profound meaning and value within new materials development. Instead of focusing on market-ready material outcomes, the process of conception at the front-end should become more intentional and thorough. Hence, this Master's project explores how design can aid the product development process in agricultural science organisations at the outset of materials research to facilitate strategic innovation. It aims to ascertain the value of cross-disciplinary collaboration toward finding applications for strong wool-based keratin composite materials. More precisely, the project centres on community involvement at the beginning of science research projects to generate more place-based and culturally grounded outcomes that meet the communities' needs. In doing so, it seeks to advocate for the value of Pacific epistemologies in research and, therein, different material understandings and ontologies in conversation, challenging the entrenched Western mindset to science and design. This is of particular interest to me due to my Sāmoan heritage and being Aotearoa-based.

The project draws on a qualitative research methodology that revolves around talanoa and is supported by participatory and material-driven design approaches, encompassing workshops, one-on-one conversations, and the making of boundary objects. It is hoped that the proposed methodology will showcase how material science research may become more accessible and contribute to the advancement of our communities in Aotearoa. Supervision, funding and facilities have been provided by both AgResearch and Massey University over one year. The project demonstrates the benefits of cross-disciplinary ways of working towards more inclusive, ecocentric and place-based futures, acting as a resource for future collaborations in the materials development space.

Keywords Boundary objects, co-design, cross-disciplinary, material-driven design, material science research, place-based, respectful design, strong wool, talanoa

↘ Fig. 4 Satin wool-based sheet (back)

↘ Fig. 5 Satin wool-based sheet (front)

Introduction

Over the summer of 2020/2021, I was taken on board as a design intern at AgResearch[1] in Lincoln, Christchurch, for a total of 10 weeks. The internship sat within the 'New Uses for Wool Partnership Programme'[2], which was established to generate alternative value streams for strong wool due to plummeting strong wool prices in Aotearoa. It is split into 3 stages. Upon receiving the brief, AgResearch entered phase 1, which consisted of understanding the natural chemistry of strong wool fibres by deconstructing the fibre. Phase 2 revolves around assembling new material formats, while phase 3 encompasses optimising material formats and developing applications. Outcomes are reviewed by Wool Industry Research Limited within and between each phase. Figure 6 illustrates the process. At this point in time, AgResearch is synthesising new materials and setting up controlled measures to determine the materials' morphological properties and to generate more consistent outcomes, as per phase 2.

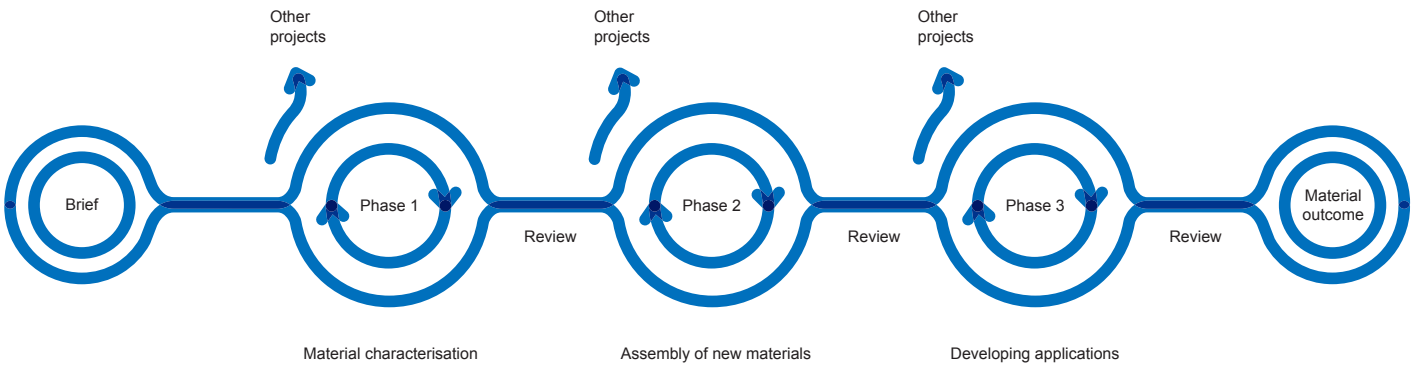
During the internship, my role comprised exploring potential applications for strong wool-based keratin materials[3] alongside ongoing material developments carried out by AgResearch's material scientists. The science-design exchange highlighted limitations of conventional material science and research whereby materials are evaluated based on their chemical composition and technical abilities alone (Bak-Andersen, 2018; Drazin, 2015; Karana et al., 2015). Thereby, materials are overlooked as experienced interfaces that shape the interaction between people and products (Karana et al., 2015, Bak-Andersen, 2018). Generating new experiences with strong wool-based materials, for instance, would contribute to better appraisals by those engaging with the physical product, leading to a higher demand for the raw material.

Conversely, design provides a user-focused and experience-based perspective and can, thus, complement AgResearch's material science process to facilitate more holistic materials development. While material science struggles to maintain a focused direction on future material applications, as became evident during my internship, design encourages an end-use outlook from the beginning. Hence, a new strategy that centres on a cross-disciplinary approach between science and design is needed, which can enrich materials innovation, potentially contributing to the regeneration of Aotearoa's strong wool sector.

[1] AgResearch is a Crown Research Institute that focuses on sustainable farming systems as well as food and bio-based products, delivering both technologies and knowledge.

[2] The "New Uses for Wool Partnership Programme" is a 7-year research project that was initiated by Wool Industry Research Limited and is co-funded by the Ministry for Business, Innovation and Employment to activate the development of high-value applications for strong wool-derived keratin (MBIE statement)

[3] AgResearch developed various strong wool-based keratin materials, which at the time of my internship included sheets, blocks, and foams. Keratin is a structural, filamentous protein prevalent in epithelial and protective tissues such as feathers, skins, nails, hooves, horns, and wool (Hill et al. 2010). Upon extraction, it can be cross-linked with other proteins and molecules to achieve different mechanical properties in new materials (Reichl et al.2011).



↘ Fig. 6 Representation of the‘New Uses for Wool' Partnership Programme

This Master's project is a continuation of my internship. It aims to investigate the relationship dynamics between science and design in agricultural materials research and how both disciplines can disrupt each other's practices and prompt mutual inquiry to create new research avenues. These research avenues are hoped to better project and meet the future needs of Aotearoa's environment and people than science alone can engender. However, matching the distinctive attributes of strong wool and future needs requires more than just a designer to facilitate these conversations. The task also calls for a diverse cross-section of expertise and input by those impacted or engaged with the proposed materials. This aligns with AgResearch's organisational goals of creating partnerships and collaborations per the company's Statement of Corporate Intent 2021-2025 (date unknown, p. 2). Hence, this project also explores the role of design as an empowering tool for communities to partake in the materials development discourse. Participatory research and collective creativity are activated, contributing to a new strategy for materials innovation in agricultural science organisations.

Given the project's embeddedness in the bicultural setting of Aotearoa, the more significant intention is the coming together of knowledge systems in the materials development space; particularly indigenous Māori and related Pacific material understandings, or ontologies, and Western mindsets. Accordingly, it seeks to advocate for the value of Pacific epistemologies in research, challenging conventional science and science research. Being of Sāmoan descent, I hope that different cultural perspectives emerging through conversation will contribute to existing initiatives towards more inclusive practice, supporting place-based communities in making decisions about their livelihoods and Aotearoa's broader material culture.

This project draws on an exploratory qualitative research methodology to build intentional relationships with strong wool and strong wool-based materials and to empathise with the lived experiences and perspectives of Aotearoa-based communities. A pilot study comprising a series of workshops was co-facilitated with a group of students centring on talanoa - a Pacific research methodology that involves relationship-building and sharing experiences to identify needs and desired future outcomes collectively. Talanoa also took effect in making boundary objects or material samples, which were instrumental in the workshop context to enable cross-disciplinary discussion. Additionally, informal and unstructured face-to-face talanoa with industry experts with practice or research experience in strong wool and Aotearoa material culture were undertaken. Through talanoa, thinking around future needs specific to Aotearoa were stimulated while new knowledge was co-created.

↘ Fig. 7 Wool-based material sample arrangement

My project will be conducive to materials research by illustrating how a design-infused [4] participatory science process can contribute to more holistic and accessible materials innovation. The exegesis presents a snapshot of alternative ways for setting science agendas from the positionality of a novice design researcher of Sāmoan descent based in Aotearoa. It should not be considered an exhaustive body of work as perspectives are contextual and research in this area is continuously expanding.

[4] 'Design-infused' is a term borrowed from American industrial designers Don Norman and Eli Spence, who apply it in a participatory context. In contrast to a design-led approach where activities are steered by designers and 'design thinking', communities are equally involved in planning and executing projects, enabling a more democratic process (2019).

The objectives of this project are tailored to the 1–year Master of Design timeframe and comprise:

01 Contextualising the situatedness of strong wool in Aotearoa's material landscape

02 Ascertaining new wool-based material experiences, and

03 Proposing a strategy for future participatory science/design collaborations in the materials innovation space

How can design shape the front-end of new materials development in agricultural science organisations to generate meaningful outputs?

How can collaborations with communities in material science research advance materials innovation in science organisations?

How can a place-based approach and different material philosophies inform materials research?

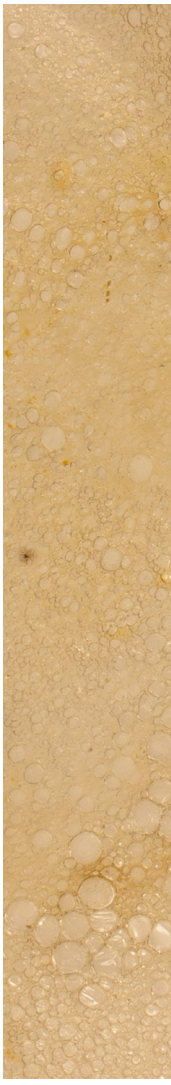
How can non-native materials (e.g., strong wool) become more accessible and inclusive to meet the needs of our communities in Aotearoa?

How can the relational space between humans and materials (e.g., strong wool) be activated?

How can we design a new strong wool experience?

Scope

This Master's project situates collective talanoa and boundary work within new materials development in agricultural material science research organisations and proposes a participatory design-infused strategy that offers a more holistic perspective on materials through different material understandings in conversation. It seeks to explore alternative ways of developing materials in the divergent phase to provide a more meaningful direction and specificity for science research to contribute to the broader materials research discourse. A sequence of activities and a set of recommendations are presented that can be incorporated into existing science value chains to leverage more inclusive and place-based materials research and research outputs.



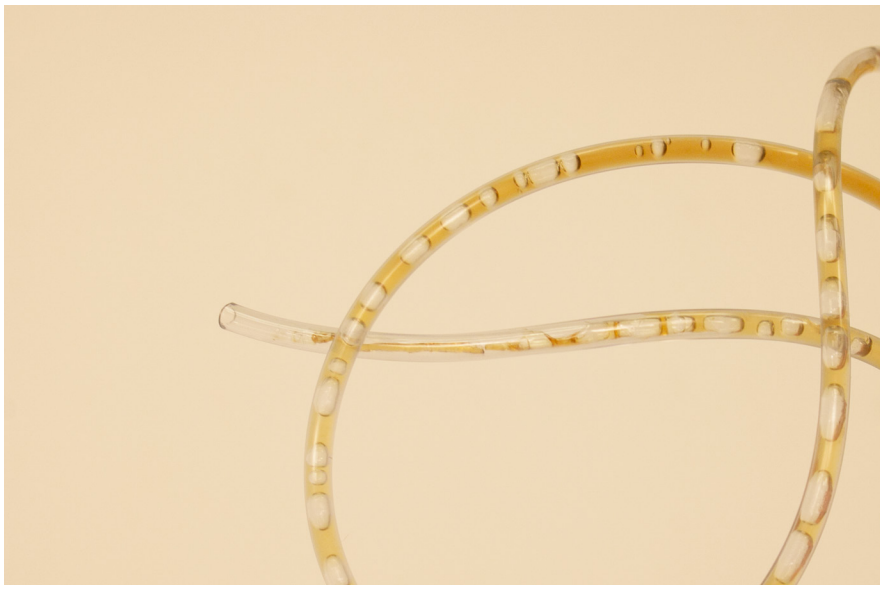
↘ Fig. 8 Top: shimmering wool-based film (fold)

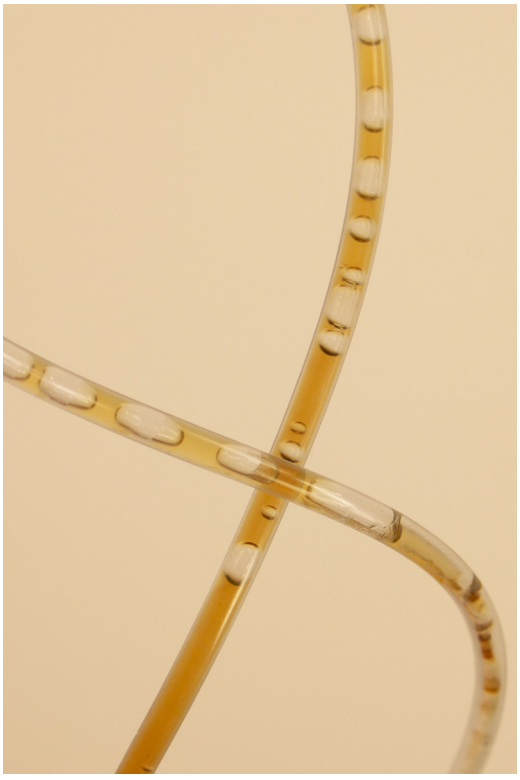
↘ Fig. 9 Middle: shimmering wool-based film (close-up)

↘ Fig. 10 Right: extruded wool-based web

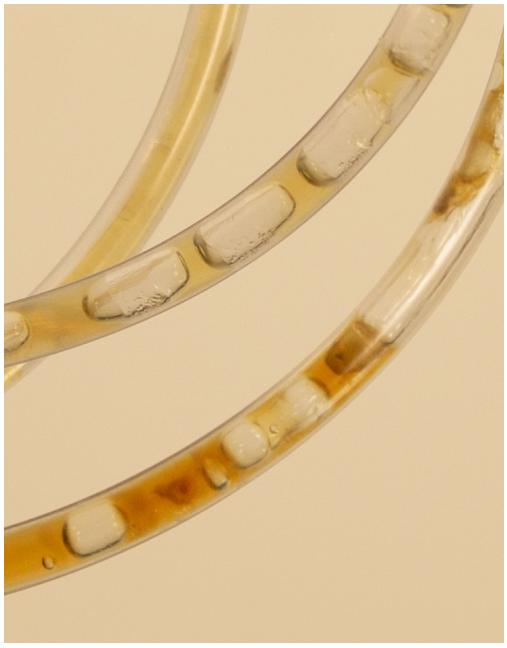
Personal Timeline

Proposal - **Context review** of science-design collaborations, participatory ways of working, and place-based material understandings (ongoing) - **1st Arohaehae** in lockdown: personal introduction and project overview - Identifying **methods** - Start: **ethics process** (ongoing) - Building a **support group** for ethics - Initiating **relationships with Massey University's student community** (ongoing) - **AgResearch trip** - Initiating **relationships with strong wool experts** (ongoing) - **2nd Arohaehae**: presenting methods - **Ethics approval** - Cancelled AgResearch trip due to Red - **One-on-one talanoa with material experts** - Progress report - **3rd Arohaehae**: design-infused strategy developments- Pilot study: **3 workshops** with students - **Interpreting findings** - **Presenting findings** to the workshop group - **AgResearch trip** - **AgResearch presentation** - **4th Arohaehae** : presenting my process, findings and recommendations





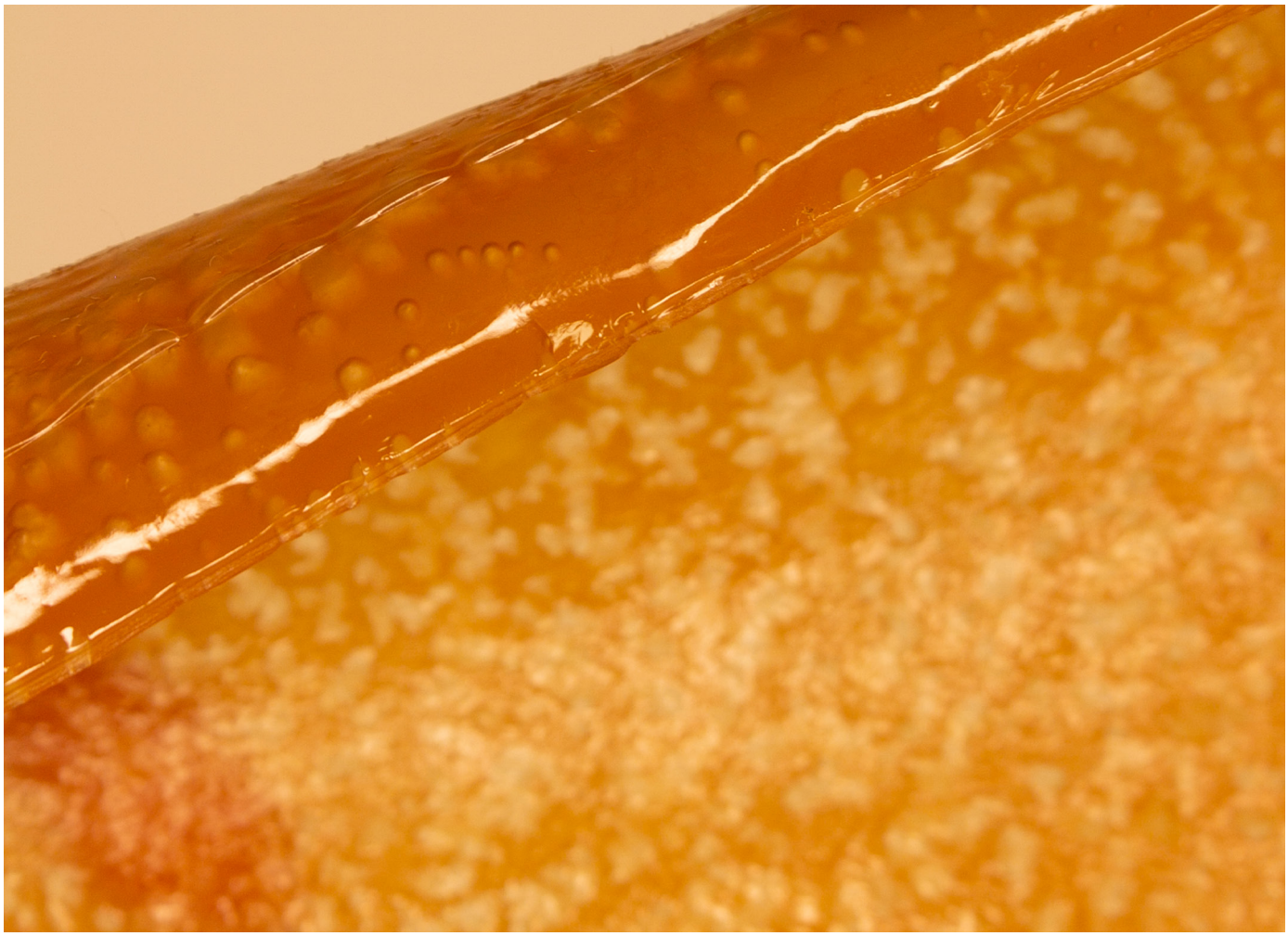
Context Review



↘ Fig. 11 Top left: wool-based filament (loop)

↘ Fig. 12 Bottom left: wool-based filament (twist)

↘ Fig. 13 Right: wool-based filament (close-up)



↘ Fig. 14 Bubbly wool-based film (melted)

Materials constitute the physical world we live in, from nanostructures almost invisible to the eye to vast configurations of matter that cast shadows over us. Through materials innovation, a process in which the performance of existing materials is improved or new materials are generated, there has been an influx of materials in recent years (Drazin, 2015). The arrival of a global climate crisis has set the need to employ more sustainability-oriented materials innovation processes in motion (Drazin, 2015). In search of suitable alternatives for overexploited materials and with a firm emphasis on circularity and regeneration, AgResearch, for instance, has shifted its focus from mature textiles practices to building capability towards “value-added bio-based products from pastoral agriculture bioresources”, as outlined in the company’s Statement of Corporate Intent 2021-2025 (date unknown, p.6).

↘ Fig. 15 Laser-engraved wool-based film

However, it has been widely recognised that materials innovation transcends the expertise of one discipline only and requires a more expansive perspective (Bak-Anderson, 2019; Drazin, 2015; Kararna et al., 2015). This can be facilitated through cross-disciplinary collaboration. As an industrial designer working with AgResearch, this exegesis will concentrate on materials innovation from a design perspective within agricultural material science research. Hence, the subsequent context review examines the mechanisms of science-design collaborations while introducing material-driven design and participatory ways of working. Furthermore, it seeks to unpack place-based material philosophies and how all of the above might inform the development of new strong wool-based materials in Aotearoa.

1

SCIENCE AND DESIGN IN PARTNERSHIP

Both science and design have established subsidiary disciplines focused on materials – material science and material design - that aspire to advance present-day material cultures. Hanna de la Motte and Miriam Ribul (2016) suggest that the respective disciplines share an interlinking “material affinity” (p. 3) as they employ similar processes that are based on physical prototyping. While material science studies materials at a microscopic level to better understand chemical associations and structural properties for the synthesis of new material formats and applications (Solala & Vuorinen, 2020), there appears to be little consideration for materials as expressive entities that shape our social lives. Conversely, material design, a relatively new discipline within design, explores a material’s ability to facilitate experiences (Karana et al., 2015) and can, therein, prompt a more targeted investigation of properties to suit a particular application (Solala & Vuorinen, 2020). Material designers especially place importance on nurturing the relationship with materials through deep tactile engagement to gather embodied knowledge (Kane & Philpott, 2016) and to identify desirable qualities and experiences. In textile design, this process is introduced as “textile thinking” (Kane & Philpott, 2016).

Similarly, Elvin Karana et al. (2015) refer to ‘material thinking’, which encapsulates the process of developing an intuitive understanding of unspecified materials or material systems through physical exploration. For instance, the authors’ hands-on investigation of used coffee grounds led to understanding the by-product’s limitations and opportunities. This resulted in various material outcomes, for example Cafe Mache, Cofflexi and CapPurcino (fig. 16), that generated positive appraisals from those engaging with them (Karana et al., 2015) and allowed the by-product to enter a new life cycle. Thus, material thinking is hoped to generate more intentional material outcomes that have the potential to be compatible with a circular economy model (Bak-Andersen, 2018). Moreover, it seeks to stimulate critical thinking in those engaging with the material or material outcome, calling for greater action towards more sustainable mindsets and practices (Solala & Vuorinen, 2020). In turn, material science can validate exploratory material outcomes through controlled measures and analysis, bringing a new material closer to commercialisation. That way, materials are both more experiential, sustainable and functional.

Furthermore, a science and design collaboration could allow scientists to gain a more comprehensive overview of their own findings and enable better communication of science to the general public (Peralta & Moultrie, 2010). This is supported by Simone Rödder's (2017) reflections regarding a specific science and art collaboration around climate change, which demonstrated "how much [scientific] research abstracts from real-world imaginations of water, soil, Earth and climate" (p. 111). The experimental nature of design can shape the scientific path by testing theories in practice through physical prototypes, simulations, visual models, and scenarios that stimulate reflexivity, allowing for the exploration of uncharted future research avenues and applications (Peralta & Moultrie, 2010). Although science-design collaborations require more time for scientists and designers to understand each other's practices, values, and objectives, the process may lead to more well-rounded and meaningful yet profitable outcomes.

While new research avenues may be forged through a science-design partnership, there is potential for conflict due to unbalanced power dynamics, which only reinstate boundaries (Peralta & Moultrie, 2010). This further perpetuates the practice of 'boundary work' where clear borders between disciplines are drawn (Rödder, 2017). Joichi Ito (2016) maintains that "often we don't recognize when we are looking at the same problem because our language is so different and our microscopes are set so differently" (p. 1). The author asserts that knowledge is circulated and expanded among the same group of specialists, failing to include outsiders grappling with expert terminology, further decreasing the prospect of future collaborations (Ito, 2016). Therefore, a more empathic approach toward collaboration must be adopted to establish a common language, avoiding misunderstandings and with clearly defined input by each participating discipline from the beginning (Peralta & Moultrie, 2010).

Despite perceived differences in values and workflows, Carlos Peralta and James Moultrie (2010) argue that pairing both disciplines at the outset of new materials development can lead to the creation of a 'third space' where new research avenues are unlocked to better project and meet present and future needs (Rödder, 2017). In this Master's project, the third space is upheld via a design-infused strategy that serves as a scaffold for participatory materials innovation. Instead of driving the design process, the designer becomes a facilitator.

↘ Fig. 16 Elvin Karana et al. (2015), "Coffee Waste Project", left: Cafe Mache, middle: CapPurcino, right: Cofflexi

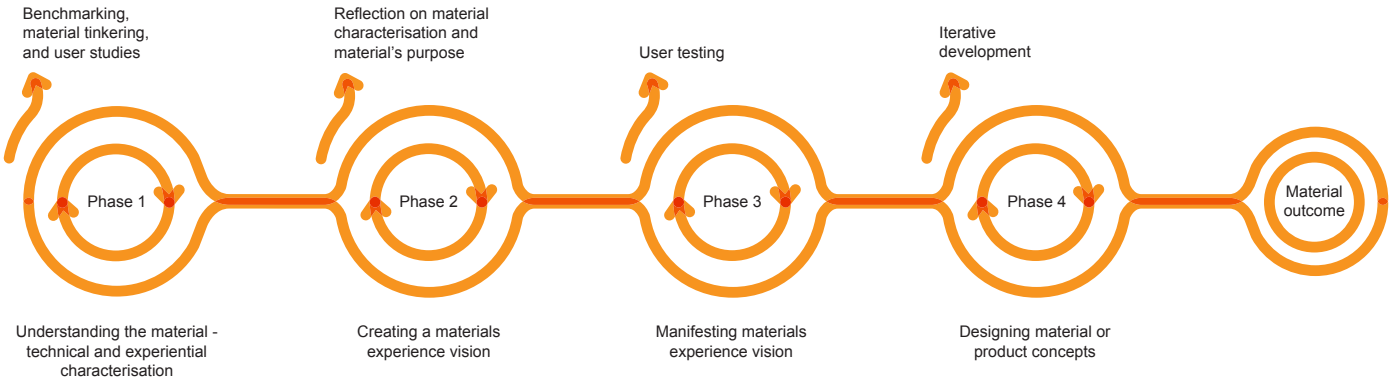
2

MATERIAL–DRIVEN DESIGN

Unlike the conventional product development process, where materials assume a passive role and are generally selected to match a product idea (Bak-Andersen, 2018), material design positions materials at the outset of design research. It investigates the role of materials and their active contribution to user experience and sustainability issues (Karana et al., 2015, Bak-Andersen, 2018). Thus, the Material-Driven Design (MDD) method, introduced by Elvin Karana et al. (2015), situates user experience at the outset of new materials development to facilitate 'materials experiences' (Karana et al., 2008). The method acknowledges four interconnected constituents that determine how materials are experienced by humans (Karana et al., 2015):

01	Sensory	relating to all senses, e.g. visual and tactile perception
02	Interpretive	the meanings materials engender
03	Affective	our emotional perception of materials
04	Performative	the way the materials' behaviour influences our interaction with them

The MDD method is split into 4 phases. Phase 1 concerns getting to know technical and experiential material qualities by examining existing materials of similar origin or makeup and their uses, generating new materials, and bringing in benefiting communities to appraise them. Subsequently, in phase 2, the designer determines which qualities previously expressed by the communities are most significant to formulate the material's intended purpose. In phase 3, the communities are invited to test whether the material's intended purpose is clear through playful material interactions. Lastly, phase 4 centres on the iterative design process, whereby materials are modified via different post-production methods, such as laser cutting, amplifying their qualities to create different experiences. Communities are then asked for feedback on new material experiences. It is worth mentioning that the process is by no means linear. Despite splitting the method into different phases, designers can alternate between tasks and steps, though the order shown in figure 17 is strongly recommended (Elvin Karana et al., 2015).

