



On This Skin
and Beneath



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ABSTRACT

On This Skin and Beneath is an art installation that explores how emotional memory can be translated into a wearable system that supports reflection on embodied experience. Drawing on body mapping and emotional mapping methodologies, as well as the artist's own embodied experience, the project investigates how emotions are sensed and located across different areas of the body, and how these sensations can be translated into visual form.

The work consists of a biomaterial bodysuit embedded with sensors and connected to a responsive display. Through touch, the display is activated, revealing a series of images derived from a self-applied body mapping process.

KEYWORDS

Bio-skin, E-textiles, Body Mapping, Emotional Mapping, Emotional Memory, Wearable Interface, Biomaterials



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Introduction

I've always been interested in the body and its interrelations with the surrounding elements: nature, society, culture, and tradition. With a background in painting, the body has been a recurring theme in my work; a liquefied body



whose margins disappear and blend into its surroundings, where skin and flesh flow into the environment.

Eventually, I took a break from painting, as I felt it had become more of a mannerism than a form of expression. I began experimenting with installation, incorporating textiles, crochet, sound, and video into my practice. Through these media and by exploring how they interact, I became more and more interested in ty, embodiment, and the relationship between materiality and memory.

More recently, I have developed an interest in body mapping and emotional mapping methodologies. The idea of viewing the body as an archive deeply fascinated me. The body, mine, ours, theirs, became a surface that stores

emotions, memories, gestures and lived experiences and a potential interface for navigating embodied experience.

Emotional experiences are not disembodied abstractions — they are felt, lived, and mapped within our own bodies

(Daikoku et al., 2025)

I joined Fabricademy with a rather simple idea: to make a bodysuit and integrate the thoughts I had developed over the past few years. On This Skin and Beneath became for me a way to investigate how emotional memories leave traces on the body and how these traces could be translated into forms, materials, patterns and tactile experiences. Through the use of biomaterials, electronics, soft sensors and body mapping practices, I explored, and I'm still exploring how the body could function as a carrier, a responsive surface and a space of narration.

The installation also reflects on how our perception of the body is shaped by personal histories, social environments, our own sensitivity and cultural structures. Throughout my life, I have been highly attentive to changes on and beneath my skin: bruises, marks, rushes, tensions, pain and other physical sensations. I perceive these traces to be connected to our lived experience and emotional states. Sometimes a moment of reflection becomes necessary to recognise it and give it form and meaning within the body.

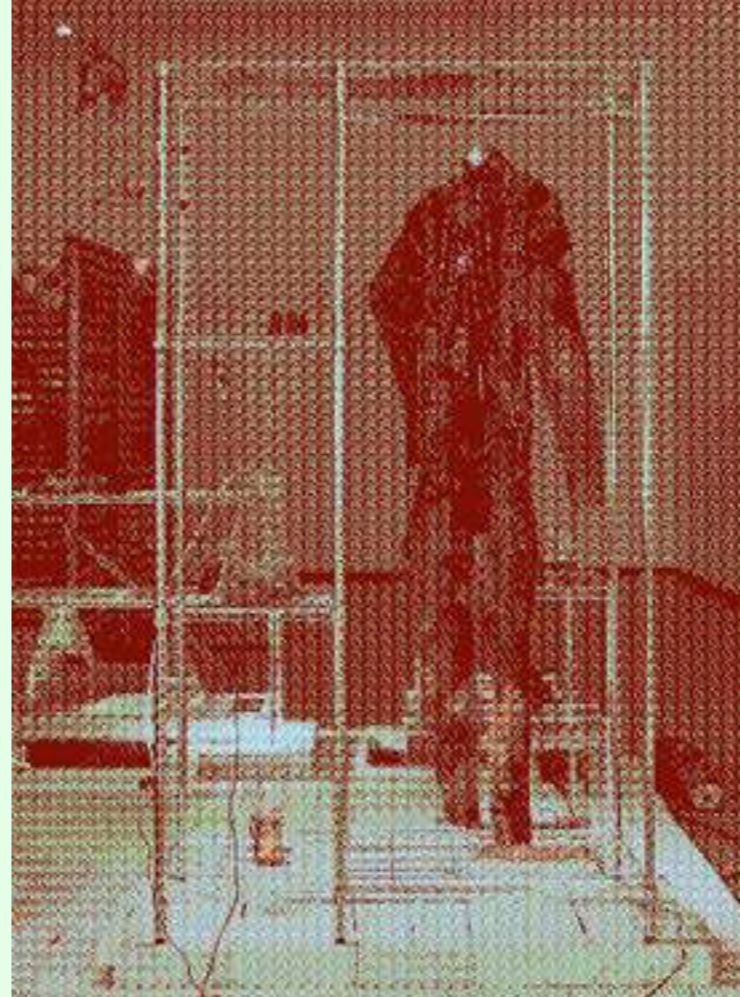
Artistic and Theoretical References

In this chapter, I analyse several artworks and artistic methodologies that inspired the development of my project. The selected works use the bodysuit, textile, or the body itself to relate to the surrounding world, while also revealing fractures in the relationships among humans, memories, technology and the ecosystem.



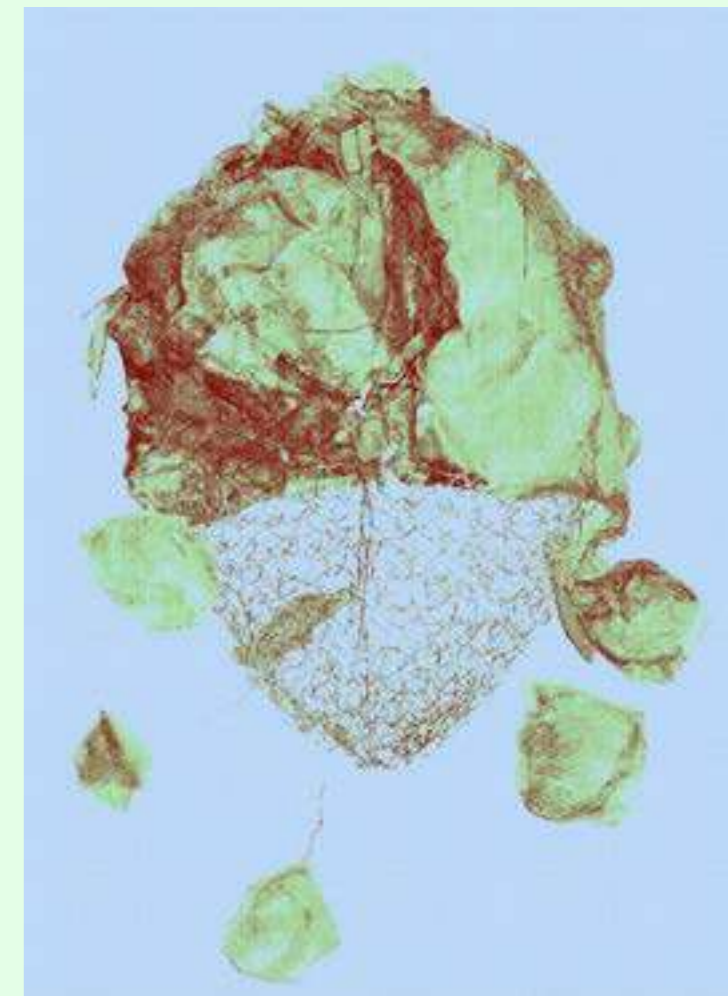
The project *An Inner-Act* (2021) by artist Chiel Lubbers bridges the inner and outer worlds. It explores the similarities between human muscle fibres and more-than-human protein fibres. The project gives equal importance to non-human and human life, seeking the essence of humanity in the ecosystem in which we participate.

