LÜM

Symbiotic Shades

Invisible Twins Bond

FABRICADEMY THESIS
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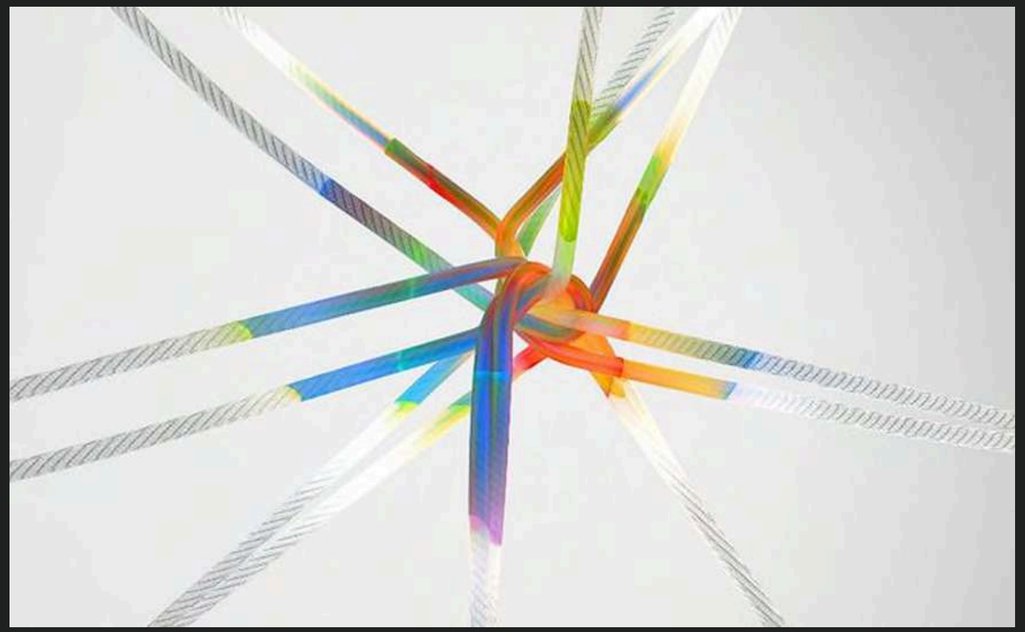
Introduction

Unraveling Bond



What is a bond?

In ithe realm of human relationships, bonds are the invisible threads that connect us, transcending physical proximity. As a twin, I've always been fascinated by the unique connection shared between twins—a bond that often feels instinctual and symbiotic. This project explores the concept of bond, not just as an emotional connection but as a tangible, interactive experience manifested through fashion and technology

As a twin, I've lived my entire life inside a connection that often escapes language. My sister and I move through life tethered by something more than genetics—an intuitive sync, a shared sensing. It's not just about closeness; it's about merging. I've always felt that this twinship isn't entirely human, but something more elemental—like magnetism, like frequency.

In LÜM, I chose to externalize this bond. Not through metaphor, but through sensation. I asked myself: Can a garment carry emotion? Can it transmit connection? What if bond could be worn, seen, heard, touched, and felt? What if fashion wasn't just about self-expression, but co-expression—a shared system between two bodies?

Through this work, I investigate the emotional and energetic language of human connection, and how digital fabrication, soft electronics, and wearable interaction design can make that language tangible. This isn't just about fashion. It's about empathy. It's about designing with the body and for the invisible space between bodies.

The Art of Bonding by Hu Bao and Hu Bei

The Emotional Clothing by Iga Węglińska

Gathered Light by Hu Bei

Case Threads Fashion-Tech Inspirations

When fashion meets circuitry and feeling follows function.

The Art of Bonding by Hu Bao and Hu Bei

Twins share an unspoken connection rooted in deep empathy while retaining their individuality, and Hu Bei's work conveys the delicate balance between this search for individuality amidst the shared experiences of twins, providing viewers with a fresh perspective on the distinct identities of these unique pairs.

The Emotional Clothing by Iga Węglińska

it merges fashion with technology, creating garments that respond to the wearer's physiological changes, such as body temperature, heart rate, galvanic skin response, and proprioception.

