Ephemeral Embraces:
milkweed fibres from land to body

by
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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Fig. 0.1 Dried milkweed pods and stems. Autumn 2022. Photograph by Shabaan Khokhar.

Abstract

Garments historically originate from organic fibres harvested from the Earth, however the visual and physical qualities of materials and their origins are not typically foregrounded in modern garment architecture. This research studies the common milkweed plant in situ, as a species on the land, and ex situ, as a harvested fibre, extending traditional ideas of thermal performance to include delight. Architect and researcher Lisa Heschong describes *thermal delight in architecture* as the joy found in the experience of temperature variation on the skin, which is as applicable to architecture as it is to garment design. The design of a transforming garment made from organic fibres provides contrasting thermal experiences on different parts of the body. Taking inspiration from the biological and morphological transformations of the milkweed plant across seasons, a garment for the human body is designed for thermal delight through visual, tactile, structural, and adaptable encounters.

Through the fabrication of a milkweed fibre-filled garment, this research explores the potential to design for thermal delight through the following parameters: *material origin* (connection between body and land), *material intimacy* (visual and tactile pleasure), *material warmth* (structured warmth), and *material adaptability* (climatic variation). The garment material and function invite a conversation about the future of envelopes in fashion and architecture mirroring the constant changing environments humans are situated in, more intimately connecting human experience back to the land.

Fig. 0.2 *Ephemeral Embrace* on the land. Autumn 2022. Photograph by Shabaan Khokhar.

Acknowledgements

I begin by acknowledging that I live, research, and create on the traditional land of the Anishinaabe and Haudenosaunee People past and present, and honour this land with gratitude. This research would not exist without the intricate concentric circles of relationships within surrounding ecologies inhabiting the land I occupy. The traditional indigenous teachings have rooted me to this land and driven my research in fruitful and fulfilling avenues, perpetually influencing my growth as a knowledge seeker and researcher.

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—Thank you all.

Fig. 0.3 Touching warmth. Autumn 2022. Photograph by Shabaan Khokhar.

Dedication

To the *abandoned*, *endangered*, and *vanishing* ones, in search of a warm embrace.

Table of Contents

List of Figures

All photographs and drawings by author unless stated otherwise.

Chapter 0

Chapter 1 / *mind*

Chapter 2 / *body*

Chapter 3 / *spirit*

Appendix A

Appendix B

Preface

/ *seeds of home*

Throughout their lives, my grandparents grew gardens to connect to their beloved Palestine. Wherever they were forced to flee and resettle, my grandfather nurtured and nourished a bountiful garden of Levantine plants, reminiscent of flavours and scents grown in their Palestinian home. Born and raised in Palestine, my grandparents were forcefully expelled from their homes during the 1948 Nakba (the catastrophe or exodus) and the 1967 Naksa (the second catastrophe) by the Israeli army. At the age of four, my mother fled her homeland, Qalqilya, with her parents and two siblings, leaving behind their homeland and acres of generational citrus orchards. As young teenagers, my father's parents separately endured the 1948 exodus on their hometown, Al-Lydd, walking eighty-six kilometres on foot to Gaza, where they would live in camps and become refugees in their homeland. Palestinians are living in the diaspora are suffering a longing to form rooted connections to a home lost and understand a current relationship to a new home and foreign land.

Seeds and plants were the constant comfort in my grandparent's lives containing familial bonds and healing from the reminiscence of a land lost.

I grew up watching my grandfather tend to his garden in Jordan as a living and breathing entity. The courtyard was surrounded by fruit trees of figs, mulberries, and olives, as well as trellis climbing grapevines. Even now as an adult, the citrus and sweet scents of gardenia and jasmine honeysuckle, remind me of a nine-year-old self running to the gate entrance of the courtyard. Growing up I witnessed only two seasons: winter, and fig/mulberry season.

During harvest season, my grandfather sent his grandchildren to gather ripened figs and mulberries in large bowls. The fruit trees grew fond of his hands and produced lush fruit bursting with sweet and tart flavours. The spirit of the garden awakened at every harvest, as if thanking his tending hands with more bounty than the season prior. We filled the bowls with white, red, and black mulberries accompanied by deep

green and purple figs. The colours and fruits of my childhood. My grandfather's definition of home was directly tied to his garden, and heavily influenced my own meaning.

At the age of nine, I moved from Jordan to Ottawa, Canada and experienced a drastic change in environment. While there are two distinct seasons in western Jordan, hot and dry summers followed by warm and wet winters, southern Ontario visibly and physically has four. The prominently cold and dry climate in the winters was a climatic shock to a body used to dry heat. In time, I grew distant from practices of human-land relationships taught by my grandfather. Despite the Canadian citizenship I held of the land I occupied, it remained a foreign land[1], ancestrally not mine.

I felt no connection to land and no longer knew what 'home' meant to me.

1. Ottawa is built on the unceded Anishinabe and Algonquin territory whose peoples have lived on this territory for a millennia.

Cambridge is situated on the Haldimand Tract, the traditional land of the Anishinaabe, Haudenosaunee, and Neutral People. A land promised to the Six Nations, including six miles on each side of the Grand River.

In recent years I began to gain appreciation for the visible quintessential passing of time witnessed in the seasonal transformations of southern Ontario. The summertime is energy infused and active with buzzing fauna and bright green flora while the dormant wintertime has the shortest days with a slowing down of the biosphere, as if telling me to slow down in response.

The transitional seasons, the spring and autumn, are the most magical. In the spring, the rainfall awakens the flora from their winter sleep, blooming in preparation for the active summer. In the autumn, fauna begin to hibernate and migrate south while trees relocate their leaves' green down to the roots, turning into hues of red, orange, and yellow to maintain life and strength throughout the winter.

Tuning in to the intricacies of the transforming ecology around me, I desired to form intimate bonds with Earths many life forms. With my grandfathers' teachings I longed to form deep connections of home back to the land. And so began my search for new seeds of home.

Fig. 0.4 Common Milkweed fruit pod forming. Summer 2022.

Introduction

/ *wearing the land*

Clothing is a means of protection and identity expression. It protects the body against environmental conditions such as the cold, heat, sun, wind, and precipitation. It is adapted to respond to the varying seasons of the year. Historically, garments were formed from natural resources harvested from the land, including animal and plant fibres. Over 120,000 years ago, Pleistocene humans residing in Morocco's Contrebandiers Cave skinned the furs and leathers of predators in the region such as sand foxes, golden jackals, and wildcats to make clothing.[1] Amongst one of the oldest garments to date is the tarkhan dress from 3000 BC, an ancient Egyptian tunic made of linen fibre derived from flax plants.[2] Materials of clothing used were dependent on availability of natural resources within the region. The human body was directly embraced by fibres harvested from the land, providing a deeper connection, appreciation, and understanding of Earth's gifts. With a dependency on organic fibres, humans had to develop a reciprocal relationship with the land and its resources to survive.

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1 Emily Y. Hallett and others, 'A Worked Bone Assemblage from 120,000–90,000 Year Old Deposits at Contrebandiers Cave, Atlantic Coast, Morocco', *IScience*, 24.9 (2021) <https://doi.org/10.1016/J.ISCI.2021.102988/ATTACHMENT/A157A6DF-7561-40BD-9C20-2C322FC330BE/MMC1.PDF>

A discovery found 120,000-year-old leather and fur production site in a Moroccan cave with specialized bone tools for making clothing.

2 Sheila Landi and Rosalind M. Hall, 'The Discovery and Conservation of an Ancient Egyptian Linen Tunic', *Studies in Conservation*, 24.4 (1979), 141 <https://doi.org/10.2307/1505776>

The remainder of an ancient Egyptian garment was excavated and stitched onto crepeline for conservation. The tarkhan dress is made of organic linen fibres and shows evidence of fabric pleating methods.

The modern manufacturing and abundant use of synthetic fibres has disconnected the land from garments embracing/enveloping the body. With the increased reliance on petrochemical processes of manufacturing fabrics, human-land relations dissipated. Modern garments also lack visual and physical qualities that could activate contrasting human senses. Visually and physically engaging fibres are often hidden inside the shells of jackets to prioritize insulation performance. Factors of material origin and sensuous monotony has disconnected the human body from the land, lacking a delightful engagement of physical and visual senses. Engaging with the softness and warmth of organic fibres through direct human contact can establish enhanced human-land relations.

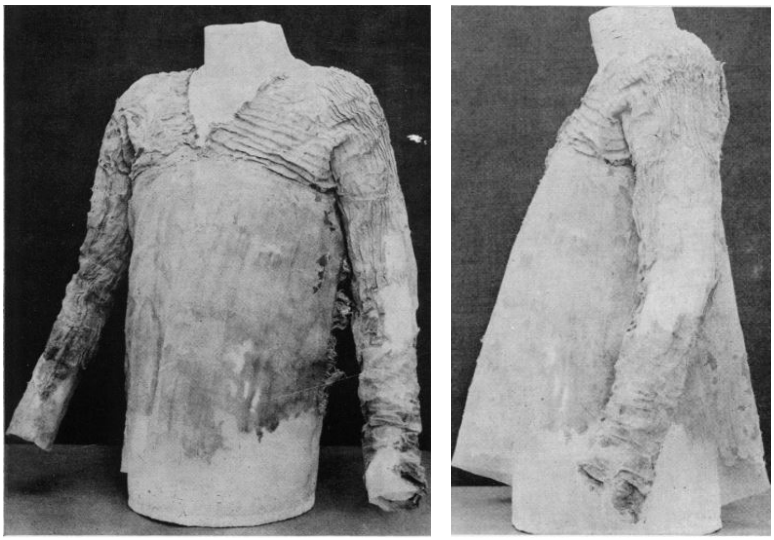

Fig. 1.1 Ancient Egyptian linen garment from 3000 BC. Photographs by Sheila Landi and Rosalind M. Hall, 1979.

Re-encountering practices of reciprocity with the land begins with a restoration of human-plant knowledge.[3] With a desire to repair the increasingly distant relationship between the ecological and human body, this thesis searches and expresses their commonalities through a holistic analysis of a single plant – the common milkweed. The direct embodied interaction with the common milkweed emphasizes the importance of ecological reciprocity and provides an opportunity to wear the land.

The seasonal conditions of the common milkweed are studied in situ then used as a harvested plant fiber ex situ to create a garment from the land on the body. The natural human desire for sensorial variation on the outermost layer of the skin is understood as thermal delight, a phenomenon coined by architect Lisa Heschong.[4] Naturally, the human skin rejects sensorial monotony and desires transforming climatic conditions, just as the plant bends its growth toward the sun or lures pollinators in the summer through morphological transformation of colour and fragrance.[5] The concept of thermal delight by Lisa Heschong is a key grounding component in the design and development of this thesis. By studying thermal delight and the common milkweed plant, the use and application of harvested fibres on the human body creates new human-land relations. To directly engage human senses with natures' milkweed silk fibres, a garment for the body is designed representing Heschong's basis of experiential thermal delight. To fit within garment architecture and sensorial human experiences, the term thermal delight

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3 Robin Wall Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', in *Traditional Ecological Knowledge*, ed. by Melissa K Nelson and Dan Shilling (Cambridge: Cambridge University Press, 2018), p. 46.

4 Lisa Heschong, *Thermal Delight in Architecture* (The MIT Press, 1978).

5 Peter Tompkins and Christopher Bird, *The Secret Life of Plants* (New York: Harper & Row, 1973), p. 10.

is expanded to involve notions of *material origin, intimacy, warmth, and adaptability*. The thesis defines *material origin* as the proximity of the material to the land while *material intimacy* is defined as the proximity of the material to the human body through tactile and visual senses. *Material warmth* is defined as the structural architecture elements of the garment providing increased designed thermal capacity *while material adaptability* is the transformation of the garment to provide varied climatic conditions.

Ephemeral Embrace

Ephemerality is a state of transience, existing in fleeting moments. To be ephemeral is to be impermanent and in constant flux, changing and adapting in response to varied internal and external forces and manifesting in physical and emotional mutations. This thesis defines ephemeral encounters as fleeting sensorial experiences of life exhibited on the land as an ecological skin and on the human as a thermal skin. Both encounters simultaneously coexist as landscapes transform throughout the seasons while the human skin shivers at the feeling of a swift cold breeze. Ephemeral conditions make up all of life on earth, existing within the biosphere as living encounters. In this thesis, ephemerality represents life and to be ephemeral is to be alive.

The ephemeral human condition is inherently connected to the ecological one, where the sustenance and nourishment of the human body is dependent on the health and well-being of the ecological body.[6] While ecological landscapes reveal ephemerality throughout their changing seasons, the human skin responds to the varied climatic conditions on the epidermis layer. As the changing atmosphere animates the living ecological world, humans isolate from surrounding environmental conditions through the construction of permanent and

6 David Abram, *The Spell of the Sensuous* (New York: Pantheon Books, 1996), p. 14.

ecologically detached envelopes on and around the human body. This isolation is exacerbated by using synthetic and monotonous materials/skins within clothes and buildings.

In the perspective of Robin Wall Kimmerer, plant knowledge is conveyed in educational systems exclusively through the object oriented and materialist lens of Western science.[7] This mindset further distances the relationship between the ecological and human body by understanding humans as consumers of the land rather than caregivers living in reciprocity with other organisms.[8]

The scope of the thesis operates at a visual and tactile one-to-one scale, manifesting in the research, design, and fabrication of a garment on the body utilizing harvested organic milkweed silk fibres. While ephemerality represents change, an embrace is a physical and visceral human feeling understood as a hug or a covering. In this thesis, to embrace is also to accept. *Ephemeral Embraces* is a garment for the body representing and accepting transience and encounters of ecological transformations.

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7 Kimmerer, p. 46.

8 Kimmerer, p. 40.

Fig. 1.2 *Ephemeral Embrace* on the body. Autumn 2022. Photograph by Shabaan Khokhar.

Chapter Summaries

The research and development of this book tries to achieve a balance between:

- the human-community and the other-than-human community[9]
- the plant as resource and the plant as teacher[10]
- scientific ecological knowledge and traditional ecological knowledge[11]
- thermoregulation and thermal delight[12]

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9 Abram, p. 161

In The Spell of the Sensuous Abram speaks to humans living in reciprocity with 'myriad beings' as 'not a matter of going back, but rather of coming full circle, uniting our capacity for cool reason with those more sensorial and mimetic ways of knowing, letting the vision of a common world root itself in our direct, participatory engagement with the local and the particular.'

10 Kimmerer, p. 46

Kimmerer writes in Traditional Ecological Knowledge 'When plants are understood as teachers, it is an act of reciprocity to be an attentive student and to pass on the teachings of the plants.'

11 Gregory Cajete, *Native Science: Natural Laws of Interdependence* (Santa Fe: Clear Light Publishers, 1999), p. 266

Cajete writes in Native Science 'Western society must once again become nature-centered, if it is to make the kind of life-serving, ecologically sustainable transformations required in the next decades'. This thesis uses the indigenous method of honourable harvesting to connect to the land.

In this thesis, the term 'indigenous' encompasses individuals or teachings that originate from different lands, such as Pueblo, New Mexico; Junín, Peru; Potawatomi Nation of the Grate Lakes region; Chippewa and Anishinaabeg tribes of Ontario, Michigan, and Wisconsin; as well as the Haudenosaunee, Anishinaabeg, and Mississauga tribes of southern Ontario.

12 Heschong, p. 36

Heschong writes in Thermal Delight in Architecture 'To enjoy being warmed or cooled we need some of the awareness process. Clearly, it is impossible to consciously enjoy what we can't notice, and yet, most of our processes of heat flow take place below our levels of conscious sensation… Clues from other senses can help make us more aware of thermal processes, enabling us to derive more enjoyment from them.'

Native scholar Dr. Gregory Cajete expands on indigenous ways of knowing as an authentic and holistic method of learning, which requires all aspects of the human: mind, body, emotion, and spirit. While mind and body focus on more research-based analysis, emotion and spirit represent the responsive qualitative accounts to the research. To achieve a holistic understanding of the common milkweed plant, all aspects of Dr. Cajete's theory of understanding and being are used in this thesis. The thesis is divided into three parts—*Mind, Body, and Spirit*—with a few short, first-person essays embedded throughout, representing *Emotion.*

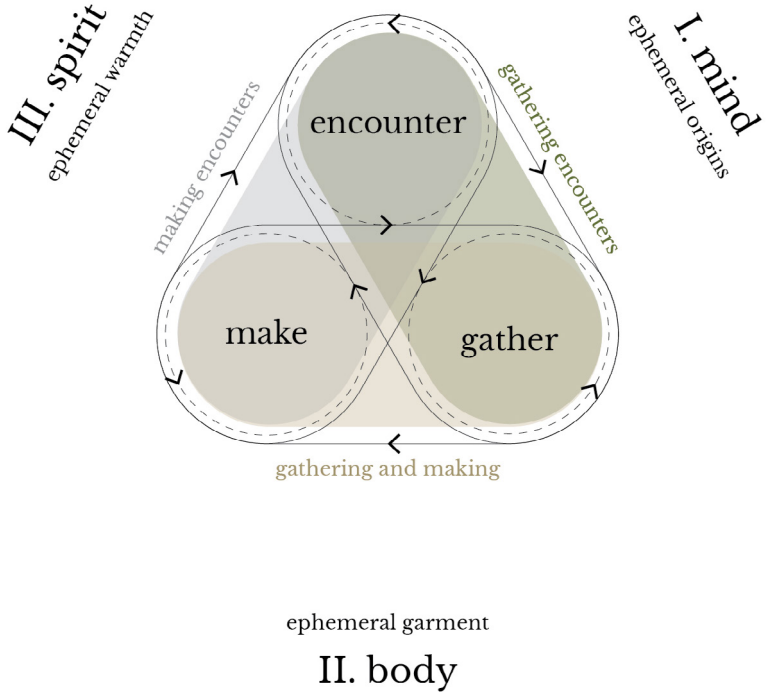


Fig. 1.3 Thesis structure showing connection of *Mind, Body, and Spirit.*

I – Mind: Gathering Encounters

This first part of the thesis provides the context and orients the self (author and reader) through the thesis research. It is the foundation upon which the *body* and *spirit* will be built upon. Gathering ephemeral encounters are experiences exhibited on the land and on the human body.

In *Ch.1.0 – 1.1: context*, *the common milkweed* plant is analyzed in situ as a living and breathing entity. Its growing conditions, interspecies relations, and companion species are expanded on to gain an overview of the plant.

In *Ch.1.2: ecological skins*, the seasonal metamorphosis and expressions of the common milkweed are comprehensively studied through firsthand embodied field research combined with references of ecological texts by Anna Tsing, Robin Wall Kimmerer, Peter Tompkins, Christopher Bird, Craig Holdrege, Ernst Lehrs, and Raoul Francé. Photography and writing are used as methods of documenting ecological encounters with the common milkweed plant and its companion species in situ. *Spring, Summer, Autumn*, and *Winter* each reveal a different ecological skin of the common milkweed, showing its ephemerality.

In *Ch.1.3: the honourable harvest*, a traditional indigenous method of harvesting is studied to ensure the harvest as a practice of reciprocity. While referencing ecological texts by Robin Wall Kimmerer, Melissa K Nelson, and Elizabeth Sumida Huaman, the honourable harvest is expanded on as a tradition of giving thanks and treating what is being harvested as a living being, thereby ensuring a sustained Earth that can continue to support human life.

In *Ch.1.4: thermal skins*, the concept of thermal delight is introduced as an example of human ephemerality present along the epidermis layer of the skin. Originally coined by architect Lisa Heschong, the term thermal delight introduced to the architectural discourse the innate human desire for varied thermal experiences. The

desire to experience various thermal temperatures on the body counters the static and monotonous conditions of thermal comfort and provides a more ephemeral or enlivening experience. Using Heschong's term, as well as scientific research by Thomas Parkinson, Richard de Dear, and James J. Kay, the concept of thermal delight is adapted from architecture to a garment that provides a direct sensorial and haptic experience of delight.

The human skin is expanded on as a living and adapting sensitive organ that responds to environmental forces in ephemeral ways in contrast to the modern static thermal layers used to envelop the body. While touching on the thermal layers in architecture, modern thermal layers for the human body are expanded on and critiqued including *polyester*, *down*, and *cotton*. The chapter concludes with the analysis of *milkweed silk fibres* as a sustainable alternative that connects the human body back to the land while providing high degrees of warmth on the human body.

In *Ch.1.5: thermal delight*, the physical and visual sensorial disconnection insulating fibres have from the human body is expanded on while referencing text by architects Iñaki Abalos and Lisa Heschong. The previously referenced ecological and scientific writing (primarily by Heschong, Kimmerer, Moe, and Weber) combined with the author's fieldwork documentation provides a holistic understanding of the responsive common milkweed plant and epidermis layer of the skin. Lisa Heschong's term, thermal delight, is adapted to fit within garment design. Four design parameters that test thermal delight in garment design are highlighted and defined by the author, including *material origin*, *material intimacy*, *material warmth*, and *material adaptability* of a garment.

II – Body: Gathering and Making

The midpoint of the thesis is the *Methodology* which is a dialogue between gathering references and making parts of the garment while learning lessons along the way. The gathering of existing work influences the making of the artifact as an expression of the *mind*. The following sub-chapters are split into two, the gathering of references and the making of the garment.

In *Ch.2.1: material origin*, the proximity of the material to the Earth is gauged through its life cycle assessment. Existing fashion companies that use milkweed silk fibres in garments, such as May West, Not Down, and Quartz Co., are referenced while assessing the origin of all materials used.

This section covers the methodology to carry the honourable harvesting of the milkweed silk fibers on various sites of harvesting. Site location and plant conditions is expanded on in each honourable harvest. In addition, the ethical and sustainable sourcing of the rest of the materials making up the garment is carried out, including materials like a silk fabric and silk thread. As an intuitive, sensorial, and emotionally involved methodology, this section of ch. 2.1 is written in first-person.

In *Ch.2.2: material intimacy*, the visible and tactile quality of the material are the parameters used to gauge the proximity of the material on the body. Under the gathering of references, literature by Finnish Architect Juhani Pallasmaa is referenced to expand on the importance of the human senses of sight and touch in interacting and connecting with the world. A project by fashion company Fluff Stuff is referenced, showing the application of the design parameter effectively, engaging senses of sight and touch directly with an organic fibre.

After various material experiments, a composite material was designed, and grades of silk were tested for rigidity, translucency, and porosity of the milkweed silk fibers.

The designed composite material consists of three layers: a silk gauze shell lining, loose milkweed silk fiber infill, and an outer layer of the silk gauze, held in place by silk thread. The first iteration of the garment was achieved using the design parameters *material origin* and *material intimacy*.