In *The Myth of the CiucciaNebbia* (2022), Gaia D'Arrigo transforms the phenomenon of air pollution into a living entity that wanders the streets of Milan, reflecting on the impact of human activity on the urban environment. The body of the CiucciaNebbia collects the fine toxic particles that settle on the facade of buildings, acting as an archive, a map, of the industrial history of the city and the life of its inhabitants. The work touches upon themes of ecology, transformation and mythology.



Similarly, in Jasper Venus' performative work *Mire of Melusine* (2024), myth, ecology, personal transformation, and identity converge. Inspired by the folk legend of Melusine, a mythical water entity with human characteristics, and by swamp landscapes, the artist explores themes such as trauma, spirituality, and the intertwining of humanity and nature through this sculptural installation and the related performance *Murky Murky, Little Bitch Witch* (2023), a critique of environmentally disruptive fishing industries driven by multinational interests.

I was also influenced by Francis Hörters' Fabricademy graduation project, *Safety Curtain/Cocoon* (2025), in which textile installations reflect upon the artist's neurodivergent experience through material and spatial expression.



Another important reference is Behnaz Farahi's work, *Can the Subaltern Speak?* (2020). This project is inspired by the historical masks worn by the Bandari women in southern Iran during Portuguese colonisation. Allegedly worn to protect women from the slave masters' gaze, from a contemporary perspective, these masks can also be understood as symbols of oppression within patriarchal and colonial settings.



Finally, *Memory as a Methodology for Filmmaking* (2019) by Emilio Angel Reyes Bassail is another artistic approach that informed my understanding of memory as an artistic methodology. In this approach, the subjective action of recalling memories is understood through artistic practice and the process is materialised through filmmaking. Here, remembering

and forgetting become creative techniques, and the subjective experience takes a leading role in the research.

All together, these references strengthen my interest in using wearable systems, textiles, biomaterials and electronics as tools for storytelling and embodied reflection.

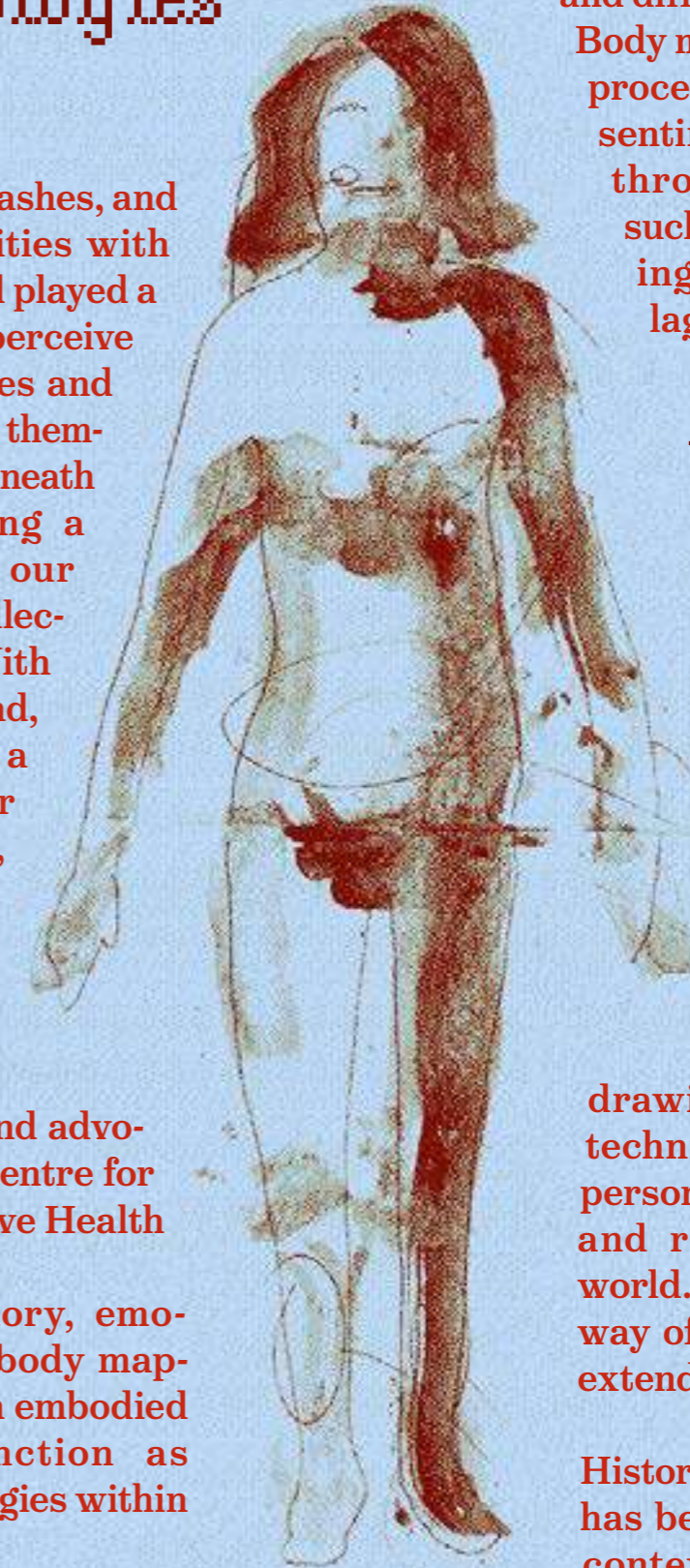
Design Methodologies

Bruises, marks, rashes, and physical similarities with my family have all played a role in the way I perceive the body. Gestures and memories imprint themselves onto and beneath the skin, forming a kind of map of our individual and collective histories. With these ideas in mind, I came across a presentation by Dr Denise Gastaldo, in which she discusses her work adapting body mapping techniques for therapeutic and advocacy purposes (Centre for Critical Qualitative Health Research, 2018).

Emotional memory, emotional mapping, body mapping, and my own embodied experience function as design methodologies within this installation.

By emotional memory, I refer to the strong emotions associated with specific memories, as memories

can carry different emotional weights and intensities. Emotional mapping helps capture the associations between emotional states and different bodily regions. Body mapping refers to the process of visually representing lived experience through graphic tools such as drawing, painting, writing, and collage.



What Are Body Maps?