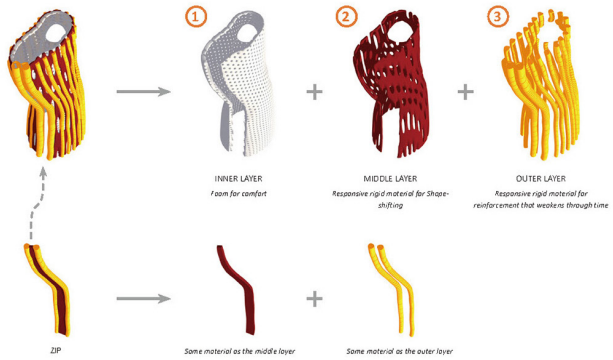


↘ Fig. 17 Adapted from Elvin Karana et al.; Material Driven Design (MDD) method, 2015, Material Driven Design (MDD): A Method to Design for Material Experiences.

Elvin Karana et al. (2015) suggest that explorations focused on ascertaining a material's experiential qualities can complement a technical-oriented approach to materials innovation to evoke meaningful material interactions. Thus, a science-design collaboration where both approaches converge could facilitate more well-rounded material outcomes and yield higher profitability (Karana et al., 2015).

Moreover, in pursuit of materials innovation that aligns with a circular economy model, material designer Mette Bak-Andersen advocates for the integration of sustainability-affirming criteria such as biodegradability, recyclability, and product disassembly (2018). The author establishes that "qualities such as innovation and sustainability are not extras that can be injected into a product at the last minute" (p. 152); hence materials must become drivers of sustainable product development. As the MDD method is based on Western modes of knowledge-making, it is crucial to remain critical, especially when referring to it in place-based research contexts where different worldviews exist.

Prototypes printed on a J750 printer



Multi-layered structure made with different materials

Case Study

Material science and design have had previous encounters in recent years. On those occasions, material scientists generated new materials, after which product designers explored more targeted applications for the respective materials (Karana et al., 2015). Though one might argue that both processes are somewhat symbiotic, they have rarely unfolded simultaneously in science-design partnerships. At times, however, as was the case in my internship, designers and scientists engage in a more ongoing exchange to identify how the properties of newly synthesised materials can be developed to suit specific applications through an iterative process.

In a more local context, the 'Science for Technological innovation' (SfTI) challenge is one of 11 challenges within the National Science Challenge, a government-funded programme running between 2014 and 2024 to tackle Aotearoa's major science issues. It brings together different Aotearoa-based research institutes to generate new knowledge and place-based solutions. Each challenge addresses a particular problem area through interdisciplinary collaboration via Spearhead (mission-led) and Seed (researcher-led) projects. The “Additive manufacturing and 3D and/or 4D printing of biocomposites” Spearhead project sat within SfTI, specifically in the area of 'Materials, manufacturing technology, and design'. It was a collaboration between postgraduate material scientists and design students centred on a design-led approach from the early research phase. The project culminated in a splint design that could respond to its wearer's wound condition and facilitate more targeted healing due to its property-changing abilities. The investigated polymers were tested using various methods, such as 3D printing (fig. 18, fig. 19). Students from both disciplines and Spearhead leaders expressed that the process was helpful within and outside the project as the exchange fostered new research capabilities and technological progress concerning 4D printing [5].

[5] 4D printing exceeds more conventional 3D printing technology in that once extruded, the surfaces can change properties in response to external stimuli. This can either be leveraged to enable continuous back and forth movement or transform into entirely different shapes altogether.

↘ Fig. 18 Physical prototypes from "Adaptive Splint" - a Master's project by Yejun Fu, 2020

↘ Fig. 19 Digital representation of mechanism from "Adaptive Splint" - a Master's project by Yejun Fu, 2020

3

PLACE-BASED PARTICIPATORY RESEARCH

In design, prior to commercialisation, proposed outcomes and iterations thereof are traditionally appraised by the intended 'user' [6] community, who ultimately determine efficacy and economic viability (Karana et al., 2015). Despite the 'user testing' phase, conventional design practice is "almost exclusively driven by the designers' own understanding of the issues they are dealing with" (Peralta & Rodriguez, 2014, p. 2). In recent years, the discipline has diversified while tackling more complex challenges like climate change. Consequently, participatory design, such as co-design, is more and more frequently implemented by designers to engage with communities throughout the design process so that outcomes meet their specific needs (Sanders & Stappers, 2008). Instead of asking for feedback towards the end of new product development, the framework confers shared responsibility and input towards designing a service or product to the intended community, renegotiating hierarchical structures (Sanders & Stappers, 2008, Wakefield, 2019).

According to Liz Sanders (2012), co-design in particular must occur at the outset of design research to bear societal value. It must directly draw on the experiences of those impacted by the research outcomes (Sanders, 2012), in this case, place-based communities engaging with new materials. Within this exegesis, the term 'place-based' refers to research undertaken in Aotearoa with and relevant to Massey University's tertiary student community, prioritising the inclusion of Pasifika [7] and Māori students and acknowledging that this project and outcomes are contextual and location-specific. Thus, this project investigates how design can enable participatory materials innovation in Aotearoa, bringing together different perspectives right at the beginning to shape the materials innovation through "collective creativity" (Sanders & Stappers, 2008, p.5).

Meanwhile, unless pre-existing partnerships with industry stakeholders exist, community engagement in science occurs in the form of consultation when members of the public are invited to approach science organisations to test and validate ideas. However, as Joichi Ito (2016) points out, scientific knowledge often does not traverse the public domain as it is documented in peer-reviewed journal articles, which are evaluated by and more readily accessible to the same disciplinary community. Instead, participatory research, particularly in the science field, can democratise the process of knowledge making and sharing by empowering communities to actively engage in advancing research outcomes.

[6] I will refrain from using the term 'user' in my research study as it dehumanises the people impacted by design decisions. Instead, I will apply the term 'community'.

[7] When using the term Pasifika, I am referring to the communities that descend from countries in the Pacific Ocean and are based in Aotearoa. These communities share ancestral ties and related cultural practices, though these vary from country to country. I am applying the term as it is currently used by our communities and not as a means to homogenise different cultures. The term Pasifika is a transliteration that replaces the English word Pacific, emulating the sound of Pacific languages, which is perceived as somewhat more empowering than the use of the term Pacific. Conversely, the term Pasifika excludes Māori communities and ignores the special relationship between Tangata Whenua and their Pasifika whānau. Being of Sāmoan descent, I can't speak to the experiences of indigenous Māori communities. Instead, as a fellow Tagata o le Moana member, I want to contribute to uplifting our place-based communities, whom I acknowledge as Tangata Whenua and whose relationship with other Pasifika nations I want to help strengthen.

The underpinnings of participatory design are far from new to Aotearoa-based indigenous Māori and Pasifika communities. For instance, the principle of whanaungatanga, which relates to collectivism within a well-established kinship system, is deeply ingrained in Māoritanga (Durie, 1997, as cited in Brougham & Haar, 2012; Te Morenga et al., 2019; Wakefield, 2019). In a Sāmoan context, the fa'amatai system approaches decision-making similarly. Both practices precede the Eurocentric co-design framework initially introduced as a business strategy that only gained traction in the design space in the 1960s (Sanders & Stappers, 2008, Te Morenga et al., 2019). Therefore, one could argue that co-design, which is based on developing solutions with, instead of for the communities in question (Sanders, 2008), has the potential to align with kaupapa Māori and work in parallel with indigenous Māori methodologies (Wakefield, 2019). The same can be said with regards to Pacific methodologies. Ideally, however, research is undertaken by someone from within the respective community as both historically and in the present, research has been conducted by outsiders (Smith, 2013). This has led to misappropriations and objectification, severely damaging trust in research by the researched communities (Smith, 2013; Wakefield, 2019).

In Aotearoa especially, indigenous Māori communities - the custodians of this land - have been disproportionately disadvantaged through Western methods in research (Smith, 2013). Similarly, Pasifika communities have experienced misrepresentation and generalisations through research (Vaioleti, 2006), though their relationship with the land is different despite shared ancestral ties. Therefore, it is essential to include Māori and Pasifika communities in all research stages and draw on culturally specific methods that align with cultural values (Smith, 2013, Wakefield, 2019), such as the practices of wānanga and talanoa.Hence, the Eurocentric co-design methodology requires rigorous scrutiny and thorough evaluation to decolonise the framework (Akama, 2019). As established by Dr Lisa Te Morenga et al. (2018), it must adhere to place-based ethics that respect and are rooted in Te Ao Māori, especially when it involves Māori communities. Particularly in an Aotearoa context, co-design should be Te Tiriti-led, with a commitment to fostering meaningful, reciprocal relationships and shared decision-making while retaining participants' autonomy (Te Morenga et al., 2018). While participatory design comes with challenges, especially when projects have time and resource constraints that can influence the broader process, the more gradual the relationship-building process and cross-disciplinary communication, the more meaningful the outcomes could be.

Penny Hagen and Simon Mark (2020) state that co-design can become an empowering tool for participants if a cultural infrastructure is established. The ‘Healthier Lives’ challenge is part of the National Science Challenge and tackles cancer, cardiovascular disease, diabetes and obesity in Aotearoa, which are prevalent in Māori and Pasifika communities. Thus, in partnership with health providers, Māori and Pasifika communities were involved in the co-designing and testing a “culturally tailored” mobile-phone health programme application named ‘Ola Ora’ that sought to reduce the aforementioned health conditions (Te Morenga et al., 2019). By respecting the relationship-building process with partnering communities and including cultural values, outcomes were perceived as positive by the health providers and the communities, demonstrating ongoing success beyond the partnership as seen in app uptake rates and feedback (Te Morenga et al., 2019). It also foregrounded that Māori and wider Pasifika communities abiding by nuanced cultural practices and values should not be homogenised, which is why the tailored approach was especially effective.

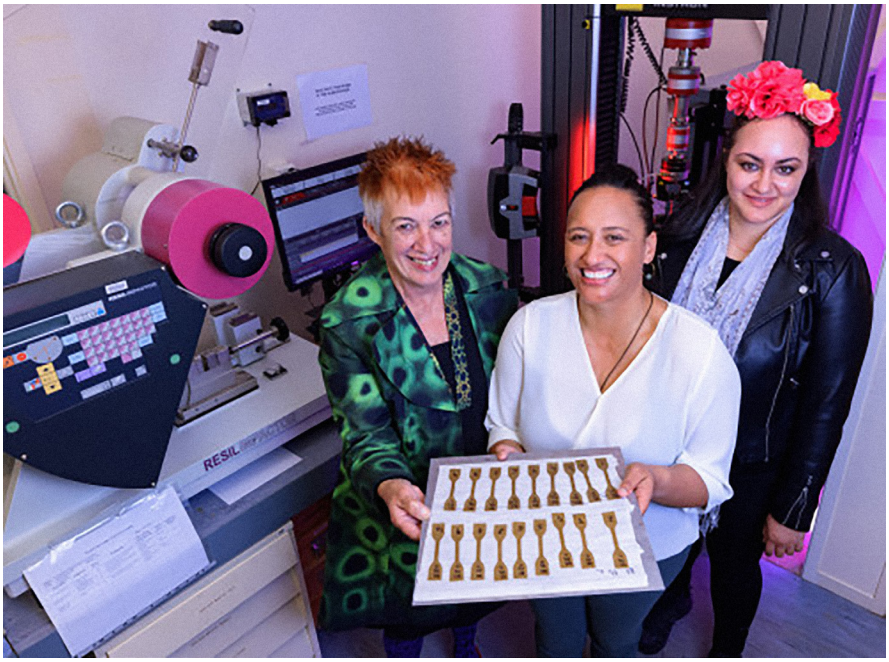
In Aotearoa, where partnership, participation and protection are stipulated within Te Tiriti o Waitangi (Te Morenga et al., 2019), it is imperative and non-negotiable to include indigenous Māori communities in place-based research. Materials innovation, in particular, requires consultation and involvement of Tangata Whenua as the land, which shares an intimate relationship with Māori communities, is deeply affected by a growing mixed material culture, which in turn, due to the interconnectedness of wellbeing, affects Tangata Whenua. The National Science Challenge acknowledges the importance of a Māori worldview in research, expressed in its Vision Mātauranga policy that is adjusted to suit each challenge. Despite bringing together Mātauranga Māori and Western science, the policy seeks to ensure that Tikanga are respected, and that cultural aspirations and obligations are maintained.

Case Study

“Weaving Tī Kōuka and Tech” - a Seed project within the SfTI challenge from 2019 - constitutes a science-design collaboration between Dr Nancy Garrity and Leilani and Anastasia Rickard, the grandmother-granddaughter design duo behind ‘Natura Aura’ - an Aotearoa-based fashion label at the nexus of nature, science, and Mātauranga Māori. Together, they explored the possibilities embedded within the endemic tī kōuka fibre, which revealed promising qualities suitable as a reinforcing ingredient in composite materials. Primarily motivated by the coming together of Mātauranga Māori and Western material science, emphasis was placed on the overall knowledge-making process and reciprocal exchange. This included familiarisation with ancestral harvesting methods across different customary practices and the respectful relationship-building with the raw material. In addition, the collaboration investigated new experiential qualities inherent in the material and drew on lab-based science approaches to understand the fibre’s chemistry and mechanical properties.

Most importantly, however, the collaboration between Nancy, who has a background in polymer chemistry and worked for Scion at the time, and Leilani and Anastasia centred on the duo’s Tikanga-based weaving and fibre collection expertise, advocating for the intentional involvement of appropriate research partners. Nancy articulates that too often, consultation is sought from the first “brown face” in an organisation to represent the broader collective when there are experts with much more targeted experiences and knowledge (Garrity, 2019). Hence, the partnership demonstrated how respectful engagement with the raw material and place-based expertise could foster culturally-grounded materials innovation.

Being of Sāmoan descent, I cannot speak to the experiences of indigenous Māori communities. Instead, I acknowledge the special relationship between Māori and wider Pasifika communities owing to shared ancestral origins. Therefore, I extend the community-centred approach to Aotearoa-based Pasifika communities. Participatory research with Māori and Pasifika communities can contribute to more inclusive and accessible knowledge and material outcomes, particularly when the communities have different histories with the material in question, such as strong wool. Thus, beyond meeting targeted needs and perpetuating economic viability, community involvement in materials research can facilitate an exchange of material understandings, which, in Māoritanga and from a Pasifika perspective, is based on human/non-human relationships. Understanding different ways of knowing and sensemaking is crucial for a successful partnership to come to fruition, and a relational approach to materials development can support the mitigation of exploitative practices for more sustainable outcomes.



↘ Fig. 20 Nancy, Anastasia and Leilani with Tī Kōuka composite materials at Scion in Rotorua, Aotearoa

4

SOCIO–CULTURAL MATERIAL RELATIONSHIPS

Our world is becoming stretched to capacity as it is overwhelmed with more and more material ‘stuff’ by the hour. Therefore, the need to rethink our relationships with our broader ecosystem is more necessary than ever - not just for our livelihoods today but to ensure a fruitful legacy for future generations. As we engage with different people and environments around us, a plethora of perspectives emerge. This is particularly evident in conversations revolving around materials and the material culture within which we are submerged.

In Māoritanga, materials are linked through whakapapa and can be traced to the living, human and non-human (Mahuika, 2019). The principle gives structure to ecosystems as it arranges all entities in a genealogically interconnected network (Hikuroa, 2017). Māori creation, for instance, started with Papatūānuku (Earthmother) and Ranginui (Skyfather); hence, everything descends from their union; from rocks, plants and rivers to insects and mammals (Roberts, 2013). Whakapapa is place-based and usually referred to in an Aotearoa-specific context. However, it is also closely linked to the histories of Pacific relatives who share the same ancestral ties (Gillon, 2020). From a Sāmoan perspective, this relational ontology is embodied in the expression of ‘gafa, which is upheld by the ‘vā’ whereby the connection between all beings is recognised (Anae, 2019). ‘Ele’ele, for instance, translates as both earth and blood, capturing the entrenched bond between people and land (Tui Atua, 2009). Through intergenerational storytelling such as tala o le vavau, and pūrākau in Māoritanga, we are further reminded of our ties to the natural world. Another example is the Sāmoan origin story of Sina, who befriended the human king-turned-eel whose head was planted in the sand, later sprouting a coconut tree.

Aotearoa-based authors Te Kawehau Hoskins and Alison Jones (2017) assert that "material things of the world [...] can speak to human beings" as they are agentic and have mauri, further explaining that "we are always already in relation to certain material objects" (p. 48). The authors unravel our interconnectedness with non-human beings in the context of Hongi Hika's moko marking on a land deed between Ngāpuhi leader Hongi Hika and British settler colonies, which was understood as a signature at the time. According to Te Kawehau Hoskins and Alison Jones (2017), the marking holds Hongi's chiefly energy or mana and that his emanating presence invites engagement beyond the passing of time. In indigenous native American ways of thinking, non-human agency is a certainty that constitutes the foundation for ethical reciprocity between humans and non-human beings (Rosiek et al., 2020). When detailing her journey with mosses, Robin Wall Kimmerer (2003) of Potawatomi heritage articulates that indigenous knowledge acknowledges that "every being is endowed with certain gifts, its own intelligence, its own spirit, its own story" and that " traditional knowledge is rooted in intimacy with a local landscape where the land itself is the teacher "(p.100; p.101). Canadian scholar Vanessa Watts (2013) from Mohawk and Anishinaabe Bear Clan, Six Nations of the Grand River refers to it as "Place-Thought", which acknowledges the landscape as a sentient and that "humans and non-humans derive agency through the extensions of these thoughts" (p.338).

The historical Western binary of knowing and being abstracts the non-human by reducing it to mere form; thus, non-human entities are perceived as resources (Rosiek et al., 2020). Consequently, this attitude gives way to opportunistic capitalist and expansionist agendas while perpetuating negligent overconsumption. The emergence of 'new materialism' - a Western school of thought that first surfaced in the 1990s - prompted a rigorous reassessment of this dualist approach and led to the adoption of similar perspectives to those of indigenous cultures; that materials are active and alive (Kirchhoff, 2009). However, there are multiple views on the level of human and non-human involvement. On the one hand, scholars like Bruno Latour argue that human and non-human entities enter into a relationship as equal partners with the same functional value (Kirchhoff, 2009). In contrast, Peter-Paul Verbeek and others defend the theory that non-human entities only become agentic through human interaction (Kirchhoff, 2009). German textile designer Svenja Keune (2021) challenges anthropocentric perspectives via the concept of 'multispecies philosophy'. Like indigenous ontological thinking, the concept recognises the equal involvement with and of everything around us in collective knowledge-making (2021). Thus, it can be argued that by acknowledging all non-human beings as alive, agentic, and related to us, our connectedness and respect for this relationship instils in us a sense of relational accountability, which may lead to more conservation-conscious practices.

Māori and Pacific customary practices and technologies have centred on endemic species and have transmitted knowledge for centuries, particularly around reciprocal human/non-human engagement (Hoskins & Jones, 2017; Enari & Matapo, 2021). For instance, harakeke plants are considered a family unit, with the mature outer leaves protecting the inner new ones (Mead, 2003). Therefore, only the outer ones may be collected to ensure continuous growth (McRae-Tarei, 2013). This embodied ancestral knowledge aspires to keep balanced relationships with the natural world intact (Hoskins, Jones, 2017), and together with evolving insights about our changing climate and the call to tread this Earth more responsibly, it could contribute to more sustainable materials practices. While the impact of today's mixed material culture is felt in every corner of Aotearoa, deep ancestral knowledge has persisted within diasporic Pasifika and urban Māori communities, which is evident in the emergence of new taonga thanks to present-day collective efforts to revive cultural practices. The reclamation of ancestral customary materials practices might enable richer conversations around today's materials, which may help to maintain a liveable environment for future generations.

Overall, perspectives must not be homogenised or generalised, and outcomes will always be perceived relative to personal preference and individual or collective values. Yet, a multiplicity of views in exchange has the potential to contribute toward the development of more inclusive material experiences. Intentionally involving place-based communities in the contemporary strong wool discourse in Aotearoa brings awareness about different social histories with wool and its functional benefits. It furthermore corroborates participation in decision-making processes about Aotearoa's broader material culture. Accordingly, it may lead to an increased demand for strong wool.

5

WOOL IN AOTEAROA

A sheep's fleece is shorn at least once a year to maintain the animal's health and hygiene. Therefore, wool is an abundant material that shows a range of unique, naturally occurring technical qualities thanks to its sophisticated architecture. As stated on The Woolmark Company's website, it is antibacterial, highly absorbent and fire retardant, as well as exhibiting moisture managing, temperature regulating and stain and UV resistant properties (accessed 2022). Aotearoa's strong wool sector has defined the country's economy for decades and provided a livelihood for local farming communities (Stringleman & Peden, 2008). In recent years, strong wool prices have plummeted, causing a significant decline in demand. AgResearch is investigating the fibre's chemical makeup to generate new strong wool-based keratin materials for novel applications to counteract this trend that is experienced across the globe. Since materials constitute physical product applications appraised by those engaging with them, it is necessary to explore how experiences can be evoked alongside these function-focused developments to increase commercial success (Bak-Andersen, 2019; Karana et al., 2015), particularly for strong wool-based materials and products.

When generating new material experiences, it is crucial to consider how "settled meanings" from past personal or third-party interactions influence our perceptions of materials (Karana et al., 2015, p. 42). Settled meanings should be unpacked alongside materials innovation to decide whether they inhibit positive experiences and appraisals or can be harnessed to constructively inform new 'material identities' [8] (Karana et al., 2015). Without exception, the same considerations apply to strong wool and, by extension, whole strong wool fibre-based products and strong wool-derived keratin materials. As an introduced material to Aotearoa, the fibre is politically charged. The arrival of British settler colonies brought new worldviews and values to the shores of Aotearoa, as well as an abundance of non-native species, which led to an ensuing extinction of numerous indigenous flora and fauna. Despite these events, indigenous and colonial settler communities began to engage in trades (Keane, 2010). Since keratinous materials, e.g., dog hair and feathers, had been prevalent in Māori and Pacific material cultures for centuries (Tamarapa & Wallace, 2013), foreign materials of similar qualities, such as wool, were more readily accepted and exchanged. Therein, wool was woven into kākahu (Te Papa, year unknown, History of Māori cloak-making, fig. 21), and later, Māori women who worked in shearing sheds collecting the fibre developed a knitting process known as 'uruapihi' using unspun wool (Pollock, 2013). Similarly, the fibre adorned Sāmoan 'ie toga (Kaeppler, 1991), fala lau'ie (fig.22) and Tuvaluan' ili (fig.23) in the 20th century, for instance.

[8] Elvin Karana et al. (2015) refer to the expression 'material identities' to emphasise the uniqueness and diversity of materials in the context of crafting new material outcomes.

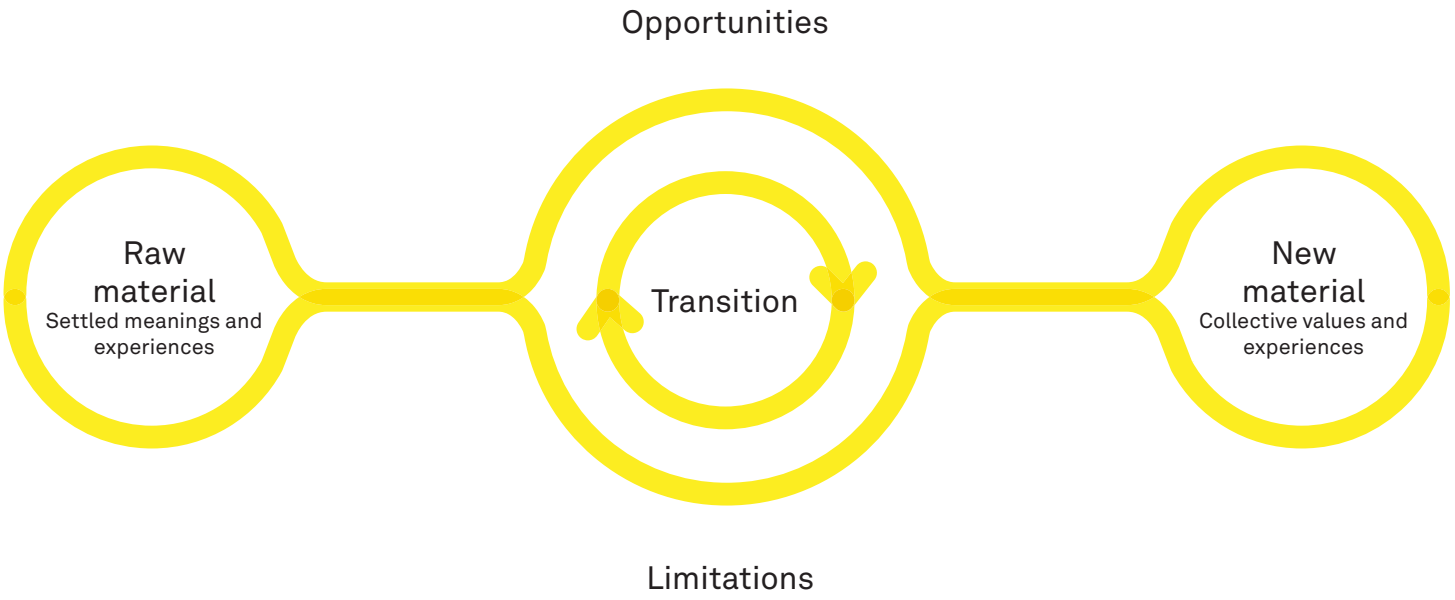
↘ Fig. 21 Kākahu with feathers and wool (cloak), 1860-1900
Muka, wool, feathers
Te Papa Collection

↘ Fig. 22 Fala lau'ie (mat)
Pandanus, wool
Te Papa Collection

↘ Fig. 23 Tuvaluan ‘ili (fan), pre-1985
Pandanus, wool, wood,
Auckland Museum Collection

With global efforts towards more sustainability-oriented futures, present-day industry standards are being challenged to pay more attention to environmental impact via criteria such as carbon footprint, life cycle, and energy input, among other things. Materials and their credentials especially have come under rigorous scrutiny. While brands such as Icebreaker and Allbirds are championing natural materials by contributing to an awareness of more environmentally feasible alternatives and increasing their demand, sustainable products are more expensive on average and, therefore, less accessible to low-income households already grappling with disproportionate material hardship. Though 'sustainable living' promotes less material consumption, even little things purchased to meet basic needs amount to a lot. Unfortunately, we are not at a point where all can entertain this lifestyle. While we must aspire to consciously choose what we integrate into our daily lives to improve existing infrastructures, above all, sustainability must become an accessible topic of discussion for everyone to partake in so that strategies and systems are re-imagined as a collective, particularly in the materials development space.

Aotearoa's mixed material culture undeniably touches us all. Within the domain of new strong wool-based materials we are navigating settled material associations and the process of imbuing existing materials and material systems with new values (fig. 10). A cross-section of perspectives should inform this process to make the material culturally more accessible and inclusive, the material's viewpoint included. Therefore, designing new strong wool-based materials calls for different material perspectives in conversation. This aligns with Colombian-American anthropologist Arturo Escobar's (2020) empathic 'pluriversal design' approach for societal transformation that recognizes the validity of different worldviews and advocates them, informing research and practice, outlined in his book "Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds". Due to the place-based and respectful approach implemented in this project, familiarisation with material understandings relevant in an Aotearoa-specific context is necessary.