In *Ch.2.3: material warmth*, the section identifies methods of manipulating and stitching the shell to improve thermal performance are studied and applied to the composite material. Under gathering of references, both fashion and science-based research was compiled. NASA's aerogel technology research provides the basis for trapped still air as a design strategy to achieve warmth. Fashion designers Rei Kawakubo, Maria Blaisse, and Issey Miyake each have pieces in which designed opportunities for warmth are evident through the deformation of the garment on the human body. Traditional methods of sewing, such as pleating and smocking, by Paul Jackson and Colette Wolff are referenced which provide structural opportunities of warmth within the shell of the garment. Material science and technology literature by Rahim Rahimi and others are referenced to understand the conventional lockstitch methods of puffer infill jackets alongside their advantages and disadvantages in the maintenance of warmth.

In the making of the garment, pleating, and smocking methods were applied to the outermost layer of the composite material, including the lining and outer layer. Honeycomb blind tucks provide cellular formations on the shell, creating space to encase the milkweed silk fibers while allowing some freedom of movement. Additionally, the honeycomb blind tucks used avoid the formations of cold spots from traditional lockstitch methods on puffer jackets. Morphology of the pleating and smocking takes inspiration from the velvet ridges of the studied milkweed pod in situ to maintain intimate connection between the designed garment skin and the studied ecological skin.

In *Ch.2.4: material adaptability*, the thermal variation of the garment is applied through varying the material composition on different parts of the body and providing the opportunity to transform the silhouette of the overall form. Under the gathering of references, existing transforming garments are compiled, including pieces by Hussein Chalayan and J. Meejin Yoon. To understand the thermal requirements of the different parts of the body, a heat thermal diagram informed fibre placement and thickness throughout the garment to provide a functionally graded material.

By using and strategically placing hidden earth magnets, the overall garment is designed to be manipulated on the body and transformed to offer different functions and thus provide varied degrees of warmth.

The combination of previous work and literature referenced provided the basic framework for designing and fabricating a milkweed infilled garment responding to the defined design parameters to achieve thermal variation, and thus experience thermal delight.

III – Spirit: Making Encounters

The final part of the thesis includes the discussion, conclusion, and outlook, to reflect the essence of the *body*.

In *Ch.3.1: wearing ephemeral warmth*, the final designed garment is revealed as an artifact representing thermal delight. Photographs of the garment are taken in situ, on the land which the milkweed silk fibers were harvested from. Embodying ephemerality within its form, material, and transformation, the garment fulfills the desire to intersect ecological and human encounters through a rediscovery of life forms' reciprocal relationships. The *spirit* of the garment is discussed in a short first-person essay, expanding on the emotions and sensorial encounters felt on the land.

In *Ch.3.2: conclusion*, the key concepts of the thesis are restated including the desire to connect with the surrounding native ecology and the deep analysis of the milkweed silk fibers in situ and ex situ. New terms developed for the thesis such as thermal delight in garment architecture and the design parameters to measure its effectiveness including material origin, material intimacy, material warmth, and material adaptability are summarized. Through the orientation of the *mind,* the *body* gathered the necessary tools to form a new artifact reflecting the *mind*. The garment designed and fabricated in the *body* provided a new essence and *spirit* of the work and a rediscovery of the *mind*. A revelation of a deeper truth and contribution of the work within the field of design, in both fashion and architecture, is expanded on, including the importance of working with the land and providing more desirable sensorial encounters for the human skin.

Ch.3.3: future skins, expands on the outlook of the thesis and future work that can be carried out. This chapter speaks to how the current project could be changed and enhanced to achieve better results, and outlines ways new future projects can be carried out using similar methods. Additionally, widening the scope to include fixtures beyond garments on the body is expanded on as a potential next step, while referencing work by designer and architect Petra Blaisse.

Future work can use the cyclical methodology of gathering encounters, gathering and making, and making encounters as steps to engage with an organic material in situ and ex situ to form deep relationships with the land. Engaging the mind, body, emotion, and spirit in the act of creative work is expanded on as important methods to create intentional and meaningful work.

mind

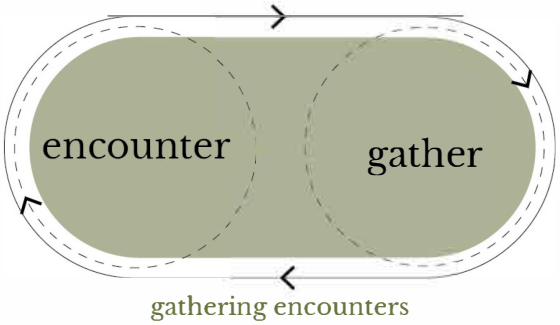
gathering encounters

Mind: Gathering Encounters

"*The Wind, in its greatest power, whirls. Birds make their nests in circles... The sun comes forth and goes down again in a circle. The moon does the same, and both are round.... Even the seasons form a great circle in their changing, and always come back again to where they were. The life of a man is a circle from childhood to childhood and so it is in everything where power moves....*" [1]

T. C. McLuhan, *Touch the Earth*

1 T. C. McLuhan, *Touch the Earth* (New York: Outerbridge and Dienstfrey, 1971), p. 42.



gathering encounters

ephemeral origins

~~the common milkweed~~
seasons
~~the honourable harvest~~

~~milkweed silk fibers~~
skins
~~thermal delight~~

1.0 Context

/ in situ

A plant is a living entity that forms itself in relation to the conditions it grows in. Throughout its life, a plant visibly becomes a disclosure of its environment, morphing and transforming in responsive and ephemeral ways.[2] A plant is only alive through its relationships and interaction with its surroundings including living and non-living forces such as the climate, the soil, and other organisms. The close analysis of a plant provides a restoration of human-plant knowledge and embodies the ephemeral rhythms of expansions and contraction evident in all of life.[3] Demonstrating the ebbs and flows of life in their bodies, the embodied interaction with the common milkweed provides a re-encountering of reciprocal human-land relationships.

1.1 The Common Milkweed

Asclepius syriaca, the common milkweed, is an urban and wild plant native to southern Canada including Quebec and Ontario and eastern United States and various parts of British Columbia.[4] As a plant in situ, the common milkweed displays intricate and complex relations in its ecology and amongst other species through its seasonal transformations. The plant's morphology is directly related to changing environmental conditions, the will to survive and multiply, and the vital role it continues to play in the biodiversity of its ecology.

In understanding and accepting the constant ebbs and

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2 Craig Holdrege, *Thinking Like a Plant: A Living Science for Life* (Great Barrington MA: Lindisfarne Books, 2013).

3 Ernst Lehrs, *Man or Matter: Introduction to a Spiritual Understanding of Nature* (New York: Harper, 1958), p. 45.

4 'Milkweed | The Canadian Encyclopedia' <https://www.thecanadianencyclopedia.ca/en/article/milkweed> [accessed 6 October 2021].

flows as forms humans are part of, an enlivening and a liberating view of life is achieved.[5]

Turning to the surrounding ecology, the biological and seasonal transformation of the common milkweed plant is the starting point of this thesis to form deep rooted relationships with a transformational ecology. These seemingly mundane processes of life need rediscovery to view the ecosystem as a community of sovereign subjects in reciprocal relationships with one another

5 Andreas Weber, *Enlivenment: Toward a Poetics for the Anthropocene* (London: The MIT Press, 2019), p. 50

Weber defines enlivenment as a new perspective on 'humans relation with the sphere we commonly call nature'. Weber views all beings as participants in a common 'economy of metabolic and poetic transformations' to dissolve the separation between human and more-than-human communities. Ecological enlivenment allows humans to acknowledge the deeply creative processes in all living organisms.

Fig. 1.4 Common Milkweed plants on the land. Spring 2022.

rather than objects of consumption.[6] Through close and mindful observation of the seasonal adapted-symbiotic-interspecies relationship between the common milkweed and monarch butterfly, the thesis rediscovers life forms.

The existing mutual relationships of life forms is further emphasized in times of catastrophe such as the climate crisis where one species' vilification can be the result of an endangerment of another.[7] It is hypothesized by Andreas Weber and Robin Wall Kimmerer that the environmental crisis is not in need of an economic or technological mindset but rather a loving relationship with ecology. An ecology of love requires an understanding of life – to learn how to love is to learn how to be alive.[8] Looking outwardly toward relationships enlivening humans will develop an inward needed affection for all life forms, enabling an enlivened integration rather than the developed isolation of the human body and soul with the biosphere.

In the book *The Branch Will Not Break*, Wright is striving to find himself in the world relative to his surroundings. In his poem titled 'milkweed', he writes "*the air fills with delicate white creatures from the wild*" [9] and through the touch of the milkweed's white silk fibres, Wright finds a sense of grounding, awareness, and comfort.

The mindful observation of the native common milkweed

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6 Robin Wall Kimmerer, *Braiding Sweetgrass* (Milkweed Editions, 2013), p. 331.

7 IUCN Red List, 'Migratory Monarch Butterfly Now Endangered' <https://www.iucn.org/press-release/202207/migratory-monarch-butterfly-now-endangered-iucn-red-list> [accessed 21 July 2022]

Typically, monarch butterflies would spend most of their summer in parts of southern North America including Ontario however my first sighting of the species occurred on July 29th, eight days after the species was added to the International Union for Conservation of Nature's endangered species list.

8 Andreas Weber, *Matter and Desire* (Chelsea Green Publishing, 2017), p. 5.

9 James Wright, *The Branch Will Not Break* (Wesleyan University Press, 1963), p. 58.

and its transformations allow for a better understanding of the land and one's relationship to it. Throughout the year of 2022, seasonal visits were carried out to a cultivated common milkweed garden in the pollinator preserve and rare Charitable Research Reserve site in Cambridge, situated on the Haldimand Tract territory of the Neutral, Anishinaabe, and Haudenosaunee peoples.

In the following seasonal observations, the rediscovery of the principle of life is embedded in the seasonal transformations: spring, summer, autumn, and winter.

Fig. 1.5 Milkweed meadow. Fall 2022. Photograph by Shabaan Khokhar.

“While I stood here, in the open, lost in myself,

I must have looked a long time

Down the corn row, beyond grass,

The small house,

White walls, animals lumbering toward the barn.

I look down now. It is all changed.
Whatever it was I lost, whatever I wept for
Was a wild, gentle thing, the small dark eyes
Loving me in secret.
It is here. At a touch of my hand,
The air fills with delicate creatures
From the wild."[10]

Milkweed

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10 Wright, p. 58.

Fig. 1.6 (above) Monarch butterfly sighting. Summer 2022.
Fig. 1.7 (left) Milkweed fibre on the land. Fall 2022.

1.2 Ecological Skins

1.2.1 Spring

During springtime in the region, the Earth slowly awakens from winter dormancy, stimulated by the moistened soils. Deep within the rhizomes of the common milkweed, the buds begin to establish shoots. Originating from a seed, the plant grows in colonies, each colony with shoots, genetically identical to one another.[11] What appears to be many individual milkweed plants overground are in fact all connected to a singular and extensive rhizome root structure underground. A colony of many individual stems is in fact all one plant.

11 Craig Holdrege, 'The Story of an Organism: Common Milkweed', *The Nature Institute*, 2010, p. 3 <http://natureinstitute.org/txt/ch/images/milkweed/Milkweed.pdf>.

Fig. 1.8 Plant bud.

Fig. 1.9 Closed umbels.

Fig. 1.10 Bloomed umbels.

The common milkweed plant has been historically listed by Ontario government officials as a noxious weed.[12] This has led farmers and landowners to destroy the plant which in turn harmed monarch butterfly populations and the biodiversity of the region. The plants resilient rhizome structure spreads extensively, having the ability to turn any type of soil into a lush milkweed habitat. As a ruderal plant, its ability to colonize disturbed habitats such as arable fields and urban sites is viewed as a nuisance and an indication of the "untended" and "wild green" when in fact it reflects the continual human disruption of the urban environment.[13] "Weeds" are symptoms of environmental degradation due to human activity and should be viewed as spontaneous and successful urban plants that provide free ecological services like temperature reduction, oxygen production, carbon storage, erosion mitigation and food and habitat for wildlife.[14] Through its major role in the biosphere, the common milkweed nourishes and protects life.

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12 Province of Ontario, 'Updating the Schedule of Noxious Weeds in R.R.O. 1990 Regulation 1096', 2014 <https://www.ontariocanada.com/registry/view.do?postingId=15464#:~:text=The species common milkweed (Asclepias,naturalized vegetation in the province.> [accessed 16 November 2022]

Noxious weeds are understood as plants that are harmful to livings things such as crop fields and livestock. The Ontario government removed the common milkweed from its noxious weeds list in 2014 upon the submission of a proposal to update the 'Schedule of Noxious Weeds' in 1990.

13 Peter Del Tredici, *Wild Urban Plants of the Northeast: A Field Guide* (Cornell University Press, 2010).

14 Del Tredici.

Fig. 1.11 Common milkweed plants growing near edges of paved roads.

Fig. 1.12 Common milkweed plants growing at edge of parking lot.

In preparation for summertime pollination, the leaves grow and appear to be larger than surrounding companion plants such as the aster and golden road. By mid-spring, small grey-pink balls of flower buds begin to form on the stems among the leaves. Where the buds form, the leaves below and above retract, and Ernst Lehrs principle of renunciation – inspired by Goethe[15] – comes to mind. Lehrs describes vegetative form as '*dying into being*'[16] through a series of withdraws and manifestations. As the umbels flow into form on the common milkweed, the plant undergoes a '*decisive ebb*'[17] in the vitality of the leaves.

The transmutation from leaf to umbel is a sudden leap and by late spring, the meadow is transformed into bloomed large spherical umbels, ready to feed and be fed.

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15 Johann Wolfgang Von Goethe, *The Metamorphosis of Plants* (United Kingdom: Bio-Dynamic Farming & Gardening Assoc., 1993), p. 6

Lehrs' concept of renunciation is based off Goethe's essay titled The Metamorphosis of Plants where he talks about 'progressive' metamorphosis and says 'it can be seen to work step by step from the first seed leaves to the last formation of the fruit. By changing one form into another, it ascends – as on a spiritual ladder – to the pinnacle of nature'.

16 Lehrs, p. 45

Lehrs sees a gap in Goethe's writing which recognizes but does not address that a plant undergoes a 'decisive ebb in its vitality' during metamorphosis. Lehrs calls this the principle of Renunciation.

17 Lehrs, p. 45.

Fig. 1.13 Spherical umbels.

Fig. 1.14 Bloomed milkweed colonies.

1.2.2 Summer

In the summertime, hundreds of small pink flowers are in bloom and the milkweed meadow is buzzing with life. The sweet smell of nectar from the spherical pink umbels invites pollinators like butterflies and bees to move umbel to umbel and spread pollen across the wild flowering plants.[18] Deep green leaves on the stems of the common milkweed invite monarch butterflies to host larvae and feed on the plant as its sole food source.[19] As the larvae grows, it eats away at the leaf to gain nutrients and transform into a caterpillar. Lehrs' renunciation is evident once again when the vitality of the caterpillar passes into the butterfly.[20]

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18 Holdrege, 'The Story of an Organism: Common Milkweed', p. 7.

19 John W. Thieret, Willliam A. Niering, and Nancy C. Olmstead, *National Audubon Society Field Guide to North American Wildflowers: Eastern Region* (New York: Alfred A. Knopf, Inc., 2001), p. 361.

20 Lehrs, p. 45.

Fig. 1.15 Sap filled leaf and stem.

Fig. 1.16 Ebb of the umbel and flow of the fruit pod.

Fig. 1.17 Evidence of previously hosted monarch butterfly larva.

The stems of the plant and veins on the leaves are visibly wider as they are filled with milk sap, ready to nourish. While the sap is toxic to other animals, larvae feed on the sap and give off a stench of toxins to potential predators.[21] Not only does the sap nourish the larvae, but it also protects it from potential harm. Just as the milkweed could not live without its pollinators, the insects would perish without the plant.[22] By ingesting the sap for survival, part of the milkweeds' body becomes a vital part of the insects it pollinates. The complexity in the form of flowering umbels makes pollinator work hard to reach the nectar, some getting stuck between the globe of flowers and losing their legs.[23] The combination of the toxic sap, the sweet nectar, and the pollination process makes a highly sophisticated plant, exemplifying a push and pull between attracting life and repelling it.

For a couple of weeks in the summer, the milkweed plant turns into a microhabitat concentration of insect life.[24] Evidence of previously hosted monarch butterfly larvae is present as holes on the leaves. Voids where the plant sacrifices bits of itself for the nourishment of monarch butterfly habitats, knowing that the butterflies will return to pollinate the umbels once again. By the end of the summer, the monarch butterflies make their way south to overwinter in the Oyamel forests of Mexico in which they roost.[25] With the butterflies' departure, signs of fruit growth begin.

While the flowering phase of a milkweed plant is rapid and productive, the fruit pod develops slowly and extensively

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21 Thieret, Niering, and Olmstead, p. 361.

22 Holdrege, *Thinking Like a Plant: A Living Science for Life*.

23 Holdrege, 'The Story of an Organism: Common Milkweed', p. 14.

24 Holdrege, 'The Story of an Organism: Common Milkweed', p. 21.

25 Steven M. Reppert and Jacobus C. de Roode, 'Demystifying Monarch Butterfly Migration', *Current Biology*, 28.17 (2018) <https://doi.org/10.1016/J.CUB.2018.02.067>.

for months.[26] With decaying umbels and butterflies' departure, signs of the slow fruit growth begin.

The rhythmic interplay of growth and decay is evident once again as the flowers wilt and tiny organs of plant fertilization are at play.[27] Without the pink umbels, the plant falls in the background of shrubs and green hues, camouflaging with its ecology. The flower withdraws and the bright green velvet fruit pods begin to swell and grow to fill the milkweed meadow. The ecological stage is once again given back to the milkweed colonies.

The plant stands tall and bright amongst its companions on the untouched land. Fruit pods ready to burst fill its stems, some accompanied with leaves, others sat solemnly in solitude. Each pod made of two shells; each shell encased in repeating diverging ridges, enclosing hundreds of silky white fibres. Unlike hanging fruits, the pods somehow defy gravity and twists to grow vertically towards the sky.

In preparation for shorter days and colder months ahead, the plants energy and function are channeled to withdrawing and storing nutrients down to its rhizome roots.[28]

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26 Holdrege, 'The Story of an Organism: Common Milkweed', p. 7.

27 Lehrs, p. 45.

28 Russell G. Foster and Leon Kreitzman, *Seasons of Life: The Biological Rhythms That Enable Living Things to Thrive and Survive* (New Haven: Yale University Press, 2009), p. 93.

Fig. 1.18 Fruit pods replace umbels.

Fig. 1.19 Fruit pods replace umbels.

1.2.3 Autumn

As autumn arrives, decaying leaves show evidence of several previously hosted larvae that provided life back into the wild in the form of a butterfly. The leaves decay in contentment, knowing their duty to serve their ecology was achieved.

The energy spent gathering nutrients and growing pods has now paid off, as the natural process of the seasons transform bright green enclosed pods into dry and brittle shells, open at its natural seam for the wind to do the work of dispersing the seeds of the plant. Thousands of seeds attached to white silk fibres are revealed when the pods burst open. The white silk fibres function as parachutes, moving delicately in the wind to scatter seeds in the wild.

Standing in the middle of a field of dormant golden rods and milkweed pods, the silk fibres fly in the November wind and shimmer in the bright sun, latching on to its dry and brittle companions. While the stems, pods, and leaves of the milkweed dry up, lose life, and become brittle, the silk fibres evoke a sense of spirit and life bringing softness and warmth to the land. As the weather gets colder, the visible warmth is spread across the landscape, as silk fibres hold onto the surrounding dormant plants, blowing in the direction of the wind. Their light weight allows the fibres to move with the wind while its natural waxy exterior shimmers under the sunlight, withstanding any precipitation.[29] The only work left to do for the plant is to prepare to slow down for the winter and use up the nutrients stored in its tubular rhizomatic roots to survive.

While the dispersal of the silk fibres across a landscape ensures the planting of seeds and multiplication of the plant, it additionally provides senses of warmth and softness, enlivening a seemingly dormant ecology.

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29 Patricia Cox Crews and others, 'Evaluation of Milkweed Floss as an Insulative Fill Material', *Textile Research Journal*, 61.4 (1991), 203–10 <https://doi.org/10.1177/004051759106100403>.

Fig. 1.20 Silk fibres on the land.

Fig. 1.21 The reveal of the silk fibres.

Fig. 1.22 Silk fibres embrace the land with warmth.

1.2.4 Winter

With no sight of life left, the milkweed meadow is buried in white snow, with some stems sticking out, swaying lightly with the chilly winds. The life of the meadow is in fact buried underground, below the snow, insulated by roots and deep soils. With food and sunlight scarcity, soil temperatures drop, activity within the meadow slows, and life forms hibernate.[30]

This is the stage of greatest withdrawal, as the buried seeds take on the role of renewing the whole cycle at the expense of the plant's appearance.[31] The energy stored in previous seasons is now being slowly and strategically released within the roots, allowing the rhizomatic structures to rest until spring approaches. There's a fascination in realizing all the meadows visible life forms have now been transferred deep within the Earth, perhaps enlivening it more than ever as a giant respiring body, rising and falling, pulling, and orbiting.

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30 Foster and Kreitzman, p. 93.

31 Lehrs, p. 46.

Fig. 1.23 Touching warmth. Photograph by Shabaan Khokhar.

1.3 The Honourable Harvest

The *honourable harvest,* as described by Robin Wall Kimmerer, is an Indigenous practice of reciprocity with nature that protects what is being harvested/hunted from over-exploitation and ensures its ability to flourish and thrive for future harvesting/hunting.[32] By governing human consumption, the *honourable harvest* ensures the continued health and well-being of humans through the protection of plants and animals within ecosystems.[33]

A symbiotic relationship between harvester and harvested involves a sophisticated balance of philosophy and practice which require thorough empirical knowledge, ethical material practices, and Indigenous values of kinship.[34] The western paradigm of conservation and protection of vulnerable populations within the ecosystem often involves the elimination of harvesting.[35] However, prescribing sustainable harvesting practices instead can inform new perspectives on the restoration of human-plant mutualism.[36]

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32 Robin Wall Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', in *Traditional Ecological Knowledge*, ed. by Melissa K Nelson and Dan Shilling (Cambridge: Cambridge University Press, 2018), p. 33.

33 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 33.

34 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 40.

35 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 40.

36 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 40.

Fig. 1.24 Spreading seeds. Photograph by Shabaan Khokhar.

The honourable harvest is also expanded on by Indigenous knowledge researcher Elizabeth Sumida Huaman when referring to Indigenous Puebla community land practices which follow key philosophies of "*only take what you needed"* and "*taking care and treading cautiously*"[37]. Indigenous ecologist and activist Melissa K. Nelson refers to the practice of reciprocity with the land as a set of "*original instructions*" [38] involving ethical and practical systems that maintains sustainable relationships with human and other-than-human life.