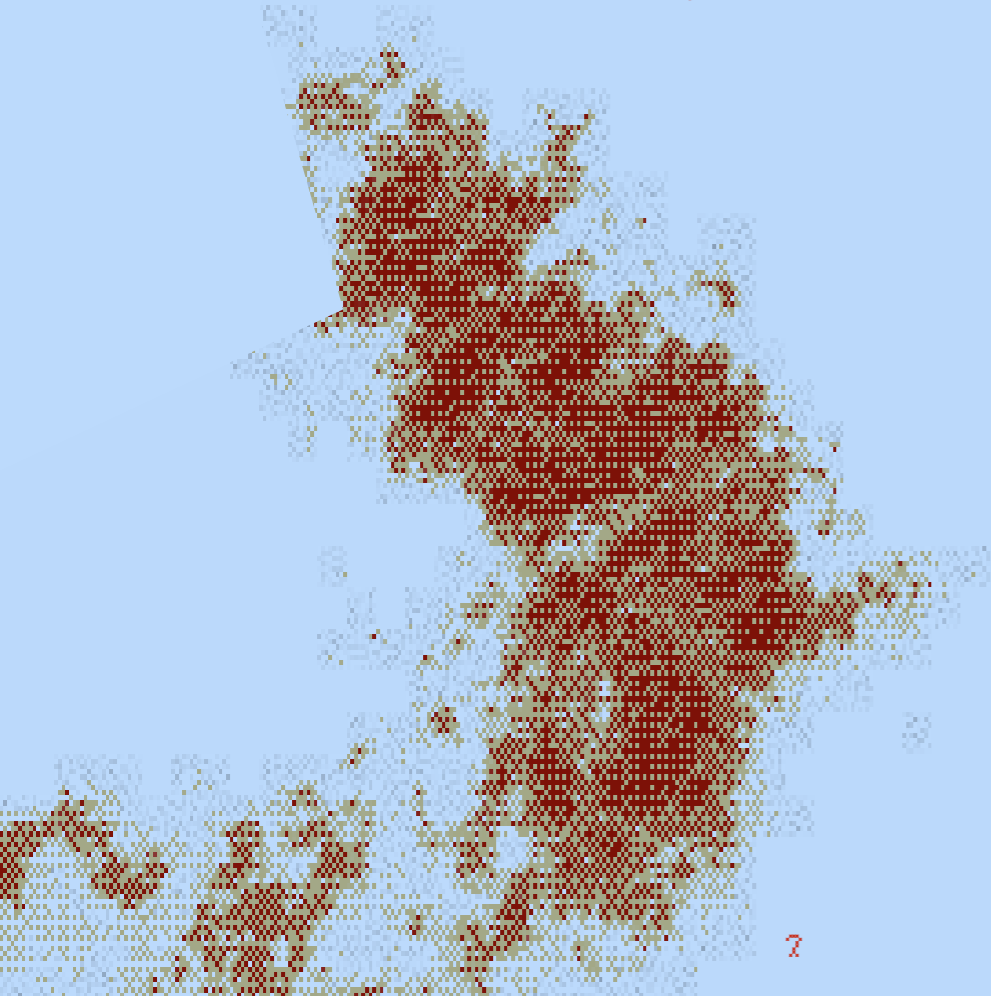
Body maps are life-sized representations of the human body, created through drawing or other visual techniques, that depict a person's life, experiences, and relationship to the world. They function as a way of telling stories that extends beyond language.

Historically, body mapping has been used in multiple contexts, including documenting working conditions and physical health, clinical research, therapy, biographical work and participatory advocacy.

For approximately fifty years, it has been applied to document workplace risks, hazards, and diseases. In clinical settings, body maps have also been used to visualise pain and musculoskeletal conditions. Within therapeutic practices, body mapping can help individuals explore aspects of their lives, such as support systems, trauma, identity, and self-image.

One of the earliest documented uses of body mapping can be traced back to Andrea Cornwall's work in Zimbabwe in the late 1980s, where body maps were used with women to explore their understanding of anatomy and physiology. The methodology later evolved through the *Memory Box Project* in South Africa, an art-therapy initiative developed for women living with HIV/AIDS. The project combined storytelling and creative practices to document the participants' experiences and create personal keepsakes to leave to their families after their death. Over time, these approaches developed into what is now recognised as contemporary body mapping methodology, combining visual expression, narrative, therapy, and research.

While body mapping is often used to map clinical or health-related contexts, this research focuses on narrating emotional journeys through an art-based approach, both visually and orally. One of the striking characteristics of body mapping methodologies is their ability to reveal the interconnected biological, emotional, and social dimensions of the body. They make visible the multiple forces that shape health, memory, perception and embodied experience.