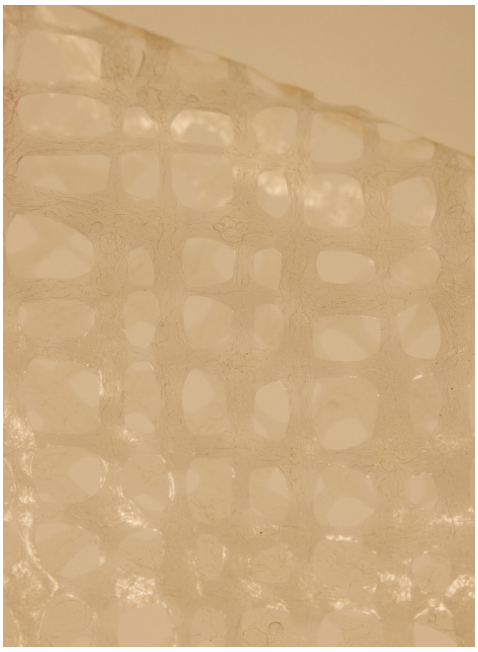


↘ Fig. 24 Representation of my thoughts on settled meanings vs. new materials experiences

↘ Fig. 25 Scrunched wool-based film (folded)

Methodology

This project revolves around building relationships with materials and communities at the beginning of materials research to generate more place-based and culturally-grounded outcomes. Therefore, a qualitative research methodology was called upon to exchange understandings and perspectives pertaining to materials – particularly strong wool. The methodology is centred on talanoa, which took effect within two interwoven contexts. Firstly, it provided the opportunity for a more personal exchange between strong wool and myself, which eventuated in the co-creation of boundary objects. And secondly, the methodology enabled the facilitation of a pilot study comprising a series of design workshops with an interdisciplinary group of students from Massey University, within which the boundary objects were embedded.



↘ Fig. 26 Left: wool-based web (rolled up)

↘ Fig. 27 Wool-based web (overlap)

TALANOA

For this research project, I drew on talanoa - an intergenerational oral tradition of collective knowledge-making that is rooted in indigenous Tongan, Sāmoan, Fijian, and Tokelauan cultures (Vaioleti, 2006). However, its meaning is nuanced in every nation (Vaioleti, 2006). Participating in talanoa encompasses meeting face-to-face either as a collective or as individuals to openly share experiences, building or strengthening relationships in an ongoing manner (Farrelly & Nabobo-Baba, 2014). The potential to collaboratively generate new knowledge and critically reflect on it is imperative, though the outcomes are secondary to the process (Vaioleti, 2006). Furthermore, it is understood that conversations are contextual and that a multiplicity of truths exists (Sauni, 2014; Vaioleti, 2006).

A mode of everyday conversation, talanoa constitutes a reciprocal and inclusive practice where power is shared among participating community members, and the vā - the "sacred space" that connects humans, humans/non-human beings, and non-human/ non-human beings - is honoured (Anae, 2019, p. 2; Enari & Matapo, 2021, Vaioleti, 2006). Meanwhile, the environment within which talanoa occurs is also acknowledged as conducive to its general tenor (Anae, 2019). Sāmoan and Aotearoa-based academic Melani Anae's (2019) concept 'teu le vā' emphasises the importance of nurturing this relational space by adhering to cultural protocols and respecting the time it takes to establish trust and cultural safety. This process will contribute to more positive energy within the vā, also referred to as mālie, which may culminate in relational accountability (Vaioleti, 2006).

Tongan scholar Dr Timote Vaioleti introduces the practice of talanoa as a research methodology for Pasifika researchers and/or researchers engaging with Pasifika individuals and communities (2006). While acknowledging his positional context as someone speaking from a Tongan perspective, he suggests that talanoa relates to other oral-based cultures and could be a familiar way of conversing with communities such as, for instance, Māori (2006). Timote's approach contrasts the Eurocentric interview method, whereby the researcher assumes the role of the interrogator. At the same time, the interviewee becomes the object of the conversation, leading to a less balanced dynamic (Vaioleti, 2006). Despite Laumua Tunufa'i (2016) arguing that talanoa is a method to collect data instead of a methodology, I understand it as an inclusive approach where the community is also involved in the sense-making process for analysing and interpreting findings (fig. 28).

Being of Sāmoan descent and living in Aotearoa, I want to contribute to research that serves and reaches our place-based communities, particularly indigenous Māori communities and the wider Pasifika communities. Hence, this project turns to a Pasifika-specific methodology to facilitate more accessible and relevant research. I set out to empathise with our local communities' lived experiences, prioritising the involvement of Māori and wider Pasifika communities to highlight how different perspectives can enrich the materials innovation discourse in Aotearoa. By respecting the relationship-building process, the community trusted me to interpret the collective insights and undertake the analysis part individually. Finally, I presented the findings to the community, who had the authority to decide whether the information represented collectively-generated knowledge and whether amendments needed to be made.

This research methodology complements AgResearch's aspirations toward more participatory science, as stated in the organisation's Statement of Corporate Intent 2021-2025. More significantly, it seeks to advocate for the value of Pacific research methods in science and design research to perpetuate their use and validity and to challenge Western mindsets. Therefore, talanoa served as a means to interact with strong wool. This took shape as boundary objects and when engaging with communities to collectively imagine the future of Aotearoa material culture within a workshop setting.

↘ Fig. 28 My personal interpretation of relationship-building and knowledge co-construction within talanoa

↘ Fig. 29 Wool-based materials layout

BOUNDARY OBJECTS

When collaborating with and across communities, it is necessary to find a standard communication mode that allows for mutual understanding of the topic. Boundary objects can aid this process. Bearing contextual meaning constructed within a specific discipline, boundary objects are flexible enough to harbour new meanings within a new interdisciplinary setting (Star, Griesemer, 1989). They can take physical or abstract shapes (Roedder, 2014). According to Susan Star and James Griesemer (1989), they are recognisable across participating disciplines and valid in that specific context. Meanwhile, they facilitate new pathways to innovation via collective, cross-disciplinary discussion and imagining (Fox, 2011).

In this research project, the concept of boundary objects manifested itself in physical strong wool-based material samples, which I created in collaboration with the fibre. These sought to simulate the material formats developed by AgResearch to illustrate potential material outcomes and stimulate discussion around future strong wool-based materials in the workshop setting. The process of making boundary objects was set in motion by building a relationship with strong wool, acknowledging it as an equal, sentient and agentic partner throughout, as is customary in talanoa (Enari & Matapo, 2021) and Māoritanga (Hoskins & Jones, 2013). Through ‘tinkering’ (Karana et al. 2015) and the reciprocal engagement with materials, different experiential and technical property-based sensations were revealed to me through touch. That way, I could cultivate empathy toward the material, which made the process of creating strong wool-based composites more intentional.

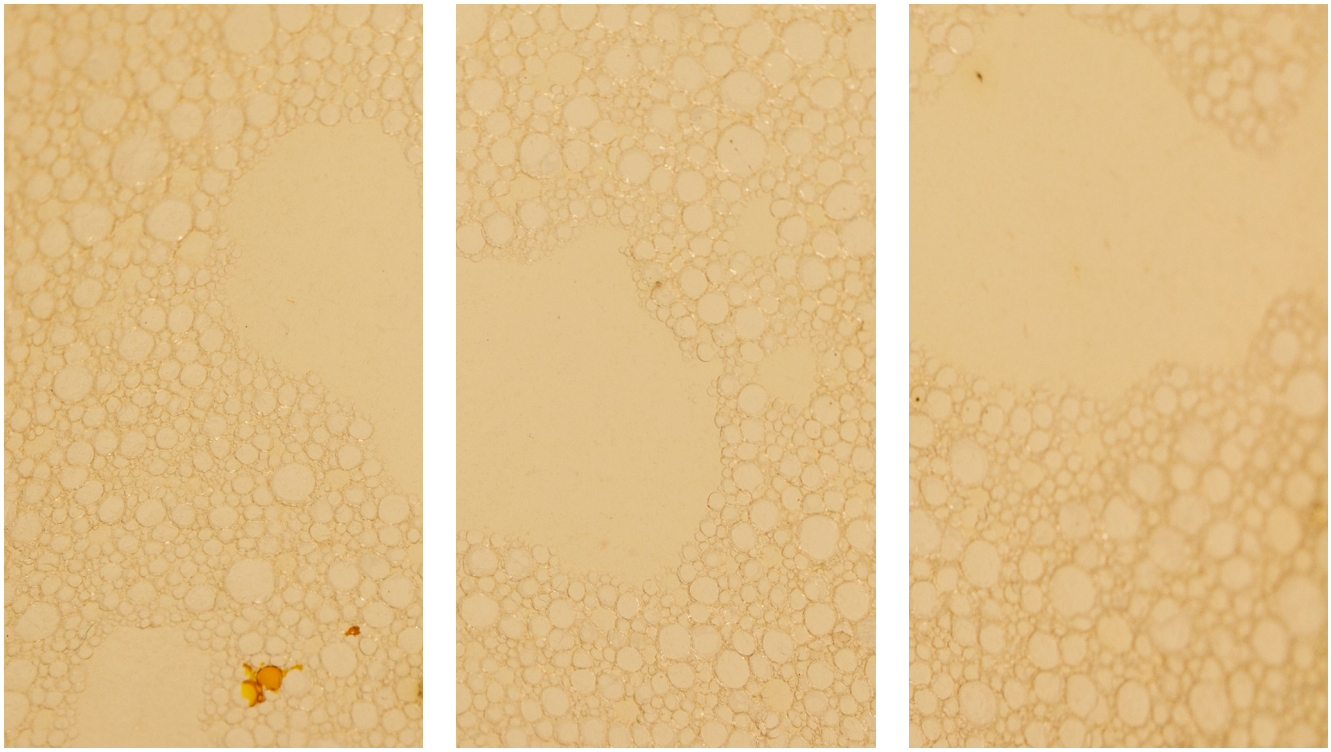
Through deep material engagement, which entailed experimenting with fibre formats and combining them with bio-based ingredients (expanded on in the 'Boundary Objects - Process' section), the materials imparted embodied knowledge. I was able to comprehend strong wool’s limitations, opportunities for new materials, and, most importantly, how new experiences can be evoked. In a textiles context, Faith Kane and Rachel Philpott (2016) explain that “our experience of textiles is sensory, lived as much as it is conceptualised: thus the significance of the textile artefact reaches beyond its physicality, also incorporating sensation, memory, and symbol into a single entity” (p. 243). By acknowledging the intertwinement and value of theory-based and experiential knowledge, a deeper understanding of materials is gained. This subsequently expresses itself in the quality of the final product, its manufacturing processes, and life cycle (Kane & Philpott, 2016).

↘ Fig. 30 Left: bubbly wool-based film (close-up)

↘ Fig. 31 Middle: bubbly wool-based film (close-up)

↘ Fig. 32 Right: bubbly wool-based film (close-up)

Simone Roedder (2017) articulates that boundary objects can help to convey a material's functional and experiential qualities to non-designers or non-material experts. Therefore, the material samples were introduced to the workshop community to experience and identify properties for new material identities as disclosed by the materials themselves. New insights and opportunities emerged through collective discussions, and the community was central to the sense-making and evaluation process, driving the research direction according to subjective material interactions. The method's participatory nature lends itself to imagining applications with a real societal, transformational value that meets projected future needs. Emphasis is placed on the notion that the material's novelty must not be mistaken as an agent of change (Karana et al., 2015). Instead, the envisioning, implementation, and final embodiment of meaningful interactions and reciprocal collaboration warrant commercial success (Karana et al., 2015).



↘ Fig. 33 Top: ingredient arrangement

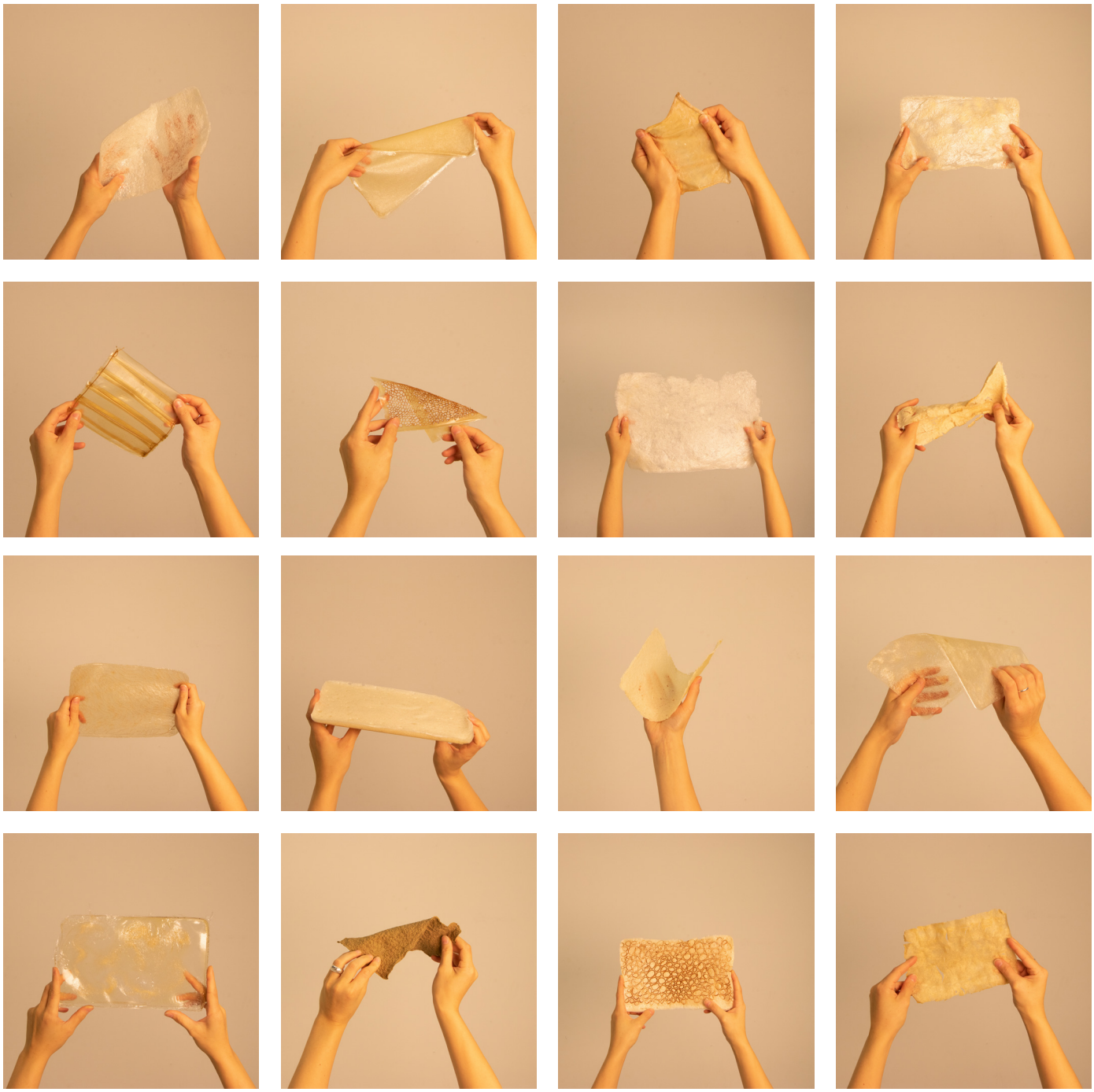
↘ Fig. 34 Middle: ingredient arrangement

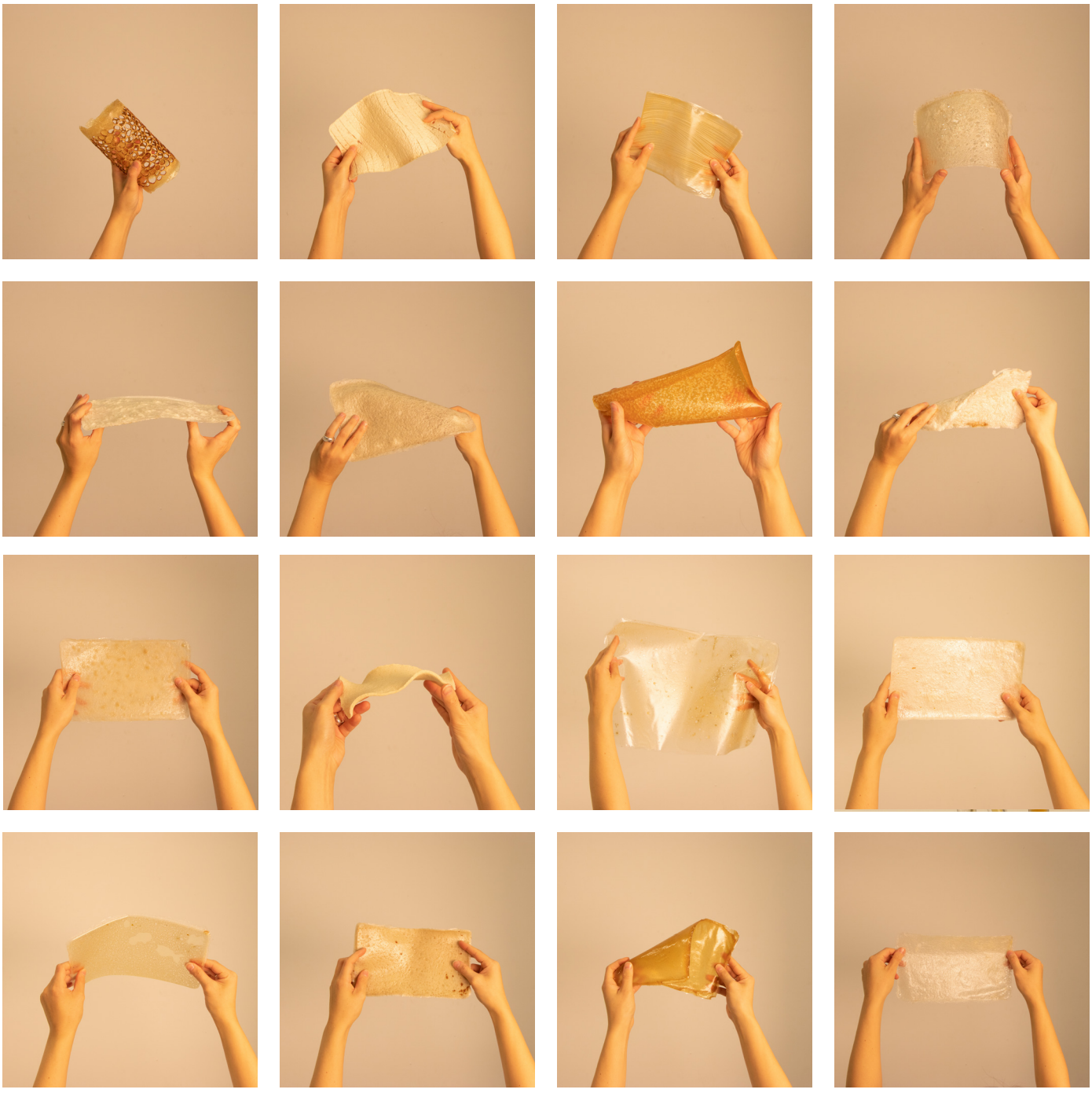
↘ Fig. 35 Bottom: ingredient arrangement

↘ Fig. 36 My journey with boundary objects

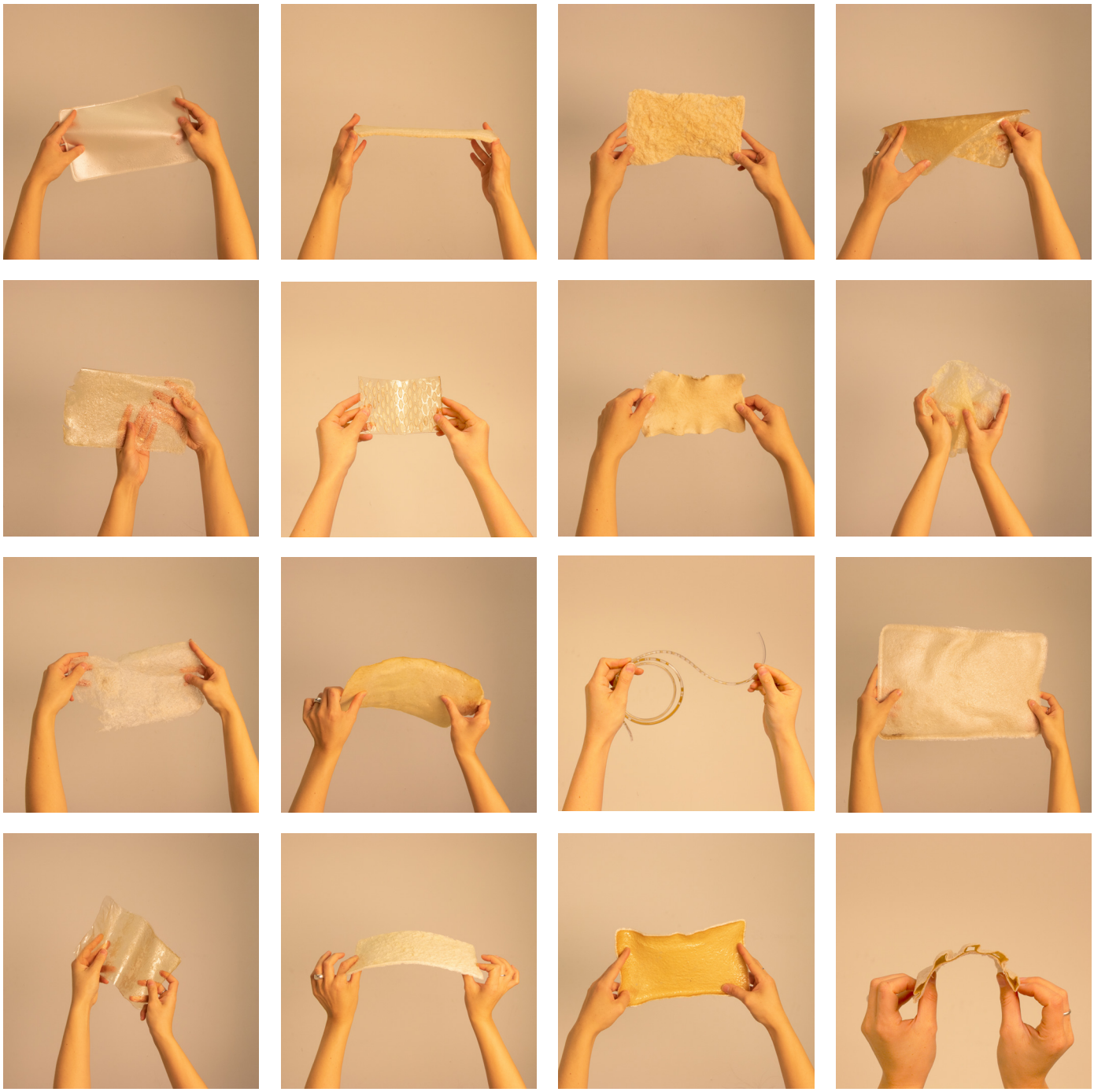
To develop well-rounded boundary objects, I established a sequence of steps that are reflected in the table below. They are by no means exhaustive.

Pre-tinkering: Respectful material engagement		— Researching approaches to interact with raw materials and handle ingredients in a respectful way, e.g., Te Kawehau Hoskins and Alison Jones' chapter 'Non-human Others and Kaupapa Māori Research' in Critical Conversations in Kaupapa Māori
1	**Expert talanoa**	— Understanding the raw material's basic chemistry and its technical qualities through continuous talanoa with Jeff, Duane, and other AgResearch scientists — Textile-based talanoa with Faith and Sonya (my supervisors) allowed me to better understand mature textile practices and how they might inform new strong wool-based materials
2	**Literature**	— Modifying existing open-source biomaterial recipes formulated by material designers (e.g. Chemarts cookbook and Materiom website), borrowing techniques from molecular gastronomy (e.g. foaming), and drawing on journal articles that outlined scientific approaches to synthesising different material formats
3	**Familiarisation — building competency**	— Setting preliminary parameters to build a robust understanding of ingredient interactions — Gathering bio-based ingredients and understanding ingredients' purpose — Testing a broad range of ingredients and combinations thereof — Altering ingredient ratios and the order of introducing ingredients — Reducing ingredient types — Testing different raw wool formats (size, hydration, etc.) — Developing reliable base recipes — Documenting samples perceived as less successful to understand basic chemistry in practice - some happy accidents evolved into more desirable samples
4	**Setting parameters**	— Revisiting and altering parameters around ingredients and methods
5	**Rigorous experimentation for variation**	— Creating a range of formats using different curing and blending methods — Trialling fabrication processes (laser cutting, moulding, embedding secondary material, lamination) — Combining recipes in the same sample — Experimenting with protein alternatives/base liquids (ocean water/ lanolin water/ wheat and silk protein) — Developing membrane materials — Consolidating reliable method for more consistent outcomes
6	**Material engagement (workshop)**	— Defining desirable qualities based on the sample's inherent semantics — Identifying how materials could be developed further — Discussing processes of constructing samples
7	**Amplifying desirable qualities**	— Tweaking construction processes for more succinct and repeatable outcomes — Working with targeted qualities and intensifying them (bubbles, laser cutting)
8	**Next step**	— Natural dyes — Combining new material formats with more traditional textiles (woven and/or non-wovens) to create membrane materials

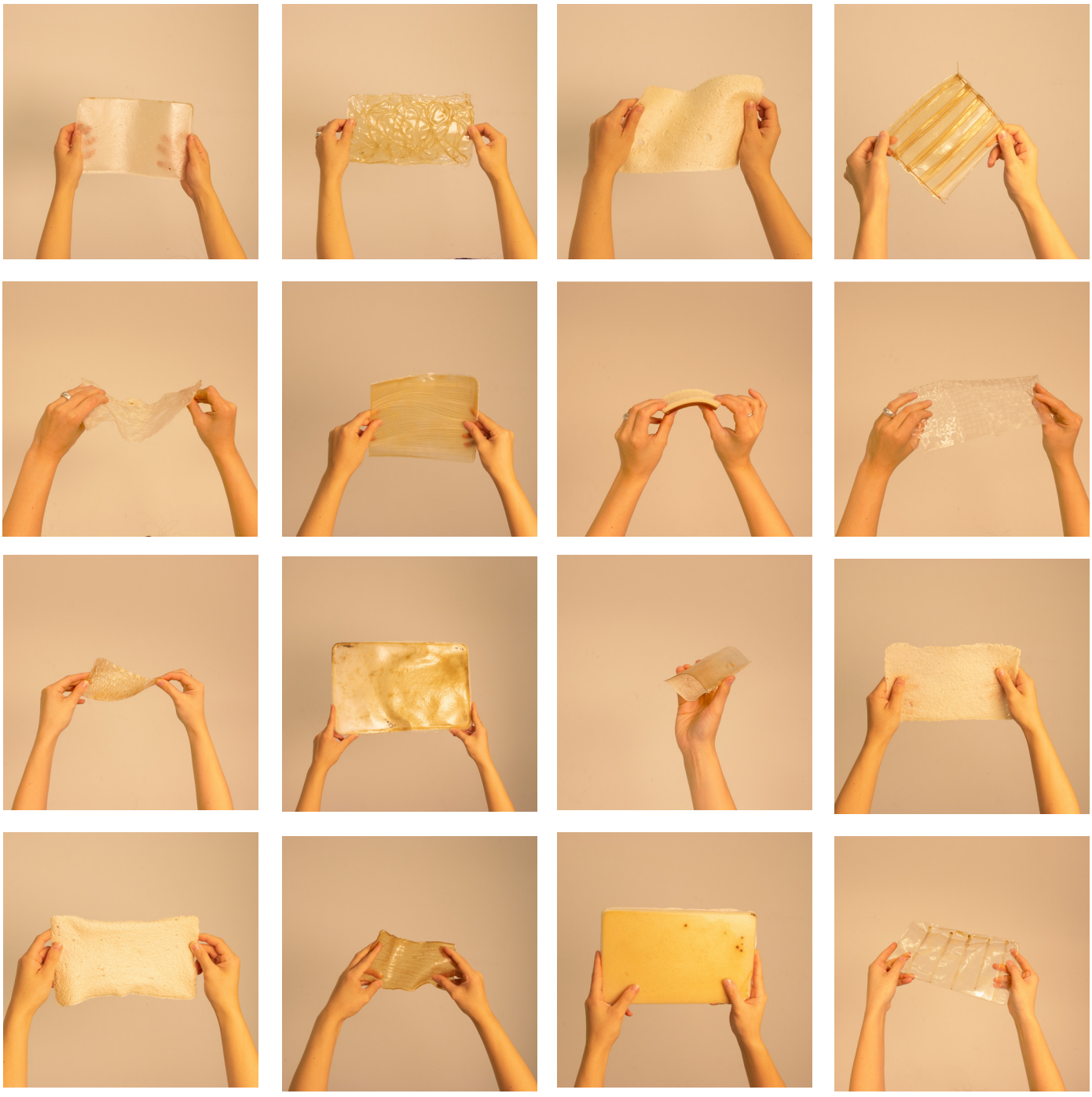




↘ Fig. 37 Wool-based materials collage (1)