Although the honourable harvest is a practice of unwritten guidelines guided by intention and intuition, Kimmerer synthesizes the practice in the following text:

"*Know the ways of the ones who take care of you, so that you may take care of them.*

Introduce yourself. Be accountable as the one who comes asking for life. Ask permission before taking. Abide by the answer.

Never take the first. Never take the last. Take only what you need.

Take only which is given.

Never take more than half. Leave some for others. Harvest in a way that minimizes harm.

Use it respectfully. Never waste what you have taken. Share.

Give thanks for what you have been given.

Give a gift, in reciprocity for what you have taken.

Sustain the ones who sustain you and the Earth will last forever"[39]

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37 Elizabeth Sumida Huaman and Nathan D. Martin, *Indigenous Knowledge Systems and Research Methodologies* (Toronto: Canadian Scholars, 2020), p. 146.

38 Melissa K. Nelson, *Original Instructions: Indigenous Teachings for a Sustainable Future* (Rochester, VT: Bear & Company, 2008), p. 2.

39 Kimmerer, *Braiding Sweetgrass*, p. 183.

Whether referred to as the *honourable harvest*[40], *original instructions*[41], *practices of reciprocity*[42], or *only take what you need*[43], the key practice of mutualism between human and other-than-human life is an age-old Indigenous tradition that has been practiced for generations. It is the key method used in the harvesting of the milkweed silk fibres for the realization of this project and expanded on in ch. 2.1.2.

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40 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 33.

41 Nelson, p. 2.

42 Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 32.

43 Huaman and Martin, p. 146.

Fig. 1.25 Harvesting fibres. Autumn 2022.

1.4 Thermal Skins

Much like the changing ecological skin, the human skin is a porous and living entity, responding, and adapting to its surrounding environment. The unity and coherence of the living body is reliant on the surrounding world, which it breathes into itself.[44] One can understand the human skin as living flesh entangled and actively intertwining with the surrounding ecological skin, both sensorial and sentient.[45] The human skin physically changes to its surrounding climate, drying up and losing moisture with the cold and dry weather. As temperatures increase, humidity fills the environment, and the porous epidermis layer of the skin begins to feel heavier and more nourished.

The human body responds to immediate environmental conditions through the epidermis, the peripheral layer of the skin to mediate conditions and bring bodies back to thermal comfort. Our bodies sweat when we are hot to cool us down and shiver when we are cold, to exert energy and warm us. Our clothing is ephemeral and changes with the seasons, used as a tool to regulate body temperature. It provides us with the autonomy and power to instantly change our state of being by simply removing or applying layers. To enhance senses of aliveness on the epidermis layer, the human body craves varied climatic and sensorial experiences when mediating environmental relationships. This climatic variation is best experienced in extremes when the body plunges in freezing cold water after

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44 David Abram, *The Spell of the Sensuous* (New York: Pantheon Books, 1996), p. 80

Abram speaks to the relationships of the sensing body and says 'We may think of the sensing body as a kind of open circuit that completes itself only in things, and in the world. The differentiation of my senses, as well as their spontaneous convergence in the world at large, ensures that I am being destined for relationship: it is primarily through my engagement with what is not me that I effect the integration of my senses, and thereby experience my own unity and coherence.'

45 Abram, p. 58

Abram references Merleau-Ponty's description of 'sensuous reality' as 'the flesh' - 'an intertwined, and actively intertwining, lattice of manually dependent phenomena, both sensorial and sentient, of which our own sensing bodies are a part.'

spending time in the hot and humid climate of a sauna.[46]

In the book *Thermal Delight in Architecture*, architect Lisa Heschong argues that temperature is best understood as a sensorial perception on the skin.[47] Temperature is perceived, understood, and ultimately felt as a sense on the epidermis. Heschong compares food to temperature and says just like the desire for different tastes there is also a human desire for varied temperature experiences on the skin.[48] Heschong refers to the desire for variation in sensorial temperature perception as thermal delight, an experience that cannot exist in thermally neutral environments.[49] A desirable thermal experience is thus one with temperature changes and climatic variation experienced on the human body. Expanding on Heschong initial concept of thermal delight from 1973, Thomas Parkinson and Richard de Dear use the term thermal alliesthesia to describe climatic variation experiences of the human skin.[50] Alliesthesia and thermal delight are understood as physiological experiences and providers of delightful sensations on the skin, opposite to thermal neutrality. Gail Brager's building science and sustainability research indicates that thermal alliesthesia is best experienced through temperature variability across different parts of the body.[51]

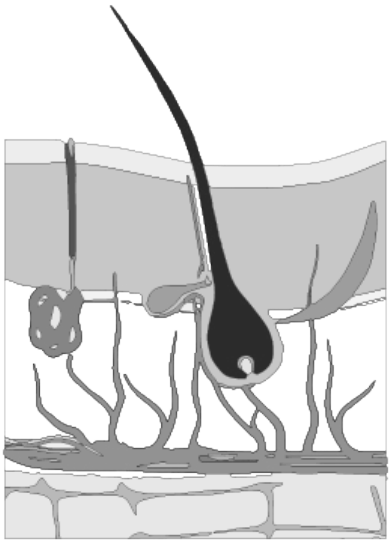

Fig. 1.26 Skin response to a hot environment cause sweat on epidermis layer to regulate body temperature. Based on a diagram by shutterstock.

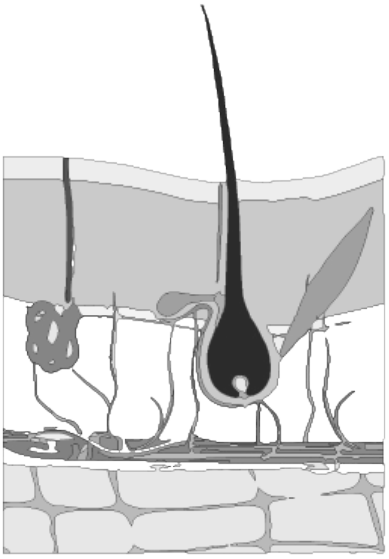

Fig. 1.27 Skin response to a cold environment cause a thickening of the fat layer and the hairs follicles to stand to regulate body temperature. Based on a diagram by shutterstock.

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46 Lisa Heschong, *Thermal Delight in Architecture* (The MIT Press, 1978), p. 32.

47 Heschong, p. 28.

48 Heschong, p. 30.

49 Heschong, p. 30.

50 Thomas Parkinson and Richard De Dear, 'Thermal Pleasure in Built Environments: Physiology of Alliesthesia', *Building Research and Information*, 43.3 (2015), 288–301 <https://doi.org/10.1080/09613218.2015.989662>.

51 Gail Brager, 'Designing for Experiential Delight', *Berkeley Center for the Built Environment*, 2019 <https://cbe.berkeley.edu/centerline/designing-for-experiential-delight/>

Gail describes alliesthesia as the 'physiological basis for thermal delight where hedonic sensations of "pleasure" come from the dynamic component of thermoreceptors in our skin.' Furthermore, "the best potential for alliesthesia will come from having some degree of variability, or contrast, either over time, or across different parts of our body".

The isolation of the human body from the surrounding natural environment physically begins at the epidermis layer of the body where clothing is worn. Through involving an embodied approach of interacting with biological life forms, a deeper connection with the land is achieved. Harvested milkweed silk fibres are transformed into a layer on the body, to mediate environmental conditions and provide hedonic sensations of pleasure beyond thermal comfort.

When met with varied climatic experience, life forms have adopted various response methods. Ecological scientist James J. Kay observes three ways life on Earth copes with a changing environment. The first way is to "*take control of the environment*" while the second is to "*isolate the system from the environment*".[52] James J. Kay states that the third way life on Earth copes with a changing environment is to "*adapt the system to the changed environment by changing the behaviour and role of elements of the system, changing the elements of the system, or changing the interconnections between elements*"[53]

While in ecology, isolating living systems from the environment is not possible or helpful, Kiel Moe writes that the use of insulation in architecture has isolated buildings from the environment in the 'vain' attempt to control it.[54] Modern insulating fibres achieve an isolated and limited function of thermoregulation while lacking an inviting visual and sensorial human connection. Today's limits of modern thermal thinking have caused a dependence on toxic synthetic fibres and naturally exploited fibres.

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52 James J. Kay, 'Complexity, Theory, Exergy, and Industrial Ecology', in *Construction Ecology: Nature as the Basis of Green Buildings*, ed. by J. Kilbert, Jan Sendzimir, and G. Bradley Guy (London: Spon Press, 2002).

53 Kay.

54 Kiel Moe, *Insulating Modernism* (Birkhäuser, 2014), p. 24.

Kimmerer speaks to the importance of the human understanding of land and how its restoration differs when viewed as real estate for natural resources than as a spiritual home and source of survival.[55] When viewed as a resource, the land becomes the machine of which humans control through a practice based on reductionist material extraction lacking understanding of ecological reciprocity and respect to the land.[56] Working with synthetic and unethically sourced materials disregards the importance of material origin and its effect on the surrounding ecology. The idea of controlling nature is emphasized by its over consumptive and commodification practices standing in the way of humans relating to their surrounding biosphere.[57] Humans' current mediation with the surrounding ecology is either the attempt to control it or completely isolate the body from it. To be aware of materials consumed from the Earth is the first step to achieving a reciprocal relationship with the land.

Modern insulative layers are often synthetic, toxic, and hidden – out of sight and out of mind. To insulate is to isolate – but how can it integrate? Instead of taking control of the environment, adapting to environmental variations through changes within the elements of the system and their ecological and sensorial interconnections is explored through garment architecture. Driven by capitalism, progress narratives in modern material culture are focused on production escalation, accumulation, and distribution of goods. With pressure on being the species with "agency", "consciousness" and "intention", progress for humans is defined as a "forward march" resulting in the constant desire of looking ahead instead of looking

55 Kimmerer, *Braiding Sweetgrass*, p. 328.

56 Kimmerer, *Braiding Sweetgrass*, p. 189.

57 Weber, *Enlivenment: Toward a Poetics for the Anthropocene*, p. 69.

around.[58] Modern methods of insulating fibres used to achieve physical warmth on the body include non-ethically sourced natural fibres and toxic petrochemical fibres having dire consequences on the health of both the ecosystem and humans.[59] The desire and need to continue to progress has desensitized humans to negatives effects on the ecology.

As a layer sandwiched and hidden between studs and finishes, there is little understanding of the negative implications and embodied energy calculations of insulative materials used.[60] Published high performance wall assembly guidelines intended to achieve 2030 targets for energy efficiency include the use of abundant petrochemical-based insulation.[61] The use of asbestos as insulation, from 1960 to the 1990, resulted in *sick*

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58 Anna L. Tsing, *The Mushroom at the End of the World* (Princeton University Press, 2015), pp. 21–22

Tsing talks about human desire of consumption and progression as 'embedded' to being human and says, 'we learn over and over that humans are different from the rest of the living world because we look forward— while other species, which live day to day, are thus dependent on us.' And proves this to be false by saying 'all organisms make ecological living places, altering earth, air, and water…Bacteria made our oxygen atmosphere, and plants help maintain it. Plants live on land because fungi made soil by digesting rocks.'

59 Sunita Bhalla, 'Toxicity of Synthetic Fibres & Health', *Advance Research in Textile Engineering*, 2.1 (2017) <https://doi.org/10.26420/advrestexteng.2017.1012>.

60 Kelly Alvarez Doran, 'Letter to the Editor: Architecture's Blind Spot' <https://www.canadianarchitect.com/letter-to-the-editor-architectures-blind-spot/> [accessed 28 September 2021]

Alvarez Doran argues that we have little knowledge on the material origin and the embodied energy values of the layers making up the complex wall assembly released by the Ontario Architects Association.

61 Cheryl Atkinson and others, 'OAA High Performance Wall Assemblies Guidelines', 2019, 16 <https://oaa.on.ca/Assets/Common/Shared_Documents/Tools-Resources/05.Documents/High-Performance-Wall-Assemblies.pdf>

In 2019, the OAA (Ontario Architects Association) released High Performance Wall Assembly Guidelines intended to achieve 2030 targets for energy efficiency.

building syndrome before the realization of the toxicity and carcinogenic nature of the material.[62] The invention of mineral wool, trademarked as rockwool, involves high embodied energy in the synthetic production of so-called 'wool' made from liquefied slag and mineral rock at temperatures as high as 1600 degrees Celsius and then blasted with intense air streams to create thin fibres.[63] The false indication of a "natural wool" based on its name is a marketing ploy and arguably why international mineral wool company rebranded from "Roxul" to "Rockwool" in 2018.[64]

Upon the invention of mineral wool insulation during the industrial revolution in 1840, fibreglass in 1938, and expanded polystyrene 1950, the use of synthetic insulation materials increased in the first third of the twentieth century.[65] The industrial processes of the aforementioned synthetic insulation materials are heavily induced with petrochemicals, plastics, and foams. Over the last two decades, more natural fibres are being used as alternatives to synthetic insulation in the construction industry.[66] Turning to naturally grown insulative fibres exhibiting renewable and sustainable properties can be the start of a radical decrease in the embodied energy weight of buildings. Existing in the scope of this project

Fig. 1.28 Mineral wool insulation. Photograph by iStock.

Fig. 1.29 Fibreglass insulation. Photograph by iStock.

Fig. 1.30 Expanded polystyrene insulation. Photograph by iStock.

62 Andrzej Obmiński, 'Asbestos in Building and Its Destruction', *Construction and Building Materials*, 249 (2020), 118685 <https://doi.org/10.1016/J.CONBUILDMAT.2020.118685>.

63 Moe, p. 153.

64 'Hello ROCKWOOL: Stone Wool Manufacturer ROXUL Inc. Is Now ROCKWOOL in North America' <https://www.rockwool.com/north-america/about-us/news/hello-rockwool/> [accessed 6 October 2021].

65 Dávid Bozsaky, 'The Historical Development of Thermal Insulation Materials', *Periodica Polytechnica Architecture*, 41.2 (2010), 56 (pp. 49, 51–53) <https://doi.org/10.3311/pp.ar.2010-2.02>.

66 Niels de Beus, Michael Carus, and Martha Barth, 'Carbon Footprint and Sustainability of Different Natural Fibres for Biocomposites and Insulation Material Study Providing Data for the Automotive and Insulation Industry MultiHemp', *Hempinc.Com*, March, 2019, 4–45 <www.nova-institut.eu>.

are the fibres the human skin is in constant contact with. Quilted and puffer jackets are often filled with toxic fibres such as polyester or naturally exploited fibres like duck down feathers and environmentally intensive cotton.

1.4.1 Polyester

Polyester is a synthetic textile made from plastic pellets that are melted at high temperatures and extruded to form long threads in a process called melt spinning.[67] As a manufactured fibre, there is freedom for the designer to achieved desired material properties, however its micro-toxins have great negative impacts on the health of all living organisms and the environment.[68] During production, polyester uses high energy, emitting 14.2 kg of carbon dioxide per kilogram produced; in 2015, the production of polyester emitted 282 billion kilograms of carbon dioxide.[69] Polyester sheds microplastics, releasing harmful chemicals and carcinogens into the atmosphere and water where it's ingested by marine wildlife. Although its long-term effects are still unknown, as a petrochemical plastic derived fabric, polyester cannot be recycled and can sit in the landfill for decades.[70]

1.4.2 Down

One of the most used insulative infill natural fibres in cold climates are duck and geese down feathers. These feathers are a soft layer, closest to the duck or goose's skin, located at their chest and belly. Down feathers are known as the best insulator in the fashion industry, providing

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67 Moe, p. 153.

68 Bhalla, p. 60.

69 Material index on polyester CFDA, 'Materials Index & Resources' <https://cfda.com/resources/materials> [accessed 3 April 2022].

70 Common Objective, 'Briefing On Polyester' <https://www.commonobjective.co/article/fibre-briefing-polyester> [accessed 3 April 2022].

more warmth per gram than any other naturally grown fibre.[71] The down industry has gained a lot of controversy due to the ethical concerns of live plucking, that severely harm the animals. Although it is natural, biodegradable, and undoubtedly warm, down feathers remain a co-product of the carbon heavy meat production industry, that additionally cause skin tears and injury to ducks and geese.[72]

Fig. 1.31 Duck down feather. Photograph by Pixabay.

1.4.3 Cotton

While cotton is a natural fibre, conventional cotton cultivation is interconnected with environmental, social, and economic issues. Monoculture planting of cotton involves the use of synthetic fertilizers which have detrimental effects on the soil, depleting nutrients and lowering biodiversity.[73] Conventional cotton cultivation is water intensive, on average using 3,644 cubic meters per ton.[74] Alternatively, organic cotton farming supports biodiversity and healthy ecosystems, increasing soil fertility while using less water – unfortunately less than one percent of cotton is certified organic since it is a more time-consuming method of growing, more costly, and requires additional skill and knowledge.

Fig. 1.32 Cotton fibre. Photograph by iStock.

Monoculture practices, however well meaning, do not meet true restoration but provide a mechanistic view of nature in which the land is a machine and humans control

Fig. 1.33 Milkweed silk fibre. Photograph by Pixabay.

71 Matthew Edward Fuller, 'The Structure and Properties of Down Feathers and Their Use in the Outdoor Industry', *PhD Thesis, Univ. of Leeds*, April, 2015.

72 Good on You, 'Material Guide: Is Down Feather Ethical and Sustainable?' <https://goodonyou.eco/material-guide-down-feather/> [accessed 3 April 2022].

73 Kathleen Delate, Ben Heller, and Jessica Shade, 'Organic Cotton Production May Alleviate the Environmental Impacts of Intensive Conventional Cotton Production', *Renewable Agriculture and Food Systems*, 36.4 (2021), 405–12 <https://doi.org/10.1017/S1742170520000356>.

74 Material index on cotton CFDA.

it.[75] It is a non-reciprocal and one-sided relationship with the land based on a reductionist and materialist paradigm. The Indigenous world view sees the ecosystem as subjects and beings of sovereign identity that become the drivers in charge of the land.[76] In the Indigenous perspective, acknowledging plants as subjects and teachers is a vital part in connecting land with people and achieving successful reciprocal relations.[77]

1.4.4 Milkweed Silk Fibres

Compared to down feathers, polyester, and cotton, milkweed silk fibers offer a more sustainable lining insulation material due to its low embodied energy content, local sourcing, biodegradability, and ability to improve the biodiversity of the habitat it grows in. Exhibiting extensive loft to disperse on the land, the milkweed silk fibres are tubular structures filled with still air.[78] Microscopically, the natural structure of milkweed silk fibres and down feathers both contain hollow tubular structures and high degrees of loft that result in their high thermal insulation values. The thermal insulation value of milkweed silk fibres are comparable to the insulation values of down feathers and are warmer than cotton fibres.[79] The air-filled silk fibre "parachute", designed to float with the wind, makes a very lightweight insulation material.

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75 Kimmerer, *Braiding Sweetgrass*, p. 331.

76 Kimmerer, *Braiding Sweetgrass*, p. 331.

77 Kimmerer, *Braiding Sweetgrass*, p. 331; Kimmerer, 'Mishkos Kenomagwen, the Lessons of Grass: Restoring Reciprocity with the Good Green Earth', p. 28.

78 T Karthik and R Murugan, 'Milkweed-A Potential Sustainable Natural Fibre Crop', 2016, p. 119 <https://doi.org/10.1007/978-981-10-0566-4_6>.

79 Crews and others.

The shimmering quality of the milkweed silk fibres is due to its hydrophobic nature, where each fibre is encased in a natural wax, providing a buoyancy property, withstanding environmental conditions like rain and snow as it disperses the plants seeds.[80] In contrast, duck and goose down[81] feathers, as well as cotton[82] fibres, are hydrophilic, losing thermal qualities once in contact with water. During the Second World War, the harvesting of the milkweed silk fibres by American citizens was advertised as a heroic act of service, resulting in the production of a million life jackets replacing the previously used kapok fibres.[83]

The natural wax layer on the milkweed silk also provides more ultraviolet protection than both down feathers and cotton fibres.[84] The complexity of down feather fibrils and their three dimensionality make it harder to control fibre thickness and directionality.[85] Analyzing milkweed silk fibres as a harvested material translated from the land to the human body explores softness and warmth and informs future potential of the plant. Its physical properties act as the starting point to determine the design of an experience and experiment of thermal delight on the human body that engages with transforming environmental conditions and enhances living ecological relationships.

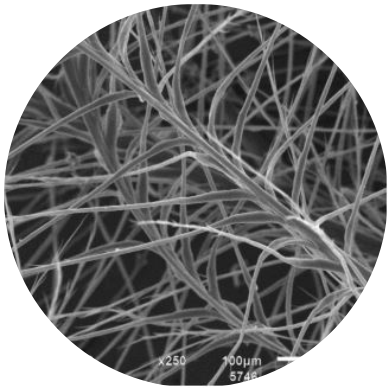

Fig. 1.34 Duck down feather under a microscope. Photograph by Matthew Edward Fuller.

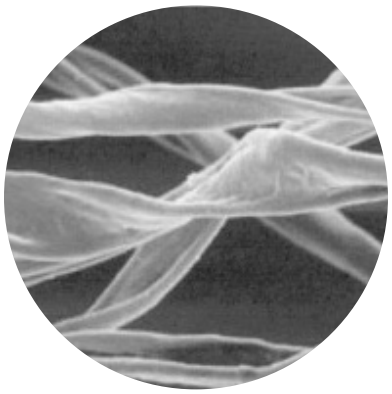

Fig. 1.35 Cotton fibre under a microscope. Photograph by M. Dochia et al.

Fig. 1.36 Milkweed silk fibre under a microscope. Photograph by Pierre Ovlaque et al.

80 Karthik and Murugan, p. 115.

81 Fuller, p. 43.

82 T Alomayri and others, 'Effect of Water Absorption on the Mechanical Properties of Cotton Fabric-Reinforced Geopolymer Composites', *Journal of Asian Ceramic Societies*, 2.3 (2014), 223–30 (p. 225) <https://doi.org/10.1016/j.jascer.2014.05.005>.

83 Del Tredici.

84 Karthik and Murugan.

85 Fuller.

1.5 Thermal Delight

In addition to toxic and unethical origin of insulative fibres, modern insulation is hidden, devoid of direct visual and physical qualities. This removes any opportunities for the human body to touch or see the fibres, thereby lacking pleasurable sensorial engagement. In Kiel Moe's *Insulating Modernism*, architect Iñaki Abalos writes that insulation materials in buildings are often dismissed as irrelevant layers or over designed with maximum R-values in the attempt to minimize energy consumption.[86] Modern insulation filling wall assemblies can take up anywhere between a few centimeters to forty centimeters.[87] Similarly, insulation materials in clothing are also hidden and designed with high CLO values to reduce energy used by the body when returning to a state of homeostasis.