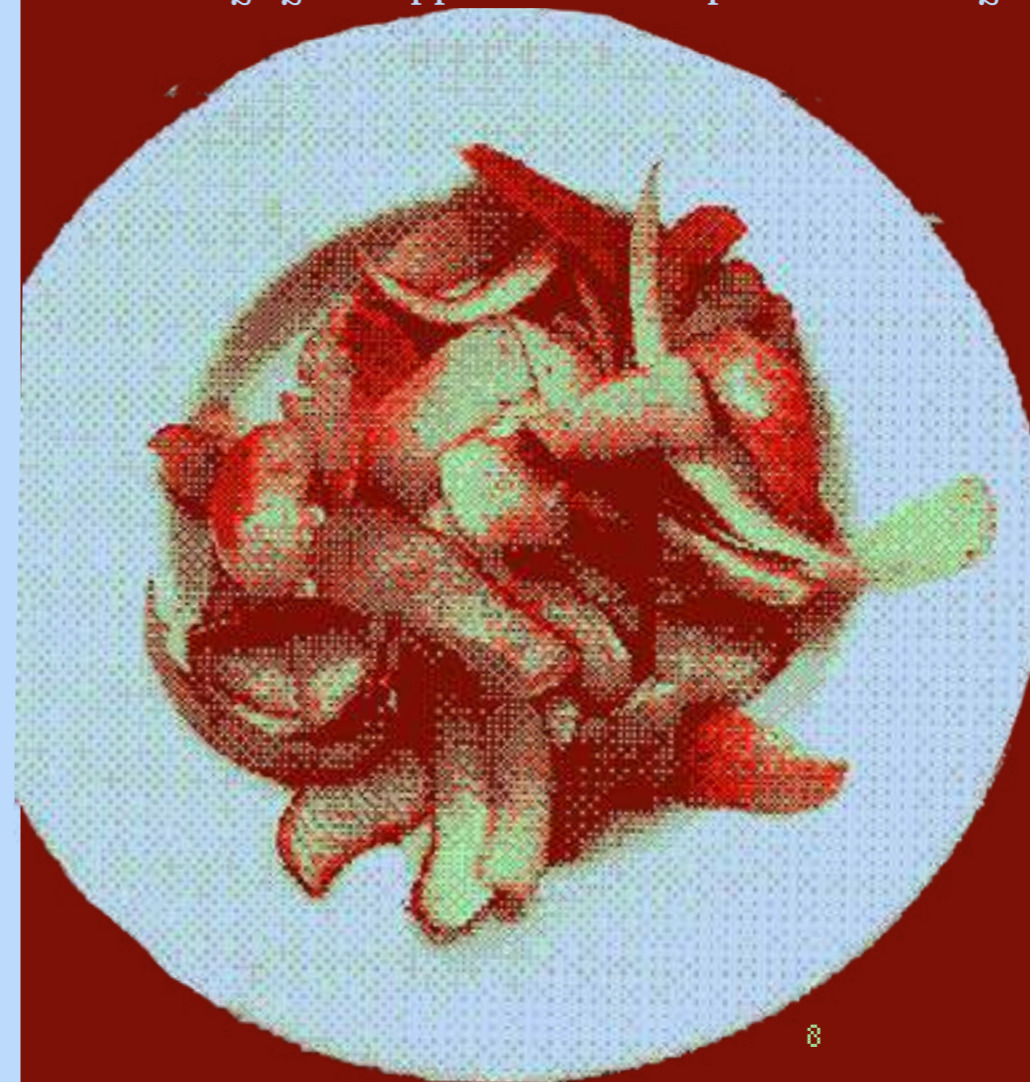
Material Research

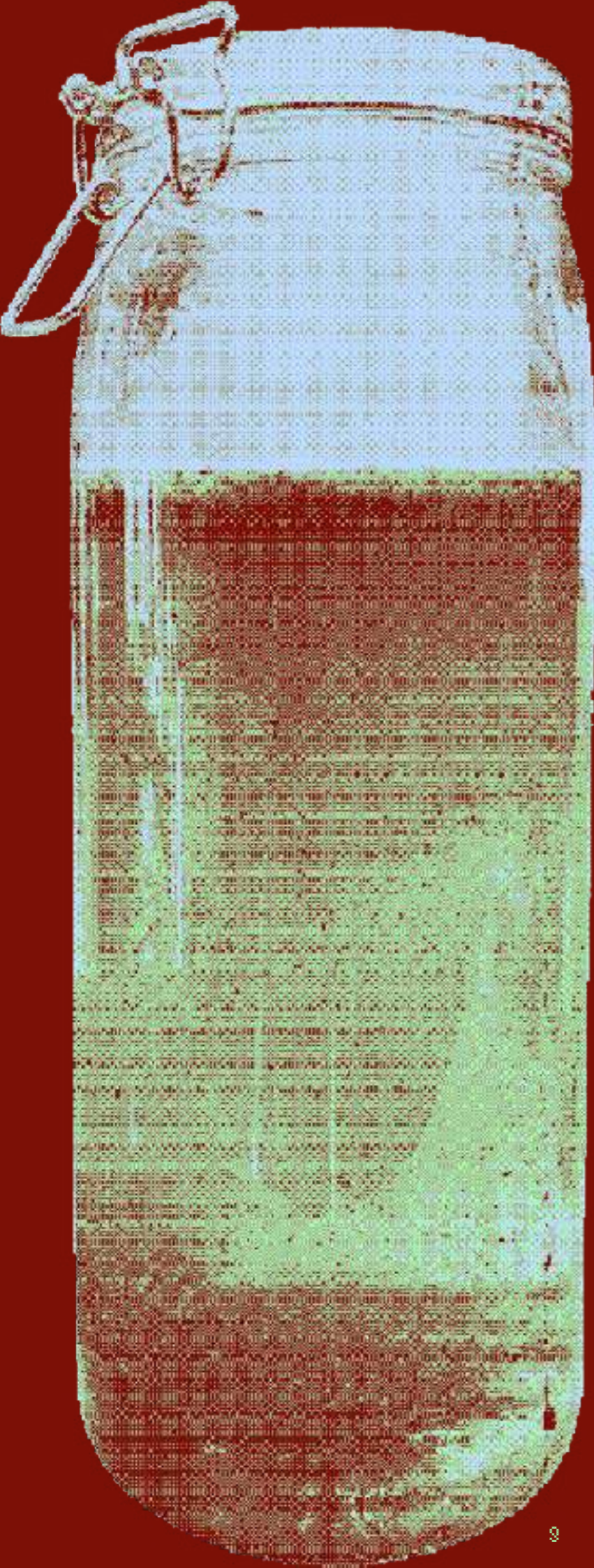
The choice of the material was guided by my being vegan, which excluded all gelatin-based recipes. While researching alternative alginate-based biomaterials, I came across the video tutorial *Making Bioplastic from Orange Peel - REMIX EL BARRIO*, a project by Susana Jurado, Elisenda Jaquemot, and Nuria Bonet. The project was created as a response to the Remix El Barrio open call by SISCODE - El Barri Circular, which reimagine how locally produced food waste could be transformed into new materials. In their project, orange peels were used to produce a bioplastic textile with properties and applications similar to those of leather.

After testing this recipe, I decided to adapt it by using more locally available fruit waste, particularly Dutch apples, instead of imported citrus fruits.

Fruits are especially valuable for biomaterial recipes because they are naturally rich in pectin, a structural polysaccharide that acts as a natural gelling and binding agent. Apples and citrus peels are among the most common industrial

sources of pectin due to their high concentration. In addition to pectin, fruit waste also contains sugars, starches, fibres, and polyphenolic compounds that can influence the flexibility, texture, colour, and antimicrobial properties of biomaterials. Using fruit waste in biomaterial production also supports circular and regenerative approaches to material design, enabling organic waste to be transformed into new, functional materials.





Bioskin Apple Recipe

5 L water

150-170 g fruit peel

140-150 g sodium alginate

450 g glycerin

(70 g oil)

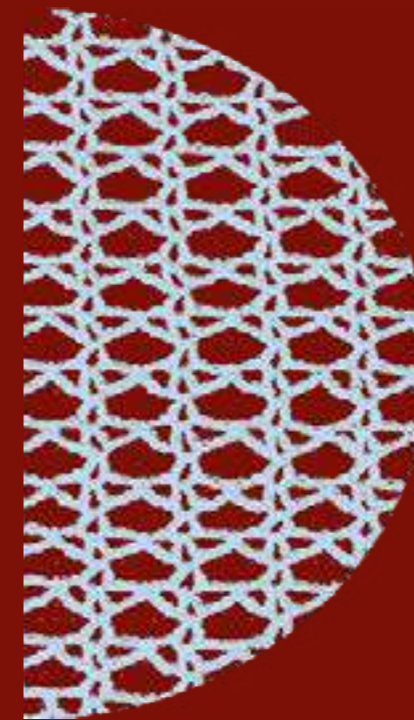
5-8 g citric acid

3-6 drops lavender

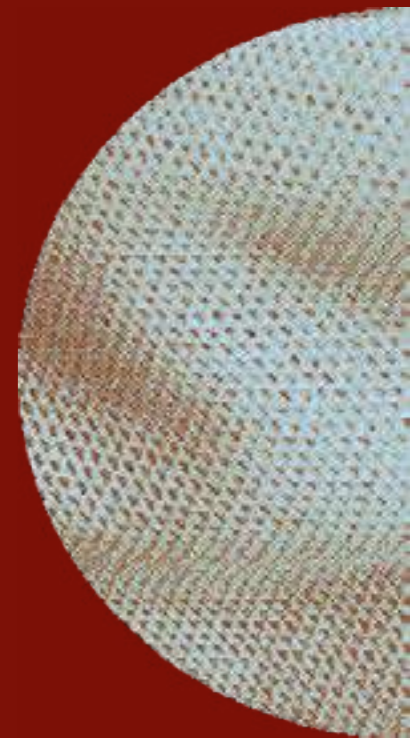
calcium chloride for curing

Material Language

I chose biomaterials because I believe they share key characteristics with memory and emotion: they are fragile, layered, reactive, composite, and constantly changing over time. Like emotional processes, biomaterials are never fixed; they shift, dry, decay, and transform in response to their environment. I was particularly drawn to the skin-like texture created by the dried apple peels: the small fragments appear as tiny dots embedded across the biomaterial's surface. The peels also gave the biomaterial a warm, brownish tone, which I decided to preserve rather than use additional natural dyes. Moreover, depending on the variety of apples, the colour of their skin, and the quantity used, which I often estimated intuitively, each batch ended up having slightly different shades and textures. These variations are not always fully visible in the final outcomes, but during the drying process, they are particularly noticeable.