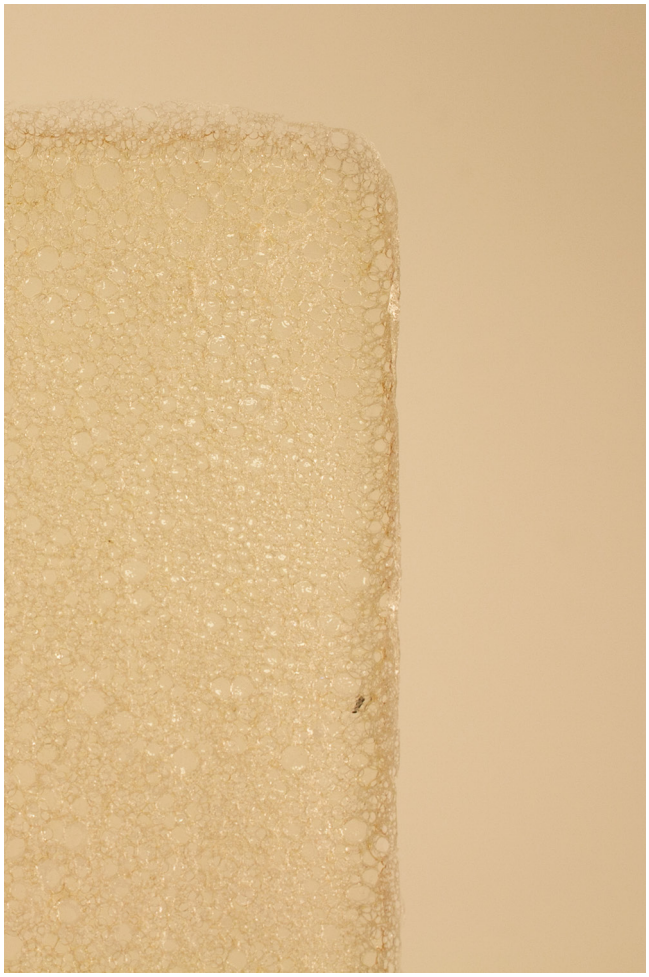


↘ Fig. 38 Wool-based materials collage (2)



↘ Fig. 39 Left:
wool-based film with
bubbles (centre)

↘ Fig. 40 Right:
wool-based film with
bubbles (edge)



↘ Fig. 41 Parameters for collaboration with boundary objects

PARAMETERS

Reduced energy input	— Cooking at low temperature — Air-drying
Biocompatibility	— Bio-based ingredients — Can be safely disposed of in domestic environment
Consistency	— Max. 6 ingredients for fewer ingredient interactions — A4 size for consistency and to have extra material to tinker with
Wool	— Must include a portion of strong wool or alternative protein powder to simulate keratin (did not have access to pure keratin)

↘ Fig. 42 Observations from engaging with boundary objects

OBSERVATIONS

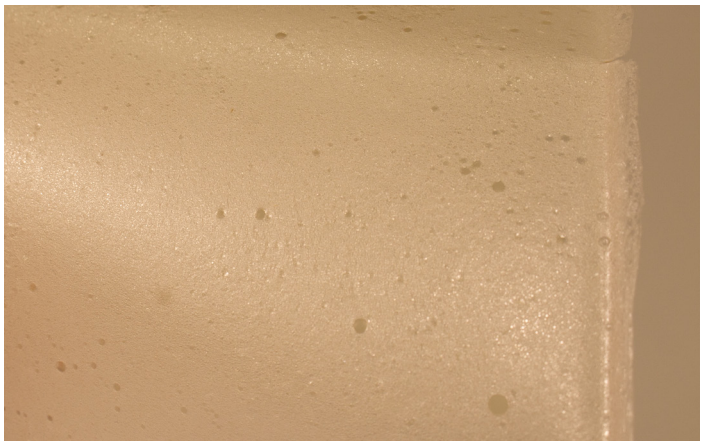
Base ingredients	— Gelatin proved to be the most reliable base ingredient as it shares a chemical association with strong wool-based keratin (as observed in SEM images) - improved bonding
Processing	— Curing samples in a mould was unsuccessful - more rigorous fabrication methods are required post curing e.g laser cutting, pressing, etc.
Secondary material	— Embedding a second material within the primary matrix caused shrinkage or buckling
Wool	— Clear sheets resembled plastic but with whole fibres - more personality — Imperfect surface - more natural feel
Layering	— Natural laminate materials developed as gelatin settled, creating a separate layer
Maturing	— Materials show the passing of time and should age well - definition of texture changes, especially in agar-based samples
LCA	— De-and reconstruction of materials demonstrated that composites break down and can be reassembled to exhibit either similar or new qualities

SUMMARY

To better understand strong wool-based materials and the process involved in assembling them, I engaged with strong wool more intimately to build a relationship with the fibre, growing empathy towards it. Recognising the raw material as a collaborator led to more intentional material outcomes in the form of physical boundary objects that were generated through playful experimentation. Therein, the material revealed opportunities for new composite materials and how meaningful interactions could be embedded within them. At the same time, it disclosed limitations, which, instead of inhibiting further developments, I honoured by not forcing the raw material into something it did not want to become. Hence, I set parameters around the making process to play within, so that all samples were somewhat linked but were able to remain their own. It was important to me to refrain from imposing full control, so while the materials cured autonomously, for instance, they could develop unique personalities. I was simply providing a scaffold for them to grow into their own preferred state.

Due to limited or no access to specialised technical equipment, ingredients and pure keratin, the boundary objects exhibited significantly different properties to the materials developed by AgResearch. However, they were valuable in the workshop setting as they translated the abstract concept of new wool-based materials to a non-science audience. The workshop group could interact with the materials and experience different qualities exhibited by the materials to determine desirable attributes.

This creative and collaborative endeavour inspired new ways of thinking about materials, particularly in regards to extractive language in relation to materials. While I attempted to capture this in my writing, I am aware that I am perpetuating an anthropocentric attitude that does not reflect strong wool's experience throughout this engagement. Hence, the journey to shift focus to more equal relationships with the natural world is ongoing and will hopefully spill over into my thinking in other areas.

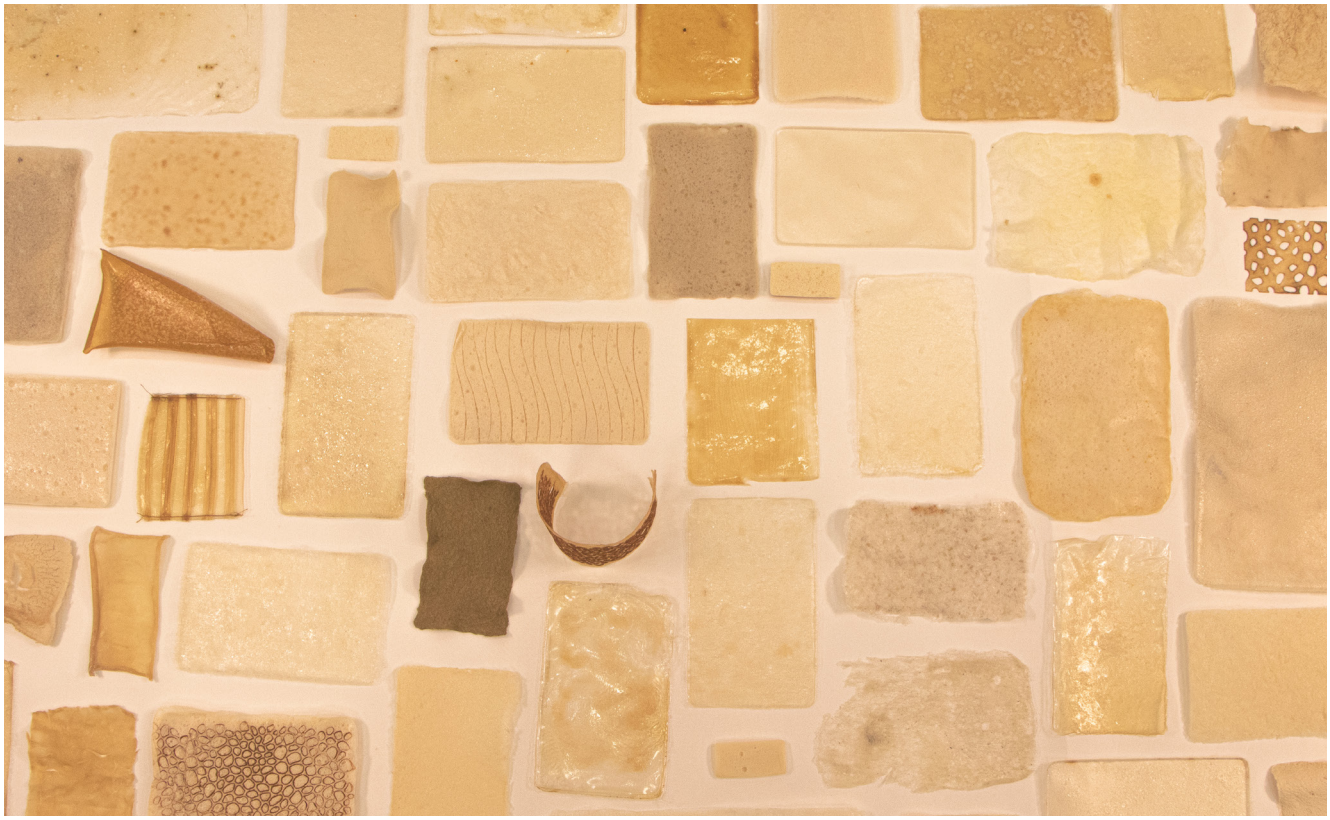


↘ Fig. 43 Left: satin wool-based sheet

↘ Fig. 44 Satin wool-based sheet in hand

↘ Fig. 45 Satin wool-based sheet (close-up)

A pilot study comprising a series of 3 consecutive design workshops was facilitated at the Innermost Gardens on Mount Victoria. It brought together 7 tertiary students from various disciplines in their third year of study, all enrolled at Massey University in Wellington. As a novice researcher, it was appropriate to test workshop and talanoa facilitation skills within a safe space. Hence, the proposed design workshops were undertaken as a pilot study to build precedents for future collaborative research undertaken with communities in the agricultural material science research space. The sessions were facilitated off-campus to remove stigmas around conventional workshops and to stimulate creative thinking in a non-academic environment.



↘ Fig. 46 Wool-based materials set-up

The workshop group size enabled a diverse cross-section of disciplines in conversation while maintaining an equal opportunity for each voice to be heard and acknowledged. Additionally, the number of students was appropriate for the intentional, ongoing building and strengthening of relationships on both an individual and a collective basis.

The study sought to raise awareness of the material culture we are embedded within in Aotearoa. By engaging in 'material thinking', the workshop group critically reflected on and exchanged lived (past and present) experiences with materials and imagined the materials of the future, with a particular focus on strong wool. The process demonstrated the benefits of collective and open talanoa in the materials innovation space, potentially leading to more meaningful product development in agricultural science research organisations.

Given the project's embeddedness in the bicultural setting of Aotearoa, it furthermore aimed to advocate for the inclusion of Indigenous material understandings/ontologies relevant to Aotearoa. Therefore, the involvement of Māori and Pasifika students was made a priority. The workshop group comprised 3 Pasifika students, 2 Māori students, one international student from Norway, and one New Zealand European student. It was hoped that different worldviews in conversation, specifically in the material development space, would contribute to existing initiatives towards more inclusive practice.

As the primary researcher in this project, I initiated the coming together for this pilot study and became the facilitator of relationships between materials and communities, materials and scientists, and scientists and communities. However, the student group guided the process as much as I did. Furthermore, it is important to emphasise that group members of Māori and/or Pasifika heritage affiliate with different iwi and villages in Pasifika nations as well as pertaining to nuanced beliefs and knowledge systems. Hence, findings acknowledge the diversity in participants' affiliations to avoid homogenisation and the perpetuation of stereotypes and ethnic indifference.

An initial interpretation of experiences was undertaken as a group in the workshop settings and included notes of discussions. Thereafter, I arranged our collective findings thematically and developed ideas further. Having consolidated a sense of accountability towards the group adn the materials through ongoing relationship-building, I treated our insights as respectfully as possible. These were presented to the group to enable further talanoa around changes, remembering that our personal experiences and stories are contextual and not quantifiable.

ETHICS STATEMENT

Involving members from Massey University's student communities in this research project necessitated careful ethical considerations and continuous consultation with appropriate academic and supporting staff and student associations throughout the study. Hence, the iterative peer-review process encompassed continuous exchange with Massey University and AgResearch supervisors and Māori and Pasifika advisors at Massey University. Since sponsorship was provided by a third party (AgResearch), there was an increased risk of conflict of interest. To address these factors and ensure members of the student communities were protected, an ethics application was submitted to the Committee of Massey University Human Ethics. Once approval was granted, I was able to approach students whom I had previously established relationships with to discuss the study's purpose, their rights as participating members, and what informed consent entailed. I also handed out a physical information sheet detailing all of the above and extended an offer to participate in this research study. All workshop group members returned their signed consent forms, and the workshop process proceeded.

On a personal note, as someone of Sāmoan descent engaging in talanoa with a diverse student community, particularly the Pasifika community I myself am part of, I found Massey University's institutional ethics process alienating as it reinforced insider-outsider dynamics, compromising authenticity for objectivity. In my opinion, culturally-specific ethics protocols should hold their own space that can be called upon when research with Pasifika or Pacific communities, for instance, is undertaken. That way, the relational vā between those engaging in research can be maintained, contributing to more culturally-informed research and research outcomes.

↘ Fig. 47 Top: wool-based sheet (scrunched)

↘ Fig. 48 Bottom: wool-based sheet (flat)

WORKSHOP PROCESS

Pre-workshops: initiating the relational vā through intentional relationship-building	**Establishing a support system** Student associations, academic and advisory staff at Massey University/AgResearch **Ethics journey** Defining mutual benefits, protective measures, and intentions **Initiating relationships with students** Being present in communal spaces on campus, partaking in and helping out with events and activities on campus, offering academic support and mentorship **Introducing students to my research project** Transparently communicating workshop idea and gauging interest **Identifying participants** Offering students the opportunity to partake in the research study **Discussing consent** Initially on an individual basis, reviewed again in the group setting
Introduction at the beginning of the first workshop: teu le vā – nurturing the vā among the group	**Welcome and group introduction** Activating the collective vā within the workshop group by introducing ourselves to one another (brief personal background, ancestral ties, current place in identity, studies, hobbies, interests **Tikanga/health and safety** Establishing cultural safety measures for the workshops as well as health and safety precautions for the physical space **Activities** Discussing a potential sequence of activities while emphasising flexibility and that the workshop content/structure will align with our talanoa **Purpose** Re-introduction to the research project, clarifying mutual expectations and intentions
First workshop	**Material awareness and common ground** Exchanging personal material understandings, observed negative associations, and hopes for future materials **Material experiences with wool** Exchanging personal material experiences with wool **Relationship-building between science and the community** Introduction to my AgResearch supervisors, Duane Harland and Jeff Plowman, who gave insight into their roles, strong wool's technical properties, and the partnership programme
Second workshop	**Recapping our talanoa from workshop I** **Material thinking through boundary work** Engaging with boundary objects to understand experiential qualities, opportunities, and limitations – Imagining superpowers of future materials – Discussing application ideas prompted by materials' qualities
Third workshop (speculative/critical design element)	**Recapping our talanoa from workshop II** **Narrowing down three areas** Discussing ideas within their intended contexts and speculating about possible changes in the future and how these might influence the initial application idea

End of each workshop	**Reflection on workshop while sharing food** All three workshops led to a reflective exchange over food, which lifted the material-centred vā and gave us the opportunity to review the workshop process. The food was blessed in prayer
Post-workshop	**Arranging notes/data** (individual activity carried out by me) Analysing and interpreting data and refining ideas to develop scenarios, initial conceptualisations **Develop ideas from workshops** (individual activity carried out by me) Physical prototyping/modifying samples in response to collective talanoa and developing visualisations of scenarios **Taking findings back to the workshop group** Presenting findings to the group and engaging in collective discussions about changes
Next steps (beyond the scope of this project)	**Targeted material and product-specific context analysis** Technical specifications, user journey, life cycle assessment, market analysis of existing products, etc.

↘ Fig. 49 Workshop process

↘ Fig. 50 Rasterised wool-based film

Session I

Exchanging material experiences

Introduction and Tikanga

The first talanoa session began with welcoming all workshop group members into the physical space and activating the ‘vā’ – the sacred, intangible space where all beings, human and non-human, can interact safely. I also expressed my gratitude for everyone’s involvement and time. Each workshop group member, me included, then proceeded to introduce themselves to the group in their own ways. Next, we acknowledged the Tangata Whenua of the Wellington Harbour area, Te Āti Awa, and addressed the use of Tikanga in the space to maintain cultural safety throughout the workshops, e.g., everyone has equal opportunity to assert their perspectives and participate in guiding the talanoa. I also clarified health and safety precautions for the physical space.

Before moving into material-centred talanoa, we discussed our expectations and intentions for the pilot study. That way, we were able to understand how we might collectively shape the workshop process, ensuring that everyone’s expectations are acknowledged and woven into this immersive, collaborative journey..

		Intentions		Expectations
The group	1	Partaking in discussions and design activities Offering support	1	Learning about strong wool-based materials and new material development Experiencing interdisciplinary collaboration
Me (researcher)	1	Facilitating relationships between students, materials, and AgResearch	1	Inspiring the re-imagining of our relationships with materials
	2	Providing a space for collective, interdisciplinary storytelling	2	Engaging in collective talanoa about our personal experiences and critical reflections of our notions of materials
	3	Stimulating critical thinking towards present-day material culture	3	Experiencing talanoa as a research methodology in action and learning a way to operate as a collective
			4	Supporting the transfer of collective design and workshop facilitation skills

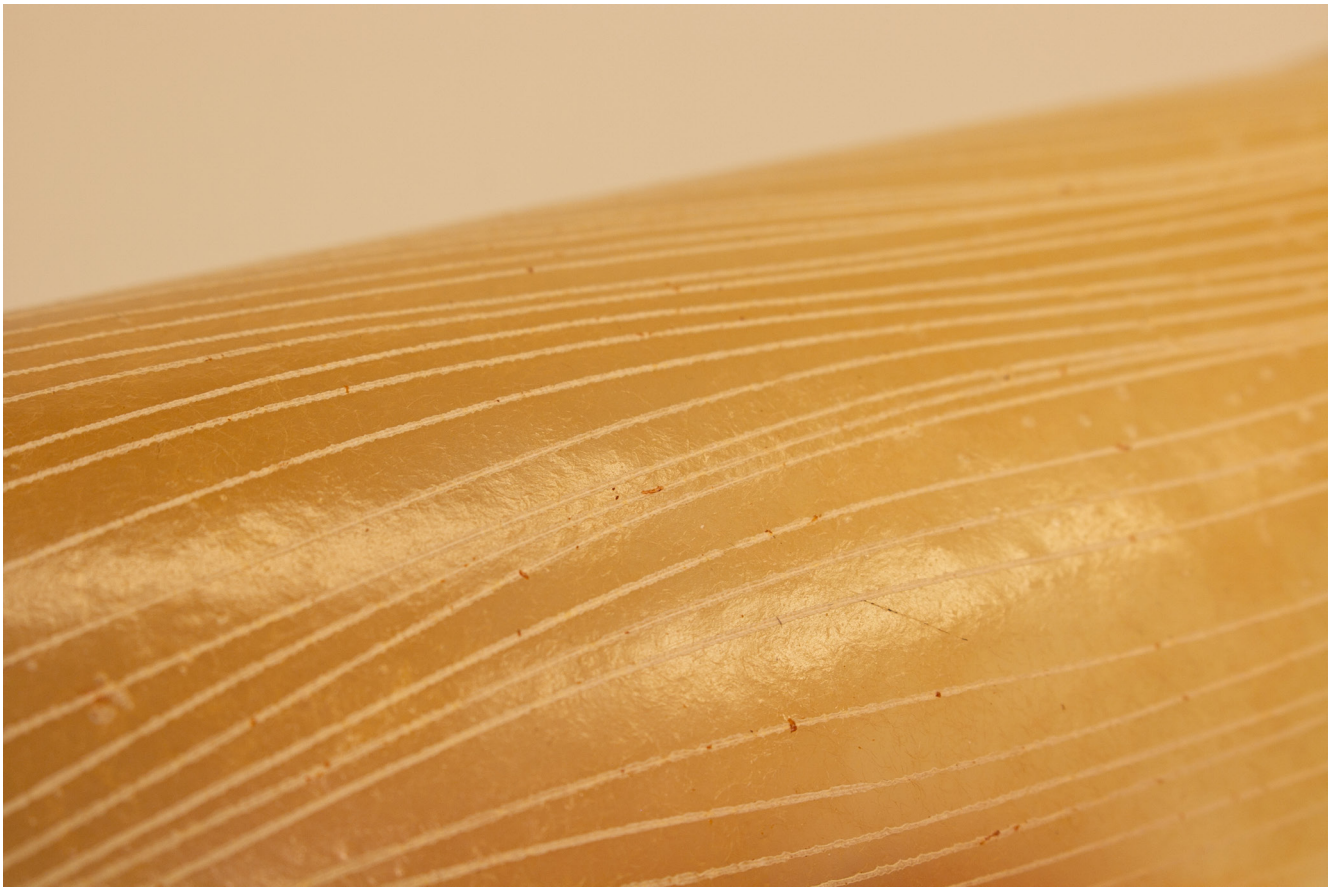
↘ Fig. 51 Intentions and expectations

Where appropriate, I will be referring to the workshop group (students and myself) with the pronouns “we”, “us”, and “our”. This approach is consistent with the practice of talanoa, where all present entities are acknowledged as contributors to the new knowledge generated in that particular context.

01

What comes to mind when you think about materials?

Our first group talanoa was initiated by the following question: 'What comes to mind when you think about materials?' This question aimed to direct awareness towards what we perceive as 'material', comprising both tangible and intangible constructs, e.g., physical properties and social meanings. We took a moment to reflect on our understandings of materials based on our lived experiences and captured our initial responses as keywords to refer back to during our talanoa. Subsequently, each workshop group member shared personal definitions of materials by articulating previous material encounters, experiences, and associations with the word 'material'. Keywords consisted of general material types, their experiential and technical qualities, as well as memories associated with them (see Appendix). Additionally, we discussed place-based references specific to Aotearoa's material culture and other Pacific contexts, e.g., harakeke and tapa.



Following each verbal account, we took turns in outlining our corresponding thoughts via group talanoa. This allowed us to relate to each other's material experiences and prompted deeper collective reflection. Consequently, we established overlapping associations with the word 'material' and that materials allude to specific uses, values, and states of wellbeing, e.g., fleece exudes comfort. We also recognised nuances and significant differences in how we define and interact with materials and that diversity in material languages exists. This became especially evident in our discussion around natural and native materials, where the term kafa surfaced. Those of us who knew of kafa recognised that it not only constitutes a binding agent in the Sāmoan fale, for instance, but it also symbolises the practice and value of collective making across different communities in the Pacific. Hence, we attributed our material understandings to our various cultural knowledge systems and upbringings.

Furthermore, we ascertained that materials are conduits of knowledge transmitted through deep material engagement. We explored the concept of 'nan's handmade knitwear', whereby intricate patterns showcase different knitting techniques and fibre processes indicative of a specific time and place. Parallel to this, we noted that the intangible aspects of thought, care, and time put into making it, especially by and for a loved one, enhance its meaningfulness and longevity. Thus, the knitwear becomes more significant as it is imbued with 'nan's essence' and enriched by passing through the hands of other loved ones. We concluded that materials contain layers of meanings, which are subjective, contextual, sometimes first-hand or learned from others, and culturally specific.

This step was crucial to set individual and collective 'material awareness' in motion, enabling robust discourse around different material perspectives whereby we challenged personal assumptions. Additionally, it enabled us to relate to one another's understandings, facilitating a sense of familiarity among the group that significantly contributed to maintaining cultural safety throughout the workshop.

↘ Fig. 52 Laser-engraved wool-based film

02

What is problematic about today's materials?

The second question, 'what is problematic about today's materials?', provided us with the opportunity to consider the negative implications of present-day materials and related practices. We engaged in the same activities for the first question of the workshop, e.g., considering the question and writing down word associations. Our subsequent talanoa focused on material origins, human-material relationships, and environmental concerns (see Appendix).