Lisa Heschong makes the point that as a hidden layer within the wall assembly, the thermal abilities of insulating fibres are only fully appreciated by the builder of the wall, who is aware of its anatomy.[88] The variability in thermal experiences on the body can allow a higher appreciation of the thermal function of an object, such as removable insulation mediating warmth and blind shutters controlling the shade. In the Middle Ages, exposed systems of insulation like carpets and tapestries were hung on the walls during the cold weather.[89] When the warm weather arrived, the exposed insulation systems were removed, visually and physically transforming the microclimate of the space. As visually appealing, physically warm, and seasonal, the hung carpets and tapestries conveyed thermal delight.

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86 Moe, p. 8.

87 Charles John, 'R49 Insulation Thickness Guide', *Airflow Academy* <https://airflowacademy.com/r49-insulation-thickness-guide/> [accessed 18 April 2022] R1.5 insulation is a few centimeters in thickness while R49 insulation can come up to forty centimeters in thickness.

88 Heschong, pp. 51–52.

89 Heschong, p. 52.

Andreas Weber's theory of ecological enlivenment is consisted of subjects in constant reciprocal transformation with one another.[90] Similarly, the human body can mediate its surrounding natural environment through a designed transforming thermal layer. Through a pleasurable and warm experience on the skin, harvested milkweed silk fibres become the tool to connect back to the land and life forms transformational processes. Through its physical attributes, milkweed silk fibres show potential use as a biomaterial insulating fibre and a material for providing thermal delight on the human body.

Lisa Heschong writes that while the uniformity in temperatures is monotonous and unnatural, thermal delight is measured by the skins response to fluctuating physical and psychological warmth, contrasting modern standards of thermoregulation and static thermal conditions on the human body.[91] In this thesis, thermal delight engages visual and tactile senses to respond psychologically and physically to changing thermal needs of the human body. Thermal delight is designed and tested through the following parameters defined by the author:

- Material origin (2.1)
- Material intimacy (2.2)
- Material warmth (2.3)
- Material adaptability (2.4)

90 Weber, *Enlivenment: Toward a Poetics for the Anthropocene*, p. 50.

91 Heschong, pp. 36, 51.

The parameters affect the degree of thermal delight experienced on the body where origin is the material's proximity to nature and intimacy is the material's proximity to the human body. Warmth is the material's designed/manipulated thermal capacity while adaptability is the transformational quality of the completed garment on the body.

The innate human desire to adapt to environmental conditions is tested along the human skin in the form of garment architecture. The ephemeral ecological condition (adapting common milkweed) and ephemeral human condition (desire for thermal delight) studied are applied. With a desire for a tactile and an intimate connection to the land, this thesis applies transformational and symbiotic relationships studied to a garment on the body using harvested milkweed insulating fibres. Through the design and construction of a milkweed fibre-filled garment, this research explores the fibre's potential to design for thermal delight through visual and tactile pleasure (material intimacy), climatic variation (material adaptability), structured warmth (material warmth) and an intimate connection between body and land (material origin). The wearable garment tests the sensorial parameters to make human-material and human-land connections.

Fig. 1.37 Fabrication process of garment. Autumn 2022. Photograph by Shabaan Khokhar.

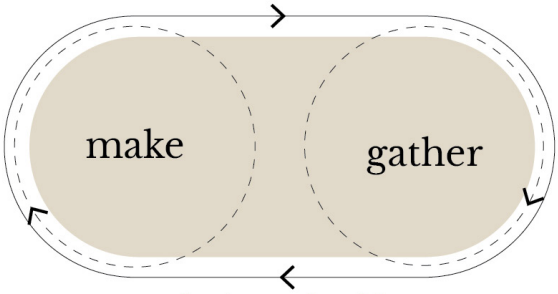
body

gathering and making

"*[Transforming] from wholeness as a living plant to fragmented strands and back to wholeness... the dual powers of destruction and creation that shape the world. [Transformation] is also the journey of a people.*" [1]

Robin Wall Kimmerer, *Braiding Sweetgrass*

1 Robin Wall Kimmerer, *Braiding Sweetgrass* (Milkweed Editions, 2013), p. 283.



gathering and making

ephemeral garment

2.0 Methodology

/ ex situ

Researching the common milkweed as a plant and as a harvested material provides a holistic framework to begin exploring the material potential of the fibres. Engaging tactile and visual senses, responding to the bodies' varied thermal desires, and connecting the body back to the land are the main driving experiential characteristics to achieve thermal delight in garment architecture. This thesis defines the following design parameters as variables that affect our perception and experience of thermal delight in fabrics: **material origin** (2.1), **material intimacy** (2.2), **material warmth** (2.3) and **material adaptability** (2.4). The next step is to design and create a garment that provides a direct sensorial experience on the human body to tests the defined parameters of thermal delight.

2.1 Material Origin / Fibre as Insulation

With a desire to connect to the land, this thesis defines material origin as the proximity of the material to the land, referring to the sustainability of the material and its life cycle assessment. This design parameter prioritizes the importance of maintaining a closed loop back to Earth when following the life cycle of the fibres and fabric used for the garment. While referring to its environmental sustainability, material origin also considers the well-being of humans and other-than-humans involved in harvesting and processing the material through methods like ethical sourcing and honourable harvesting. Ethically sourced materials consider the impacts materials have on humans and communities that create them while the Indigenous tradition of the honourable harvest is a set of principles that considers other-than-human species involved in the harvesting of the material.

Fig. 2.1 Dried milkweed pods and stems. Autumn 2022. Photograph by Shabaan Khohkar.

2.1.1 Gathering References

Engaging with natural materials through embodied first-hand experienced with the human body reflects the surrounding local ecology and creates a distinct sense of place.[2] Material type can have great effect on humans' emotional stimulation; softer materials to the touch such as velvets and furs have been proven to evoke more pleasant emotions.[3]

This thesis uses organic milkweed silk fibres as an insulative infill material which ensures awareness of material origin. The use of the soft fibres responds to the desire to connect to the land by enveloping the body with a material directly from it. Material circularity is carried through in the use of biodegradable materials exhibited in the silk shell, the silk thread, and the infill milkweed silk fibres.

As highlighted in the previous chapter, milkweed silk fibres provide adequate thermal insulation values to replace down feathers in garment insulation infill. Previous work that has successfully infilled garments with milkweed silk fibres includes work by companies *May West*[4], *Not Down*[5], and *Quartz Co.*[6] By making use of the milkweed silk fibres, the three companies claim to potentially improve the habitats of milkweed plants and thus increase habitats for the endangered monarch butterfly.

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2 William Browning, Catherine Ryan, and Joseph Clancy, '14 Patterns of Biophilic Design', 2014, 60.

3 Cyril Bertheaux and others, 'Emotion Measurements Through the Touch of Materials Surfaces', *Frontiers in Human Neuroscience*, 13 (2020), 455 <https://doi.org/10.3389/FNHUM.2019.00455/BIBTEX>.

4 Rebecca Burgess and Courtney White, *Fibershed: Growing a Movement of Farmers, Fashion Activists, and Makers for a New Textile Economy* (Chelsea Green Publishing, 2019), p. 277.

5 Le Lin, 'Not Down: Milkweed Jacket' <https://www.behance.net/gallery/90896739/NOT-DOWN-Milkweed-Jacket>.

6 Kelsey Begg, 'The Urban Winter Parka Made with Milkweed' <https://altitude-blog.com/en/altitude-sports-x-quartz-co-urban-winter-jacket-with-milkweed/>.

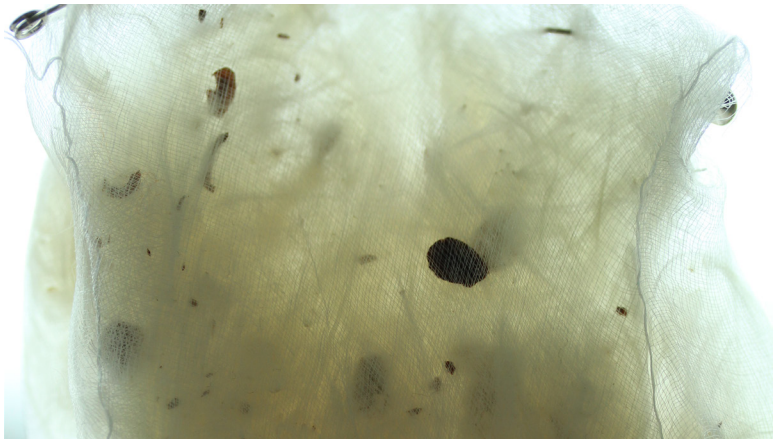

Fig. 2.2 Soft composite material. Handwoven silk gauze, milkweed silk fibres, milkweed seeds, silk thread.

Fig. 2.3 Soft milkweed silk fibres from harvested milkweed pods.

Fig. 2.4 *Quartz Co., Altitude Sports* and *Monark* collaborative parka and care/content label. Photographs by Kelsey Begg. https://www.altitude-sports.com/a/blog/altitude-sports-x-quartz-co-urban-winter-jacket-with-milkweed/

In addition, the limited quantity of fibres required to achieve high thermal insulation values and thus providing a very light product is highlighted. While the three companies mention the ethical origin of the fibres being animal-free and directly harvested from land, *May West* and *Not Down* follow through with utilizing natural materials in all aspects of their garments while *Quartz Co.* does not.

Quartz Co., a Quebec company specializing in making jackets and parkas, launched a line of milkweed insulated parkas alongside *Altitude Sports* and *Monark*. The company's use of milkweed silk fibre insulation is marked on their jackets as '100% natural plant-based fibre cultivated locally', however, their jackets are filled with only fifty percent milkweed fibres, while the other fifty percent is filled by plastic-based polyethylene.[7] They also use polyester and nylon fabrics for the shell and lining of their jackets.[8]

To hold the milkweed silk fibre insulation, *May West* uses a cotton canvas exterior fabric, a naturally dyed cotton liner and wooden buttons which together maintain the earthly quality of the garment. Additionally, *May West* highlights the collaboration with rural communities in and around the city of Vermont in harvesting and supplying the milkweed silk fibres.[9]

7 Begg.

8 Begg.

9 Burgess and White, p. 277.

Not Down is a student project which infills milkweed silk fibres inside the shells of 100% naturally dyed and unbleached cotton, promoting their stance against animal cruelty, fast fashion, and labour exploitation. The company makes a statement on the generational migration of the butterfly through a garment that is envisioned in three generations, each generation providing more warmth than the previous.[10] While both *May West* and *Not Down* provide garments made from organic fibres beyond the use of milkweed silk fibres, the origin and sourcing of cotton used is unclear and as highlighted in ch. 1.4.3 can be originated from soil depleting cotton monocultures.

For *Quartz Co.* the milkweed silk fibres seem to exist in the jackets as feathers would, free and exhibiting maximum loft while *May West* and *Not Down* treat the silk fibre as batting material, compressing the fibres and turning the individual air-filled tubes into mats of insulation. Most importantly, all three companies completely isolate the milkweed silk fibres from the exterior, disconnecting any opportunity of tactile or visual connection to the material.

10 Lin.

Fig. 2.5 *May West* milkweed batting filled garment. Photograph by Nick Tenney. https://www.charlottexcsullivan.com/may-west

Fig. 2.6 *Not Down* vest and care/content label. Photographs by. https://www.behance.net/gallery/90896739/NOT-DOWN-Milkweed-Jacket

2.1.2 Making the Garment

To begin making and working with milkweed silk fibres as a material, the fibres need to be harvested. To collect the milkweed silk fibres, the previously studied Indigenous method of the honourable harvest is carried out on various sites. Honourable harvesting ensures an ethical and sustainable origin of the fibres needed for the purpose this thesis. As analyzed in ch. 1.2.2, the milkweed silk fibres are harvested after the monarch butterfly has migrated south and is no longer in need of the milkweed plant for nourishment and larva habitat. The following is a first-person essay written by the author evoking emotional experiential responses to the act of *honourable harvesting*.

**The honourable harvest is explained in length in ch. 1.3. The following are embodied experiences of honourable harvests carried out by the author on three sites between the years 2021 and 2022.*

Fig. 2.7 Milkweed plant, monarch butterfly, and companion species seasonal cycle.

Honourable Harvesting

To ask from the living Earth for a piece of its life is nothing but an honour and a privilege to be tended and nurtured. Just like myself, the land is living and ephemeral, carrying on its back populations of organisms, complex ecosystems, and intricate roots. From hidden and complex systems of mycelium in the soil to bright orange roosting colonies of monarch butterflies, each living organism plays a role in sustaining the Earth. To touch and reach out is to become a part of the intricate cycles that exists. Our touch must be a careful embrace. An intentional tread.

To ensure an honourable harvest I *intend*, I *search*, I *harvest*, and I *give*.

I intend

The practice of the honourable harvest needs an intention and mindfulness. Before setting out to harvest milkweed silk fibres, I orient myself with the well-being of the ecology in mind and set out my intentions. I intend to search for wild milkweed colonies of at least six shoots before preparing for harvest. I intend to leave the roots untouched, and scatter harvested seeds back to the milkweed colony.

I intend to only harvest in the autumn when the monarch butterflies have gone on their journey south, and the milkweed pods are almost ready to burst and reveal their parachute silk fibres. My harvest will not impede on the monarch butterfly and common milkweed symbiosis, it will rather become an added encounter to the existing cycle. An encounter that will leave the colony with more hope and life for its future.

I intend to gather an approximate of three grocery bags of milkweed silk fibres to experiment and fabricate with. Still, I set out no expectations and let the plant decide how much of its fruit it's willing to share. I proceed, led by the ephemeral ecology.

I search

I park on the side of a highway in Gatineau, situated on the unceded Anishinaabe Algonquin territory

I walk along the edges of crop fields in Ottawa, situated on the unceded Anishinaabe Algonquin territory.

I hike to a meadow underneath a bridge overpass in Kitchener, situated on the Haldimand Tract territory of the Neutral, Anishinaabe, and Haudenosaunee peoples.

Each site abundant with milkweed colonies, thriving in the wild on untouched green, beside highly disturbed land.

In the autumn breeze, I enter the habitat of milkweed colonies. I recognize enough shoots and greet the plant by lightly touching the stems, leaves, and pods. With no signs of resistance or fragility, the colony proves to be healthy and willing to share. The path shows no trace of recent tracks, and the stems look untrimmed, proving no signs of previous harvest. No visible organisms are occupying the leaves, pods, or stem. I proceed with the harvest.

I harvest

As I collect, the words of Indigenous Pueblo philosophy repeat in my head

Take care. Tread cautiously.

I take less than half.

From each shoot, I gather no more than one pods worth of silk fibres. from each colony, I harvest from no more than half of the shoots.

I give

I give back by *sharing*.

Although I gathered the fibres, they do not belong to me. I acknowledge that whatever I do with the fibres will be a shared. I will share the knowledge the fibres will provide me. I will share their spirit with colleagues in the form of created artifacts.

I give back by *gifting*.

I leave the site in a better condition by pruning surrounding shrubs and removing dead matter. I scatter seeds on the harvested site and on new places nearby to spread the plants' population. I gift seeds to family and friends and sow seeds in my backyard.

I give back by *returning*.

I make the artifacts as ephemeral subjects with their death in mind. At the end of their life, the spirit encased within the hundreds of individual fibrils is returned to unite once again with the living and breathing soil. Encased with fibres and seeds, I plan the return of the artifacts back to the land as ephemeral subjects. Sewn artifacts will become sown threads.

Fig. 2.8 (above) Harvesting fibres with Brenda and Brendan. Meadow, Kitchener, Autumn 2022.
Fig. 2.9 (right) Harvesting pods with Don. Side of highway, Gatineau, Autumn 2021.

Milkweed silk fibres are harvested to recreate on the human body the experience of warmth and softness exhibited on the land. Harvesting warmth is the physical act of gathering milkweed silk fibres from the land to gain proximity to the land and form rooted connections.

In observing and analyzing the common milkweed plant, one rediscovers the transformational relationships responsible for ecological life. As discussed in ch. 1.1, ecological relationships are ephemeral encounters that transform both sides. In harvesting the common milkweed plant, a third side involving the human is created. With the embodied touch of the milkweed silk fibres, an encounter is formed that expands the existing ecological concentric circles[11] of relationships.

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11 Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (Durango: Kivaki Press, 1994), p. 119

In Look to the Mountian Cajete says 'Concentric rings radiate from everything and every process. The concentric ring provides a visual symbol of relationship; it is a way of visualizing how all processes radiate concentric rings, which in turn affect other rings of other processes. The symbol of concentric rings is useful in seeing how one thing affects another, how one thing leads to another, and how one thing is connected to another. The concentric ring is also a basic symbol of wholeness.'

Fig. 2.10 Harvesting pods with Mama. Edge of crop field, Ottawa, Autumn 2021.

2.2 Material Intimacy / Visibility and Tactility

This thesis defines material intimacy as the visible and tactile quality of the material. To enhance the studied properties of the fibres on the epidermis, fibre softness and fibre translucency in the visible and haptic qualities of the material are considered.

2.2.1 Gathering References

As the largest and most sensitive organ on the human body, the skin is where thermal delight can be immediately experienced. As the oldest organ, it is the first human medium of communication, mediating the human experience with the world.[12] Relying on the sense of sight alone to create meaningful spatial experiences suppresses the haptic sense and pushes the body to isolation. The domination of the eye can weaken other senses and the capacity for empathy, compassion, and participation with the world.[13] When hegemony is solely given to the sense of sight, there is a gradual increasing separation between the self and the world.

In comparison to other senses, the sense of sight is the most distant from the surrounding world, separating humans from the rest of the world while other senses work to unite the human body with its surroundings.[14] While the sense of vision validates the haptic sense, when

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12 Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 2012, p. 12.

13 Pallasmaa, p. 24.

14 Pallasmaa, pp. 28–30

In The Eyes of the Skin, Pallasmaa compares the separation between humans and the rest of the world to the development Western ego-centrism; a limited world view where 'vision separates one from the world while other senses unite'.

vision is isolated, the human experience of the world becomes limited. The tactile sense is what integrates human experiences of the world directly with oneself. It is through the skin in which humans can most efficiently and accurately communicate and understand the world of materials and surrounding climatic conditions around. As an example, Alto university students design a plant-based textile filling in a project titled *Fluff Stuff* which begins to embody the visual and haptic qualities of thermal delight.[15] By using a translucent shell, the plant fibre filling, which includes harvested cattails from rewetted wetlands, are visible to the wearer thereby making a statement on sustainability and fashion. While the material origin of the shell is unclear, there's an effective translucency of the fibres and ephemerality of the garment shown.

Directly connecting the body with the milkweed silk fibres means not only a visual connection, but also a haptic connection that counters the isolated and hidden nature of the fibres in modern insulated garments. A soft, visible, and ethically sourced exterior for the garment is needed to make the sensorial connection with the harvested milkweed silk fibres.

Fig. 2.11 *Fluff Stuff* vest. Photographs by Aalto University, Mikko Raskinen and Anna Berg.

15 Jane Englefield, 'Fluff Stuff Is a Plant-Based Textile Filling' <https://www.dezeen.com/2022/09/12/aalto-university-students-plant-based-textile-filling-created/?utm_medium=email&utm_campaign=Daily Dezeen&utm_content=Daily Dezeen+CID_699a3bcbabe3e2452836207e424766ca&utm_source=Dezeen Mail&utm_term=Fluff Stuff is a plan>.

2.2.2 Making the Garment

Many experimental material tests were carried out to gain a better understanding of the material. Tests included spinning the fibres, covering the fibres in a bio-resin, and combining milkweed silk fibres with the plants' bast fibres. Working with the material in a translucent shell in early experiments is the method chosen to develop and carry forward in the form of a full-sized wearable garment. While each method prioritizes the visual exposure of the fibres, using a translucent and soft shell engaged most delightfully with visual and tactile senses. (fig. 2.12)

Fig. 2.12 Early material experiments 1.

- **a.** Transparency and rigidity test with warp stitching of composite material.
- **b.** Transparency and rigidity test with warp and weft stitching of composite material.
- **c.** Transparency and rigidity test with weft stitching and hard pleats of composite material.
- **d.** Ruching test of composite material with anisotropic directionality of milkweed silk fibre.
- **e.** Origami manipulation with isotropic directionality of milkweed silk fibre test 1.
- **f.** Origami manipulation with isotropic directionality of milkweed silk fibre test 2.
- **g.** Warp and weft directionality of hand-spun milkweed silk fibres.
- **h.** Infusing milkweed silk fibre in bio-resin with warp and weft directionality of fibres.
- **i.** Infusing milkweed silk fibre in bio-resin with anisotropic directionality of fibres.

a.

b.

c.

a.

b.

c.

d.

e.

f.

h.

i.

j.

a.

b.

c.

d.

e.

f.

d.

e.

f.

g.

h.

i.

Various grades of silk gauze were tested for rigidity, translucency, and porosity, ultimately choosing a silk gauze in which the fibres could both be felt and seen through the gauze. A play of material translucencies in the light was an additional deciding factor for the exterior material. The material composite designed constitutes of three layers; loose milkweed silk fibres sandwiched in between two layers of handwoven silk gauze and held in place by white silk thread.

Fig. 2.13 Early material experiments 2.

a. Translucency test with anisotropic directionality of milkweed silk fibre.
b. Translucency test with isotropic directionality of milkweed silk fibre 1.
c. Translucency test with isotropic directionality of milkweed silk fibre 2.
d. Dewaxing milkweed silk fibres.
e. Dyeing milkweed silk fibres in black bean water test 1.
f. Dyeing milkweed silk fibres in black bean water test 2.
g. Hand spinning milkweed silk fibres.
h. Extracting milkweed bast fibres.
i. Carding and hand spinning milkweed silk fibres with milkweed bast fibres.

Fig. 2.14 Loose handwoven silk gauze as shell of the material composite.

Fig. 2.15 Silk gauze infilled with milkweed silk fibres.

Fig. 2.16 Translucency of designed material composite.

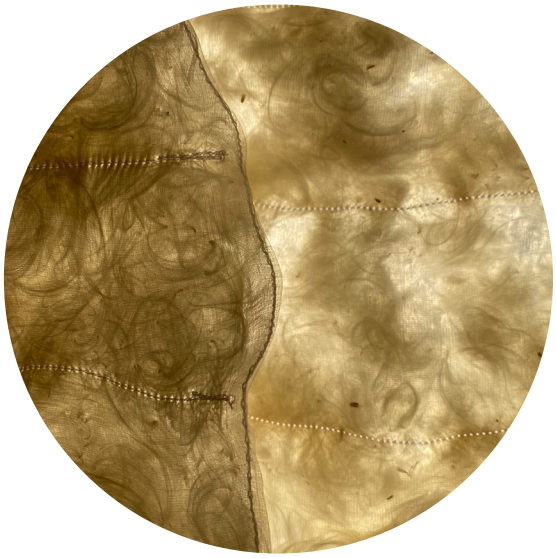

Fig. 2.17 Layering of material composite.