To give the biomaterial a stitchable structure, I used a highly stretchable synthetic fabric (90% PA and 10% EA) as the substrate for 5 of the bioskins. For one of the moulds, I instead incorporated a crochet piece I made from 100% cotton yarn, following the pattern of a piece from my mother's wedding trousseau.



To create the moulds, I built four wooden frames by cutting and screwing together four pieces of wood, using leftover panels from previous Waag events as a base.

Three of the moulds measured 95 × 65 cm, and one measured 115 × 80 cm. I then pinned the fabric substrate onto the frames to create tension across the surface.

Initially, I sprayed the moulds with a mixture of water and calcium chloride (about 10% calcium chloride compared to the volume of water). However, because the fabric likely came into contact with the bottom of the frame while I was pouring the alginate solution, the textile substrate did not integrate properly with the biomaterial, leading to partial detachment. Although this first attempt produced a visually interesting surface, the material was difficult to stitch afterwards.

For the following batches, I adjusted the process by spraying calcium chloride solution only onto the top surface of the solution to initiate the curing process.

The bottom part was instead dried more gradually using heating mats, which resulted in better adhesion between the biomaterial and the textile substrate. Interestingly, this way, the underside of the biomaterial captured every imprint of the supporting panels used for the moulds. Since the panels were made from corrugated cardboard, subtle vertical lines became embedded into the bioskin's surface. In some areas, pieces of tape attached to the panels also transferred their glossy texture onto the material.

After testing different recipes found online and selecting this one for my project, I also came across *Adam Sheet*, a waterproof biotextile developed from apple waste by the Japanese design studio Sozai Centre. The material was designed in response to the large amount of apple waste produced in Aomori

Prefecture, Japan, an important environmental concern.

According to the designers, *Adam Sheet* is waterproof, machine-washable, scratch-resistant, semi-transparent, and can be cut and sewn like conventional textiles. These characteristics fascinated me, especially because they demonstrate the wider material potential of fruit-based biomaterials. The project also reinforced my interest in working with apples as a locally accessible and versatile organic resource.

Constructing the Bodysuit

The biomaterial Layer

Although I had done some sewing in the past, this was my first experience with pattern-making. I initially searched online for existing patterns to serve as inspiration, but I could not find anything that fully matched what I had in mind. The idea was to create separate arms, legs, and a central body piece connecting the front and back through the crotch and legs. Most bodysuit patterns I found either treated the body and legs as a single continuous piece or treated the lower section more like a trouser pattern, neither of which was the silhouette I was looking for.

After a long process of adjusting, pinning, cutting, fitting, drawing, and redrawing, with the help of Cecilia, I eventually arrived at a pattern that felt satisfying and coherent. I transferred the panels onto the biomaterial using tailor's chalk and then cut all the pieces by hand. Because of time constraints and

the handmade nature of the process, I did not have enough time to properly test laser cutting on the biomaterial.

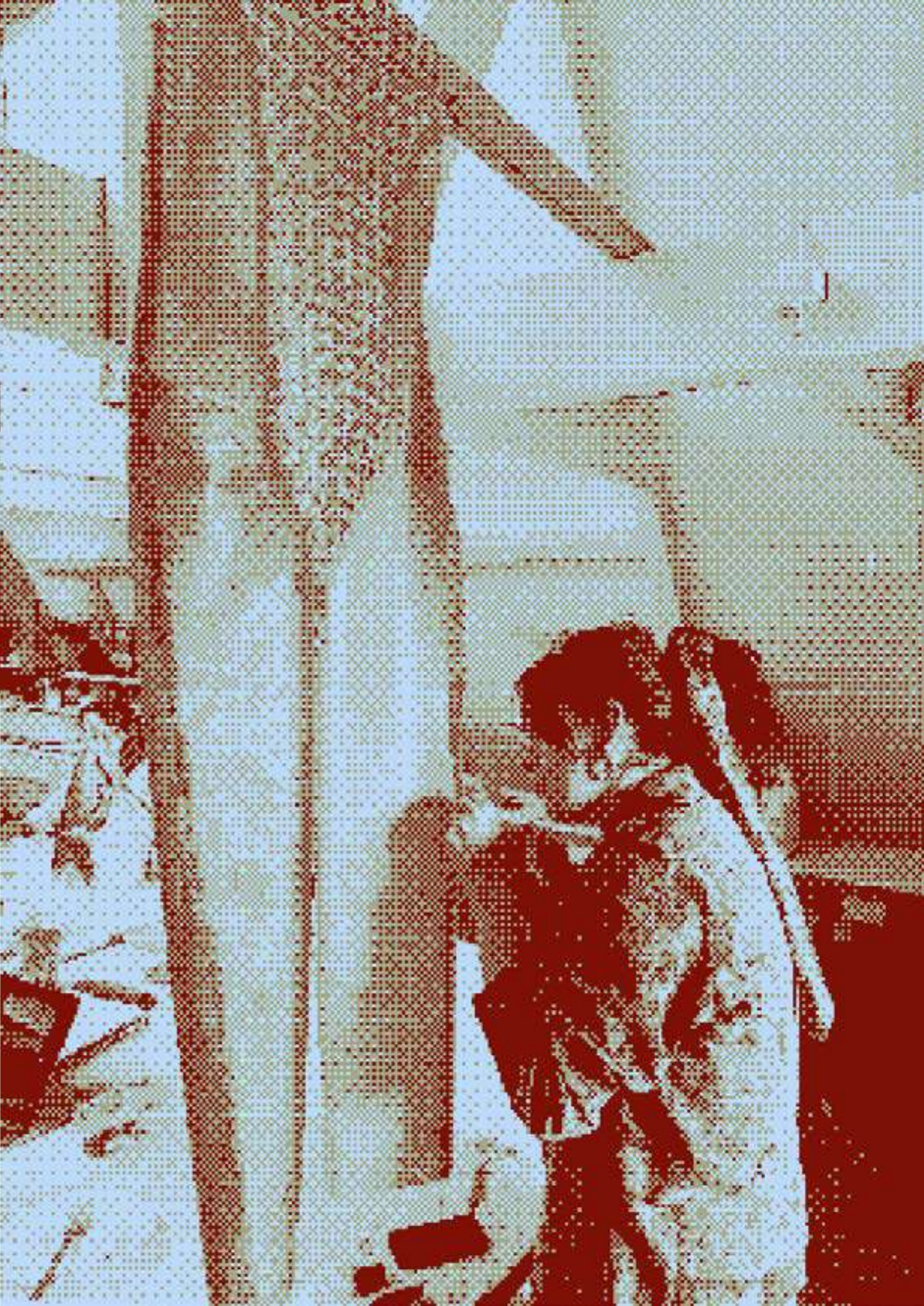
The legs and arms were cut from the bioskin with fabric as the substrate, while for the front and back body panels, I used the one with crochet as the substrate. The bodysuit's closure was designed similarly to a corset. I cut openings along the edge of the bioskin and used the holes already present in the crochet structure to weave a crochet chain through the back, allowing the suit to be tightened and closed.