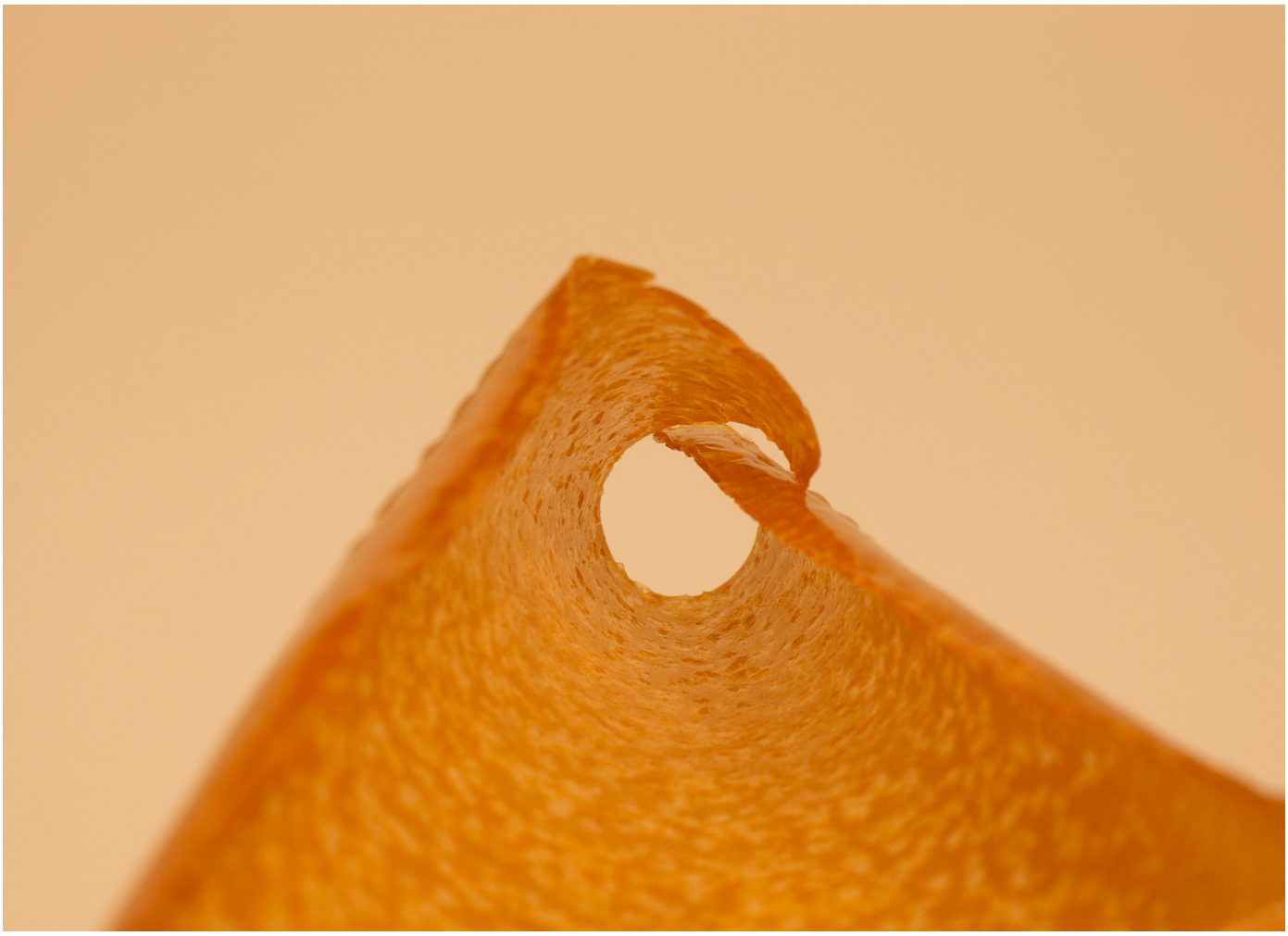
We established that Western capitalism and consumerism have led to materials (and products thereof) being perceived as transient vehicles for temporary satisfaction. To us, this hegemonic misconception has caused a sense of detachment that is reflected in exploitative material practices, including energy-intensive manufacturing processes like fracking and the excessive, fast production of 'empty' (meaningless) goods for commercial gain. Through talanoa, we critiqued the linear consumption model where materials are 'harvested', 'used', and disposed of, disregarding the relationship between the time it took the raw material to grow and its lifespan as a product. Additionally, we discussed that materials are embedded within a broader ecosystem, an attitude long practised by indigenous Māori and Pacific communities. Therefore, we asserted that we must restore this mindset and respect the interconnectedness between all beings, especially since internal and external changes affect the entire network. Subsequently, we challenged our present-day relationships with raw materials, which could further prompt empathy towards their derivatives or 'relatives'. Through our talanoa, we identified the mutual desire to work towards a more regenerative and ecocentric infrastructure while honouring our responsibilities as kaitiaki - stewards of Aotearoa.

Altogether, our talanoa was conducive to establishing criticality towards contemporary material practices and revealed the need to rekindle our relationships with materials. We discussed that customary Indigenous Māori practices and wider Tangata Moana ontologies are invaluable in teaching us about partnership thinking with non-human entities. Hence, we concluded that we desperately need to re-negotiate our internalised human-centred ideals to re-establish ecological balance in Aotearoa. In response, once our collective criticality was ignited, we could exchange positive visions for future materials.

↘ Fig. 53 Top: satin wool-sheet (creased)

↘ Fig. 54 Middle: satin wool-sheet (bent)

↘ Fig. 55 Bottom: satin wool-sheet (flat)



↘ Fig. 56 Rolled up bubbly wool-based sheet

COLLECTIVE IMAGINING

03

What comes to mind when you think about the materials of the future?

After exchanging material experiences and discussing our concerns about present-day materials, we delved into the following question: ‘What comes to mind when you think about future materials?’ This question sparked talanoa around the qualities future materials might express and how these affect engagement with humans and their environments. After noting down our initial thoughts, we took turns in outlining our hopes and had the chance to respond to each other’s reflections. Our talanoa answered our previously expressed environmental concerns and centred on the mechanisms that could help to facilitate more holistic material interactions and practices. For instance, taking into account potential advantages and disadvantages for the broader ecosystem more extensively and deliberately, as well as who/what the material and related processes serve and affect should occur before it is physically made (see Appendix).

Future materials were primarily thought of in two ways: firstly, in connection with products and how they could become more eco-friendly, and secondly in relation to their situational context. We discussed that we hoped materials of the future were local, of renewable origin, and that they flowed back into the ecosystem without jeopardising ecological balance. Similarly, we expressed that durability and multi-purpose functionality could foster extended material life cycles. Our talanoa echoed previously articulated desires to decentralise human agency and

↘ Fig. 57 Wool-based materials arrangement

to prioritise the reciprocal exchange between humans and materials, as is the case in mātauranga Māori. Therein, a material's mauri, mana, and equal status to humans are acknowledged, with the potential of inspiring deeper relational accountability. We identified that this, for instance, manifested itself in more mindful material collecting protocols such as karakia and waiata, which pay tribute to ancestral connections and facilitate conversations with the material to understand how it wants to be engaged.

Overall, this step helped to stimulate our collective imagination, allowing us to voice real-life concerns around unethical material practices, e.g., extractivism, from a lack of empathy and responsibility towards materials and their environs. Together we explored possible corresponding measures, e.g., understanding a material's origin and situatedness, honouring its agency, and perpetuating respectful engagement. After discussing materials in a broader sense, we could access material-related thinking more readily, which became evident in the following wool-centred talanoa.

RECOLLECTION OF PERSONAL WOOL ENCOUNTERS

04

What do you associate with wool?

How does wool sit within Aotearoa's material culture?

The questions above allowed us to contemplate our relationships with wool and ascertain our perceptions of the raw material. We captured our thoughts on paper and shared them via group talanoa. Our discussion brought to the surface our varying personal histories and levels of engagement with wool and that our awareness of the material and its properties are linked to our social and cultural contexts (e.g., upbringing). Experiences were primarily product-specific, ranging from intimate and conscious to distant and somewhat subconscious. They constituted interactions with inherited heirlooms that carried nostalgic memories, and comprised more commonly known assumptions, including 'itchy', 'old school', 'craft', and 'comfort'. Keywords also referred to mature textile practices, farming culture, and performative properties (see Appendix). To some of us, wool constituted a generational material that was highly valued as a symbol of status in our grandparents' era and prior. This attitude towards the fibre has remained among some of our families in the group, especially with respect to its technical qualities. Meanwhile, we identified wool as a material of privilege perceived as somewhat foreign and exclusive to others, which sparked talanoa around wool's place in Aotearoa.

Despite being an introduced material, we touched on wool being attributed to the brand 'New Zealand' owing to the tourism and export industry. The expectation that the fibre contributes largely to the country's national identity has persisted, particularly from an outside perspective. Thus, unsurprisingly, most workshop group members also linked wool to the word "Kiwiana". We critically reflected on this, particularly since the word itself diminishes a lengthy history and presence of conflict between Tangata Whenua and British settler colonies and descendants, suggesting that there is one unified nation and single culture in Aotearoa. Concerning wool, this discussion denoted that the fibre is politically charged.

↘ Fig. 58 Wool-based film (bubbles)

Our wool-centred talanoa demonstrated that the raw material bears various settled meanings and experiential qualities, which influence our relationships and shape our future interactions with it. Some preconceptions have lasted through generations, either inhibiting or encouraging engagement. Yet, there is not one single material identity. After this, we directed our attention toward wool's technical qualities.

INTRODUCTION TO WOOL'S SUPERPOWERS AND AGRESEARCH

Following an exchange of our personal wool encounters, we shifted focus to the fibre's inherent technical abilities, which stimulated a deeper appreciation for the material, as was voiced by the workshop group. Jeff and Duane joined us for half an hour to talk about their roles at AgResearch, the partnership programme, and their interest in strong wool. This step was instrumental in initiating a relationship between AgResearch and the workshop group/ non-science community. Realistically, outside of this pilot study, the relationship-building process between AgResearch and the non-science community would occur in an ongoing manner, with many bursts of interactions throughout to encourage participatory decision-making. Despite grappling with hyper-specialised chemistry vocabulary when meeting Jeff and Duane, which was a resounding issue for all members, the workshop group expressed that it was helpful to connect face-to-face to activate the relational vā.

Upon reflection, discussing strong wool's technical qualities before transitioning to the boundary objects - which were due to be introduced in the second workshop - limited the group's ability to freely imagine future materials without linking their envisioned qualities to strong wool. I openly shared my observations with the group in hindsight to not disrupt the natural progression of our talanoa at the time. We later revisited the topic and drew on it as leverage to inspire other potential positive attributes (see 'Future materials' section towards the end of Workshop II).

↘ Fig. 59 Wool-based satin sheet in hand

REFLECTION OVER FOOD

Each workshop session ended with a group reflection and blessing over food. According to the group, the first workshop was a good starting point to think about materials more deliberately. We also briefly touched on our expectations discussed at the very beginning, which we had started to respond to, e.g., learning about wool and new materials development. Admittedly, it would have been helpful to provide more space for the group to voice potential personal and academic benefits of participating. However, the group found that the informal discussion-based approach made them feel more at ease in the workshop setting while it also challenged their assumptions about scholarly research.

Session II

Towards more inclusive material identities

REVIEWING MATERIAL SAMPLES

05

What material stands out to you?

What qualities stand out to you?

In the second workshop, we briefly recapped our previous talanoa regarding more general material experiences and our diverse relationships with wool. As a reminder to ourselves and everyone else, we touched on our intentions and expectations, which had remained the same. Subsequently, I introduced the group to the boundary objects. We took some time to explore and experience the materials' varying form languages, gaining haptic feedback through touch, feeling, stretching, and distorting the samples based on what the materials afforded us. Through focused engagement, or 'material thinking', whereby samples were furthermore layered, held up against a light source, folded, smelled, scrunched up, and pressed into 3-dimensional shapes, among other things, initial impressions were measured against each sample's physicality. This step helped to activate the relational vā between the workshop community and the strong wool-based material samples.

Through our talanoa with the materials, we investigated the question 'which materials and which qualities stand out to you?', determining desirable attributes revealed to us by the materials (fig. 60). The talanoa between the workshop group and the boundary objects allowed each to become more familiar with the other, meanwhile helping to convey what potential future strong wool-based materials might look like and how they might behave. Thereby, the somewhat abstract process of deconstructing strong wool to synthesise new material formats was communicated to a non-science audience more tangibly. We discussed that the incorporation of whole strong wool fibres further amplified this. In addition, their visible presence, or traces thereof, made the materials seem more natural, simultaneously actuating the group's curiousity toward the materials' ingredients. While the boundary objects comprised bio-based constituents, we addressed the imminent danger of greenwashing. The strong wool fibres might distract from non-biocompatible elements in other contexts where natural, and non-biocompatible synthetic ingredients might be blended to give intended audiences the impression of being more sustainable.

Our talanoa also established that the materials conjured up familiar sensations, such as waxed leather, diffuser paper, and squishy shoe soles. Additionally, the stimulation of multiple senses was perceived as enriching the overall material experience, e.g. olfaction-beeswax; concurrently, embedded secondary materials sparked an urge to fold the respective materials along their internal structures and into 3-dimensional configurations. Moreover, we touched on superficial scratches, permanent indentations, or gradual 'random' discolouration contributing to the materials being perceived as more 'full-bodied' and meaningful. Going back to the previous talanoa around materials carrying layers of intangible meanings, we discussed that these markings accentuate embedded stories. Besides capturing the narrative of how the materials came to be, or memories of past engagements, the markings also indicate the passing of time. Thus, graceful ageing, or maturing, presents an exciting quality to explore further.

01

Beeswax contributed to the material's overall perception as pleasant; the intentional stimulation of multiple senses enabled more extensive engagement.

02

The embedded thread/ information inspired different 3-dimensional shapes.

03

The incorporation of strong wool fibres connoted to sustainability and eco-friendliness.

04

Familiar tactile experiences due to leather-like sensations (cured effect); flexibility and stretch

05

Contrasting textures within the same sample – smooth underside; particularly laminate materials

06

Imperfect surfaces, marks/
scratches add character

07

Thin layer of bubbles
and translucency/light
interaction

↘ Fig. 60
01 Beeswax foam
02 Embedded Vermicelli
03 Shiny sheet
04 Embedded thread
05 Jelly laminate
06 Patchy sheet
07 Clear film
08 Thick foam

08

Soothing effect,
cushioning; memory/
bounce back

Overall, paying attention to the inherent qualities disclosed by the materials raised the group's awareness of potential further material developments, what superpowers they might have, and what applications they could assume. Contrary to the conventional industrial design process, the workshop group not only appraised the boundary objects but was also actively involved in shaping the subsequent material discourse and decision-making by asserting their views. This activity greatly encouraged collective autonomy as well as getting a taste of design in practice. Furthermore, the gradual and conscientious relationship-building with materials introduced the group to the idea of materials as collaborators.

06

How do you think the material that stands out to you most could be developed further?

After engaging in talanoa with the boundary objects through physical touch and exploring which characteristics perpetuate further interaction, we discussed the question, “how do you think the material that stands out to you most could be developed further?”. Therein, we determined how the attributes we perceived as desirable as a group might be amplified in the next material iteration. This activity sought to spark collective creativity, with each one of us responding to each other’s thoughts.

01

Surprising other senses, e.g., scents - beeswax

02

Writing/printmaking intentional marks, braille

03

Scaling the boundary objects up to comprehend how their performative qualities change relative to size; multi-use

04

Combining different formats to create a membrane material or laminating similar ones to create bulk and interesting lighting effects; introducing conventional textile methods such as weaving

05

Experimenting with different thicknesses without losing well-defined surface textures, e.g. brushing the material onto a tray prior to curing to thin them out

06

Interactive surfaces - projecting human qualities onto materials; retention of technical properties (strong wool)

07

Dyeing with natural pigments/ dyes – gradients, concentrated areas, patterns

The variety of boundary objects inspired the combining of formats to create membrane materials, which could elicit a broader range of experiences and functionalities, e.g. a film as a barrier layer, foam as an absorbent layer, and an inward-facing permeable sheet. We discussed that the retention of strong wool's technical qualities would be useful and that their benefits would be amplified via lamination. Our talanoa also revolved around interactive or responsive surfaces that communicate with us, e.g. by changing colour, texture, or spatial dimensionality. This idea was prompted by a closer exploration of embedded secondary structures that appeared to modify the primary matrix's morphology, e.g. shrinkage around the embedded material. Furthermore, they are reminiscent of reinforcing scaffolds that afford targeted mechanical folding. In addition, due to the juxtaposition of contrasting textures within the same sample, we discussed the smoothing out of one textured area and another protruding in turn, which could be indicative of specific environmental changes or the presence of particular odours, for instance.

Altogether, the question facilitated more intentional, prolonged material engagement, culminating in teasing out ideas. Suggestions concerned different experiential aspects of a particular sample based on its form language in conjunction with subjective preference, considering sensory, performative, etc., elements that could lead to more positive appraisals (fig. 61). Overall, taking the time to build a more intimate relationship with specific materials allowed us to think about possible functional characteristics that closely align with their intrinsic semantics.

↘ Fig. 61
01 Beeswax foam
02 Glossy film
03 Embedded thread
04 Jelly laminate
05 Thick foam
06 Wavy sheet
07 Glacial clay

07

What superpowers might the materials of the future have?

Based on our talanoa pertaining to the samples' amplified experiential qualities, the question ‘what superpowers might the materials of the future have?’ enabled us to speculate about the functionalities and functions of future materials. We related our ideas to the boundary objects and the form language they exhibited. As mentioned earlier, our strong wool-centred talanoa influenced how the group used their sensibilities to imagine potential qualities and uses for (and together with) the boundary objects. Thus, this question sought to provide an opportunity for strong wool's technical attributes to inspire other qualities. To further stimulate creativity, we picked samples up and moulded them into different shapes as we spoke to demonstrate our ideas to the broader group or generate new ones in collaboration with the materials on the spot (see Appendix). Therein, we nurtured the vā between us and the materials.

The ability to change shape was explored in great depth, particularly how it might elevate prevailing interactions with existing products. For instance, we explored the idea of an evolving jacket that adjusted to the wearer’s body and grew with its wearer. We discussed that this quality amplified the notion of materials as alive and agentic and contributed to a more interactive and reciprocal engagement through sensory feedback. Our talanoa extended beyond the human-material exchange and investigated environmental factors that could induce transformation, which was touched on in previous talanoa. Thus, biomimicry was continuously referred to as inspiration for different ideas, such as smaller

elements within a material that opened and closed to release oxygen or capture carbon dioxide. The shape-changing element prompted texture, temperature, and colour-changing qualities that could, for instance, soften falls or indicate food spoilage. We also examined how time might influence these abilities and whether materials could adapt to changing climates and evolve over extended periods. Additionally, we unpacked symbiotic materials, or the idea of materials harbouring other organisms that could heal damaged parts in a material, for instance, in return for having shelter or a nutrient medium to proliferate.

This exercise allowed us to dream about future materials and material interactions and, more generally, to project our ideas into the future to better understand how we imagine our futures. We established a longing for visual or tactile feedback from materials by morphing into different forms, enabling materials to express their agency while we humans feel more connected with them.

↘ Fig. 62 Bent engraved wool-based sheet

REFLECTION OVER FOOD

Though most of the workshop group was new to the materials innovation discourse, the group voiced that the physical boundary objects sparked extensive ideation toward new materials development. The group expressed that they enjoyed the material engagement activity, and while they appreciated the variety of samples, they also found them to be overwhelming when having to specify distinctive qualities. Time was noted as a significant constraint that influenced the depth of exchange with different samples. Thus, the number of boundary objects needed to be adjusted to the timeframe. However, they were accessible throughout, and the workshop group continuously engaged with them, though only superficially at times.

Session III

Considering practicality and real-life contexts

APPLICATIONS

08

What applications do the materials inspire?

Starting with a brief reflection on our previous talanoa, where we discussed experiential and functional material qualities, the third workshop began with the question, “what applications do the materials inspire?”. It initiated talanoa around potential 3-dimensional material embodiments with respect to our disciplines. We applied our sensibilities while, once again, playing with the boundary objects, exploring the different application areas (fig. 63).

Although we initially focused on areas of potential within each of our disciplines, we also addressed personal needs as well as unmet needs observed in our respective extended communities. At first, application ideas included surrogate materials to replace unsustainably generated materials, such as leather or EVA shoe soles, or even elevating existing strong wool commodities by embedding additional functionalities. After that, medical applications were a recurring theme of discussion owing to the foam materials that ranged from being bouffant/lofted to more densely packed, exhibiting soothing yet sterile qualities. This talanoa, along with strong wool’s inherent functional properties, prompted the idea of introducing strong wool-based materials into the hospital environment - from furniture, accessories such as implants and medical textiles, and attire, among other examples. We subsequently honed in on skin/joint conditions predominantly prevalent in Pasifika communities, e.g., gout, tendonitis, arthritis, and eczema/asthma.

This activity rendered it possible to bring the boundary objects into real-life contexts and think about possible scenarios. Previous exercises were needed to lay a foundation so that exchanges regarding materials and their future uses became more accessible. Interestingly, we discussed ideas mentioned in journal articles and conversations I had had with AgResearch scientists during my internship and my Master’s that validated strong wool-based materials as viable options in the identified areas.

01

Packaging due to uniformity and foldability

02

Medical implants and textiles sparked by strong wool's technical qualities and in continuation of hospital conversation

03

Medical - Pasifika communities (gout, tendonitis, arthritis, eczema/asthma) inspired by strong wool's technical qualities and lofted foam samples

04

Architecture – light interactions, translucency

05

Existing strong wool products (insulation, carpets, rugs) – elevating everyday commodities by embedding special powers/ functionalities

06

Wool leather - surrogate material

07

Shoe soles - squishiness, cushioning via foam

↘ Fig. 63
01 Bent satin sheet
02 Thin foam
03 Creased web
04 Bubbly film
05 Shiny sheet
06 Buckled foam
07 Squishy foam

Further unpacking application ideas

In continuation of our previous talanoa, we narrowed our ideas down to three application areas. Similar to the divergent phase in the more conventional design process, this exercise provided the opportunity to select targeted findings to be further expanded on collectively (see Appendix).

The three areas identified through talanoa were packaging, hospital environments, and the ability to change shape.

PACKAGING

Packaging was a resounding topic throughout our talanoa, which we attributed to the materials' uniformity and flatness, affording mechanical folding into 3-dimensional shapes. Accordingly, we established that today's single-use materials and products were highly problematic and detrimental to our ecosystems, necessitating more regenerative packaging systems. Inspired by the boundary objects' contrasting surface finishes, initial ideas encompassed embedding innovative functionalities within the packaging material that would express themselves through the material's semantics, e.g., well-defined rhythmic and tactile textures, elevating the user experience more holistically and enhancing the material's longevity. Thus, our talanoa revolved around smart packaging that communicated with those engaging with it in a more discernible way, by changing colour, texture, fragrance or shape, for instance. Therein, we imagined flavour-enhancing packaging for meat and other perishable goods or packaging that circumvents spoilage by exuding increasingly enticing aromas to activate the urge to consume the encased products. As packaging traverses different spaces, new experiences, functionalities, and holistic material outcomes could improve a variety of applications, e.g. in the medical, sanitary/personal car, and food areas.

↘ Fig. 64 Boundary objects arrangement

HOSPITAL ENVIRONMENTS

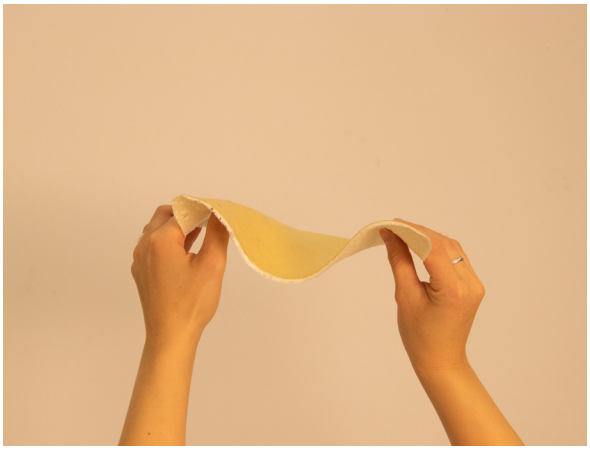
Engaging with the foam samples sparked associations with health and wellbeing, more specifically injury recovery and prevention, which the workshop group ascribed to an inherent 'bounce-back' effect and their resemblance to cushions and sponges. Our talanoa concerning strong wool's natural superpowers further consolidated this proposition, particularly since keratin can become a carrier for therapeutic agents, for instance. Having touched on health conditions especially prevalent in Māori and Pacific communities earlier - e.g., gout, arthritis and eczema - we concluded that wound dressings for targeted conditions would be valuable. We explored the idea of absorbable dressings that combined formats within a membrane and could deliver vitamins and minerals to boost the wearer's internal wellbeing besides nurturing an external lesion or scar. If we had had more time, we would have expanded this talanoa to address the realisation that developing applications with Māori and Pasifika communities in mind requires input from those affected. It also calls for deep consideration of culturally-specific healing practices and how these might influence the overall material outcome, product idea and design.

Subsequently, we extended the health and well-being-centred talanoa into the broader hospital setting. Based on strong wool's technical properties and the experiential variation that could be achieved within boundary objects, we envisioned strong wool-based materials to contribute to more soothing and pleasant hospital experiences for patients, staff and visitors. As an ingredient material in more visible applications such as medical furniture and accessories (curtains, acoustic panels, etc.) in patient rooms to more discrete components for highly-specialised equipment in operating theatres, strong wool-based materials could actively add value to a patient's recovery journey.

SHAPE-CHANGING MATERIALS

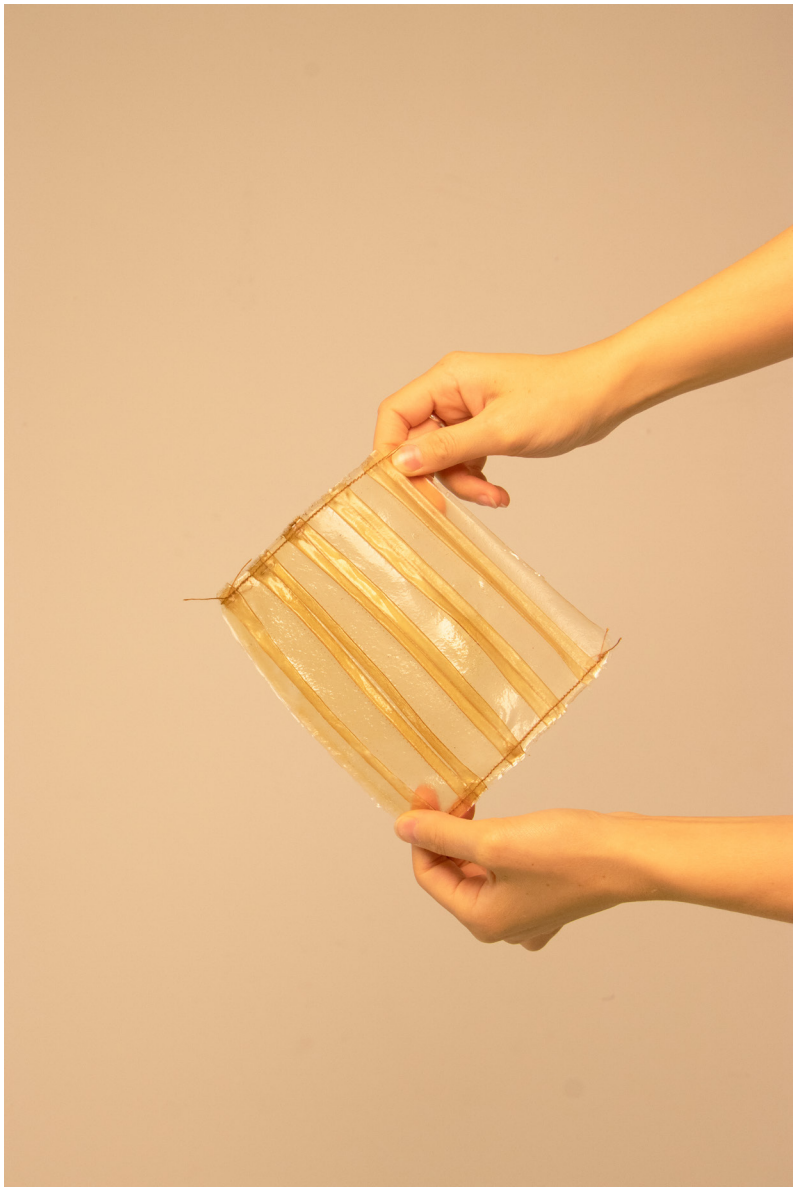
When imagining future materials, the prospect of material responsiveness in an ontological and practical sense stimulated lengthy talanoa. Transferring this quality to applications was therefore met with what I perceived as increasingly palpable enthusiasm and curiosity in the workshop group. Based on observations of product engagement today combined with biomimetic design inspired by the behaviour of raw materials in their natural habitat, we discussed that there appears to be a growing expectation for surfaces (comprising materials) to be 'smart' and to communicate with us. Hence, interactive functionalities have become more prevalent in recent times. Through our talanoa, we identified that a material's agency could facilitate interactive exchanges instead of relying on elaborate electrical circuits embedded within them. Thus, we established that materials could be self-actuating, activated by external natural stimuli to change shape, for example.