Fig. 2.18 *Vest*. First garment iteration. Loose handwoven silk gauze, milkweed silk fibre infill, milkweed plant seeds, and cotton thread.

2.3 Material Warmth / Manipulating the Shell

With a desire to provide more opportunities for warmth, methods of manipulating the shell making up the material composite are used to help improve thermal performance. In this thesis, material warmth is referred to as designed manipulation of the material composite layers to achieve higher degrees of warmth on the human body.

2.3.1 Gathering References

According to NASA's aerogel insulation technology, trapped, still air is the best-known insulator.[16] Thermal capacity in trapped air is also evident in clothing, where the less the contact between clothing and skin, the better the thermal capacity. Ways of introducing designed trapped air through the architecture of the garment is explored through the manipulation of the milkweed silk fibres and the manipulation of the handwoven silk gauze.

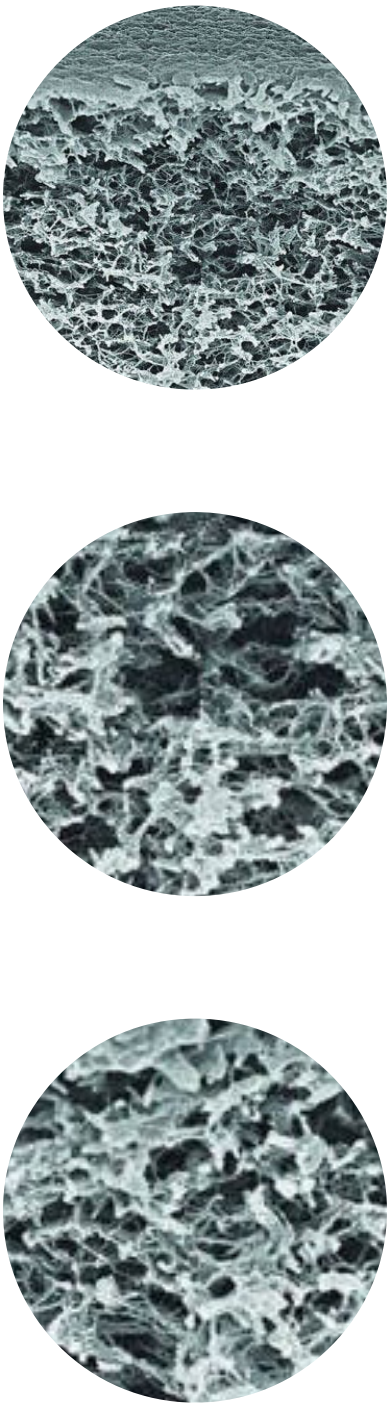

Fig. 2.19 NASA polymer aerogel insulation technology under a microscope. Photograph by NASA. https://newatlas.com/polymer-aerogel-stronger-flexible-nasa/23955/

16 National Space Agency, 'Aerogels: Thinner, Lighter, Stronger' <https://www.nasa.gov/topics/technology/features/aerogels.html> [accessed 5 April 2022]

NASA's silica aerogel insulative technology is composed of 95% air and is the best insulator in the world with a thermal conductivity of less than 0.03 W/mK.

Rei Kawakuba of Comme des Garcons calls her fashion pieces 'objects for the body'. In their spring/summer 2014 collection, the atelier released pieces that transcend the body, suggestive of art sculptures and avoid the 'limitations of the body'.[17] In the large sculptures enveloping the models, Kawakuba pieces suggest new ways the female body can take up space, criticizing an industry that normally celebrates bodies with restrictive parameters. The body is rejected entirely, creating dramatic and sculptural silhouettes, transforming the model's figure. The space created between the models and the garments becomes a part of the design. While creating a new silhouette on the body, it additionally provides opportunity for designed still air and thus further warmth. Through pleating, pattern making and strategic stitching, flat pieces of fabric that would normally drape the human figure now sit beyond the figure. Fervent Comme des Garcons collector Michelle Elie describes the pieces like wearing "a poem, like an expression of the world. The pieces make you dream... like you are a floating cloud...".[18]

Fig. 2.20 Rei Kawakuba of Comme des Garcons spring/summer 2014 collection. Photograph by Amy Troost. https://i-d.vice.com/en/article/qjbwg3/rei-kawakubo-on-hunger-and-power-in-fashion

17 Andrew Bolton, *Rei Kawakubo/Comme Des Garcons: Art of the in-Between* (New Haven: Yale University Press, 2017).

18 Olivia Singer, 'Rei Kawakubo on Hunger and Power in Fashion', *I-D*, 2022 <https://i-d.vice.com/en/article/qjbwg3/rei-kawakubo-on-hunger-and-power-in-fashion>.

Fig. 2.21 (right) Rei Kawakuba of Comme des Garcons, Clothes/Not Clothes gallery of Art of the In-Between exhibition. Metropolitan Museum of Art, New York City, 2017.

Rei Kawabuka's collection contrasts Maria Blaisse's collection, *Onda*, which instead features multifunctional tubular forms that either sculpt various parts of the body or become extensions of the body, making the shape of the body an essential part of the final form.[19] On their own, Blaisse's pieces sit flat and rely on a model to take on a form, whereas Kawakuba's pieces sit unoccupied as sculptures, giving no importance to the physical human body.

19 Maria Blaisse, *The Emergence of Form* (Rotterdam: nai010, 2013), pp. 94–101.

Fig. 2.22 *Onda* by Maria Blaisse. Knitted and felted wool wearable tubes wrapping the body (right) and extending the body (above), 2000. Photographs by Anna Beeke.

Fig. 2.23 Dancer wearing *Pleats Please* by Issey Miyake, 1990. Photograph by Irving Penn.

Fig. 2.24 *Pleats Please* by Issey Miyake, 1989. Photograph by Herb Ritts.

Existing between Kawabuka and Blaisse's work, Issey Miyake's collection *Pleats Please* includes pieces that are light and flexible, translating bodily movement into material form while still allowing a degree of autonomy to the garments.[20] While the pieces do not mimic the body entirely like Blaisse's collection, they transform with the body, reshaping the silhouette at every movement. Miyake's pieces act like kinetic sculptures that expand and contract when worn, where the 'memory' of the fabrics still holds its pleats as it takes on new forms of the figure it covers.[21]

Miyake pioneered the concept of creating garments from *A Piece of Cloth (A-POC)* which was a manufacturing method in which fabric, texture, and garment components is all made from a single piece of fabric and in a single process.[22] This method provided continuity in the garment, made from one pattern with minimal seams. The pieces of *Pleats Please* and *A-POC* explore the relationship between body and dress and the space created in between. The empty space, once again, becomes an essential part of the design, playing a role in the thermal and emotional experience. It exists between body and material, whether it be between each pleat, fold, smock, or the distance the material is offset from the body.

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20 Issey Miyake, *Pleats Please* (Taschen, 2012).

21 Brooke Hodge and others, *Skin + Bones: Parallel Practices in Fashion and Architecture* (London: Thames & Hudson, 2006), p. 164.

22 Hodge and others, p. 164.

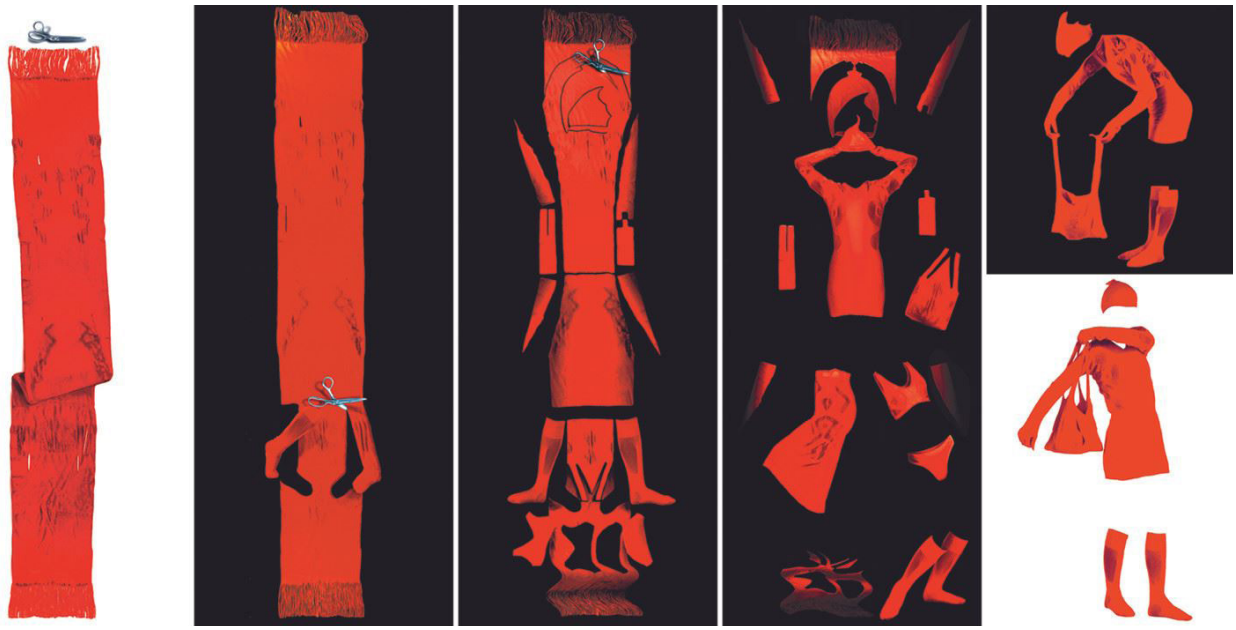

Fig. 2.25 *A-POC* by Issey Miyake, 1997. Photograph by Pascal Roulin.

2.3.2 Making the Garment

Fig. 2.26 Milkweed silk fibres ex situ.

Fig. 2.27 Milkweed silk fibres in situ.

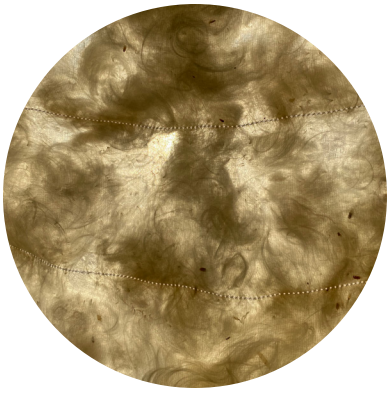

Fig. 2.28 Milkweed silk fibres ex situ.

As opposed to the first garment iteration, which used two flat pieces of silk gauze encasing loosely filled silk fibres, methods of pleating and smocking are tested to add three-dimensionality and designed airgaps. The flat surface of a fabric transforms into a three-dimensional spatiality with simple sewing techniques like pleating and smocking, which involve the folding and gathering of the fabric in a repetitive and rhythmic pattern. These ways of gathering fabric can increase the thermal capacity of a garment by designing for cells of trapped air throughout the garment. Naturally, silk offers excellent thermal protection due to its low air permeability.[23] While the loose silk weave shell allows the wearer to interact physically and visually with the milkweed silk fibres (refer to *2.2 material intimacy*), the loose weave influences the thermal properties of the shell and overall composite material. An opaque silk shell would perform better to retain heat but will in turn influence the designed *material intimacy* parameter.

Pleats are used to create volume in a garment through the design and application of folded creases on the fabric, resulting in a narrower circumference. Pleats can be pressed with the use of heat to maintain a sharp edge crease, or can be left unpressed, resulting in soft and rounded folds.[24] Smocking is a technique used to gather fabric at various points so that it can stretch, resulting in both a flexible and fitted fabric. Historically, smocking was used in areas where buttons were undesirable such as cuffs, bodices, and necklines.[25] Like pleating, smocking requires reducing the length of the fabric to achieve a three-dimensional effect. Smocking techniques can

23 Brojeswari Das and others, 'Comparative Studies on Thermal Comfort Properties of Eri Silk, Mulberry Silk, Wool and Linen Fibres', *Journal of The Institution of Engineers (India): Series E*, 102.1 (2021), 145–54 (p. 153) <https://doi.org/10.1007/S40034-021-00208-2/FIGURES/8>.

24 Paul Jackson, *Complete Pleats*, 2015.

25 Colette Wolff, *The Art of Manipulating Fabrics* (Krause Publications, 1996).

begin with a grid of lines and dots showing corners of the grid to be gathered and connected.[26] Applying pleating and smocking techniques to the outermost layer of the material composite allows the milkweed silk fibres to freely move within the garment and further accentuate the three-dimensionality provided by the folds.

26 Wolff, p. 141.

Fig. 2.29 Pleating silk gauze shell.

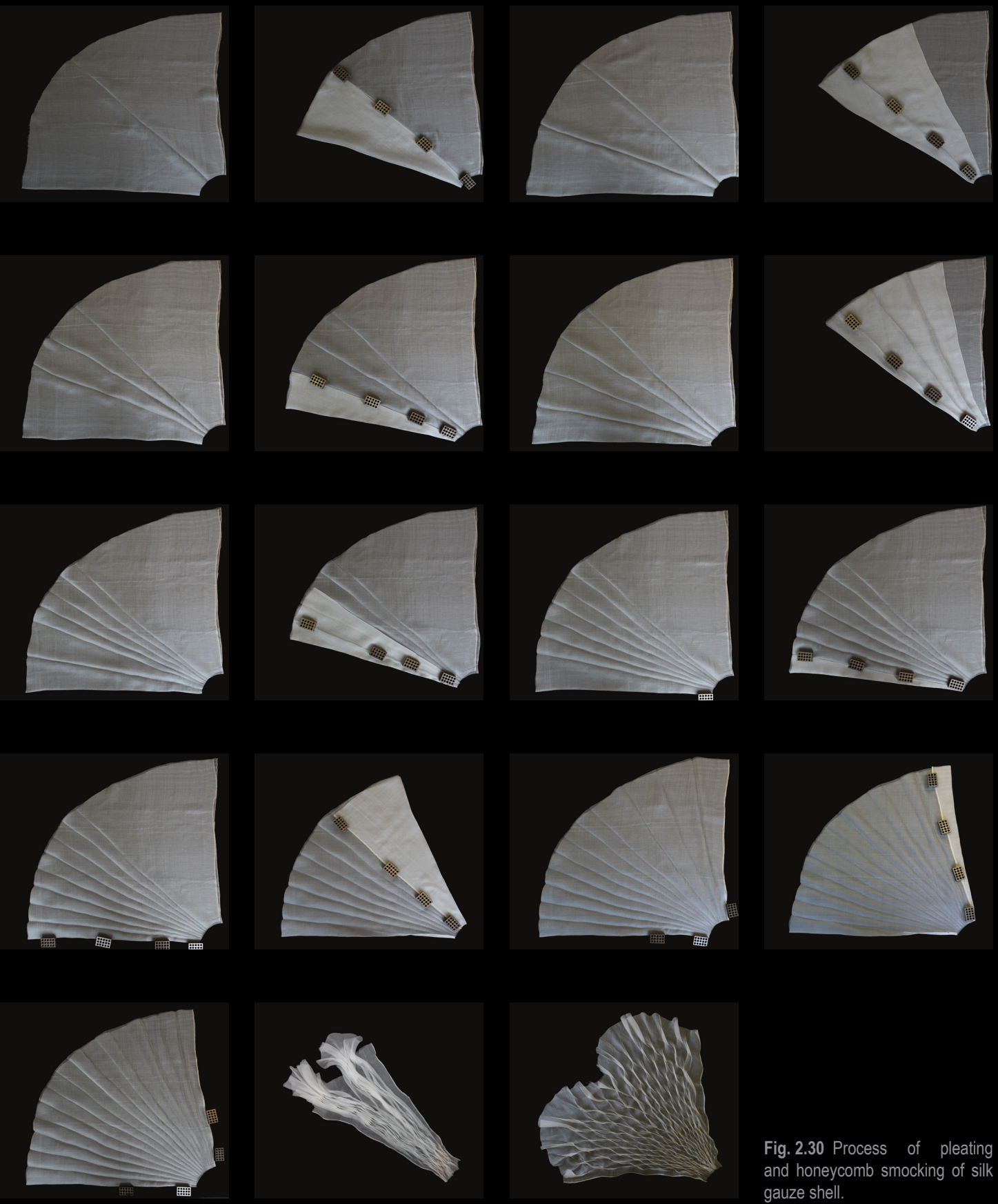

Fig. 2.30 Process of pleating and honeycomb smocking of silk gauze shell.

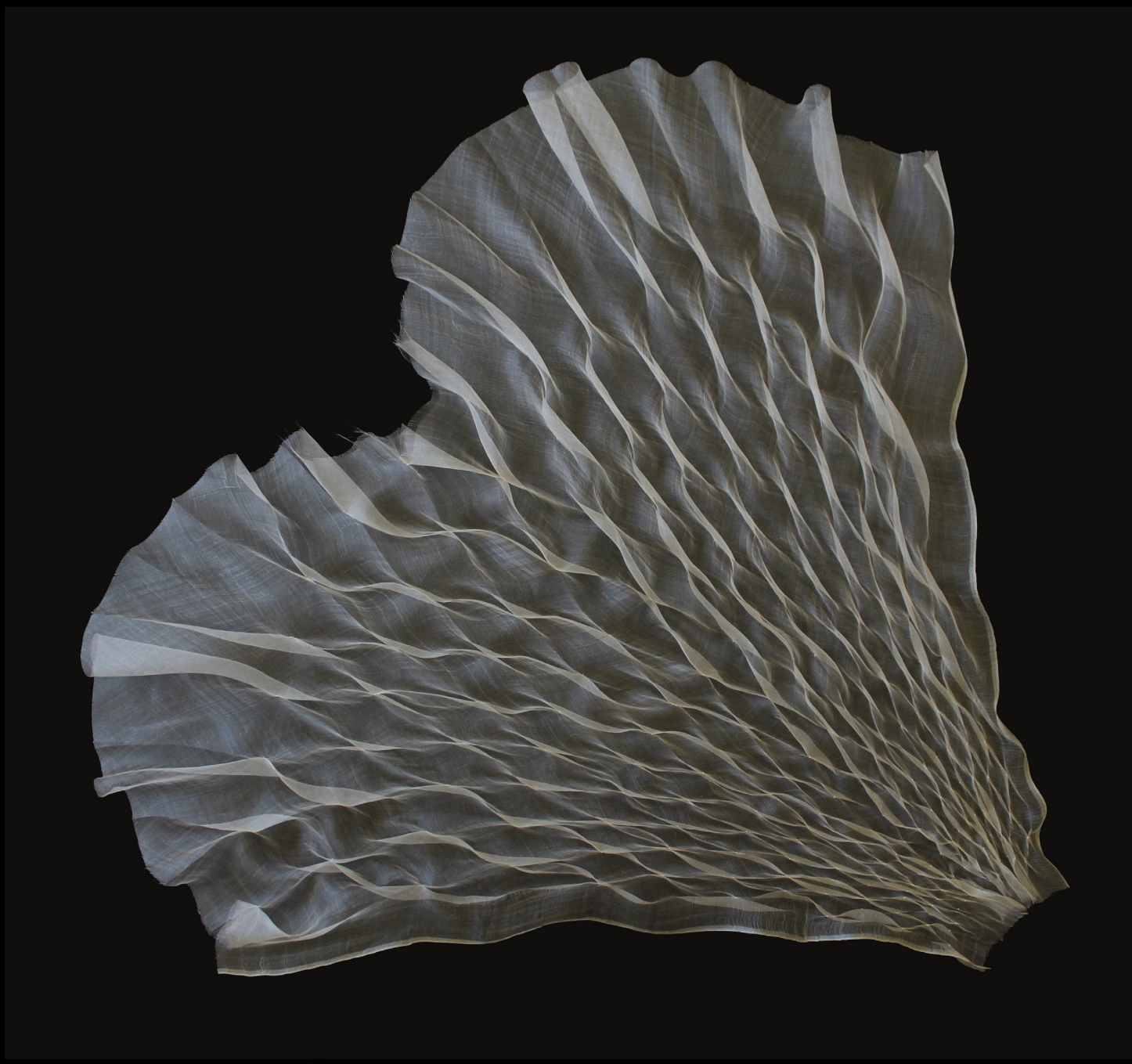

Fig. 2.31 Final 1 out of 4 silk gauze shell, blind tucks smocked with honeycomb stitching.

Fig. 2.32 *Skirt.* Silhouette manipulation of garment shell design warming the lower torso and legs.

Fig. 2.33 *Vest.* Silhouette manipulation of garment shell design warming the torso and upper legs.

Fig. 2.34 *Skirt (tucked).* Silhouette manipulation of garment shell design concentrating warmth on upper legs.

Fig. 2.35 *Vest (tucked).* Silhouette manipulation of garment shell design concentrating warmth on torso.

When given the space and opportunity to fly, it is reminiscent to how the silk fibres are found in nature – freely dispersing the seeds in the atmosphere. The irregularity and sporadic nature of the milkweed silk fibres increases its loft, thermal capacity, and its freedom to move in the garment as the body moves in space.

Taking inspiration from Kawabuka, Blaisse, and Miyake to manipulate the silhouette of the body and create an intentional designed space between body and dress, pleating and smocking methods of the silk gauze were tested and used to hold the milkweed silk fibres.

Blind tucks smocked with honeycomb stitching into cellular formations are created to encase the milkweed fibres. The cells of fabric provide some control over the fibres while the wearer freely moves about in the garment. This was tested in a material composite sample for continuity and ability to hold fibres. (fig. 2.36)

Fig. 2.36 Final material composite. Loose handwoven silk gauze, milkweed silk fibre infill, milkweed plant seeds, and silk thread.

Fig. 2.37 Final garment design with diverging pleats, gradually increasing in size.