To stitch the bodysuit together, I used an industrial sewing machine available at Waag: a Global 3900 AUT. I used a straight stitch with a length of 3.25 mm. The stitching technique was similar to that commonly used in leather construction. Instead of folding the seams inward as in conventional sewing, the two pieces were overlapped with a 1 cm seam allowance. This method reduced stress on the biomaterial and helped prevent tearing, as folded seams would have made the material more fragile.

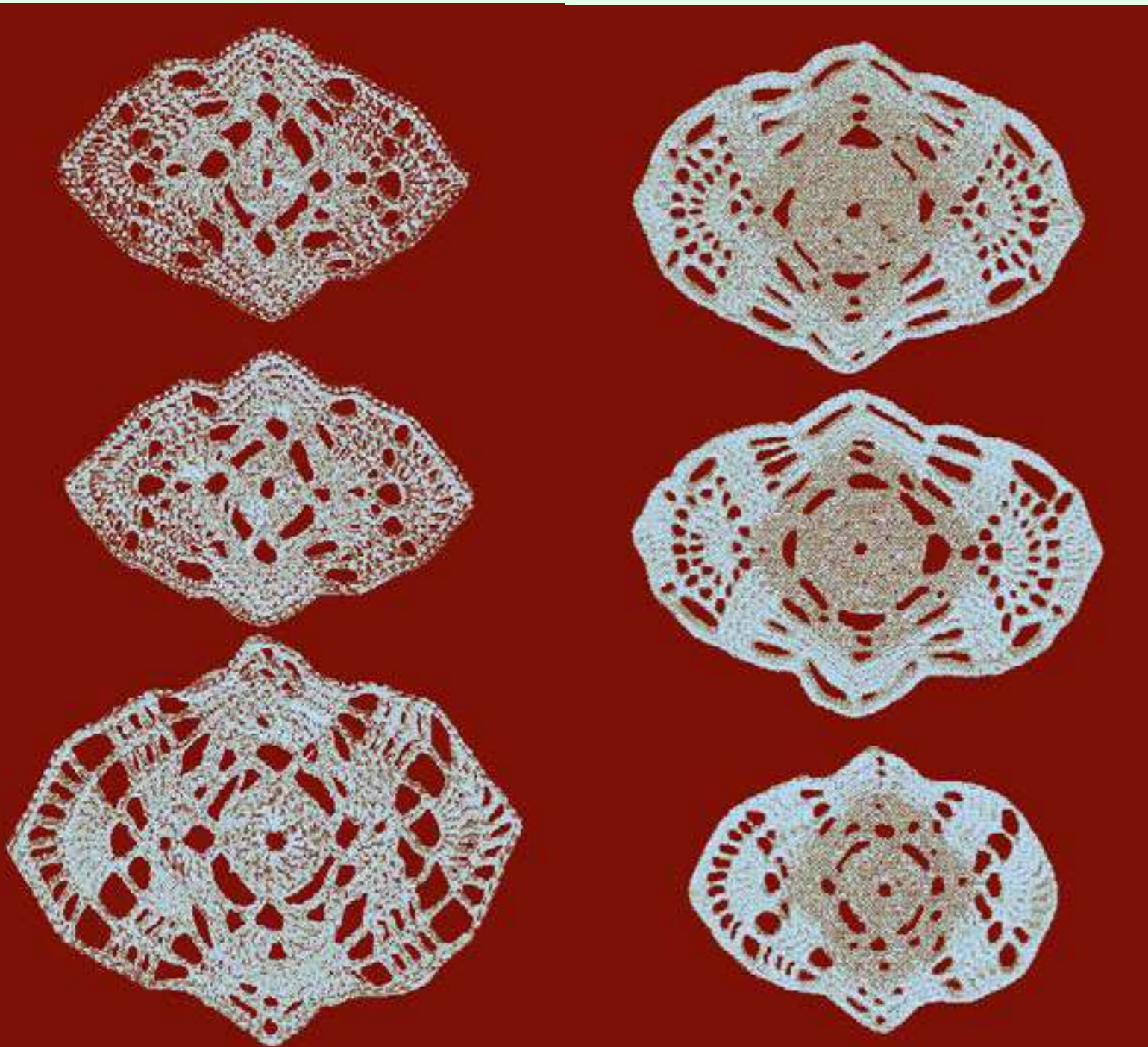
Because the sewing machine could not fully close the cylindrical shapes of the arms and legs, Cecilia suggested machine-stitching along the two long edges first, then joining the final sections by hand-stitching. This creates the illusion of continuous machine-stitching in areas where it was not possible. I used the same solution when attaching the arms to the shoulders, especially as the bodysuit became heavier and increasingly difficult to manoeuvre under the machine. Since the biomaterial had a rubber-like texture and did not slide smoothly across the sewing machine surface, I placed parchment paper underneath the panels to help the material move more easily while stitching. One side of the biomaterial exposed more of the textile substrate, which improved its ability to glide during sewing.



The Sensors

The crochet sensors were designed using patterns inspired by my mother's wedding trousseau and traditional lace crochet techniques. I created six sensors in total, positioned across key areas of the body: the arms, legs, chest, and stomach.

The sensors are made from 100% cotton yarn, while the central section incorporates conductive thread, with a resistance of less than 80 Ω /m, and includes an additional transparent TPU (thermoplastic polyurethane) coating, allowing it to function as a touch sensor.