Despite our varied histories with strong wool, we explored new strong wool-based materials to imagine meaningful material experiences. Therefore, this step demonstrated that the materials innovation discourse could become more accessible through collective talanoa and that non-materials experts could enrich the process.



REFLECTION OVER FOOD

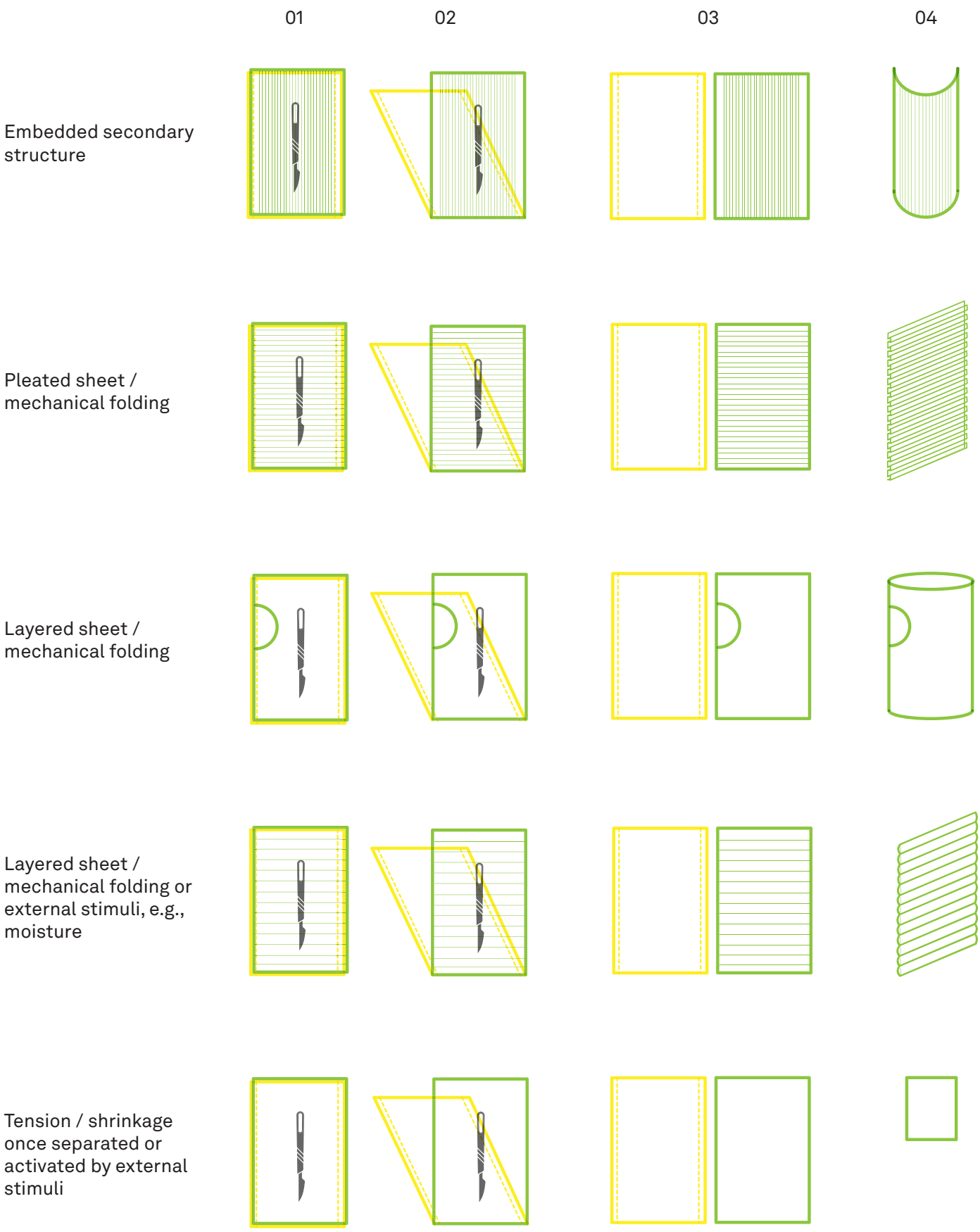
As a group, we assessed our joint notes and findings and got excited about the breadth of initial ideas and scenarios we generated, particularly the speculative ones. The group also verbalised that they would have liked to continue the process to test ideas and were interested in keeping track of further developments. We also critically reflected on the transfer of design capability, which we discussed was an idealistic expectation. Yet, the group thought they got a good sense of what materials design entails by experiencing the process first-hand. Additionally, the discussion-based approach was perceived as valuable.

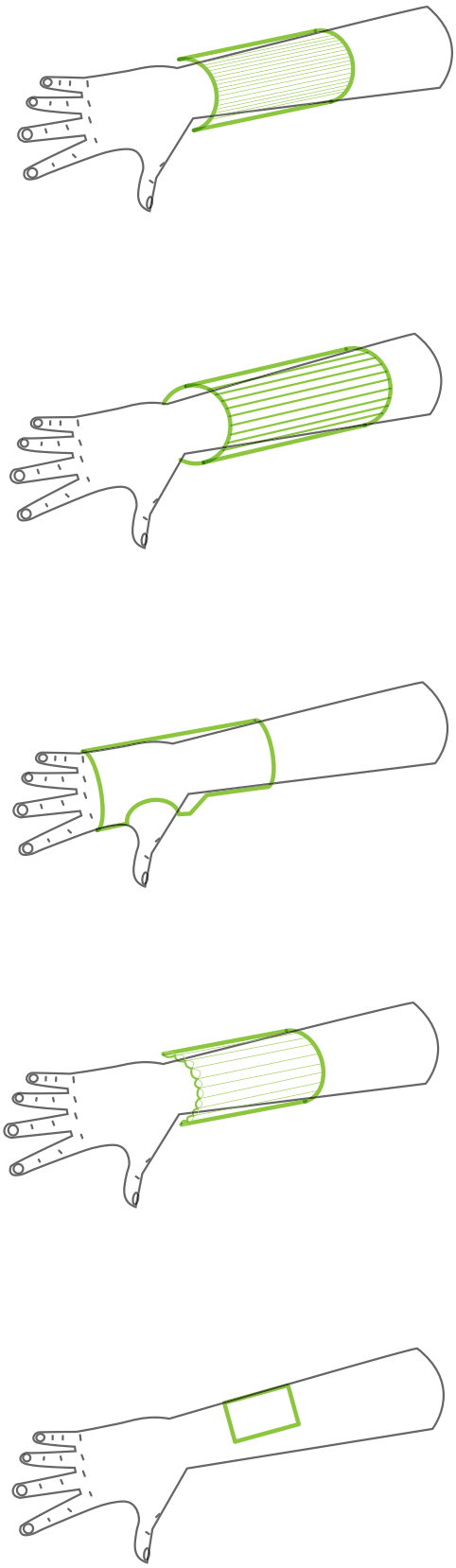


↘ Fig. 65 Left:
slumped wool-based
laminate

↘ Fig. 66 Middle:
Pleated wool-based
film

↘ Fig. 67 Right:
Laser-engraved
wool-based film


01
02
03
04
Embedded secondary structure
Pleated sheet / mechanical folding
Layered sheet / mechanical folding
Layered sheet / mechanical folding or external stimuli, e.g., moisture
Tension / shrinkage once separated or activated by external stimuli
Membrane material backing
Film material layer - however, this could also be a membrane material that would be folded, etc.

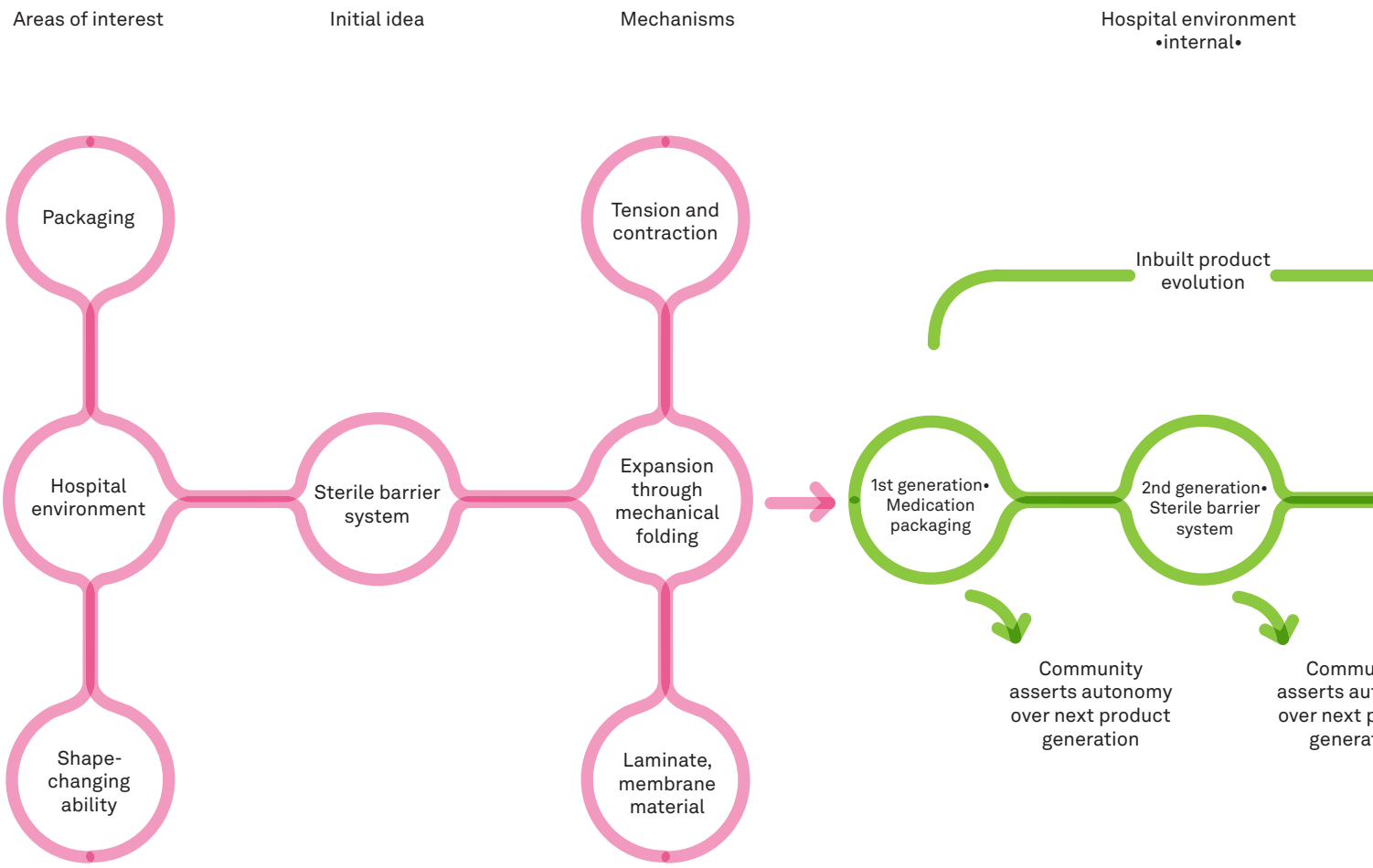


POST-WORKSHOP (INDIVIDUAL)

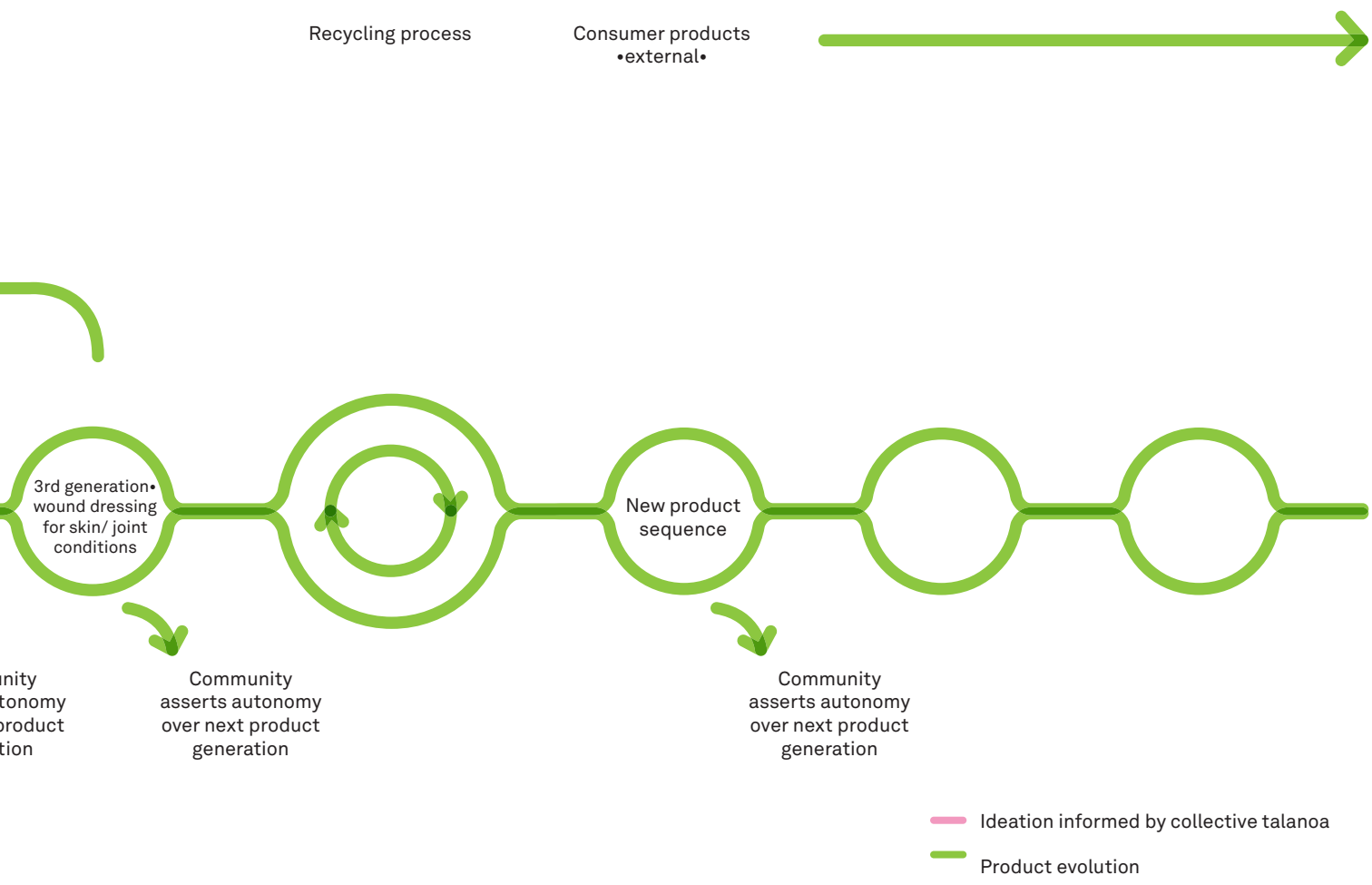
Upon clustering joint workshop notes and reviewing our applications-centred talanoa, I concluded that our last three insights (packaging, hospital setting, and shape-changing abilities) could inform one evolving product. Based on our collective conversations and the materials' inherent semantics, I conceptualised a laminated, strong wool-based retort pouch that functions as a sterile barrier system for hospital settings. Like a conventional pouch, it includes two layers that provide an aseptic microenvironment ideal for surgical instruments/ medical devices. On top of that, the concept pouch can transform into a wound dressing once the surgical instrument is removed. In this process, the sterile packaging system must precede the next-of-skin application to avoid contamination. Hence, product evolutions must consider the direction of transformation. As a third application, I investigated pharmaceutical/ nutraceutical packaging since the proposed mechanisms are transferable to other packaging systems. I envisioned this to constitute the first product generation as pharmaceutical packaging needed to be as sterile as the sterile barrier systems into which it would transform afterwards.

Parallel to generating concept ideas, I developed material samples in response to revealed favourable material qualities while also trialling different mechanical mechanisms to transform the retort pouch into a wound dressing. Hereby, I also accounted for shape-change activated by external stimuli, e.g. temperature change (fig. 68). Building a more personal relationship with the boundary objects and the workshop group led to relational accountability towards both to deliver more meaningful outcomes. Hence, prototyping in response to group findings became more intentional.

↘ Fig. 68 Representation of wool-based material mechanisms



Embedding the secondary and tertiary product generation within the first product could skip an energy-intensive manufacturing step. Thus, instead of aiming for products to be disposed of in compost bins after single use only, the concept considers products as vessels or systems capable of facilitating other experiences without undergoing rigorous recycling, enabling more seamless transitions between products. In this systems approach, one product transforms into its next stage of life (fig. 69). This idea is consistent with contemporary advances in additive manufacturing, specifically 4D printing.



↘ Fig. 69 Representation of a material systems approach

This overall concept is still in its infancy and does not take into account stringent regulations, legislations, and product specifications relevant to hospital environments. Just as importantly, however, it requires extensive input by those affected or engaging with parts of, or the entire system. Therefore, the concept has yet to undergo substantial experiential and technical testing. While each application can be integrated into a sequential process - particularly in a controlled environment where transitions could take place in-house, such as the hospital - they can be interacted with in isolation. Thus, individuals or communities engaging with them can assert autonomy and decide how they want to evolve the product/s. The proposed mechanisms embedded within the materials account for flexibility of use.

While the systems approach in figure x communicates the unfolding and manifesting of ideas to different audiences, it is contextual. Furthermore, limitations to the concept include insufficient stress on culturally-tailored solutions to respect the nuances between Māori and Pasifika knowledge systems despite shared ancestry. Accordingly, the emphasis remains on the broader participatory approach/process within which these ideas are situated.

TAKING FINDINGS BACK TO THE GROUP

After collating joint findings, expanding material samples, and visualising concepts, I invited the workshop group into the Master's space at Massey University to present findings comprising material developments and concepts over food. Overall, the ideas were received well and sparked further talanoa around potential material applications, functionalities, and experiences. While the group playfully explored new boundary objects, I talked through the post-workshop activities and the proposed product evolution. I also shared the overall design-infused strategy for AgResearch and how the workshops shaped the final outcome.

Though I had intended to set up another meeting with the group and Jeff and Duane, which all parties were interested in pursuing, we were nearing the busy end of the semester. Therefore, we decided to call it off. However, this step is incorporated into the joint strategy.

WORKSHOP SUMMARY AND REFLECTIONS

Through a series of interlinked workshops facilitated by collective talanoa, different worldviews and material perspectives were brought together to sequentially imagine future materials innovation, with a focus on strong wool-based materials. A set of questions and the incorporation of boundary objects guided the process, enabling personal reflexivity and heightened material awareness, an embodied human-material exchange, and collective creativity, culminating in various pathways for new materials development. The collaborative endeavour furthermore provided an opportunity to activate relationships between the workshop group and science, the group and myself, and most importantly, the group and the material samples. The all-encompassing vā, which was nurtured throughout, provided a safe realm to express diverse experiences and hopes for Aotearoa's material culture.

By engaging in talanoa with the boundary objects, the materials revealed desirable experiential qualities that prompted ideas around subsequent iterations. Therein, new material identities could emerge that might not be comparable to conventional material categories. From a technical point of view, as is the case in material science, this could facilitate a clearer understanding of what to measure in a material, with the inherent potential of challenging existing material standards and methods. In addition, I observed that the group showed signs of becoming more invested in the boundary objects the more they engaged with them, which was expressed through what I perceived as increasingly more animated talanoa and a continuous flow of ideas and possibilities. Thus, I was hopeful that if the study continued over a more extended period of time, the group would develop a sense of ownership over the collaborative process and the broader study.

Lastly, the discussion-based talanoa approach respectfully requires time to establish relationships and develop ideas. Despite not getting as far as we had discussed initially, allowing space to respond to each other's perspectives led to more thorough and richer insights. However, as is consistent with talanoa, our conversations are contextual and not representative of broader opinions held by others outside of this setting. Since the students already shared an interest in materials and were immersed in a learning environment, our discussions flowed steadily, which might not be the case in other instances where critical thinking is not as readily accessible. Though overall, the process of collective knowledge-making remains the focal point.

↘ Fig. 70 Bubbly wool-based film (cropped)

↘ Fig. 71 Bubbly wool-based film (edge)

↘ Fig. 72 Bubbly wool-based film (corner)

One-on-one talanoa with industry experts

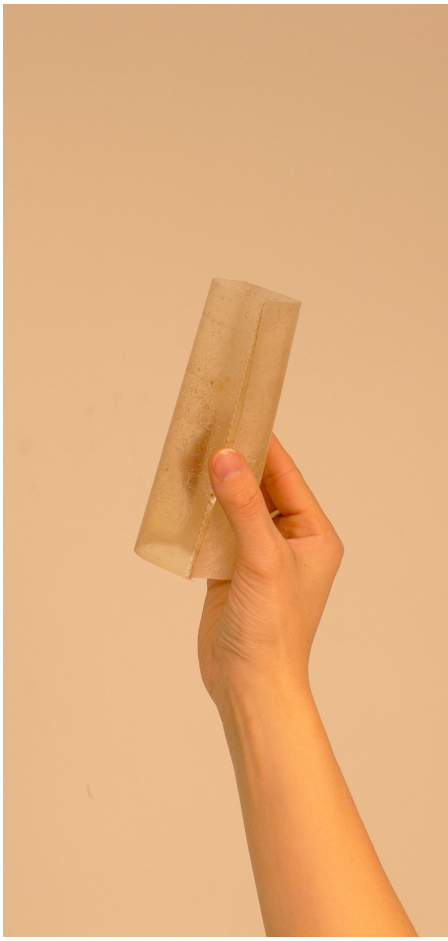
Initially, one-on-one talanoa with strong wool industry experts were undertaken to understand the mature strong wool industry and to build relationships with key players. I wanted to get to know the people behind the brand face-to-face to hear their needs and concerns expressed by them. Instead of constructively exchanging ideas on future strong wool-based materials after initiating a relationship, however, industry experts proceeded to advocate for their own agendas, e.g., how to expand their ranges or how to get products tested at AgResearch. I realised that there needed to be more capability building towards creative thinking and separating oneself from the respective business to think more freely. Thus, I felt as though our talanoa sessions no longer aligned with the broader research aim, which is why I decided to leave them out of this exegesis. However, this undertaking offers potential for other projects.

I also engaged in one-on-one talanoa with material practitioners (scientists and artists) to understand how materials are perceived and interacted with in each discipline. While most conversations validated my assumption around emotional attachment (artists) and distant observation (scientists), I felt as though I had not sufficiently established relationships to respectfully reflect their voices in this exegesis. Hence, I have refrained from including them.

↘ Fig. 73 Left: sewn wool-based pouch (inner)

↘ Fig. 74 Middle: sewn wool-based pouch (front)

↘ Fig. 75 Right: sewn wool-based pouch (side)



RECOMMENDATIONS FOR AGRESEARCH

All insights combined, I generated five recommendations that could assist AgResearch in orienting future new materials development toward more holistic material outcomes to meet the needs of Aotearoa-based communities. The recommendations are manifested within a design-infused strategy (fig. 76) that centres on merging technical and experiential material expertise and activating participatory ways of working with place-based communities. While the 'New Uses for Wool' Partnership Programme is nearing its end, this exegesis presents an alternative perspective on materials innovation that could benefit oncoming bio-based materials research at AgResearch. Despite communicating potential steps to diverse audiences, the process is by no means linear, e.g., other projects could emerge at different stages. It should be viewed as an initial concept in need of further testing, especially since the last 4 out of 9 phases have not been explored in this project and are therefore speculative. However, it demonstrates how a community-centred science-design partnership could unfold in the future.

DESIGN-INFUSED

Agricultural material science research should include an experience-focused design perspective to generate more holistic material outcomes.

COMMUNITY-CENTRED

Agricultural material science research should adopt a participatory approach to bring together different worldviews, stimulating richer discussions and enabling communities to partake in decision-making about Aotearoa's material culture. This also fosters mutual accountability for more meaningful outcomes.

PLACE-BASED

Agricultural material science research should involve Aotearoa-based communities and perspectives, with emphasis on Tangata Whenua, to address place-based needs and develop more culturally-grounded outcomes. Furthermore, a place-based approach can activate new material relationships and more sustainable outcomes.

BOUNDARY OBJECTS

Agricultural material science research should generate boudary objects to communicate science to non-science audiences, making science more accessible and inclusive.

SYSTEMS-FOCUSED

Agricultural material science research should adopt a systems approach, looking beyond the next 5 years and considering long-term material impacts on our ecosystem.