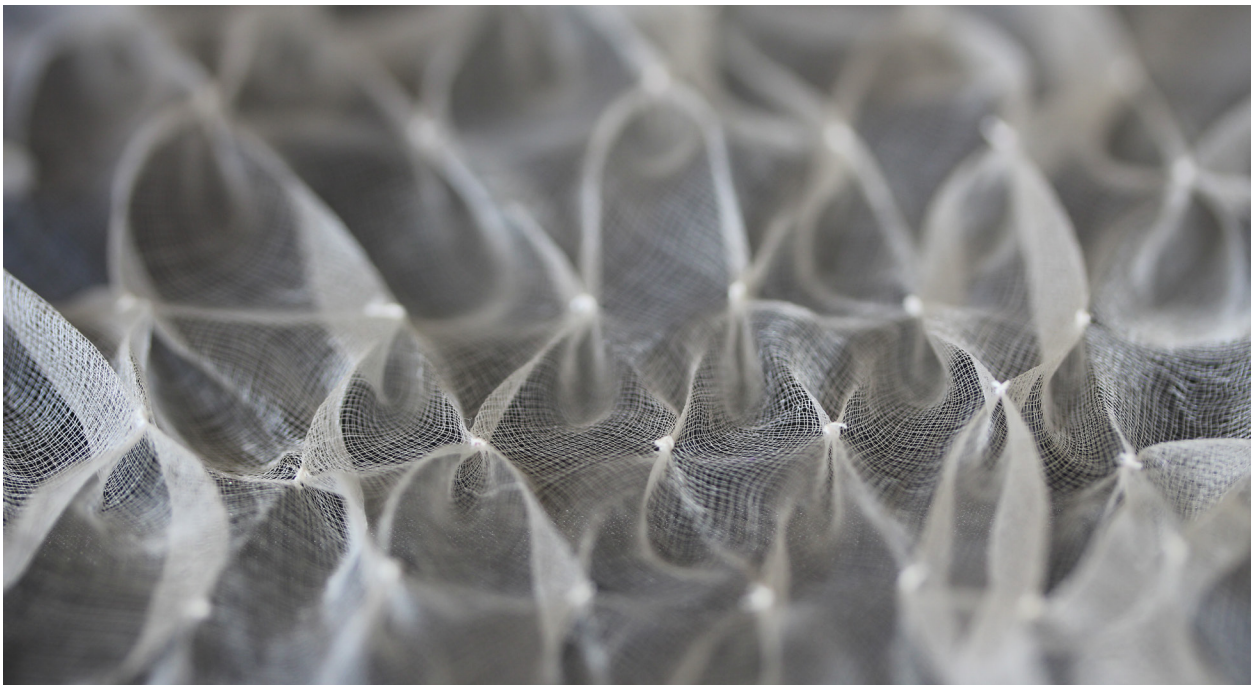

Fig. 2.38 Honeycomb smocking exhibiting hard pleats, revealing stitching points.

Fig. 2.39 Honeycomb smocking exhibiting soft pleats, revealing cellular formations.

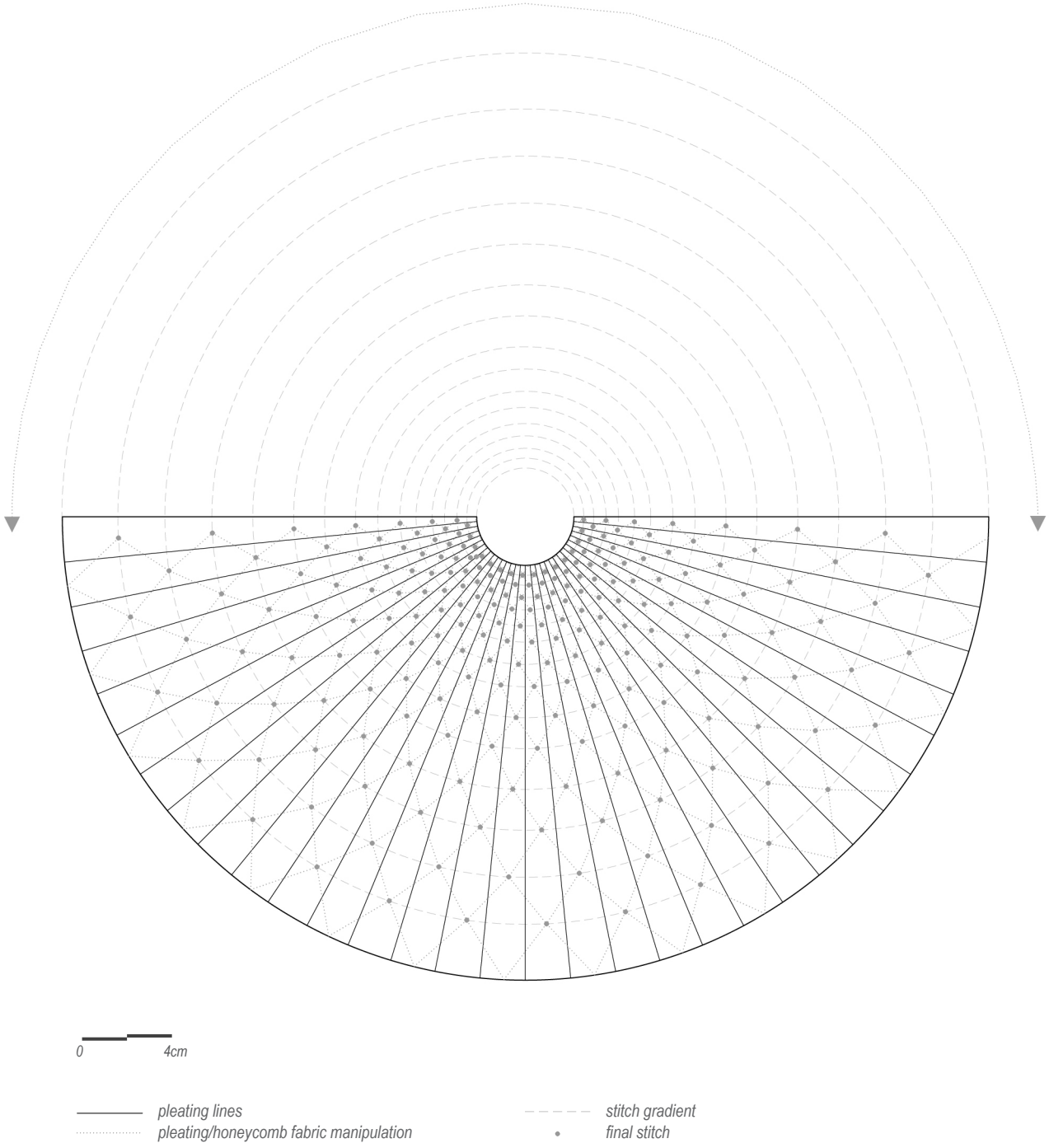

Fig. 2.40 CAD drawing showing manipulation of pleating and smocking lines, gradient of stitching, and final stitch points.

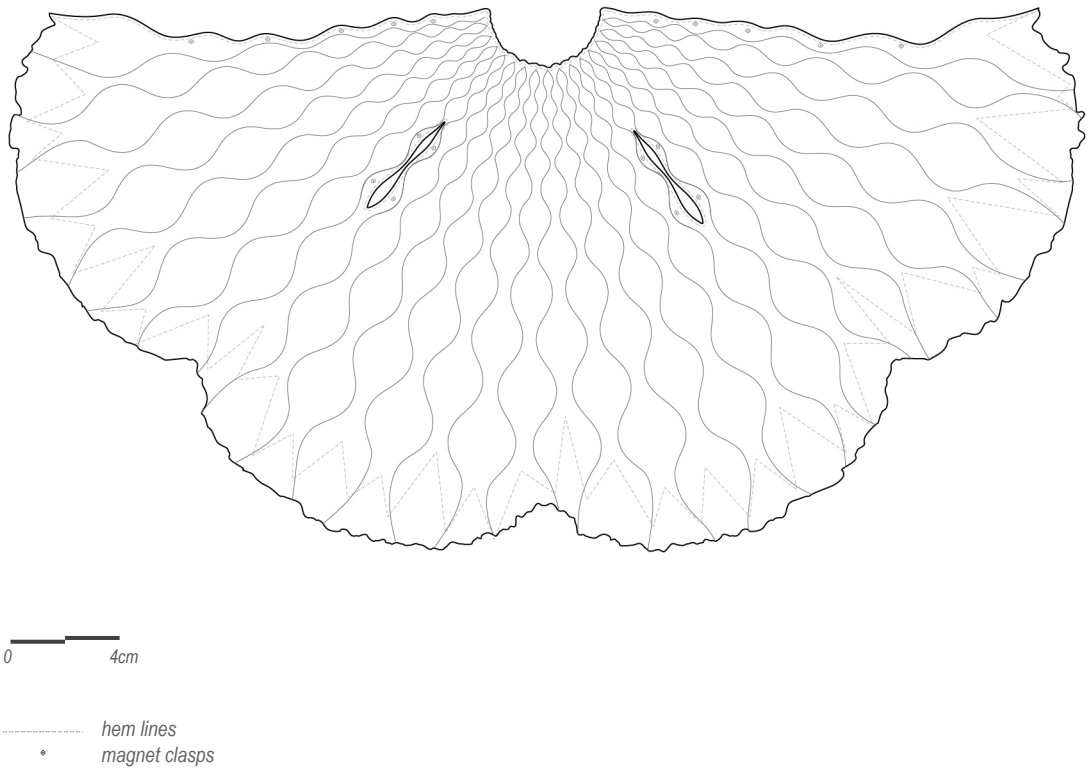

Fig. 2.41 CAD drawing of outer layer, showing continuity of soft pleats, location of hem lines, magnet clasps, and arm holes.

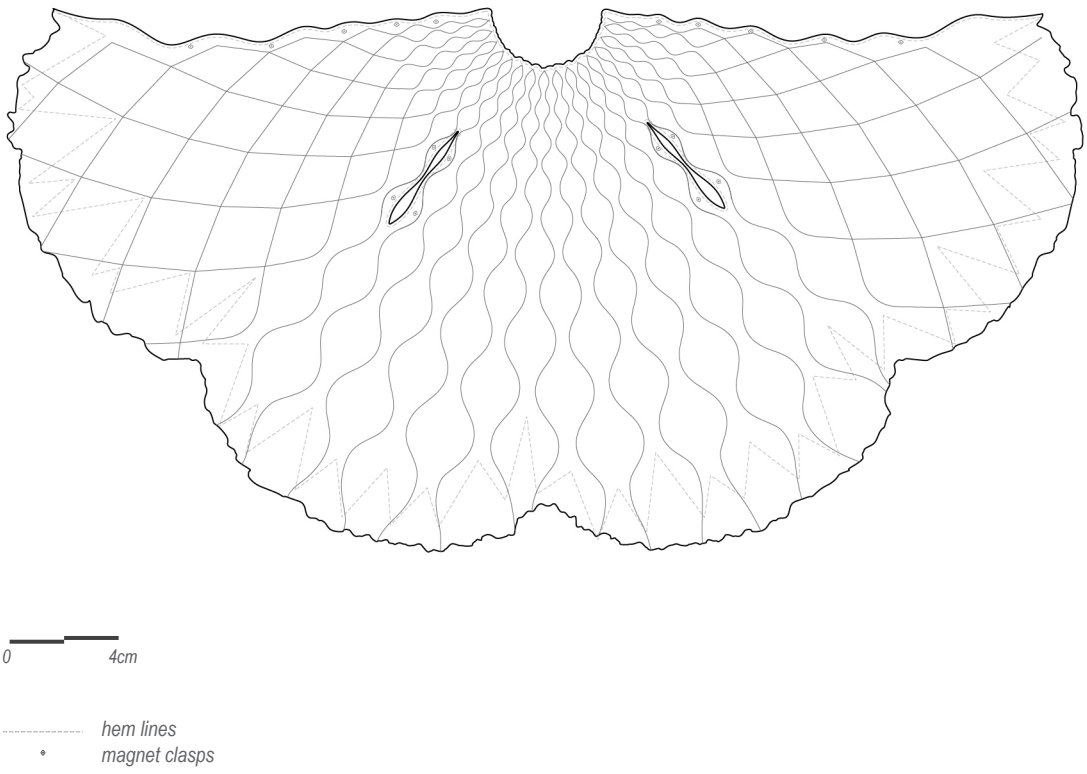

Fig. 2.42 CAD drawing of lining layer, showing hard and soft pleats, location of hem lines, magnet clasps, and arm holes.

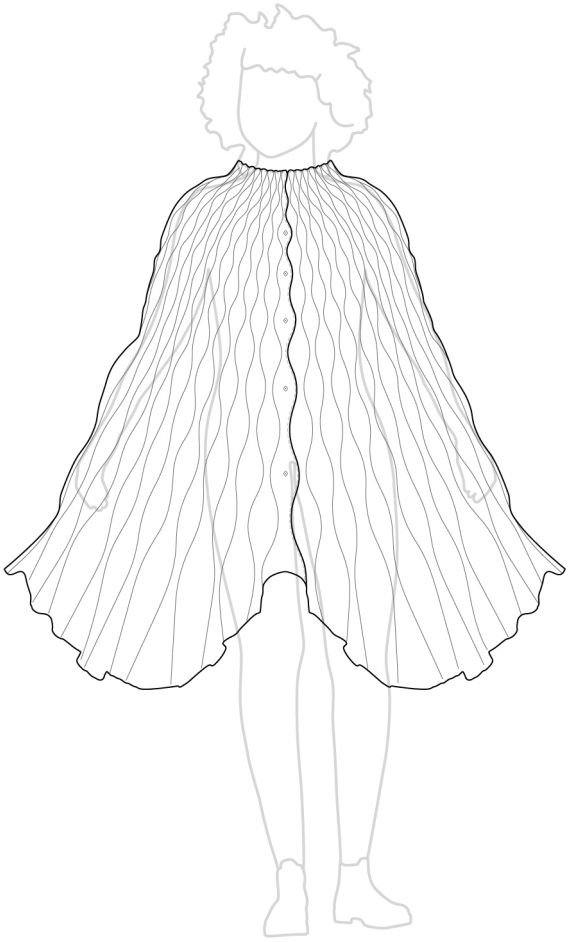

Fig. 2.43 CAD drawing of the final garment worn as a poncho.

Inspired by the soft velvet ridges of the milkweed pod, the pleats on the garment diverge from a compressed point and taper out to a curving edge. The seamless and blind tucks provide a continuity on the garment found on the uniform biological formations of the milkweed pod.

Taking inspiration from Miyake's *A-POC* and the uniformity of the milkweed pod, the garment is made from a seemingly* singular piece of fabric, providing uniformity and continuity on the garment, with seams only visible on the edges. (*size of fabric was restrictive and required additional seams to make one cohesive piece of fabric)

Naturally, the seams on the milkweed pod exist only on the edges of the pod, becoming the mechanism that allows the pod to open, while on the garment the seams become structural elements to hold the silk fibres and clasps, and provide holes for arms to go through.

Fig. 2.44 Natural velvet ridges of the milkweed pod (right).
Fig. 2.45 Designed ridges of the composite material (above).

Additionally, the use of blind tucks smocked with honeycomb stitching differs from the conventional lockstitch of puffer jackets, which stitches through the garment, forming cold spots.[27] The conventional lockstitch is evident in the first garment created where horizontal lock stitches are typically sewn in to hold fibres in place and prevent them from accumulating to the bottom. (fig. 2.18) This technique, however, causes a thermal bridge, thus resulting in the coldest parts of the garment. When the lines of stitches are repeated multiple times, these cold spots are felt on the body. Instead of stitching through the garment continuously and repeatedly, the blind tuck honeycomb smocking provides a solid base to hold the fibres, and fewer stitches are then needed to be applied through the garment to further reinforce the fibres in place.

27 Rahim Rahimi and others, '"Spacer Stitching", an Innovative Material Feeding Technology for Improved Thermal Resistance', 2017 <https://doi.org/10.1088/1757-899X/254/13/132004>.

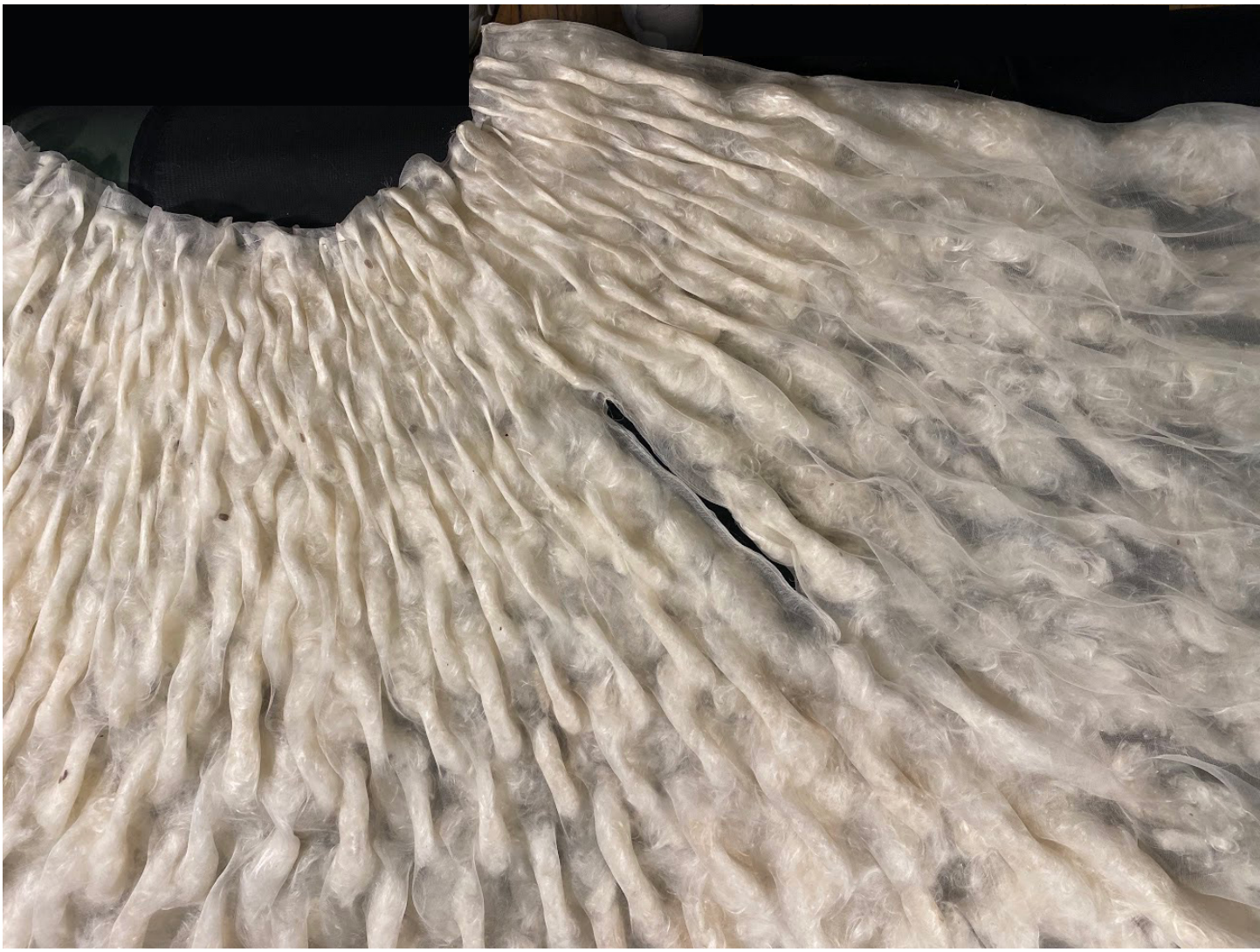

Fig. 2.46 Combing soft pleats and hard pleats of honeycomb smocking stitch in final garment design instead of conventional lockstitch pattern.

2.4 Material Adaptability / Manipulating Warmth

Fig. 2.47 *Afterwords* by Hussein Chalayan. Transforming table to skirt, 2000. Photographs by Jean-Bernard Villareal.

With the desire to provide thermal variation, this thesis refers to material adaptability as fabric manipulations affecting warmth felt on the body through the composition of the material as well as the transformation of the completed garment.

2.4.1 Gathering References

Transformational garment architecture by Hussein Chalayan[28] and J. Meejin Yoon[29] are design pieces that change in function and body silhouette. Chalayan's 2000 collection *Afterwords* features objects outside the body that transform into clothing for the body.[30] In his collection, a coffee table transforms into a skirt on the body of the model, representing transformation in function through form. This exemplifies the desired transformational quality of an artifact to perform various functions. *Mobius Dress* by Meejin Yoon is made of one single piece of fabric that rotates, twists, and turns to provide many different variations of silhouettes and warmth on the body.[31] The dress exhibits no hierarchy, without warp or weft, thereby structured only by the body.[32] Previously gathered references on designing warmth through methods of pleating and smocking are used as a basis to design the varying material composition and its adaptations.

28 Hodge and others, p. 60.

29 Hodge and others, p. 256.

30 Hodge and others, p. 60.

31 Hodge and others, p. 256.

32 Hodge and others, p. 256.

Fig. 2.48 *Mobius Dress* by Meejin Yoon. Transforming single piece of fabric, 2004. Photographs by Meejin Yoon/MY Studio.

2.4.2 Making the Garment

To provide thermal variation within the garment, the material composition and orientation of manipulated outer layer and lining layer of the shell affect the thermal capacity of the garment. When the outer and lining layers of the garment both exhibit soft pleats, the milkweed silk fibres are encased by two cells, providing the most amount of warmth. (fig. 2.51, 2.52) When the outer layer is composed of a soft pleat while the lining layer is a hard pleat, the milkweed silk fibres are encased by one cell, providing less fibres and thus less warmth. (fig. 2.49, 2.50)

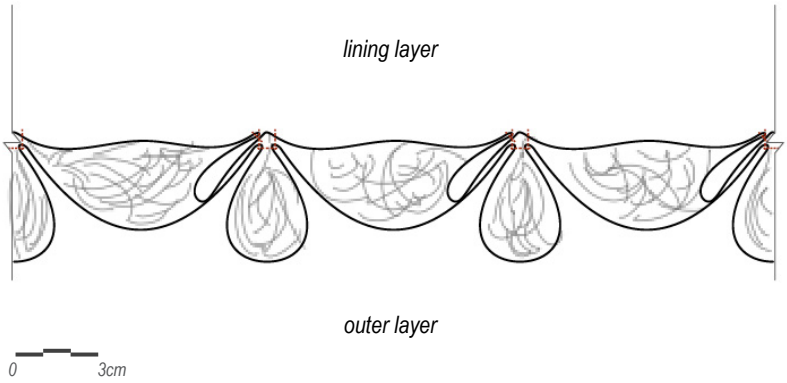

Fig. 2.49 Soft pleats of outer layer and hard pleats of lining layer.

Fig. 2.50 Hard pleats.