Designed as a sensory prosthesis, these innovative pieces use advanced sensing technology to foster mindfulness and enhance emotional awareness by helping individuals connect more deeply with their physical state. By interacting with the garment, wearers are encouraged to become more conscious of their body's responses

Gathered Light by Hu Bei

Even to our dearest ones, can be strained by time and space. Her interactive piece, Gathered Light, shines as a symbol of hope, reminding us that it is okay to reach out, especially to those who matter the most to us, and serves as a powerful testament to the idea that human beings are not meant to navigate life's challenges alone.

You Are My Twin by Kristina Varaksina

No Where Now Here by Ying Gao

Metamorphosis Textiles

Case Threads Fashion-Tech Inspirations

When fashion meets circuitry and feeling follows function.

You Are My Twin by Kristina Varaksina

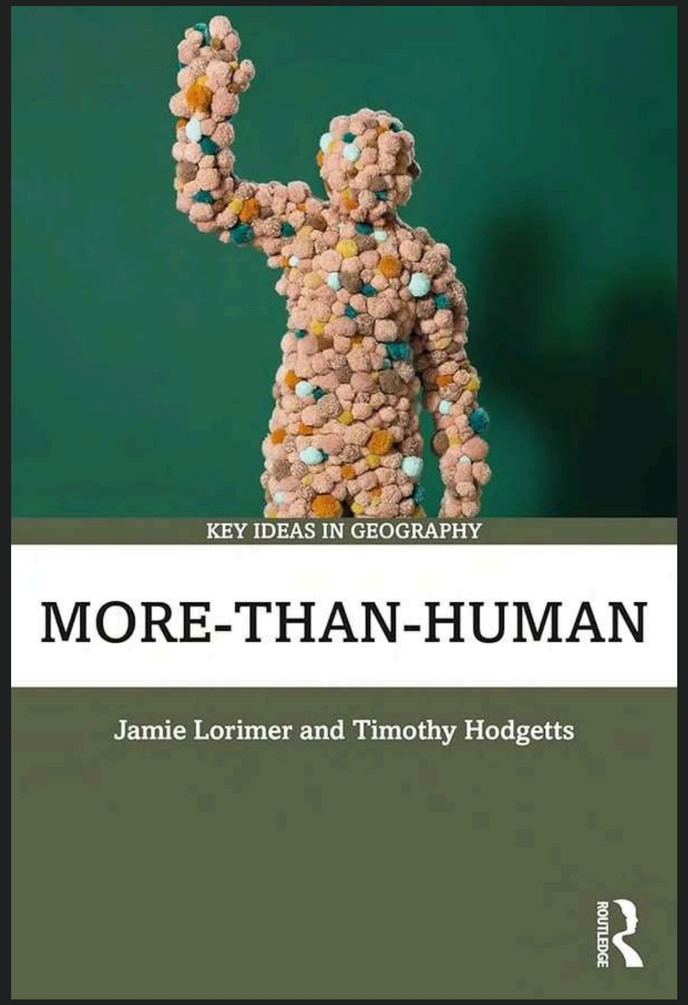
This fine art photography project delves into the psychological dynamics of twin relationships, using metaphoric props and sets to narrate their unique connections. link the title markdown

No Where Now Here by Ying Gao

Tiny motors hidden in the fabric get activated by the wearer's eye movements, causing the dresses to react in real time. In the dark, they even look like glowing jellyfish, adding a whole new level to interactive fashion.
Gao's work blends fashion, technology, and a bit of magic, making clothes that don't just move with you, but because of you.

Metamorphosis Textiles

The Metamorphosis collection reflects the metamorphic essence of our existence. It provokes thoughts, ignites imaginations, and stimulates reflections on our evolving identity, shaping a new fashion ethos that's as thoughtful as it is stylish.