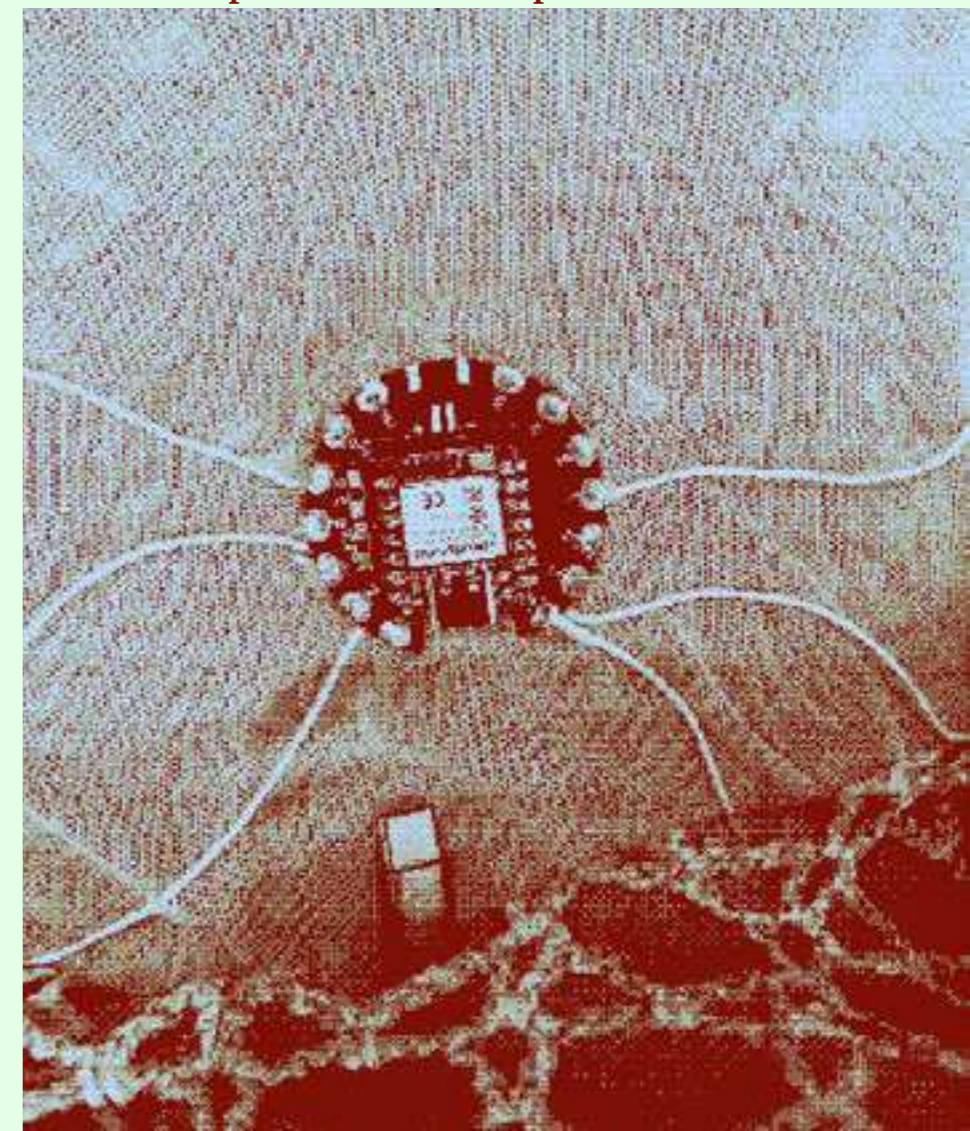
Electronic Layer and Interaction

The idea of creating two separate layers, instead of mounting the electronics directly onto the biomaterial bodysuit, emerged during a mentoring session with Rachel Freire, a transdisciplinary artist, designer, and researcher working across clothing, costume, and wearable technology. This separation made modifications and adjustments to the electronics easier to manage. Additionally, keeping the electronic components separated from the body and the biomaterial helped reduce possible interference. Since the biomaterial still retained some humidity, direct contact between the conductive elements, the bioskin, and the material itself could affect conductivity and sensor responsiveness.

The electronic layer consisted of a XiaoSeed ESP32S3 mounted onto a FabriXiao, a textile-friendly development board developed at Fab Lab León and designed for Fabricademy and e-textile education in collaboration with Nuria Robles. The board was created as a compact, beginner-friendly alternative to ATtiny boards and to LilyPad systems. It allows easy USB-C programming and it integrates smoothly with conductive fabrics, threads, and textile sensors.

I soldered six cables onto the board and protected the exposed connections with hot glue. Using the remaining holes on the board, I stitched it directly onto the bodice made from the same skin-coloured high-stretch fabric that I had previously used as a substrate for the biomaterial. In this case, the bodice included an opening at the crotch area to make dressing and fitting easier.

The cables connecting the microcontroller to the sensors ran through the seams joining the biomaterial panels. The width of the seams and the thickness of the cables allowed the wires to pass through relatively easily. The connection between the cables and the sensors



was achieved using small alligator clips hidden behind the sensors and attached to the loose ends of the conductive thread.

To prevent any additional interference, I added extra patches of high-stretch synthetic fabric beneath the sensors and on top of the microcontroller, so the electronic components would not directly contact the bioskin. To power the bodysuit, I used a USB cable connected to an external power supply. The cable ran from the microcontroller along the lower back and exited through the corset-style opening at the back of the suit.



The Display

Here, I would like to present both the initial concept behind the display and the direction I envision for the project in the long term. Initially, I decided to focus on two areas of the body to design a wearable system capable of translating emotional memories into material and visual form. By emotional memory, I refer to the ability to recall past events that carry a strong emotional response.

Area: Hands and Feet

Emotional Memory: grief, childhood loss, family

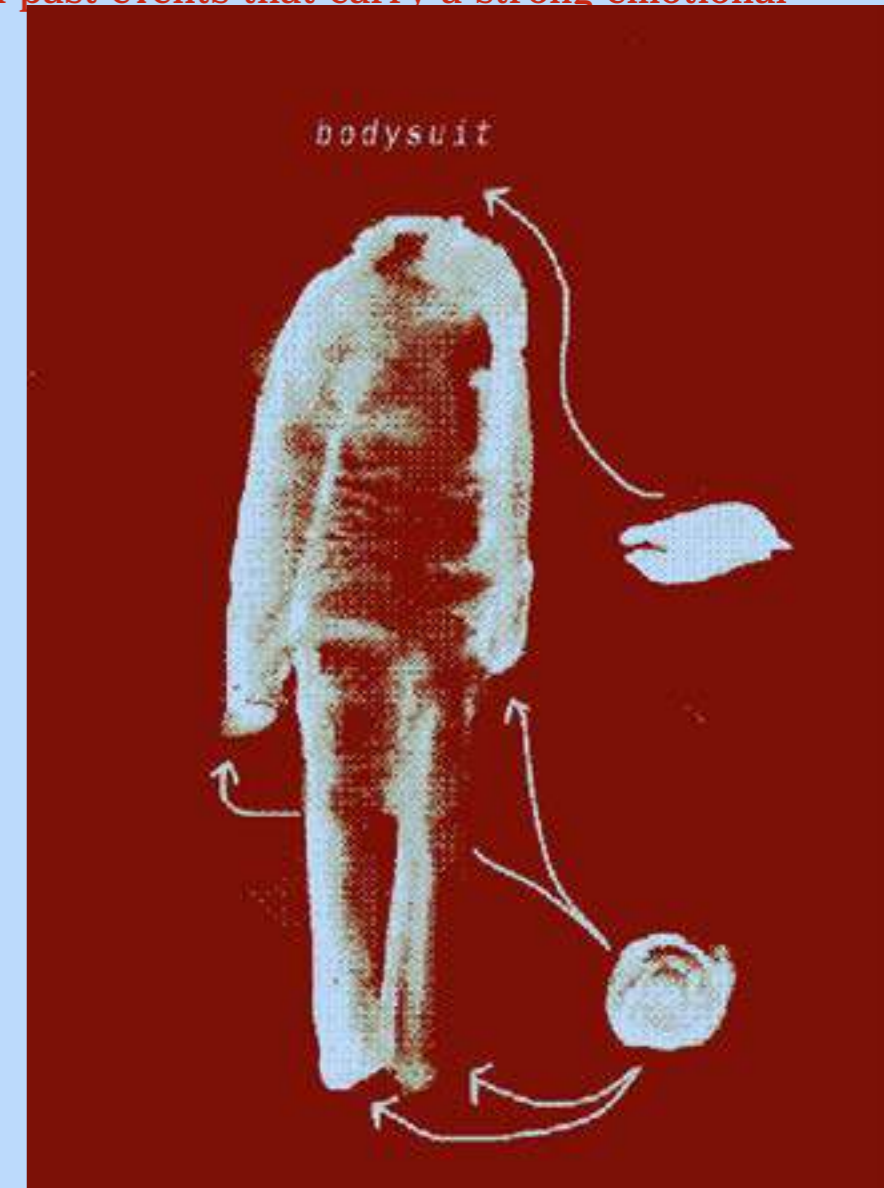
Between the ages of three and five, children begin to develop an awareness of death, even though they are not yet able to fully comprehend its permanence. During grief, children may ask repetitive questions in an attempt to understand what has happened and where their loved ones have gone. They may also experience anxiety, speech regression, and feelings of helplessness in response to the grief experienced by the adults around them.