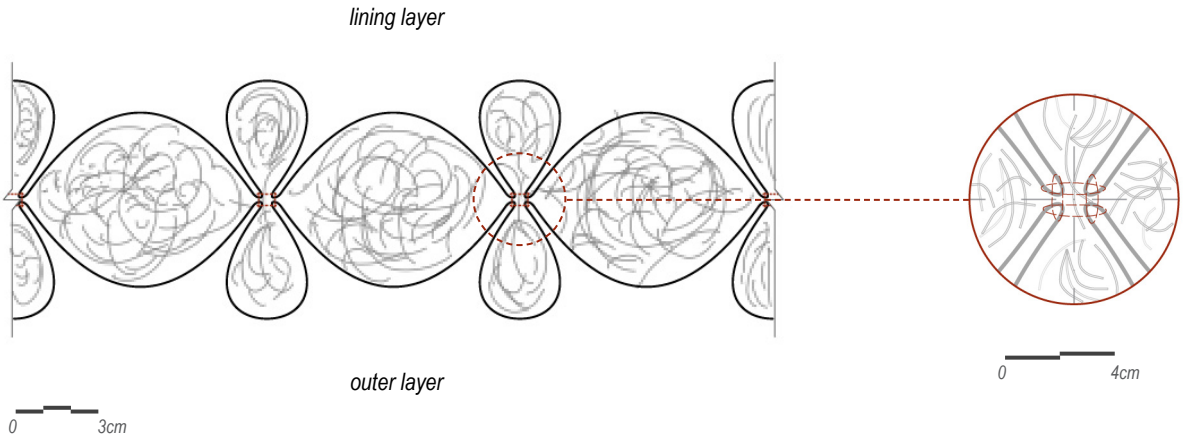

Fig. 2.51 Soft pleats of outer and lining layer.

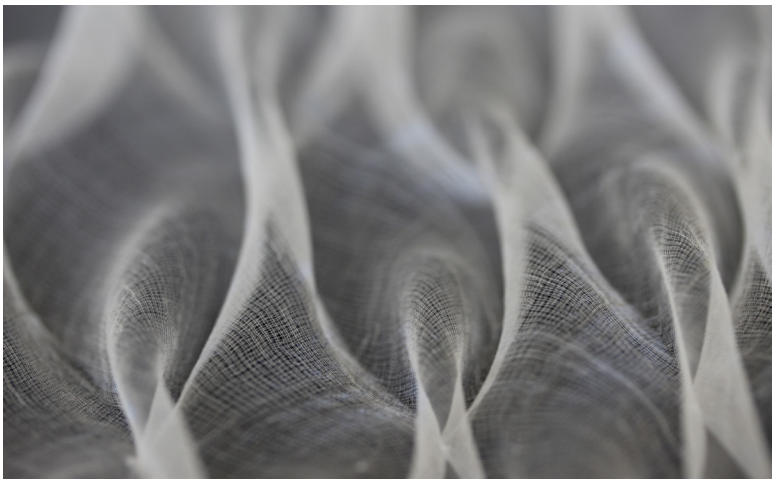

Fig. 2.52 Soft pleats.

With the desire to maintain visual and tactile continuity of the garment, one side of the silk shell, the outer layer, remained constant, while the lining layer was manipulated to control number of fibres and provide a functionally graded garment. (fig. 2.53)

Parts of the body that require the most protection from heat loss include the neck and torso, which determined where more silk fibres need to be. In these spots, the lining layer and outer layer both exhibit soft pleats of the honeycomb stitching with blind tucks. However, since the outer layer maintained a soft pleat all around with blind tucks, the continuity and uniformity of the garment is evident on the outside, with the designed functionally graded fibre dispersion composition evident on the lining layer.

A transforming garment is designed to adapt to different configurations and provide varying forms of warmth on the body. Adaptability of the garment provides warmth on various parts of the body depending on garment form and function.

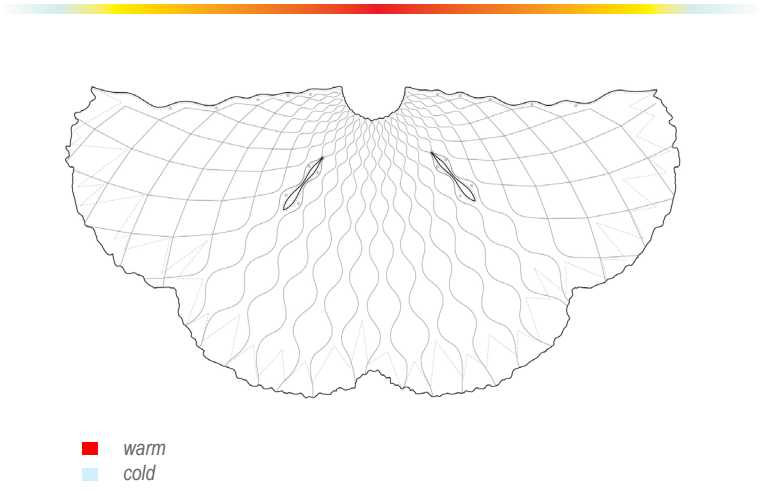

Fig. 2.53 Warmest to coldest parts of the garment.

The garment transforms from vest, to poncho, to skirt. In each adaptation, the garment silhouette varies, providing varied distances between body and dress and providing warmth to different parts of the body.

As a vest, the garment prioritizes maintaining the warmth of the human body's core. When the core is warm, other parts of the body follow – thus the core is the most important part of the human body for achieving warmth.[33]

As a skirt, the garment wraps around the waist and falls along the hips and legs of the wearer.

As a poncho, vest holes are shut closed through magnetic clasps, providing a free-form garment, free of a silhouette and for any adult body size, keeping arms and core warm.

The three adaptations of the garment can be further modified using the magnetic clasps along the bottom perimeter of the garment that allows a tucking in of the material, and thus a rounder silhouette is achieved with farther proximity to the body. Due to the fluidity of the smocking and lack of rigid structural additions to the garment, it is successfully able to adapt and provide various functions, silhouettes, and degrees of warmth. A total of six symmetrical configurations are achieved.

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33 Andrea Kurz, 'Physiology of Thermoregulation', *Best Practice & Research Clinical Anaesthesiology*, 22.4 (2008), 627–44 (p. 631) <https://doi.org/10.1016/j.bpa.2008.06.004>.

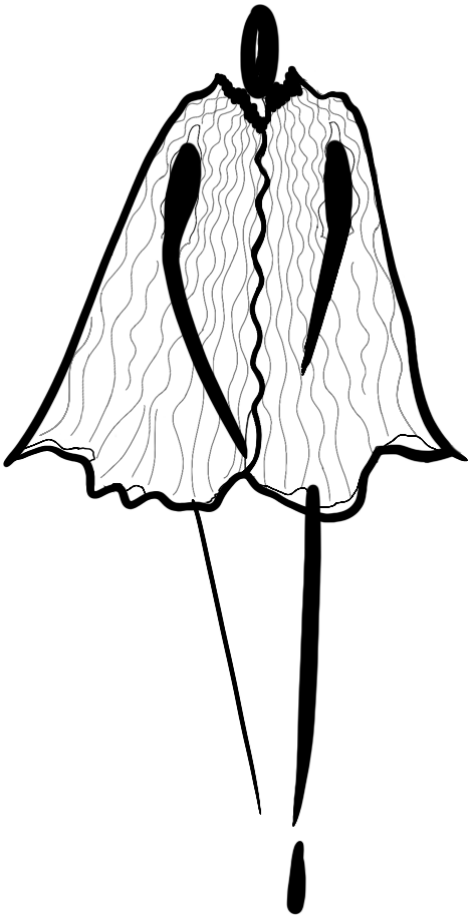


Fig. 2.54 Garment as Vest.

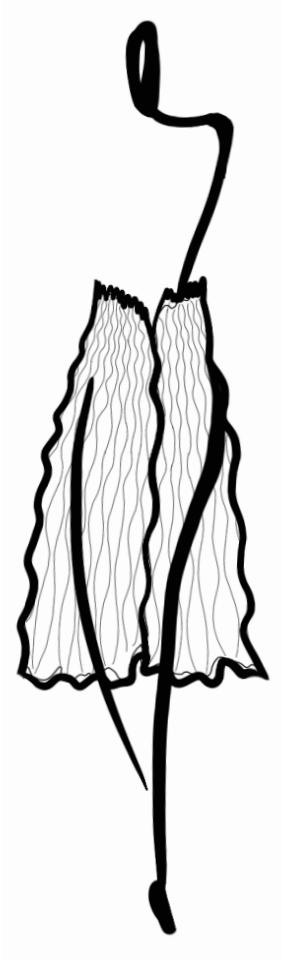


Fig. 2.55 Garment as Skirt.

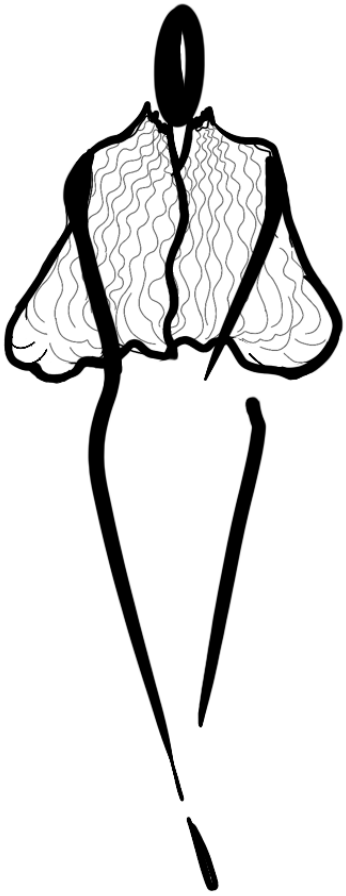


Fig. 2.56 Garment as Vest (tucked).

Fig. 2.57 Garment as Skirt (tucked).

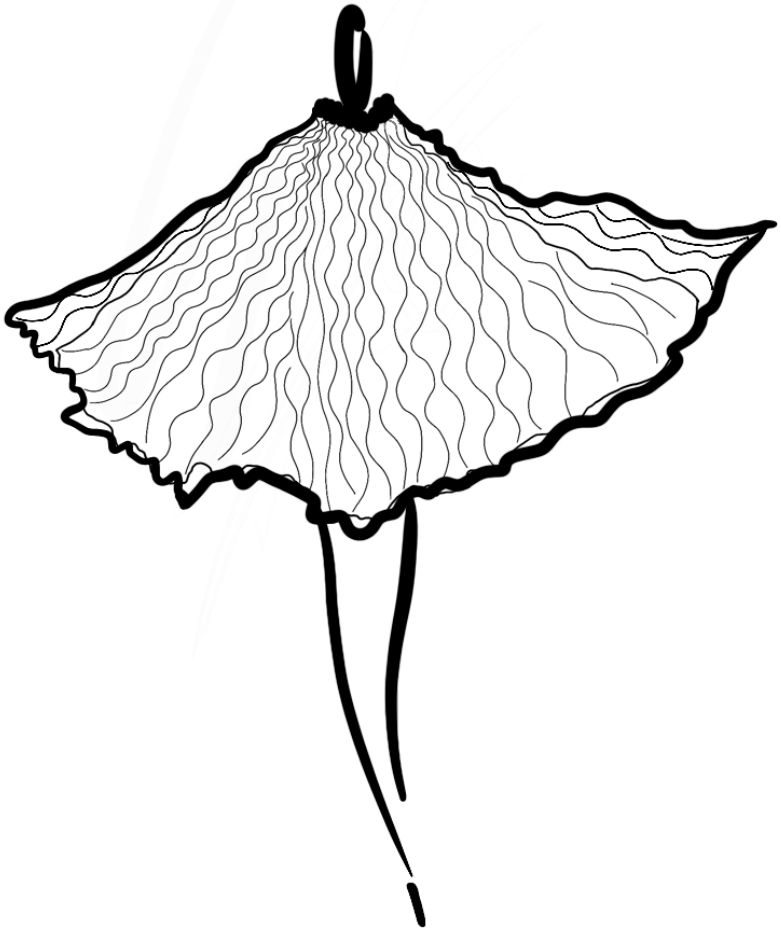
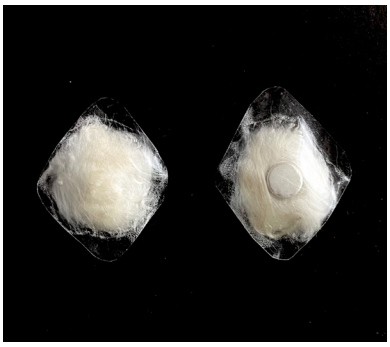


Fig. 2.58 Garment as Poncho.



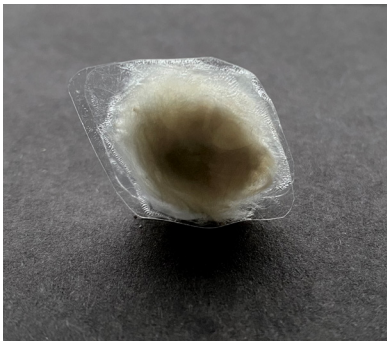


Fig. 2.59 Garment clasps. 3mm diameter earth magnets encased in milkweed silk fibers and thermally sealed with plastic lamination sheets.

To maintain senses of fleeting and fluidity of the milkweed silk fibres, a hidden clasp mechanism is designed to transform the silhouette and function of the garment. The magnet clasps are hidden and sewn within the blind tucks to ensure a visual uniformity during garment transformations. To achieve a hidden clasp mechanism, earth magnets sized at three-millimeter in diameter are used and thermally sealed in plastic lamination to control the force required to connect and disconnect the clasp.

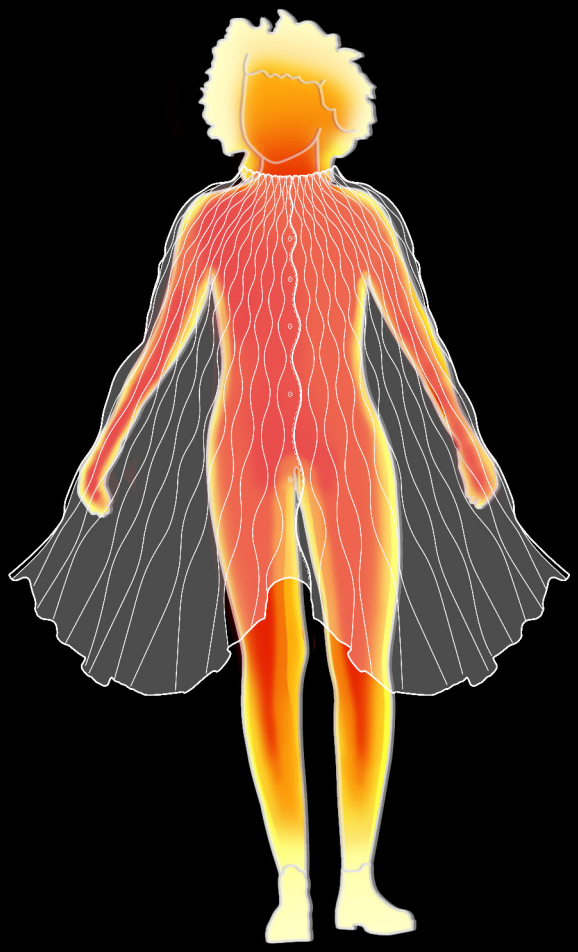


Fig. 2.60 CAD drawing diagramatically showing garment warmth transferring to warmth of the neck, torso, and upper legs.

Fig. 2.61 Poncho.

Fig. 2.62 Poncho.

Fig. 2.63 Skirt.

Fig. 2.64 Skirt.

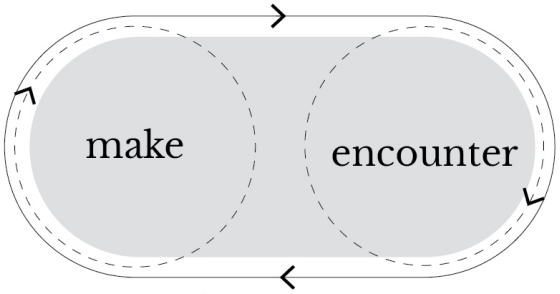
spirit

making encounters

"*The core of identity must take root and sprout branches through exchange with its surroundings in a mutual play.*" [1]

Andreas Weber, *Matter and Desire*

1 Andreas Weber, *Matter and Desire* (Chelsea Green Publishing, 2017), p. 112.



making encounters

ephemeral warmth

~~enveloping the body~~
enveloping the land
~~re-encounters~~

3.0 Discussion

/ ex situ-in situ

3.1 Wearing Ephemeral Warmth

The garment designed for thermal delight embodies the four design parameters of material origin, material intimacy, material warmth, and material adaptability. The garment is made of sustainable and ethically sourced materials from the Earth. It provides an intimate relationship with human and other-than-human life forms through visual and tactile connections to the milkweed silk fibres. Shell manipulation of the outer and lining layers provide material warmth while material adaptability is present in the transforming form of the final silhouette. Testing the designed thermal delight on the skin by enveloping the final garment on the land is the next step in forming land connections. The following is a first-person essay written by the author evoking emotional experiential responses to the act of *wearing ephemeral warmth*.

Fig. 3.1 *Ephemeral Embrace* on the body. Autumn 2022. Photograph by Shabaan Khokhar.

Enveloping the Body and the Land

On a cold autumn day, I return to the milkweed meadow with a gift: an ephemeral artifact ready to envelop and be enveloped. The garment encases fibres and seeds from the land I stand on.

Standing still in the meadow under clear blue skies, my skin is alive with sensations, inhaling the surrounding winds. I hear the dried milkweed pods rustle in the wind and watch at the stems sway in response. My entire body is captivated by the expansiveness of the present, awakening my senses.

My ears take in the gentle whispers of dried autumn leaves moving in the winds. The tiny hairs of my body move with every breeze. My legs outstretched on the high grasses accompanied by tall and delighted milkweed stems. I feel present.

As I wrap my body with the garment, I'm protected from December's below zero winds. The still air in the hollow fibrils are at work, warming my inner core and transferring warmth to my external skin. The spirit of the garment is awakened as tiny shimmering fibrils escape out of the porous shell and dance in the wind around me. With every modification, movement, and transformation, tiny fibrils continued to fly out of the shell, as if the garment were a living breathing entity. Standing among the dried milkweed stems,

the garment envelops my body and resembles a milkweed fruit pod ready to embrace the land with warmth. I feel one with the ecology.

Between my own flesh and the encompassing flesh of the world lies the garment, animating the interplay of senses on my body. A mediation between body and Earth, shifting between warm and cold. My body is coldest in between garment transformations. Opening the enveloping shell allows still air between body and garment to escape. My body feels warmest when the garment is a poncho, keeping my torso and back warm and covering my arms and upper legs. I feel the soft and smooth texture of the milkweed fibres and silk lining on my skin. In this configuration, the fibres feel like a microclimate of warm embrace.

Enveloping the land, the garment embodies an ephemeral vulnerability. A profound exchange with the enveloping Earth. Without hard edges, the garment takes form of the landscape it embraces. With soft and visible fibres, the garment interacts gently with life forms it touches. With the end of its life in mind, the garment is impermanent and ready to return to the Earth which it came from. What are now sewn artifacts will transform to be sown seeds creating new life as sprouting milkweed rhizomes. The garment is expressive and alive – it is an ephemeral embrace on land.

Fig. 3.2 *Ephemeral Embrace* on the land. Autumn 2022. Photograph by Shabaan Khokhar.

3.1.1 Re-encounters

Dr. Cajete speaks to the transformation of the self through the art of creating and says "*art is an alchemy of process in which the artist becomes more [them]self through each act of true creation.*"[2] Similarly, Kimmerer speaks to land transformation as land rejuvenation.[3] As the land transforms, it experiences renewal, and as the self experiences the land, the self renews. With each ephemeral ecological encounter, one is renewed with new knowledge and land connection. In this sense, a re-encounter of life forms through the common milkweed in situ and ex situ becomes a renewal and rebirth of the self. The renewal allows oneself to detach from isolating ideologies of living and attach oneself directly in relation to the land. When attaching one's being directly to the land, there is room to form relational reciprocities with the land, thereby forming relationships that sustain Earth and are sustained by Earth. Ensuring prosperous relationships with the land can be achieved by '*following back the thread of life in everything and pay it respect*'[4]; as the common milkweed starts and ends with a seed, the garment follows a similar thread of life, following its origins back to the ground.

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2 Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (Durango: Kivaki Press, 1994), p. 149

While comparing art to self creation, Cajete also says '[the artist] transfers [their] life in a dance of'' relationship with the life inherent in the material that [they] transform into an artistic creation. In each process of creation, there must be an initiation, purification, death, and rebirth of the artist through focused creative work. In working, reworking, and suffering into being a work of art, the artist is creating and recreating himself. It is, in a metaphoric sense, a matter of' life, death, and rebirth.' '.

3 Robin Wall Kimmerer, *Braiding Sweetgrass* (Milkweed Editions, 2013), p. 258

Kimmerer observes surrounding ecological encounters and says '[a] well pours from a cleft in the bluff with a strength that endures even the deepest drought and fills a clear mossy pool. In the still water, you can see your face. The land speaks the language of renewal.' .

4 Kimmerer, p. 154.

Fig. 3.3 *Ephemeral Embrace* on the body. *Vest*. Autumn 2022. Photograph by Shabaan Khokhar.

Setting out to form new land connections, the project analyzed the common milkweed plant as a species on the land and a harvested fibre off the land. The project tries to balance traditional ecological knowledge of the honourable harvest and working with the land with scientific knowledge of organic fibre insulation properties. The attempt to balance scientific and traditional ecological knowledge was a humbling experience which proved the difficulty in acquiring an expansive and balanced understanding of both perspectives. The project also set out to balance the qualitative and quantitative qualities of thermoregulation and thermal delight. In the end, the project took a stance on the sensorial aspects of garment design, defining more qualitative than quantitative parameters of thermal delight within garments.

Controlling organic materials, including the milkweed silk fibres and the silk shell, as desired, was proven to be difficult. Learning that all organic materials have physical properties including strong and weak points was a humbling learning experience, proving that the organic material will with time morph in the direction and shape it chooses. It became evident that it is best to work with, rather than against, the natural properties of organic fibres. When the manipulation of the silk fibres failed, it became clear that the natural hollow structure of the fibres want to be left to fly. When provided a home, such as the chosen loose woven silk shell, the fibres are given the space and opportunity to *be*, reminiscent to how the silk fibres are found in nature.

While setting out to practice the honourable harvest of the milkweed silk fibres, it was difficult to locate thriving and wildly grown common milkweed plants. It took multiple hikes in various different cities to gather the needed amount of milkweed silk fibres. This proved the increased vilification of the milkweed plant, making the harvested fibre a more precious material. More importantly, the plants' increased uprooting and declining habitat was further proven in the recent endangerment of the monarch butterfly. Studying a single plant, the common milkweed, within its habitat by analyzing its transformations and relationships to companion species, provided a re-encouter of Earth's lifeforms. One cannot help but wonder what other native plants can teach and gift humans.

Fig. 3.4 (above) Monarch larva home. Spring 2022.
Fig. 3.5 (right) *Ephemeral Embrace* on the body. *Vest*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.6 (above) Bloomed milkweed plant. Spring 2022.
Fig. 3.7 (right) *Ephemeral Embrace* on the body. *Vest*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.8 (above) Monarch butterfly wings. Summer 2022.
Fig. 3.9 (left) *Ephemeral Embrace* on the body. *Poncho*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.10 (above) Milkweed pod forming. Summer 2022.
Fig. 3.11 (left) *Ephemeral Embrace* on the body. *Vest (tucked)*.
Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.12 *Ephemeral Embrace* on the body. *Skirt*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.13 (above) Dried milkweed pods and stems. Autumn 2022.
Photograph by Shabaan Khokhar.