More Than Human by Jamie Lorimer and Timothy Hodgetts

Twinstincts

Symbiosis in Human Form

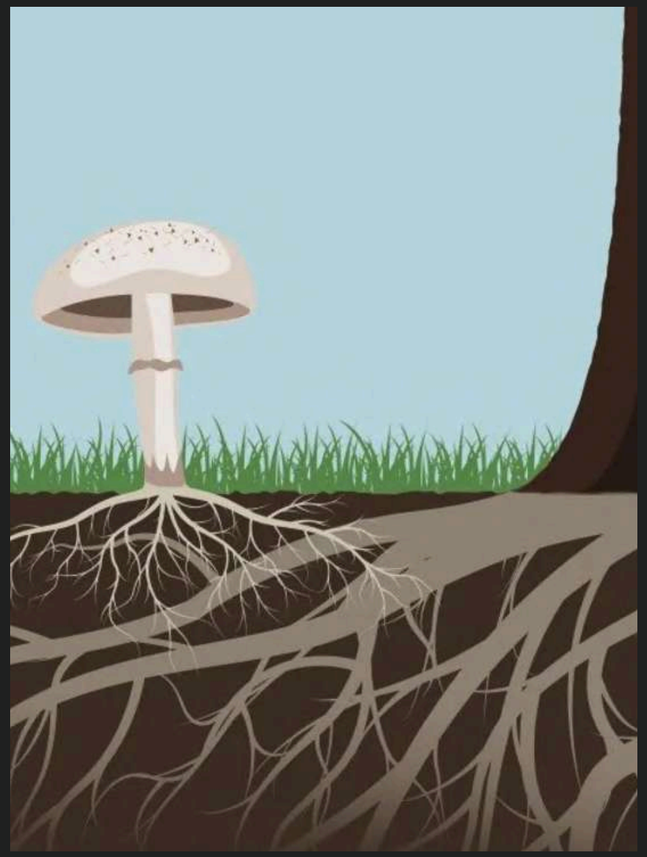
Jamie Lorimer invites us to reimagine our place in the world—not as dominant species, but as cohabitants in a lively, relational system where microbes, forests, machines, and animals all have influence. It's a call to design, act, and live in ways that respect the mutual dependencies between human and more-than-human worlds

Explores the idea that humans are not the center of the universe but part of a complex web of life—interconnected with animals, plants, microbes, technologies, and ecosystems. The book challenges anthropocentrism and encourages thinking in terms of entanglement, coexistence, and agency of non-human beings

A twin's bond is not just genetic it's symbolic.

Drawing from my personal experience as a twin, I explored the concept of symbiosis in relationships. Symbiotic relationships in nature—mutualism, parasitism, commensalism and endosymbiosis—offer a framework to understand human connections. I aimed to translate these dynamics into wearable technology, creating garments that embody the essence of twin bonds and symbiotic interactions.

Twins are born as mirrors, but they often grow into interdependent systems—systems that feel more like living ecosystems than individual identities. My experience as a twin has always felt more symbiotic than simply relational. We coexist in a way that blurs the boundary between self and other.



Example Mutualism : fungi and Trees

rticles on Matualism
BBC

Example Endosymbiosis : Lichens and Trees

Articles on Endosymbiosis
Gregory Moore, The University of Melbourne

Twinstincts

Symbiosis in Human Form

This led me to explore the world of symbiosis—where organisms live in close, often long-term relationships that shape their existence. There are three main shades of this ecological intimacy:

- Mutualism, where both entities benefit—like the mycorrhizal fungi and tree roots, exchanging nutrients and life force beneath the forest floor.
- Commensalism, where one benefits and the other is unharmed—like barnacles attaching to whales, traveling vast oceans on a free ride.
- Parasitism, where one thrives at the cost of another—complex, uncomfortable, and deeply real in some human dynamics too.
- Endosymbiosis, a more integrated form of mutualism, where one organism lives inside the other—like mitochondria within our cells, a biological merger that redefined life as we know it. This deep fusion became a powerful metaphor in my project for the hidden, internalized bonds between twins—intimate, inseparable, and essential.

But the form that inspired me most was endosymbiosis—a kind of inner intimacy, where one organism lives inside another. The mitochondria within our cells are ancient bacteria that once lived independently.

Over millennia, they became so integral to our survival, we can't exist without them. This merging is not romantic; it is biological dependence—a literal fusion of life systems.

This biological intimacy mirrors the twin bond. It's not just close—it's internal. So I asked: how can this inner bond be worn? How can it become visible, sensorial, shareable?