↘ Fig. 76
Representation of the proposed strategy

Design-infused participatory materials innovation process

Brief

Activating the science-design partnership and the research comunity

Familiarisation with each other's practices, approaches, and organisational values •science and design•

Establishing a balanced partnership through shared values, responsibilities, intentions and expectations •science and design•

Adopting a Te Tiriti-led approach

Expanding cultural competence and building advisory group for support

Identifying and building relationships with the research community

Getting to know the raw material

Scoping the wool industry to understand the material's situatedness within Aotearoa's material culture - settled, present and emerging material meanings, experiences, and associations

Strengthening relationships with the research community

Benchmarking similar materials, esperiences and associations

Developing boundary objects

Activating material relationships within the va

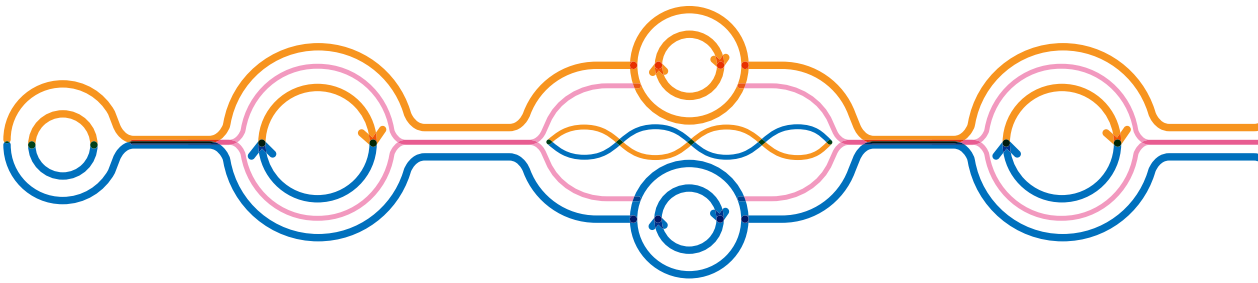
Bringing the research community together to activate the collective va

Identifying values and aims through collective talanoa, building trust

Incorporating boundary objects to provide context and to spark - material thinking' and material relationships

Identifying unmet or unsatisfactorily met needs

Developing application scenarios with the research community that consider the material in future applications and contexts



Investigating the material's biological functions and inert technical qualities

Deconstructing the material to understand the chemistry, different constituents and their functions

Benchmarking similarly structured bio-based material building blocks, e.g., collagen

Interpreting findings and assembling materials in response to collective conversations

Analysing and interpreting findings to further unpack with the research community

Developing more refined boundary objects that consider the community's values and desired material qualities revealed by the material

Approaching and building relationships with existing manufacturers and retailers to understand how the material might fit into the existing industry and manufacturing capacity

Refining target applications and developing a production scheme

Refining scenarios and concepts as a research community and testing them in situ, e.g., through workshops

Identifying opportunities and limitations of material ideas

Envisaging the material's wider infrastructure by developing a preliminary production scheme and potential start-ups/spin-offs

Investigating industry readiness and refining final materials

Consolidating an experience-centred journey through further testing and validating with the research community

Continuously challenging opportunities and limitations and making final adjustments to the process

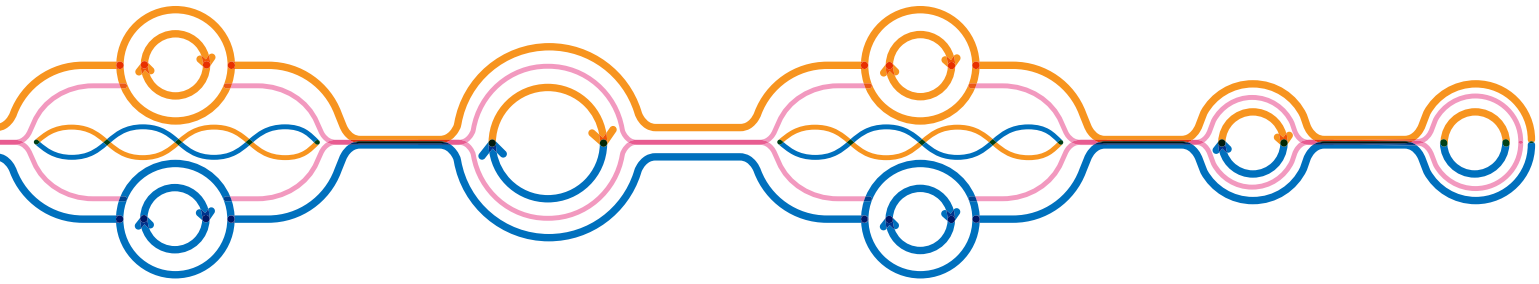
Ongoing conversations with industry to match ideated production processes with local manufacturing capacity

Branding and marketing

Final outcome discussion and reflection on the process

Final outcome discussion and joint process reflection

Commercialisation and continuing other related projects



Assembling and testing different material formats and defining properties in response to feedback on boundary objects

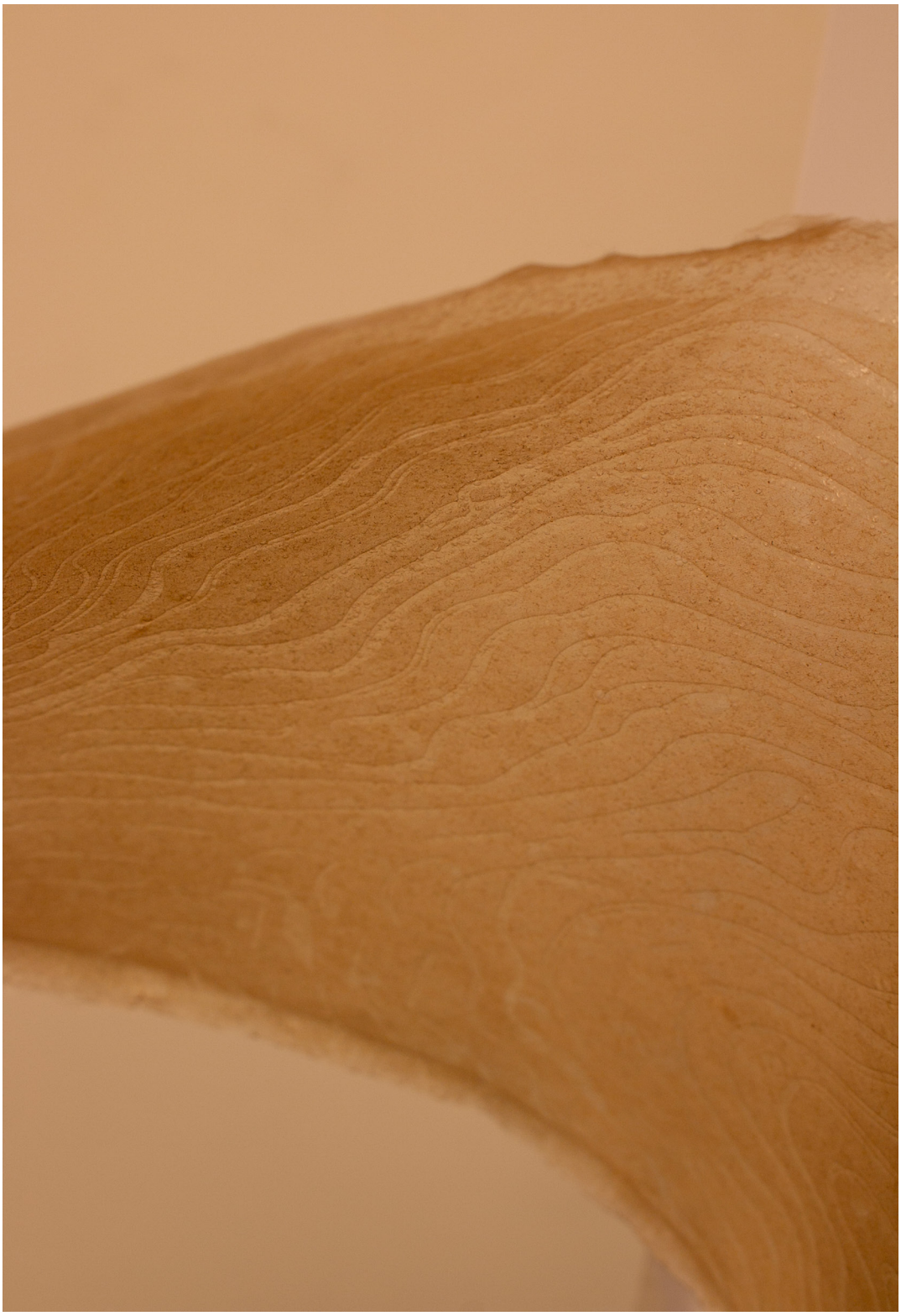
Establishing controlled measures and production processes that are potentially replicable on a larger scale

Iterating and refining samples

Implementing feedback from joint process to refine and test samples and production processes

Assembling final products and testing them

Design
Science
Relationship-building with the community



REFLECTIONS WITH JEFF AND DUANE

Throughout the year, I was supported by Jeff Plowman and Duane Harland, my supervisors from AgResearch, with whom I exchanged and identified opportunities and limitations for a new materials innovation strategy. Their input shaped the overall research path significantly. Toward the end of this Master's project, we reflected on our collaborative journey and shared our thoughts on realistic outcomes.

Jeff and Duane articulated that they got a better understanding of the design process and its potential in materials research, and we discussed the possibility of in-house design capability or long-term arrangements with tertiary design education providers to leverage the momentum this project has fostered. Both found it interesting to view wool as a non-traditional fibre, which surfaced in conversation with Sonya and Faith when taking a closer look at Pacific-based material culture. Additionally, they observed that the boundary objects prompted excitement among different communities, e.g., AgResearch's science community I presented to and the design community that participated in my Arohaehae. Thus, their incorporation shows promising potential in future materials research projects. Meanwhile, as enriching the practice of talanoa was perceived, we established that the methodology presupposes the involvement of Pasifika researchers and communities, which is why it can not be transferred to AgResearch unless the former applies. However, it highlighted that research approaches need to be tailored to the participating communities' cultural values. In addition, though some of the workshop findings and outcomes reflected previous discussions between Jeff, Duane and myself, they remain contextual.

In continuation of this partnership exercise, we identified that the compatibility between AgResearch's existing materials development process and the proposed strategy needed to be examined more in-depth. This will help to adopt and implement parts of the process, or possibly even the entire process. Sonya and Faith suggested that the discipline of transition design, which concentrates on solving wicked problems through interdisciplinary collaboration to achieve social innovation, may provide a more straightforward pathway to adopting targeted elements.

↘ Fig. 77 Rasterised wool-based film (curved)

↘ Fig. 78 Scrunched wool-based sheet (curved)

CONCLUSION

In this Master's project, I explored a place-based approach to materials innovation toward more inclusive material identities through talanoa and science and design in partnership. Through the example of strong wool, a material facing hardship due to synthetic competition, the project set out to re-imagine AgResearch's present-day material science process to develop more culturally-grounded outcomes, culminating in a design-infused strategy and a set of recommendations. Therein, it drew on different methods, such as material-driven design and boundary objects, exchanges with material scientists from AgResearch, and workshops involving Massey University's diverse student community in a series of workshops. Its purpose is to facilitate more participatory materials research guided by the needs of Aotearoa-based communities while forging new research pathways to boost the strong wool sector.

The project furthermore seeks to challenge our relationships with materials and endorses different knowledge systems and material ontologies in conversation. In the case of wool, which is imbued with various settled meanings, it encourages the untangling of past and present interactions and perceptions to generate new material identities with and for Aotearoa-based communities. More broadly, it facilitates the opportunity to make decisions about Aotearoa's material culture as a collective, meanwhile enabling access to science.

↘ Fig. 79 Scrunched wool-based sheet (raised)

This research project is significant as it provides a more holistic path to place-based materials innovation. While the proposed process works toward more democratic ways of knowledge-making, it is far from the ultimate solution. Rather, it highlights possibilities in participatory research for more relevant and inclusive outcomes. Further opportunities and limitations may emerge once the process is tested in practice.

As a design researcher, this journey has challenged my formal industrial design training and practice and has introduced me to new ways of undertaking research. Being situated at the intersection of disciplines and subject areas has proved to be both confronting and inspiring. In the future, I hope to share and expand my knowledge in the bio-based materials innovation space through applied collective talanoa. Additionally, I would like to deepen my understanding of the practicalites and mechanisms involved in transitioning organisations toward more systems-minded practices and futures.

↘ Fig. 80 Wool-based jelly laminate

BOUNDARY OBJECTS

01
Format
Sponge

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) —
tap water

Qualities
Light-weight — web-like —
spongy — squishy — flexible
—foldable

02
Format
Pleated film

Ingredients
Gelatin — Glycerol —
0.1 micron wool — tap water

Qualities
Bendy — translucent —
extendable — smooth

03
Format
Rasterised film

Ingredients
Gelatin — Glycerol —
0.1 micron wool — tap water

Qualities
Drapey — translucent — soft —
textured

04
Format
Film

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) and
whole fibres — tap water

Qualities
Bubbly — sticky — drapey — soft
—stretchy — malleable

05
Format
Laser-cut film

Ingredients
Gelatin — Glycerol — 0.2 micron
wool — tap water — Aquafaba

Qualities
Bendy — translucent — smooth
— burnt edges — textured

06
Format
Film

Ingredients
Agar agar — Glycerol —
Ashford's strong wool (cut) and
whole fibres — lanolin water

Qualities
Stretchy — opaque — shrinkage
— cured — leathery

07
Format
Sponge

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water -
Aquafaba

Qualities
Light-weight — web-like —
foldable

08
Format
Foam

Ingredients
Gelatin — Glycerol — 0.2 micron
wool — tap water — Aquafaba
— honey

Qualities
Stiff — bulky — smooth
underside — a bit of bounce
back — light-weight —
somewhat uniform

09
Format
Sponge

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water —
Aquafaba

Qualities
Light-weight — glossy —foldable
— squishy

10
Format
Foam

Ingredients
Agar agar — Sorbitol —
Ashford's strong wool (cut) and
whole fibres — lanolin water —
Vermicelli noodles

Qualities
Hairy — cracked where noodles
popped out — bendy — aged-
looking

11
Format
Film

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) and
0.2 micron strong wool — tap
water

Qualities
Bubbly — bendy — translucent —
foldable — visible wool fibres

↘ Fig. 81
01 Sponge
02 Pleated
03 Rasterised
04 Drapey
05 Laser-cut
06 Leathery
07 Creased
08 Thick
09 Glossy
10 Cracked
11 Patchy

12
Format
Laser-cut film

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) — tap water — Aquafaba

Qualities
Bendy — translucent — smooth — burnt edges — textured

13
Format
Sponge

Ingredients
Pectin — Glycerol — Ashford's strong wool (cut) — tap water - Aquafaba

Qualities
Light-weight — glossy — rigid — squishy — uneven surface due to clumped wool patches

↘ Fig. 82
12 Holes
13 Lumpy
14 Patchy
15 Wavy
16 Sticky
17 Spongy mat
18 Bubbles
19 Shimmery
20 Engraved
21 Squishy
22 Opaque

14
Format
Film

Ingredients
Pectin — Sorbitol — Ashford's strong wool (cut) and 0.2 micron strong wool — tap water

Qualities
Bendy — translucent — foldable — visible wool fibres — patchy

15
Format
Foam

Ingredients
Gelatin — Sorbitol — Ashford's strong wool (cut) and whole fibres — lanolin water

Qualities
Laminate — flexible — craters — incisions for targeted folding — contrasting textures

16
Format
Sponge sheet

Ingredients
Pectin — Glycerol — Ashford's strong wool (cut) and whole fibres — seawater

Qualities
Sticky underside from salt — flexible — contrasting textures — soft top

17
Format
Foam

Ingredients
Agar agar — Glycerol — Ashford's strong wool (cut) and whole fibres — lanolin water

Qualities
Spongy — stretchy — uniform thickness — light-weight — shrinkage

18
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) and 0.2 micron strong wool — tap water

Qualities
Bubbly — bendy — translucent — foldable — visible wool fibres — sparkly

19
Format
Film

Ingredients
Agar agar — Sorbitol — Ashford's strong wool (cut) and 0.2 micron strong wool — lanolin water

Qualities
Bubbly — translucent — drapey — patchy — visible wool fibres

20
Format
Engraved film

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) and 0.2 micron strong wool — tap water

Qualities
Smooth — bendy — translucent — foldable — visible wool fibres

21
Format
Foam

Ingredients
Carrageenan — Glycerol — 0.2 micron strong wool — tap water

Qualities
Squishy — flexible — light-weight

22
Format
Foam sheet

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) — tap water

Qualities
Light-weight — glossy — bendy — uneven surface due to clumped wool patches

23
Format
Foam sheet

Ingredients
Gelatin — Glycerol — hydrolised silk protein — tap water — glacial clay

Qualities
Textured — rough — bendy — shrinkage

24
Format
Sheet

Ingredients
Agar agar — Glycerol — 0.1 micron wool — tap water — lanolin — soy lecithin

Qualities
Greasy — translucent — malleable — creased

25
Format
Film

Ingredients
Gelatin — Glycerol — 0.2 micron strong wool — lanolin water

Qualities
Smooth — glossy — small bubbles — uniform — foldable

26
Format
Laser-engraved foam

Ingredients
Gelatin — Glycerol — 0.2 micron wool — tap water — Aquafaba — honey

Qualities
Bulky — smooth underside — a bit of bounce back — light-weight — burnt motif

27
Format
Foam

Ingredients
Gelatin — Glycerol — 0.2 micron wool — tap water — Aquafaba

Qualities
Rigid — bulky — removed gelatin underside — light-weight — shrinkage on underside

28
Format
Sheet

Ingredients
Agar agar — Glycerol — hydrolised wheat protein — tap water — lanolin — soy lecithin

Qualities
Cured — leathery — cracked — creased — opaque — pliable

29
Format
Film

Ingredients
Gelatin — Glycerol — 0.2 micron strong wool — lanolin water

Qualities
Smooth — glossy — small bubbles — uniform — foldable

30
Format
Foam

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) — tap water — Aquafaba

Qualities
Rigid — rough — removed gelatin underside — light-weight

31
Format
Sheet

Ingredients
Gelatin — Glycerol — 0.1 micron wool — lanolin water

Qualities
Craters — uniform — rough — light-weight — foldable

32
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's strong wool (cut) and whole fibres — tap water

Qualities
Patchy — clumped wool fibres — foldable — contrasting textures — bubbles

↘ Fig. 83
23 Glacial clay
24 Scrunched
25 Satin
26 Burnt foam
27 Rigid
28 Cut
29 Translucent
30 Rough
31 Curved
32 Textured

33
Format
Film

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) and
0.2 micron strong wool — tap
water

Qualities
Bubbly — bendy — translucent —
foldable — visible wool fibres

34
Format
Foam

Ingredients
Gelatin — Sorbitol —
Ashford's strong wool (cut) and
whole fibres — lanolin water

Qualities
Laminate — flexible — craters
— incisions for targeted folding
— contrasting textures

↘ Fig. 84
33 Bubbly
34 Spongy
35 Embedded
36 Spotty
37 Stiff bubbles
38 Floaty
39 Screen
40 Melted
41 Web
42 Buckled

35
Format
Film

Ingredients
Gelatin — Glycerol — 0.1 micron
wool — tap water — Vermicelli
noodles

Qualities
Translucent — internal
secondary structure —
shrinkage — flexible

36
Format
Foam

Ingredients
Carrageenan — Glycerol — 0.2
micron strong wool — tap water

Qualities
Squishy — flexible — light-
weight

37
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water —
orange peel wax

Qualities
Hard — transparent visible wool
fibres — bubbly — smooth

38
Format
Film

Ingredients
Agar agar — Sorbitol —
Ashford's strong wool (cut) —
lanolin water — hydrolised silk
protein

Qualities
Bubbly — translucent — drapey
— patchy — visible wool fibres

39
Format
Film

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) and
0.2 micron strong wool — tap
water

Qualities
Bubbly — bendy — translucent —
foldable — visible wool fibres

40
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water

Qualities
Translucent — transparent
visible wool fibres — shiny —
uniform — rigid

41
Format
Filament film

Ingredients
Pectin — Glycerol — Ashford's
strong wool (cut) — 0.1 micron
wool — tap water

Qualities
Transparent — visible wool
fibres — shiny — uniform —
drapey

42
Format
Foam

Ingredients
Agar agar — Glycerol —
Ashford's strong wool (cut) and
whole fibres — lanolin water

Qualities
Spongy — stretchy — uniform
thickness — light-weight —
shrinkage

43
Format
Sheet

Ingredients
Gelatin — Glycerol —
Ashford's strong wool (cut) —
tap water

Qualities
Light-weight — web-like —
spongy — squishy — flexible
—foldable

44
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water

Qualities
Translucent — transparent
visible wool fibres — shiny —
uniform — flexible

45
Format
Foam

Ingredients
Gelatin — Glycerol — 0.2 micron
wool — tap water — Aquafaba
— honey

Qualities
Stiff — bulky — smooth
underside — a bit of bounce
back — light-weight — rough top

46
Format
Sheet

Ingredients
Gelatin — Sorbitol —
Hydrolised wheat protein —
lanolin water

Qualities
Laminate — flexible —
contrasting textures

47
Format
Filament

Ingredients
Gelatin — Glycerol —
0.1 micron wool — seawater —
pine rosin

Qualities
Not set — clumped

48
Format
Sewn sponge sheet

Ingredients
Pectin — Glycerol —
Ashford's strong wool (cut) and
whole fibres — seawater

Qualities
Sticky underside from salt —
flexible — contrasting textures
— soft top

49
Format
Foam

Ingredients
Gelatin — Sorbitol —
Ashford's strong wool (cut) and
whole fibres — lanolin water

Qualities
Laminate — flexible — bubbly —
contrasting textures

50
Format
Sheet

Ingredients
Gelatin — Glycerol —
0.1 micron wool — lanolin water

Qualities
Bubbly — uniform — rough —
light-weight — stiff

51
Format
Sheet

Ingredients
Agar agar — Glycerol —
0.1 micron wool — tap water —
lanolin — soy lecithin

Qualities
Greasy — translucent —
malleable — creased

52
Format
Film

Ingredients
Gelatin — Glycerol — 0.2 micron
strong wool — tap water

Qualities
Embedded foam pattern —
contrasting textures — bendy
— transluscent

↘ Fig. 85
43 Torn
44 Smooth
45 Sandwich
46 Contracted
47 Filament
48 Pockets
49 Laminate
50 Stiff
51 Crinkled
52 Patterned

53
Format
Jelly sponge

Ingredients
Gelatin — Glycerol —
0.1 micron wool — tap water

Qualities
Laminate — bounce back —
soft bottom layer — flexible—
constrasting

54
Format
Sheet

Ingredients
Pectin — Glycerol —
0.1 micron wool — seawater

Qualities
Laminate — uniform — smooth
— light-weight — stiff

↘ Fig. 86
53 Jelly
54 Rigid
55 Shrunk
56 Clear
57 Solid
58 Pouch
59 Combined
60 Inverse
61 Skimmed
62 Beeswax

55
Format
Film

Ingredients
Agar agar — Sorbitol — 0.2
micron strong wool — tap water
— wool thread

Qualities
Shrinkage around thread
— transluscent — rubbery —
pliable

56
Format
Film

Ingredients
Gelatin — Glycerol — Ashford's
strong wool (cut) — tap water

Qualities
Visible wool fibres — shiny —
uniform — rigid — transparent

57
Format
Foam

Ingredients
Gelatin — Glycerol — 0.2 micron
strong wool — tap water —
honey

Qualities
Honey smell — smooth —
uniform — rigid

58
Format
Sewn pouch

Ingredients
Gelatin — Glycerol —
0.1 micron wool — seawater —
Aquafaba — Pectin

Qualities
Contrasting textures — uniform
— smooth — light-weight —
foldable

59
Format
Film

Ingredients
Gelatin — Glycerol — Agar agar
— 0.2 micron strong wool — tap
water

Qualities
Transparent — shiny —
embedded Agar agar pattern
— shrinkage

60
Format
Film

Ingredients
Gelatin — Glycerol — 0.2 micron
strong wool — tap water

Qualities
Embedded foam pattern —
contrasting textures — bendy
— transluscent

61
Format
Sheet

Ingredients
Gelatin — Glycerol —
0.1 micron wool — lanolin water

Qualities
Craters — uniform — rough —
light-weight — foldable

62
Format
Foam

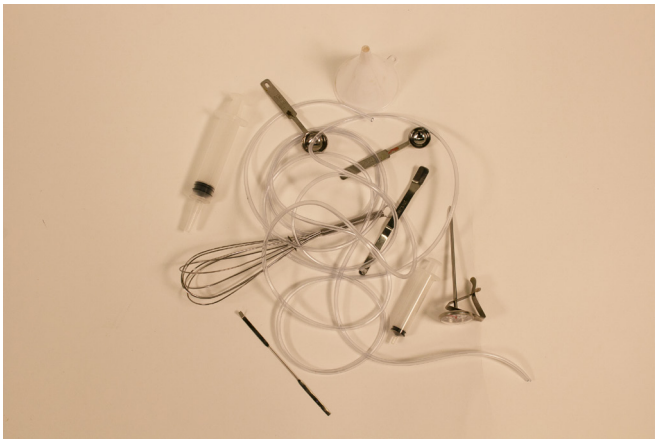
Ingredients
Gelatin — Glycerol — Agar agar
— 0.2 micron strong wool — tap
water — beeswax

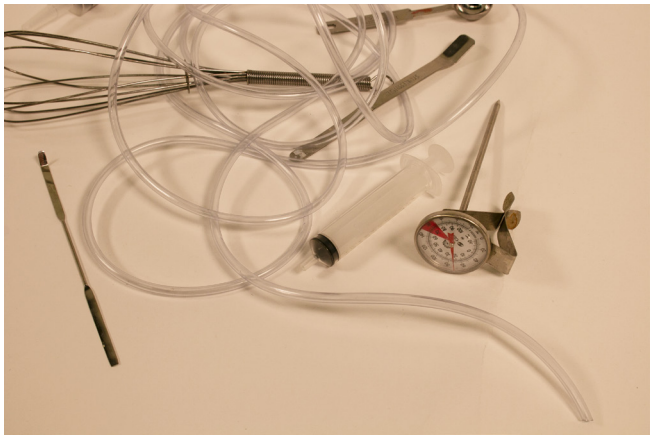
Qualities
Beeswax smell — removed
gelatin base layer — web-like
— bendy

Base protein	Keratin from wool (cut, hydrated, dry, milled) - considerations: virgin wool, salvaged wool from textiles, wool from sheep bred for meat Hydrolysed wheat protein Hydrolysed silk protein
Biopolymer	Gelatin (protein) Pectin (polysaccharide) Agar (polysaccharide) Carrageenan gum (polysaccharide)
Bioplasticiser	Glycerol Honey Sorbitol
Solvent	Water Seawater Lanolin water Aquafaba
Additives	Lanolin Glacial clay Detergent Aquafaba Soaked Vermicelli noodles Beeswax Pine rosin Orange peel wax
Foaming agent	Aquafaba pH-neutral eco detergent

↘ Fig. 87 Ingredients list

↘ Fig. 88 Ingredient layout





↘ Fig. 89 Utensils (1)

↘ Fig. 90 Utensils (2)

↘ Fig. 91 Method

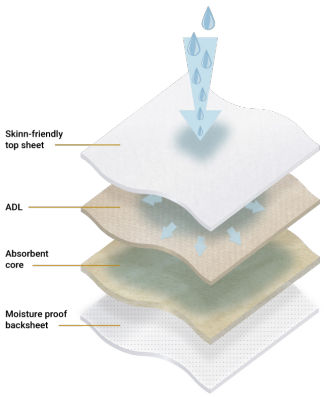
Method	The biopolymer/s (thickening agent) is/are dissolved in the solvent/s. After that, the bioplasticiser/s is/are added into the mixture for flexibility while bringing the temperature up to no more than 40*C. Subsequently, additives are incorporated, stirring the mixture constantly to disperse the ingredients evenly. In this case, a protein source (mostly strong wool) was incorporated into every sample. The mixture is then poured into the tray and left to set for at least 24h. Lastly, once set, the material is removed and exposed to other processes, e.g., laser-cutting, moulding, etc.
Sheets	Following the steps in the method, the mixture is poured into the tray, only just covering the surface for thin materials.
Foams	Before pouring the mixture into the tray, it is foamed using a whisk or blender, depending on the preferred outcome.
Films	When incorporating additives, more liquid than solid mass should be present in the mixture. The mixture is then poured into the tray, only just covering the surface for thin materials.
Sponges	Before pouring the mixture into the tray, it is foamed using a whisk or blender, depending on the preferred outcome. The foam is then skimmed off and spread across the tray. The liquid component can be used for films or as a vehicle for more sponges by adding more foaming agent.
Processes	Cooking Foaming (whisking or blending) Lamination Moulding Laser cutting/engraving De-and reconstruction

CHEMARTS

The Chemarts project - a collaboration between Aalto University's chemical engineering and arts faculty - is one example of many where collective creativity in new materials development achieved innovative material outcomes. Initiated by Finland's government, it sought to re-imagine the Finnish cellulose industry, bringing together different disciplines to generate new business concepts, novel applications, and technologies for Finnish cellulose. The project delivered various new composite materials and value streams for the product in question, e.g., cellulose composites, nano-cellulose fibres and films, coatings and foams. At the same time, material-specific processes were developed (wet spinning, 3D printing and writing, foam forming technology). While scientists focused on the material's technical abilities, designers investigated perceptual attributes and how new experiences can be generated. The collaborative endeavour resulted in the 'Chemarts Cookbook' (Kääriäinen et al. ,2020), which I drew on to explore different material outomes.