Fig. 3.14 *Ephemeral Embrace* on the land. Autumn 2022.
Photograph by Shabaan Khokhar.

Fig. 3.15 *Ephemeral Embrace* on the body. *Vest*. Autumn 2022.
Photograph by Shabaan Khokhar.

Fig. 3.16 *Ephemeral Embrace* on the body. *Skirt*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.17 *Ephemeral Embrace* on the body. *Poncho*. Autumn 2022.
Photograph by Shabaan Khokhar.

Fig. 3.18 *Ephemeral Embrace* on the body. *Vest (tucked)*.
Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.19 *Ephemeral Embrace* on the body. *Skirt (tucked)*.
Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.20 *Ephemeral Embrace* on the body. *Vest (tucked)*. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.21 *Ephemeral Embrace* on the body. *Skirt (tucked)*.
Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.22 Spherical umbels. Spring 2022.

Fig. 3.23 *Ephemeral Embrace* on the land. Cellular fomations. Autumn 2022. Photograph by Shabaan Khokhar.

3.2 Conclusion

This thesis investigated thermal delight in garment design by engaging directly with plant fibres. Through observation and use of the native common milkweed plant, a garment is designed and fabricated embodying ephemerality encountered within human and ecological conditions. The project is actualized through Dr. Cajete's creative process involving all aspects of the human (the mind, body, spirit, and emotion) where mind and body are based in literature and making, emotion is based on the self, and spirit is within the land. The mind is involved in the gathering of ephemeral encounters while the body encompasses acts of making the artifact through researching. The spirit embodies the life of the land and a re-encounter of the harvested fibres with the land. Throughout the project, various points of first-person accounts by the author reflect emotion.

Ephemeral encounters are defined as experiences involving the interaction of two or more subjects (environmental forces, humans, other-than-humans), leaving at least one of the subjects changed. With a desire to re-connect to life forms through the surrounding native ecology, ephemeral ecological encounters are rediscovered in the close observation of the seasonal transformation of the common milkweed. Observing the plant in-situ throughout the seasons revealed its living transformations that allow it to thrive in its ecosystem and provide a healthy habitat for its companion species.

Ephemeral human encounters are observed in the responsive epidermis skin to surrounding changing temperatures. While surrounding life forms adapt and work with other living organisms to mediate environmental conditions, humans create isolated environments, blocking out all visual and tactile connections to their surroundings. The isolated environments have developed thermally regulated spaces which embody unnaturally neutral and monotonous environments. This is further exasperated in the often toxic and

unethically sourced insulating materials responsible for thermal comfort.

The concept of thermal delight by architect Lisa Heschong was a key grounding component in the design and development of this thesis. *Thermal delight in architecture*, as coined by Heschong, is the joy in experiencing varied temperatures on the skin, an often missed design opportunity in architecture. To directly engage human senses with natures' milkweed silk fibres, a garment for the body is designed representing Heschong's basis of experiential thermal delight. Heschong's architectural definition of thermal delight is expanded to include notions of *material origin, material intimacy, material warmth, and material adaptability*. Together the parameters offered a garment design that engages with tactile and visual human senses to provide designed warmth while considering ecological implications of materials.

To ensure the ethical sourcing of *material origin*, an Indigenous method of honourable harvesting is carried out by the author on various sites to collect milkweed silk fibres. Receiving from the Earth in the form of the honourable harvest allowed a deeper connection to land and the common milkweed plant. Material intimacy is designed in the garment by involving human physical and visual senses using translucent and porous material. Traditional methods of honeycomb smocking are applied to the shell providing cellular formations to encase additional fibers and affect material warmth. Material adaptability is carried out in the transformation and customization of the completed garment, providing varying micro-climates on different parts of the body.

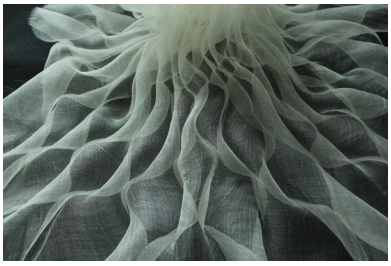
Wearing the designed ephemeral garment on the milkweed meadow where fibres were harvested connected the body back to the land and in turn connected the land to oneself. The processes of interacting, receiving, and giving with the ecology became a fulfilling and enlivening experience. Ecological interaction was experienced through observation of the milkweed meadow in situ and studying the milkweed silk fibres ex situ through the method of honourable harvesting. Analyzing the common milkweed on and off the land provided a holistic view of the plant. Working with the fibres off the land and on the human body provided an opportunity to design with a piece of the Earth, ultimately connecting the body back to the land. Finally, the act of giving is experienced as a reciprocal relationship between body and land. While the garment and body gave back to the land in the form of seeds and a biodegradable artifact, the land and the garment provided a delightful and pleasurable experience on the human body, embodying ecological life forms and the human role within it. Viewing oneself as a part of the ecology allowed a rediscovery of life forms' mutual relationships and transformations. Filled with seeds and fibres harvested from the land, the garment embraced ecological ephemeral conditions, to be returned back to the Earth as sown threads. This thesis inspired the future of envelops in both fashion and architecture to follow ephemeral ecologies humans are situated in while providing enlivening and delightful experiences connecting one back to the land.

3.3 Future Skins

Beyond what the thesis accomplished, it is possible to speculate ways to improve the current project and provide an outlook for future research. The project *Ephemeral Embraces: milkweed fibres from land to body* explored thermal delight in garment design through harvested organic materials. The defined design parameters that tested thermal delight within garment design are *material origin*, *material intimacy*, *material warmth*, and *material adaptability*.

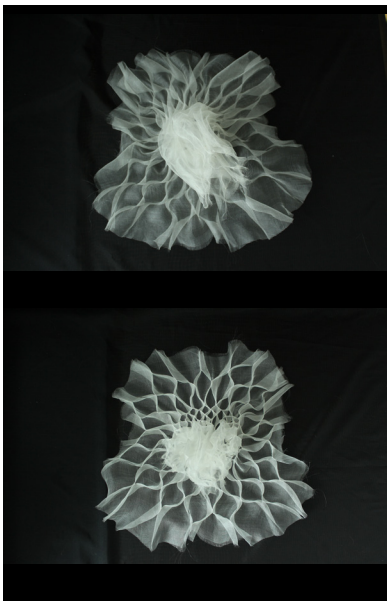
The *material origin* design parameter can be improved through exploring various clasp methods beyond plastic laminated earth magnets. The earth magnets used were encased in plastic lamination sheets as clasps for opening, closing, and manipulating the garment. Utilizing plastic laminate to control the magnetic strength of the earth magnets compromises the biodegradability of the garment as a whole and contradicts the intentions of the defined parameter *material origin*. Future work will investigate sustainable options of laminating the earth magnets such as biodegradable plastic or use of multiple layers of fabric such as organic cotton or ethically sourced silk. Experimenting designs that avoid utilizing clasps would further simplify the garment structure and avoid the use of non-biodegradable materials. Future research and writing on ethical ways of sourcing milkweed silk fibres that emphasize the importance of avoiding monoculture practices of the plant can further speak to the significance of *material origin*.

The *material intimacy* design parameter can be enhanced by experimenting with different types of shells with various degrees of porosity, translucency, and rigidity. Testing various ethically sourced silk varieties of porosity and a combination of various porosities can further engage senses with the garment. While the intent was to use a single piece of silk fabric for the lining and outer layer, the sourced silk shell has size constraints with a maximum width and length size. This resulted in additional seams to create one single piece of fabric



(top to bottom)

Fig. 3.24 Enclosed loop pattern to be smocked and infilled with fibres.
Fig. 3.25 Neck piece completed with diverging honeycomb smocking to be infilled with fibres.
Fig. 3.26 Celular formations of neck piece.



(top to bottom)

Fig. 3.27 Neck piece completed with diverging honeycomb smocking exhibiting soft pleats. Neck piece completed with diverging honeycomb smocking exhibiting hard pleats.

which compromised the visual and physical continuity of the fabric on the body. More importantly, additional seams may have caused heat to escape, affecting the thermal capacity of the garment and affecting the *material warmth* design parameter. Utilizing one single piece of fabric with a single seam for fibre infilling can provide a seamless visual and physical interaction while trapping heat in.

The *material warmth* design parameter can also be improved by using a more tightly woven silk shell which could provide better thermal insulation properties of the overall garment and can be used in combination with the loosely woven silk fabric. More durable materials can be tested which include different grades of ethically sourced cotton and bamboo fabrics, as well as biodegradable plastic shells. Experimenting with different types of smocking, pleating, and combining fabric manipulations can also provide more thermally dynamic results.

To improve the *material adaptability* design parameter, functionally graded material within the garment can be designed to follow different types of fabric manipulations beyond honeycomb smocking. Additionally, to provide more inclusive garments regardless of size and shape of the body, an earlier designed garment in the shape of a fully enclosed loop can be further developed. Using a similar composite material, an enclosed loop can twist and turn to wrap around as many times as desired while embodying the defined design parameters. A designed neck covering could also be fabricated utilizing similar methods of fibre infilling and shell manipulation. Expanding the garment collection can provide more opportunities of thermal delight on various parts of the body, and thus *material adaptability*, through wearing multiple different garments.

While thermal delight is currently tested through qualitative and experiential measures of feeling and wearing the garment, expanding testing methodology to include quantitative thermal values can solidify experimentation and add to the contribution of the project.

Expanding the scope of the thesis to include fixtures and fittings outside of the body such as curtains, wall coverings and window coverings could provide an interesting and larger scale challenge to the project. Future scale and scope of the project can follow a similar trajectory as work by designer Petra Blaisse which involves the design and fabrication of sound and thermal insulation curtains as architecture elements used to design and control use of space. Existing between the scope of fashion and architecture, designing experiences of microclimates outside of the body can still follow defined parameters of thermal delight including material origin, intimacy, warmth, and adaptability.

While the garment was designed with its end of life in mind, it has yet to be returned to the land. To truly embody ephemerality, the next and equally important part of this project is to return the garment back to the land. With the garments return, the accumulated seeds at the base will be sown and planted in the soil. With time, the biodegradable silk shell and milkweed silk fibres will decompose, leaving the accumulated seeds to germinate and sprout into milkweed rhizome roots. Once the bulk of the garment disappears, the plastic laminated earth magnets will be the only component left to collect.

The utilized designed cycle of gathering encounters, gathering and making, and making encounters can be used for future projects which aim to engage with the land through an embodied approach of material experimentation. Referencing Dr. Cajetes concepts, the creative process will continue to involve mind, body, spirit, and emotion with future work with the land.

Fig. 3.28 *Ephemeral Embrace* on the land. Adjusting garment. Autumn 2022. Photograph by Shabaan Khokhar.

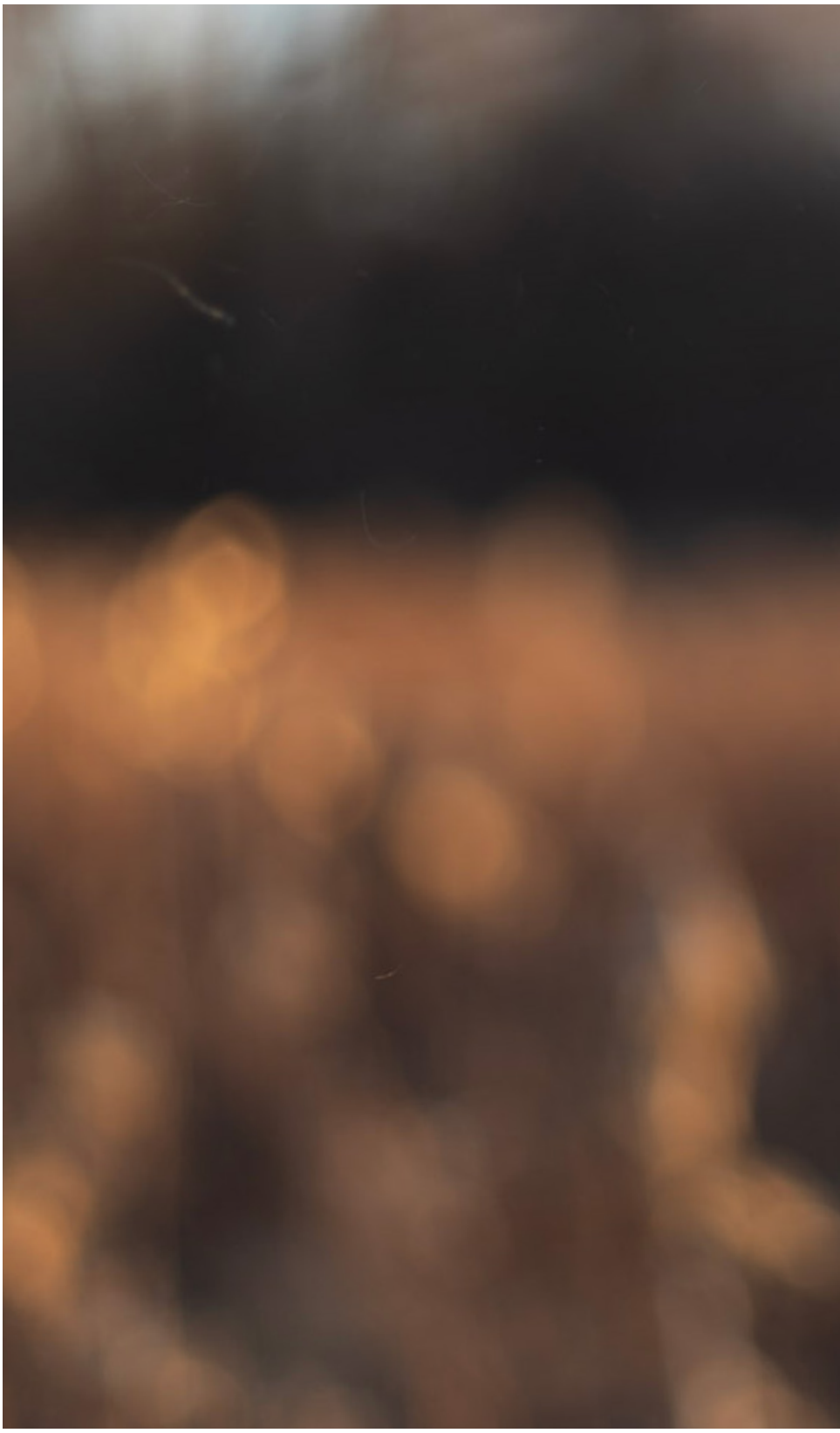


Fig. 3.29 Touching warmth. Autumn 2022. Photograph by Shabaan Khokhar.

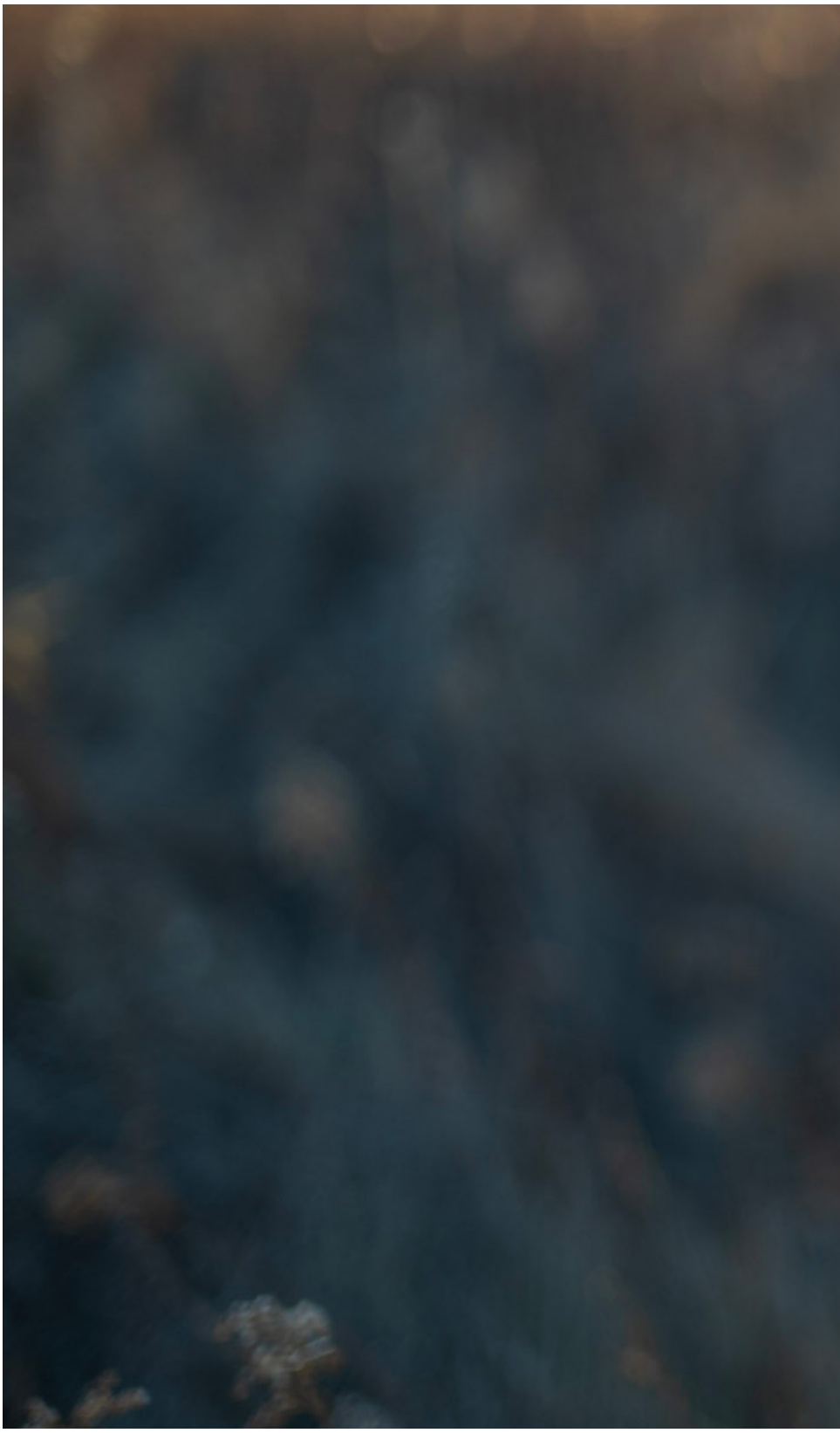


Fig. 3.30 Spreading seeds. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.31 *Ephemeral Embrace* on the land. Autumn 2022. Photograph by Shabaan Khokhar.

Fig. 3.32 Bloomed milkweed colony. Spring 2022.

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METHODOLOGIES

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Appendix A

/ *garment of identity: kufiya*

The process of designing and creating a garment that embodies the connection to a land is reminiscent of the Palestinian kufiya, a symbolic scarf representing identity, heritage, and land. Palestinians have long used embroidery techniques and motifs to preserve their identity and connection to the land, dating back to at least the 1800s.[1] Symbolic motifs, such as birds, trees, and flowers, are stitched onto garments as a way of wearing the land itself. The kufiya, a Palestinian garment, features embroidery that represents culture, identity, and connection to the land. It is a symbol of both displaced and indigenous Palestinians, representing the past, present, and future. The kufiya is a white cotton fabric measuring forty-seven inches by forty-seven inches, embroidered with black cotton threads depicting various cultural symbols and motifs, such as fishnets, olive leaves, and trade routes. The fishnet stitch represents Palestinian sailors and fishermen on the Mediterranean Sea, highlighting the importance of fishing in Palestinian coastal cities. The olive leaves, curved and interconnected, symbolize the resilience of Palestinian olive trees that have existed for thousands of years, reflecting the resilience of the Palestinian people. The thick trade routes bordering the kufiya represent the connections between different cities in historic Palestine for trade and cultural exchange, linking the coastal and inland areas, the Mediterranean Sea and the olive trees.

To me, the kufiya tells a story of a Palestinian driving across the country, experiencing the diverse landscapes and natural resources, from the vibrant olive groves in Beit Lahim to the freshly caught fish in Yaffa from the Mediterranean Sea. It represents a story of liberation, historic evidence, and a collective memory of a lost land.

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1 Widad Kawar, *Threads of Identity: Preserving Palestinian Costume and Heritage* (Nicosia, Cyprus: Rimal Publications, 2011).

The kufiya embodies what was, what is, and what can be, encompassing hope and despair, freedom and captivity. In times of despair, the fishnets turn into barbed wire, a constant reminder of the occupation, and the bold routes transform into the concrete wall surrounding the West Bank, obstructing access to arable lands and culturally and economically significant olive trees.

As I delved into my thesis, I found myself reflecting on the Palestinian kufiya, and gradually, various facets of my identity began to manifest in my work. The blind tucks, intricately woven with honeycomb smocking, seemed to echo the honeycomb fishnet stitching traditionally found on the kufiya. With great care and mindfulness, I stitched the edges, connections, and layers of the composite material, all the while contemplating the intentional design of the kufiya. My Palestinian heritage and the cultural underpinnings of the kufiya intuitively supported me through my journey of designing and fabricating a garment that embodied a profound connection to the land.

Fig. A.1 Blind tucks with honeycomb smocking before and after milkweed fibre infill.

Fig. A.2 Palestinian kufiya showing olive leaves, trade routes, and honeycomb fishnet.

Appendix B

/ *ephemeral embraces: thesis defence*

The thesis defence took place on April 11, 2023, in the Design at Riverside Gallery in Cambridge. The space was designed as an exhibition and divided into three sections: a final designed garment with a video projection, a presentation projection in the centre, and milkweed plant and fibre studies. A black curtain backdrop was used to create a cinematic-like atmosphere, emphasizing the garment and projection. The video projected onto the garment featured hundreds of thousands of monarch butterflies roosting in their overwintering sites in Mexico, juxtaposed with harvested milkweed fibres. This highlighted the importance of considering all species involved when working with organic materials. The garment's softness and translucency invited audience members to touch and wear the garment, engaging directly with the warm embrace of the fibres.

Fig. B.1 Milkweed garment close-up. April 2023. Photograph by Shabaan Khokhar.

Fig. B.2 Wearing the garment. April 2023. Photograph by Shabaan Khokhar.

Fig. B.3 Milkweed garment with projection of monarch butterflies. April 2023. Photograph by Shabaan Khokhar.

Fig. B.4 Thesis defence set up. April 2023. Photograph by Shabaan Khokhar.

Fig. B.5 Thesis defence presentation. April 2023. Photograph by Shabaan Khokhar.

Fig. B.6 Milkweed plant and fibre studies. April 2023. Photograph by Shabaan Khokhar.

Photograph by Shabaan Khokhar