Patterned Connections

From Nature's Code to Wearable Emotion

LÜM began with a question: **how can the silent, emotional connection between twins be translated into a visible, wearable experience?**

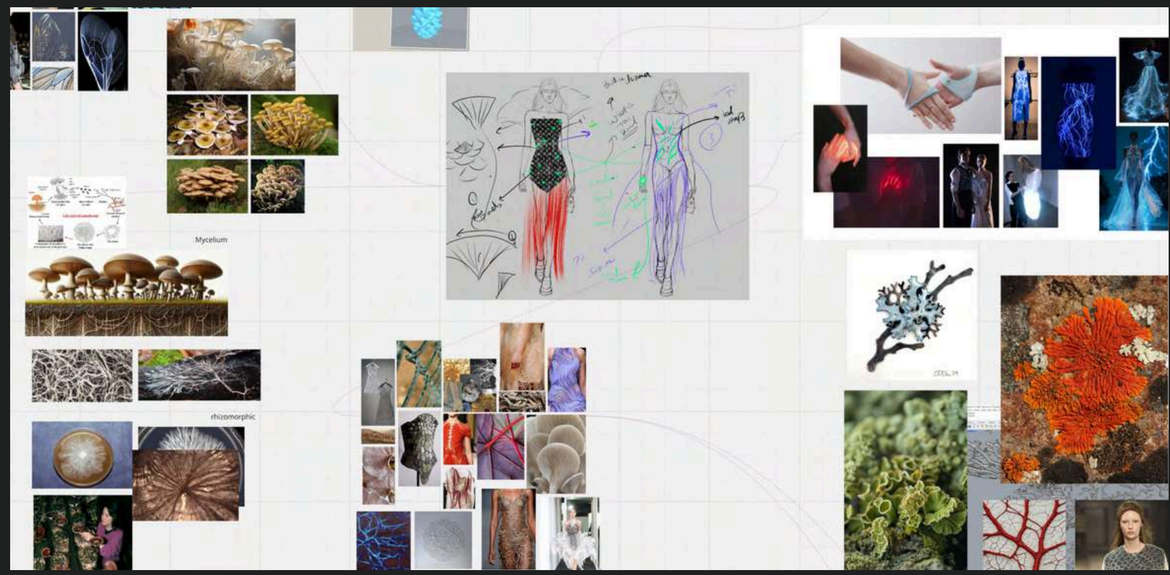
To explore this, I turned to the natural world where patterns aren't just decorative, but functional systems of communication and survival. I studied how trees share nutrients through underground fungal networks, how lichens form through symbiotic union, and how branching patterns carry signals in both plants and neural systems. These organic architectures became my visual and conceptual vocabulary.

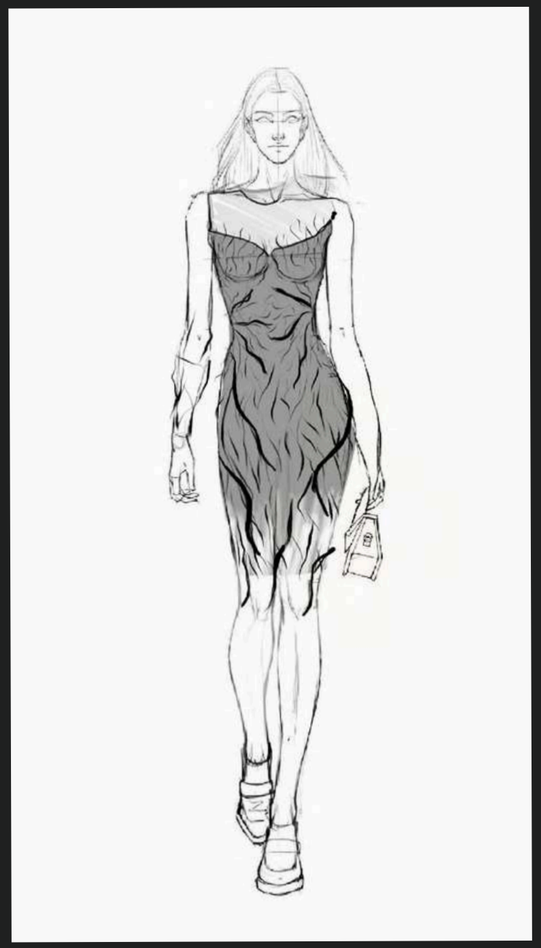
I began designing garment structures inspired by these patterns—mimicking the modularity of lichen textures, the intimacy of interwoven roots, and the reach of branching systems. The idea was not to just make clothing that looks organic, but to craft garments that behave organically reacting and adapting based on emotional triggers.