↘ Fig. 92 Chemarts project material explorations

↘ Fig. 93 Lanaco's helix filter



↘ Fig. 94 Woolchemy's ingredient materials

STRONG WOOL CASE STUDIES

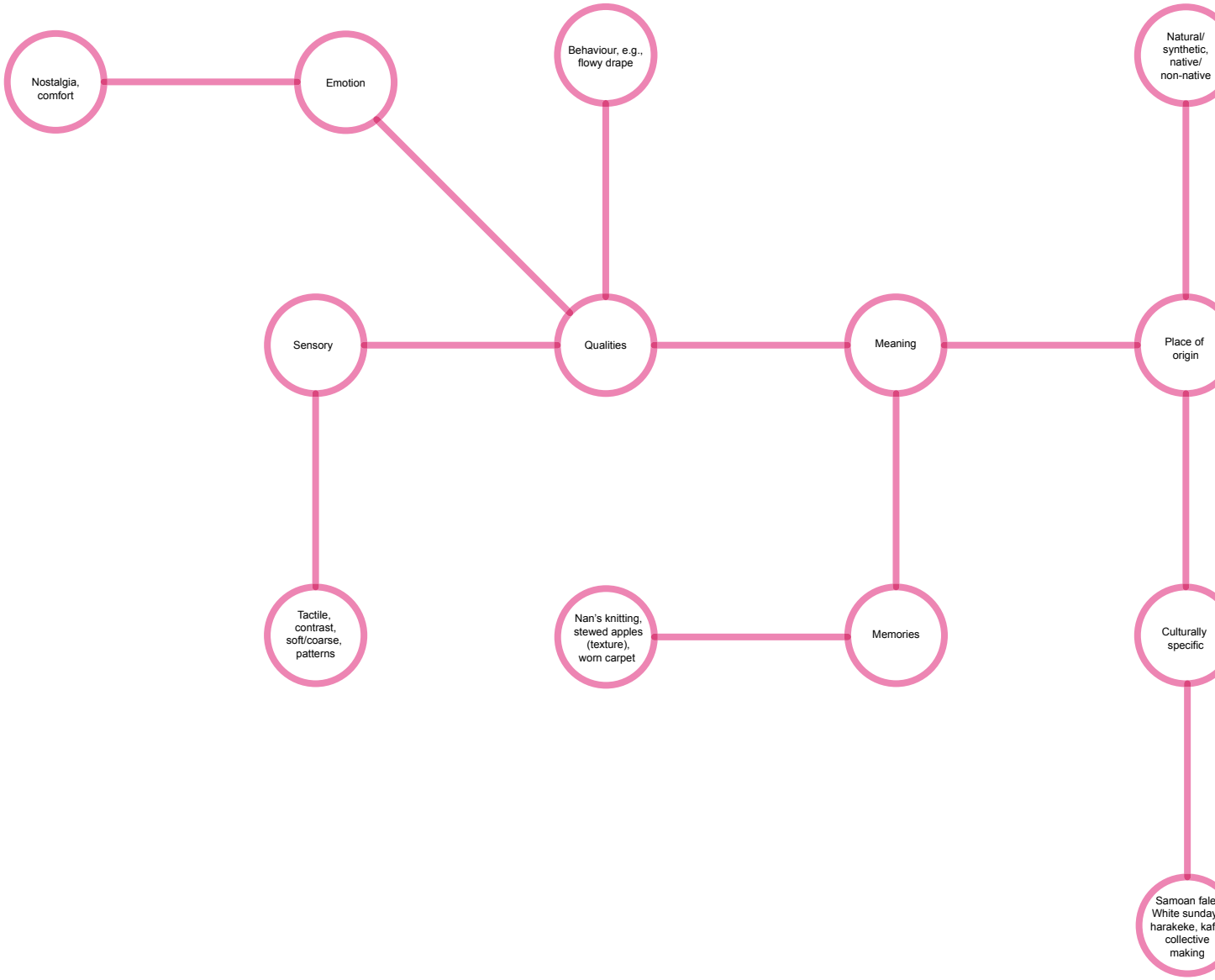
Aotearoa New Zealand has pioneered its own unique niche businesses and products that utilise strong wool derivatives that have since acquired global attention.

Canterbury Lincoln-based Keraplast Manufacturing has been developing innovative functionalised keratin products since 2001. The company has patented a range of extraction processes and technologies that have enabled the development and commercialisation of keratin-based hair products, nutraceuticals, and wound/burn dressings or gels sold around the world. At the heart of Keraplast's ethos lies keeping the protein and its adjacent amino acids intact, meanwhile sourcing wool sustainably and ensuring ethical animal welfare practices are equally as important.

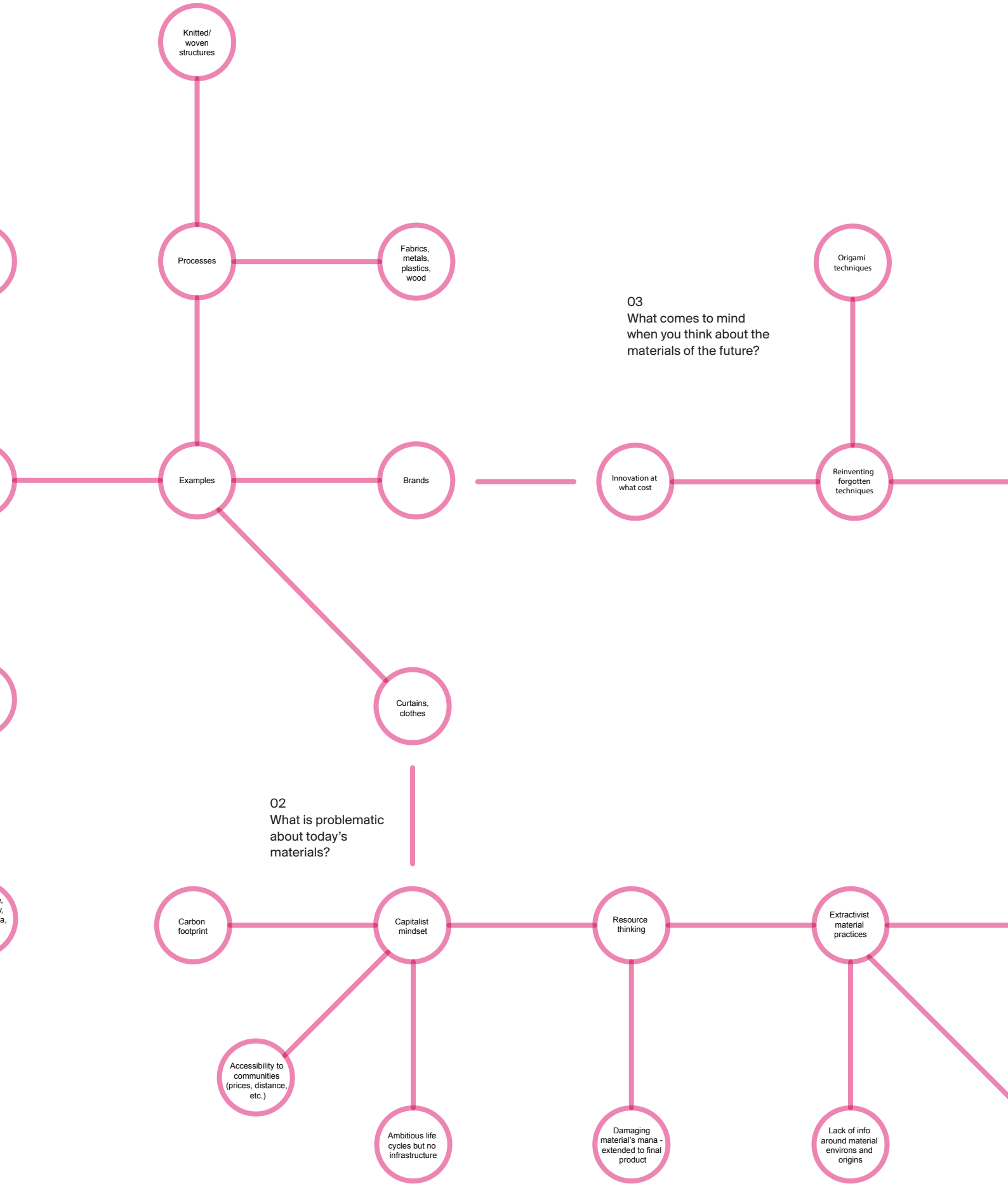
Like Keraplast, Lanaco is an enterprise located in Aotearoa whose focus revolves around the incorporation of proprietary strong wool-based materials in filtration and purification products. From personal masks to hood range filters and vacuum cleaners, the company continuously updates and adds to their repertoire of applications. Additionally, Lanaco has collaborated with designers such as Karen Walker (fig. 93) to reinforce the use of strong wool in everyday products to reach a mainstream audience. Lanaco's values include highlighting the benefits of keratin, regenerative farming practices, responsible use of land and water, and animal welfare.

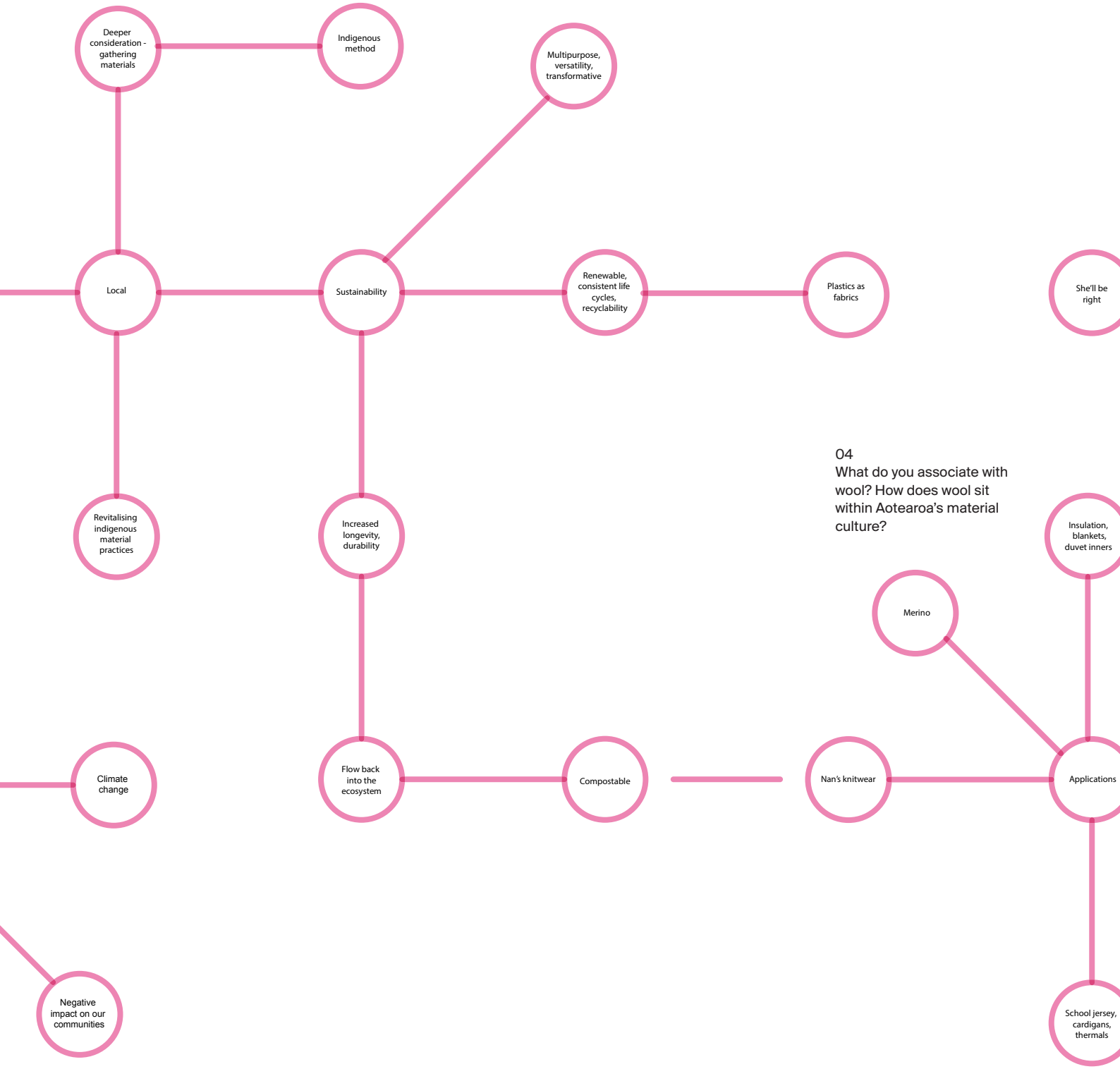
Woolchemy (fig. 94) has designed a washable sheet membrane material that is suitable for a range of applications such as sanitary products, filtration,and apparel. The mechanical properties of its main constituent – strong wool – are modified to increase absorbency levels, meanwhile ensuring the liquid in question remains in contact with the composite material. The company was formed as a result of the founder's concerns for her children's wellbeing and passion for environmental conservation, to eliminate fossil-fuel derived products that not only pollute the environment, but that also cause unforeseen skin and respiratory reactions.

01
What comes to mind when you think about materials?

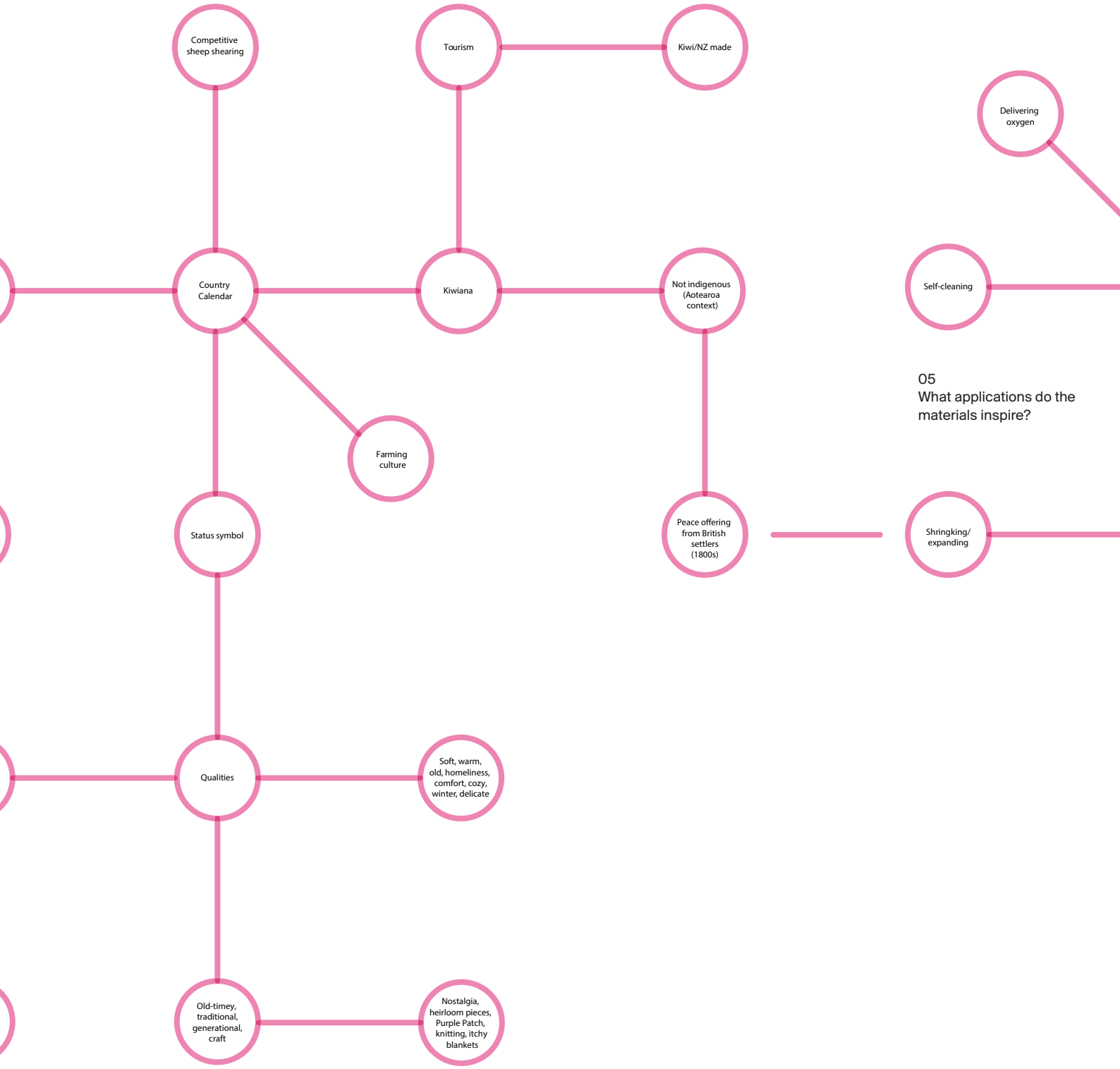


↘ Fig. 95 Collective brainstorm generated during workshops

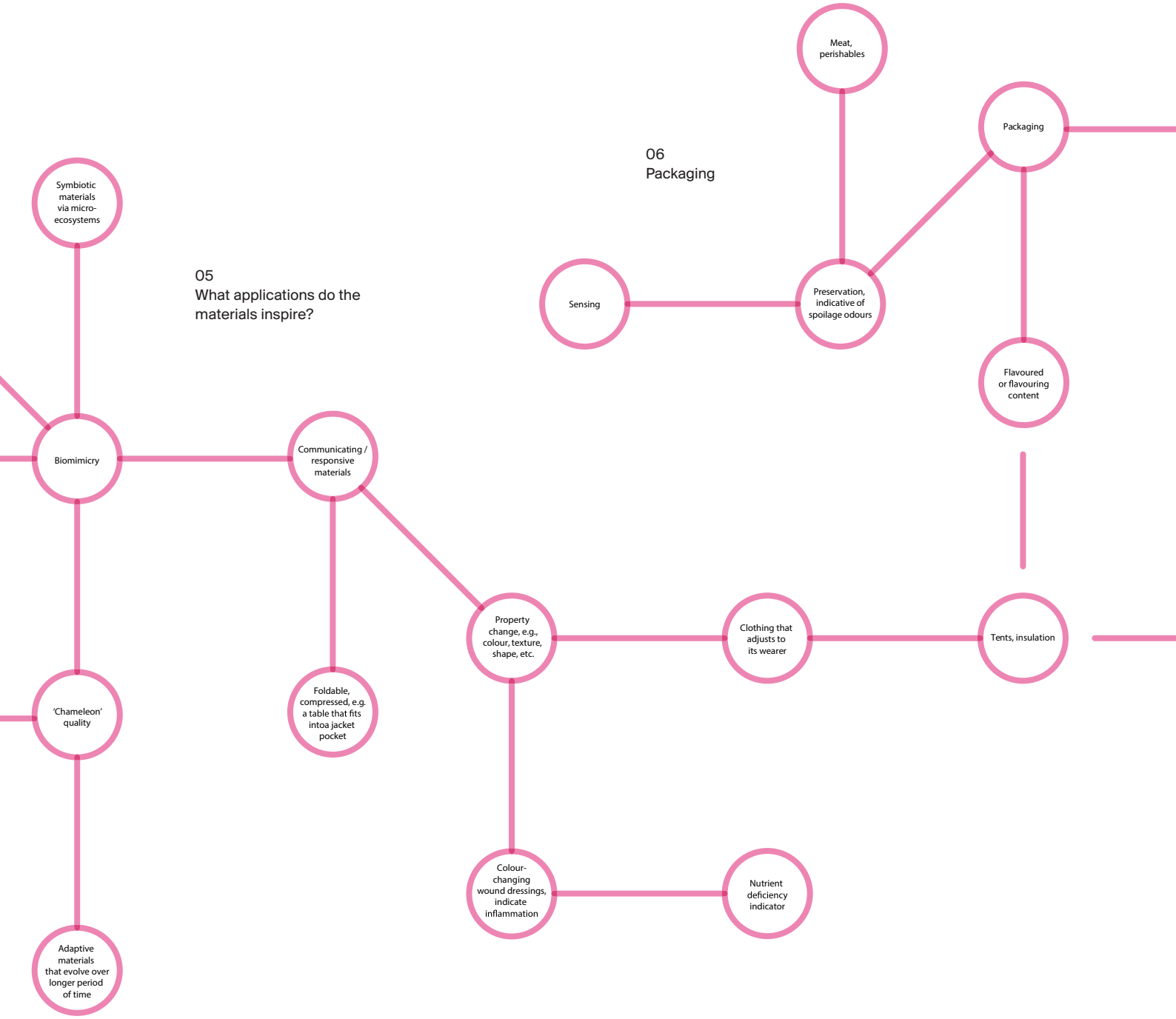

Knitted/ woven structures
Processes
Fabrics, metals, plastics, wood
Examples
Brands
Curtains, clothes
03
What comes to mind when you think about the materials of the future?
Origami techniques
Innovation at what cost
Reinventing forgotten techniques
02
What is problematic about today's materials?
Carbon footprint
Capitalist mindset
Resource thinking
Extractivist material practices
Accessibility to communities (prices, distance, etc.)
Ambitious life cycles but no infrastructure
Damaging material's mana - extended to final product
Lack of info around material environs and origins

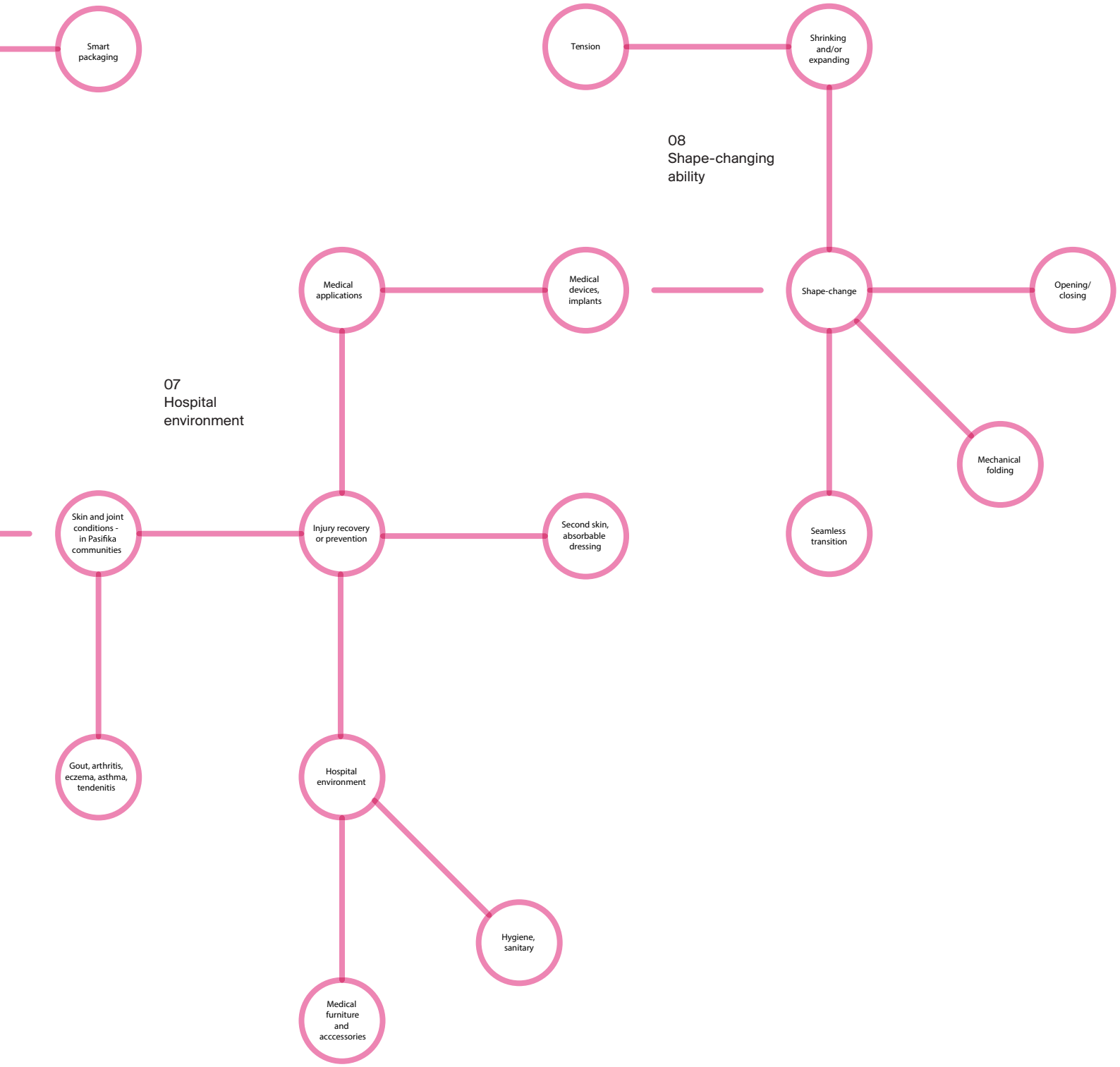


04
What do you associate with wool? How does wool sit within Aotearoa's material culture?



05
What applications do the materials inspire?


05
What applications do the materials inspire?
06
Packaging
Symbiotic materials via micro-ecosystems
Biomimicry
'Chameleon' quality
Adaptive materials that evolve over longer period of time
Communicating / responsive materials
Foldable, compressed, e.g. a table that fits intoa jacket pocket
Property change, e.g., colour, texture, shape, etc.
Colour-changing wound dressings, indicate inflammation
Nutrient deficiency indicator
Clothing that adjusts to its wearer
Tents, insulation
Sensing
Preservation, indicative of spoilage odours
Meat, perishables
Packaging
Flavoured or flavouring content


Smart packaging
Tension
Shrinking and/or expanding
08
Shape-changing ability
Medical applications
Medical devices, implants
Shape-change
Opening/ closing
Mechanical folding
07
Hospital environment
Skin and joint conditions - in Pasifika communities
Injury recovery or prevention
Second skin, absorbable dressing
Seamless transition
Gout, arthritis, eczema, asthma, tendenitis
Hospital environment
Hygiene, sanitary
Medical furniture and acccessories

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

4/04/2022

Dear: Charlotte Klinge

Re: Ethics Application - SOB 22/04 - From Protein to Product: Re-imagining Aotearoa New Zealand strong wool through science and design in partnership

Thank you for the above application that was considered by the Massey University Human Ethics Committee:

Human Ethics Southern B Committee at their meeting held on **Thursday, 10 March 2022**

On behalf of the Committee I am pleased to advise you that the ethics of your application are approved.

Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand T 06 951 6841; 06 95106840
E humanethics@massey.ac.nz; animalethics@massey.ac.nz; gtc@massey.ac.nz

From: Patsy Broad <P.L.Broad@massey.ac.nz>
Subject: HEC: Southern B Application SOB 22/04 - Amendment One
Date: 3 August 2022 at 1:36:06 PM NZST
To: Charlotte Klinge <charly.klinge@gmail.com>
Cc: Faith Kane <F.Kane@massey.ac.nz>, Sonya Withers <S.Withers@massey.ac.nz>

SOB 22/04 Future making of Aotearoa's material culture In conversation with wool: a place-based approach to re-imagining materials innovation through talanoa and science and design in partnership
Charlotte Klinge (HEC: Southern B Application 22/04)
Department: School of Design
Supervisor: A/Prof Faith Kane, Sonya Withers

Thank you for your email dated 30 July 2022 outlining the change you wish to make to the above application.

The change to the title of your research has been approved and noted, as follows:

From: "From protein to product: Re-imagining Aotearoa New Zealand strong wool through science and design in partnership"
To: "Future making of Aotearoa's material culture In conversation with wool: a place-based approach to re-imagining materials innovation through talanoa and science and design in partnership"

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee. If over time, more than one request to change the application is received, the Chair may request a new application.

Ngā mihi
Patsy
On behalf of the Chair, HEC: Southern B

Patsy Broad | Team Leader, Research Ethics | Research and Enterprise
Massey University | Private Bag 11 222 | Palmerston North 4442 | New Zealand | DDI 06 951 6840 or ext 83840
Web: http://www.massey.ac.nz/massey/research/research-ethics/research-ethics_home.cfm

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Figure 93 Lanaco. (n.d.). Lanaco Helix Filter [Photograph]. Https://Lanaco.Co.Nz/. https://www.rnz.co.nz/national/programmes/afternoons/audio/2018668123/nz-wool-on-trial-for-space-travel"

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