These patterns formed the base of textile components that were later integrated with electronics. When worn, the garments respond to a twin's emotional presence through:

- Light that pulses, fades, or shifts color when the other twin interacts with their piece.
- Touch-based reactions, such as triggering a glow or feedback on the paired garment.
- Proximity sensing, creating a soft alert or transformation as twins come closer or move apart.

Each patterned surface became a map of connection—not only aesthetically inspired by nature, but also functioning as an interface between emotional states and physical responses. The result is a garment that behaves like a second skin, transmitting signals through light and movement, echoing the invisible bond between two people in physical form.





Vera vs. Luma

Manifested Personas

✧ Concept Narrative

Vera and Luma are not just garments—they are characters. Each one manifests a distinct emotional and sensory role within the twin bond. While Vera reflects visibility, radiance, and outward emotional signaling, Luma holds the internal, sensing, and receptive side. Together, they complete a system of silent communication.

✧ Design Process Commentary

"The design process began by translating abstract emotional traits into material and form. I assigned behaviors, light interactions, and texture logic to each garment. I focused on how Vera might express presence through dynamic light animations, while Luma listens through proximity sensing and subtle haptic feedback. These personas helped guide decisions in material choice, electronics layout, and pattern geometry, ensuring the garments are not only symbolic but functional as communicative twins."

Luma /loo-mah/

A light that lives within.
Inspired by endosymbiosis, Luma channels the curious bond between lichens and trees — two lives intertwined as one.
Nestled shapes, hidden lights, and a pulse that glows from the inside out

Vera /vɛ-rah/

A calm force of nature.
Inspired by mutualism, Vera reflects the quiet harmony between fungi and tree roots — where both give, and both grow.
Earthy veins, soft layers, and glowing connections.

Wearable Dialogues

Interaction Design

The interaction between Vera and Luma goes beyond the surface of the fabric. It's an embodied experience, where the garments are not only reactive to physical touch but also responsive to proximity and emotional energy.

This dynamic system is made possible by integrating XIAO ESP32 Bluetooth sensors, which enable a seamless distance-based interaction between the garments.

The Interaction Mechanics

The garments use XIAO ESP32 Bluetooth modules embedded within each piece. These sensors detect proximity, meaning that when the wearer gets close to another garment, or touches the gloves connected to the garment, the proximity sensor sends a signal via Bluetooth to activate the embedded vibration motors and LEDs within the fabric. The result is an immediate response, transforming the garments into a living system that reacts to the wearer's actions.

1. **Proximity Activation**: As the wearer moves closer to the other garment or touches the glove, the XIAO ESP32 Bluetooth sensor detects the distance. This proximity triggers a vibration motor at the sensation points and activates the LEDs underneath the garment, creating a feedback loop that symbolizes the bond between the garments.
2. **Touch-Triggered Responses**: The gloves act as the primary point of interaction, with touch or proximity to the garment triggering the sensory feedback. A gentle vibration occurs at specific sensation points to mirror the feeling of connection, while the LED lights change color based on how close or distant the wearer is from the other garment.

Behavior Flow with XIAO ESP32 Bluetooth

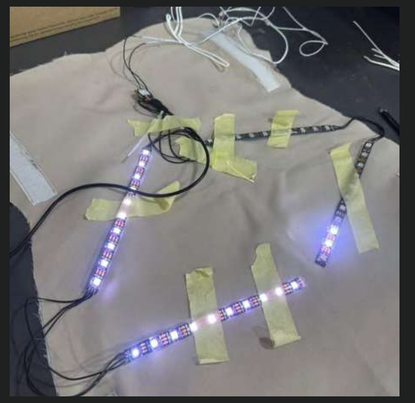
The XIAO ESP32 Bluetooth modules form the heart of the system, enabling communication between the two garments. Here's how the interaction works:

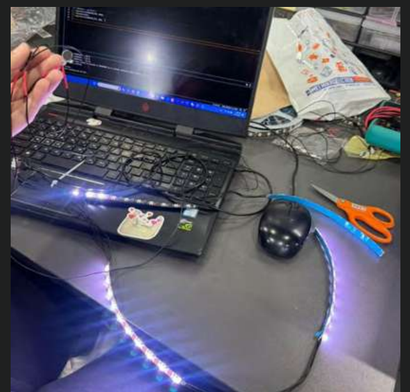
1. **Proximity Detection**: When the garments (or gloves) get within a specific range of each other, the XIAO ESP32 Bluetooth sensor detects the distance and sends this data to the microcontroller.
2. **Sensation Points**: The data triggers the vibration motors at the sensation points, providing the wearer with a tactile feedback that mimics the feeling of being connected to their twin. The closer the garments are, the stronger the vibrations.
3. **LED Feedback**: The LEDs embedded beneath the garment fabric respond to the proximity data as well, changing colors based on how close the garments are. A red LED could represent intensity or connection, while a blue LED might signal a calmer or more neutral state. The light gradually intensifies as the garments draw closer together.
4. **Continuous Interaction**: The interaction is continuous. As the wearer touches or moves around, the proximity sensors continuously measure the distance and trigger real-time reactions.

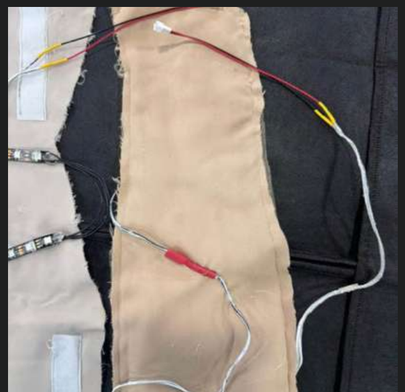
Technical Explanation: From Proximity to Activation

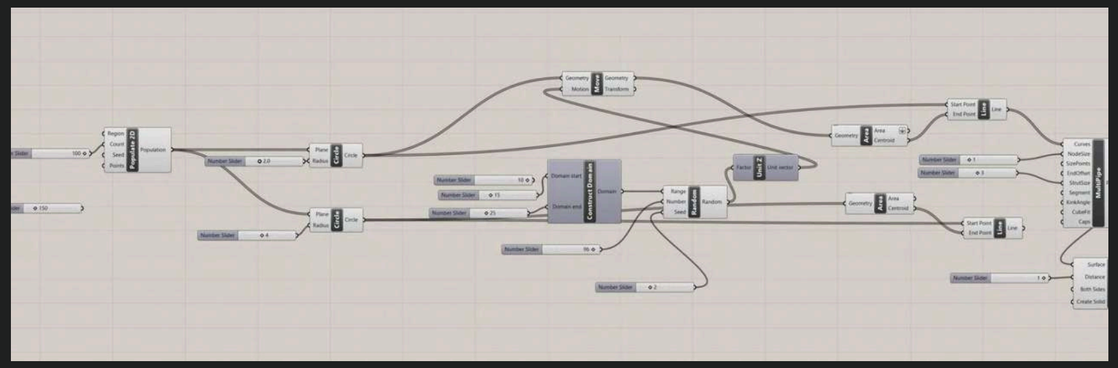
The XIAO ESP32 Bluetooth sensors enable a low-power wireless connection between the garments, allowing them to detect each other's presence without physical wires.

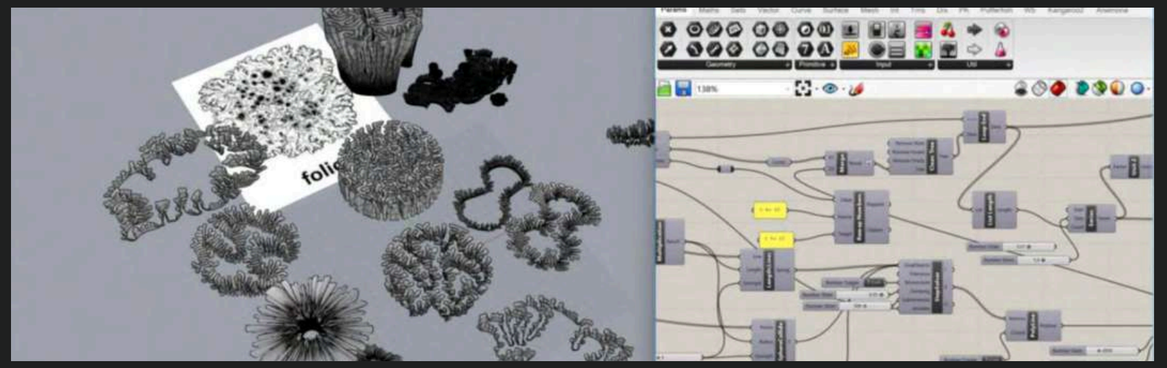
1. **Bluetooth Communication**: When one garment (or glove) comes near the other, the proximity sensor detects this change in distance. The Bluetooth connection sends a signal to the microcontroller, which activates the vibration motors and LED lights within the garment.
2. **Motor and LED Control**: Each vibration motor and LED unit are controlled through the microcontroller. The system is designed to respond with tactile vibrations and visual cues (LED color changes) based on the proximity of the garments.
3. **Responsive System**: The system is built to be dynamic and responsive, offering real-time feedback that mirrors the emotional and physical bond between the wearer and their twin garment.

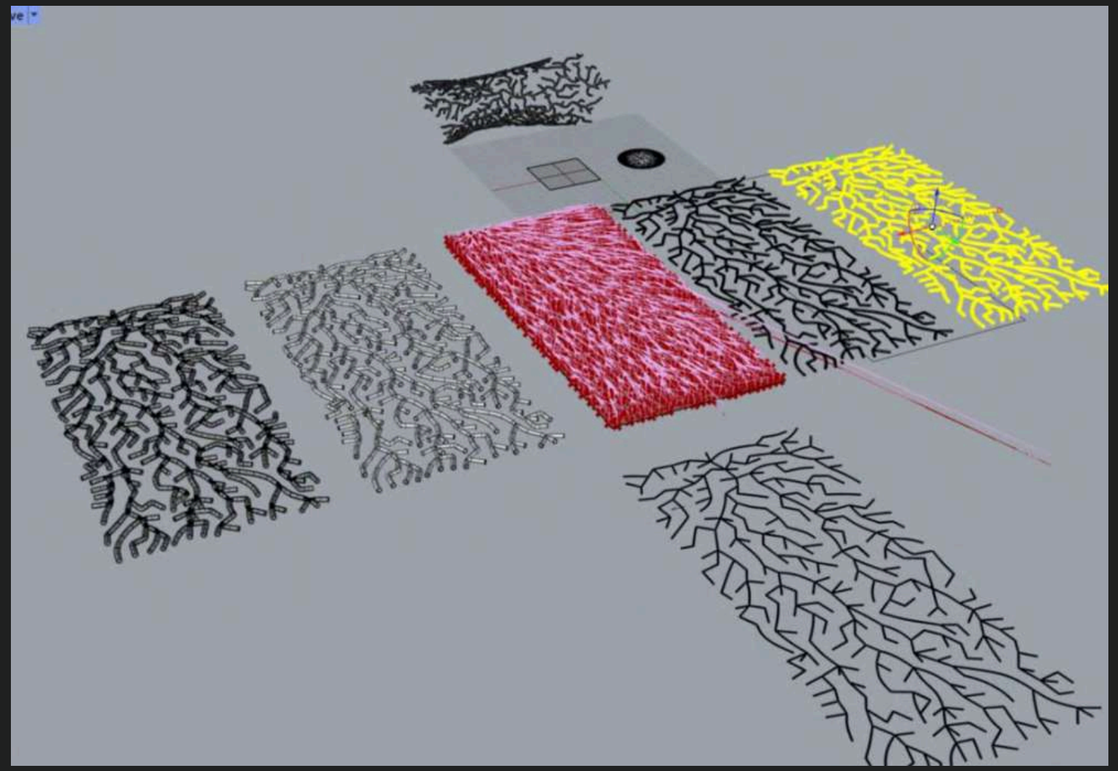












Codewoven Threads

Grasshopper & Digital Fabrication

To translate the essence of natural symbiosis into textile structures, I turned to computational design tools—specifically Grasshopper, a visual programming language integrated with Rhino 3D. This tool allowed me to mimic biological growth patterns through a generative approach that feels more like cultivating a living system than designing a static object.

Plugins & Techniques (in brief):

1. Anemone – Used for recursive loops to generate natural patterns like coral, veins, or branches.
2. Dendro – Enabled voxel modeling to create printable, organic geometries with controllable volume and thickness.
3. Space Colonization – Mimicked natural growth (like fungi or roots) to form branching textile patterns.
4. Attractor Curves – Directed the flow and density of patterns, creating spatial or emotion-driven complexity.
5. Mesh+ & Weaverbird – Refined and smoothed meshes for flexible yet structured 3D-printed textiles.

The Dual Dance

Wearing the Bond

What happens when emotion takes form?

Vera and Luma are not just garments, they're two entities in a conversation of nearness, tension, and care. Each piece is coded with emotional sensitivity, responding through light and vibration when their wearer moves closer to the other.

The garments are designed using digital fabrication techniques like 3D printing on fabric and wearable electronics, ensuring both aesthetic fluidity and functional precision. At the heart of their responsiveness is the embedded XIAO ESP32 Bluetooth module, which functions as a proximity sensor. This allows the garments to detect the wearer's distance from another, triggering the interaction.

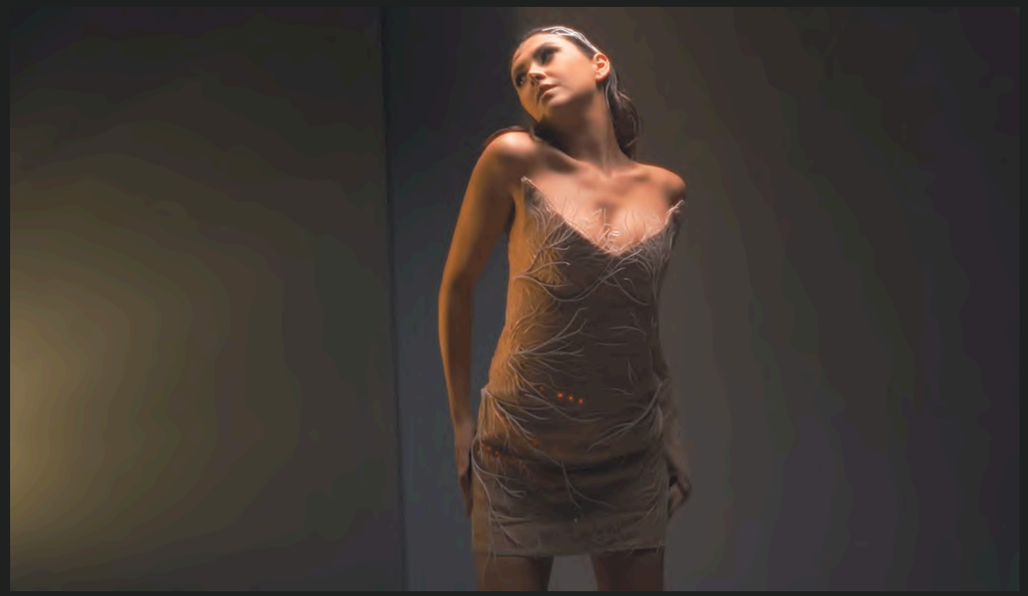
The design process was heavily influenced by parametric modeling, where natural patterns and organic forms were translated into the structural design. Branching patterns inspired by space colonization algorithms and attractor curves were used to guide the garment's structure, ensuring the fabric would move fluidly with the wearer while accommodating integrated tech like vibration motors and LED lights.

The vibration motors embedded in key points of the garment provide tactile feedback to the wearer, producing subtle vibrations to indicate the emotional state or proximity. The LEDs, embedded beneath the fabric's layers, respond to proximity by gradually lighting up or dimming, creating a dynamic visual experience that mirrors the emotional connection between the two wearers.

To fabricate these interactive garments, I utilized 3D printed fabrics with flexible mesh structures. This allowed the embedded electronics to be seamlessly integrated into the fabric, preserving both comfort and functionality. The printing process ensured that the textiles were lightweight yet durable, offering the flexibility needed for both movement and digital interaction.

Through the combination of digital fabrication, wearable electronics, and interactive design, Vera and Luma evolve beyond the traditional garment. They are embodiments of emotional connectivity, where fabric meets technology to tell a story of closeness, tension, and expression.

Gallery



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