Token - Area: Hair

Emotional Memory: femininity, distance, heritage

Hair can act as a carrier of ancestry and memory. I look at the hair of my mother and grandmother and recognise traces of my own. For me, hair becomes a symbol of power and sensitivity, acting as a bridge between myself and my ancestry. As I move further away from home, it becomes one of the elements that keeps me connected to where I come from.

My long-term intention for the project is to create physical “tokens” derived from these bodily areas – external objects representing emotional memories



that could interact with the bodysuit through sound or tactile responses,

expanding the narrative space of the installation beyond the wearable itself. Due to time constraints, however, I decided to focus primarily on body mapping methodologies for this iteration of the project. I created a series of images in response to emotions, sensations, and a set of questions I developed to navigate emotional responses across my body. These images will also inform future developments of the installation.

Display Case Design

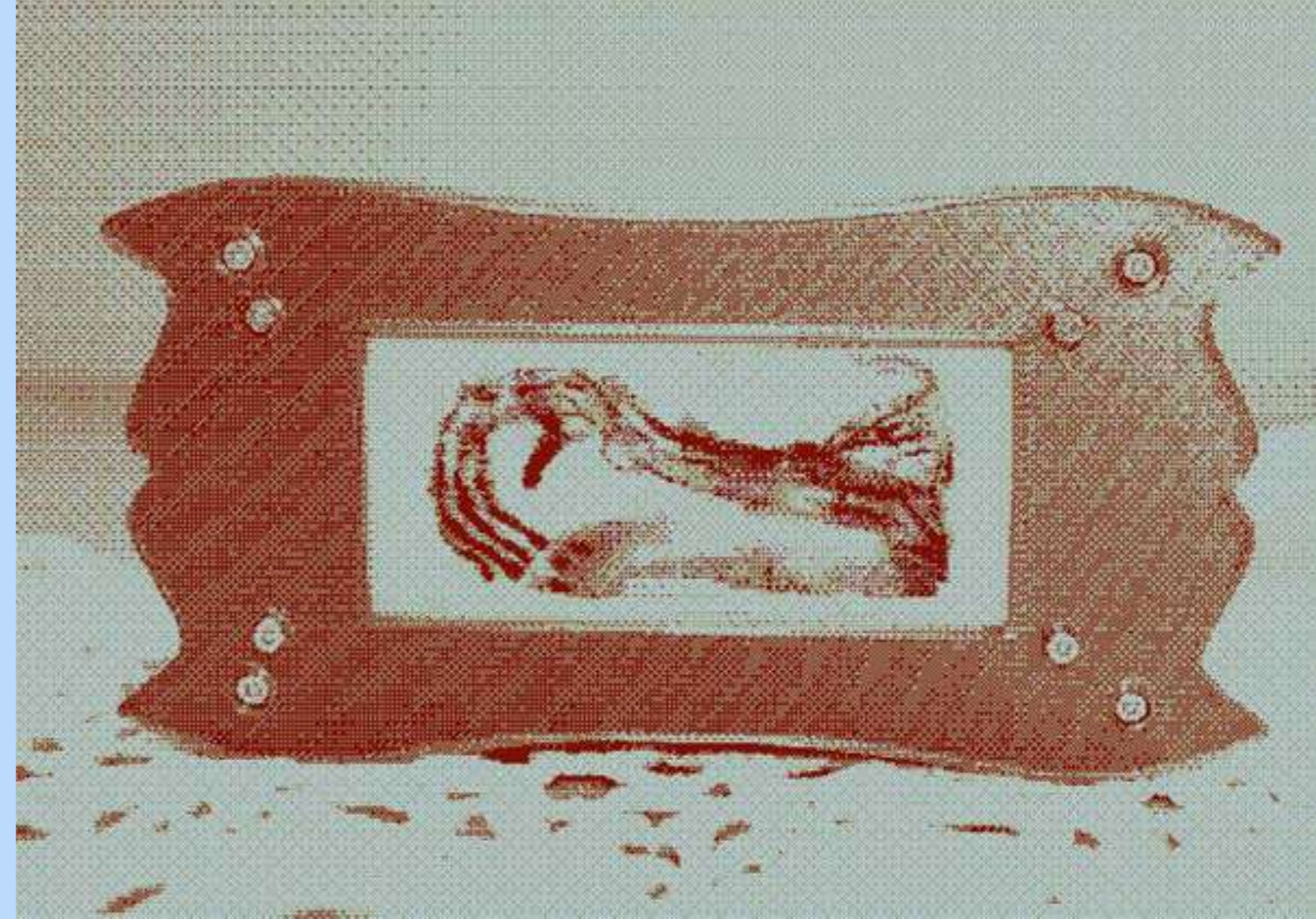
With Asli's help, I also designed and fabricated a custom case for the display in Rhino. First, I created a small test for the top section of the case, where the screen would rest. I designed a 1.5 mm-thick surface, extruded a rectangular opening matching the display's dimensions, and added 3 mm holes for the screws.

This design allowed the mounting section of the 2.9-inch e-ink display to remain hidden while positioning the screen slightly recessed inside the frame. I printed the test using the CoreOne 3D printer and PLA filament, chosen for its rigidity and structural stability.



Final Box Design

The final case was designed as a two-part enclosure with a removable top and bottom section, allowing easy access to the electronics inside. I also included an opening on the side for the power cable and connections. The case also helped frame the display as an object within the installation



rather than simply an exposed electronic component. I intentionally wanted

the display to remain relatively small and discreet, as the focus of the work was not the image itself, but the communication occurring between the bodysuit and the display. The important aspect for me was the invisible transmission between the two objects: touch becoming signal, signal becoming image.

Images

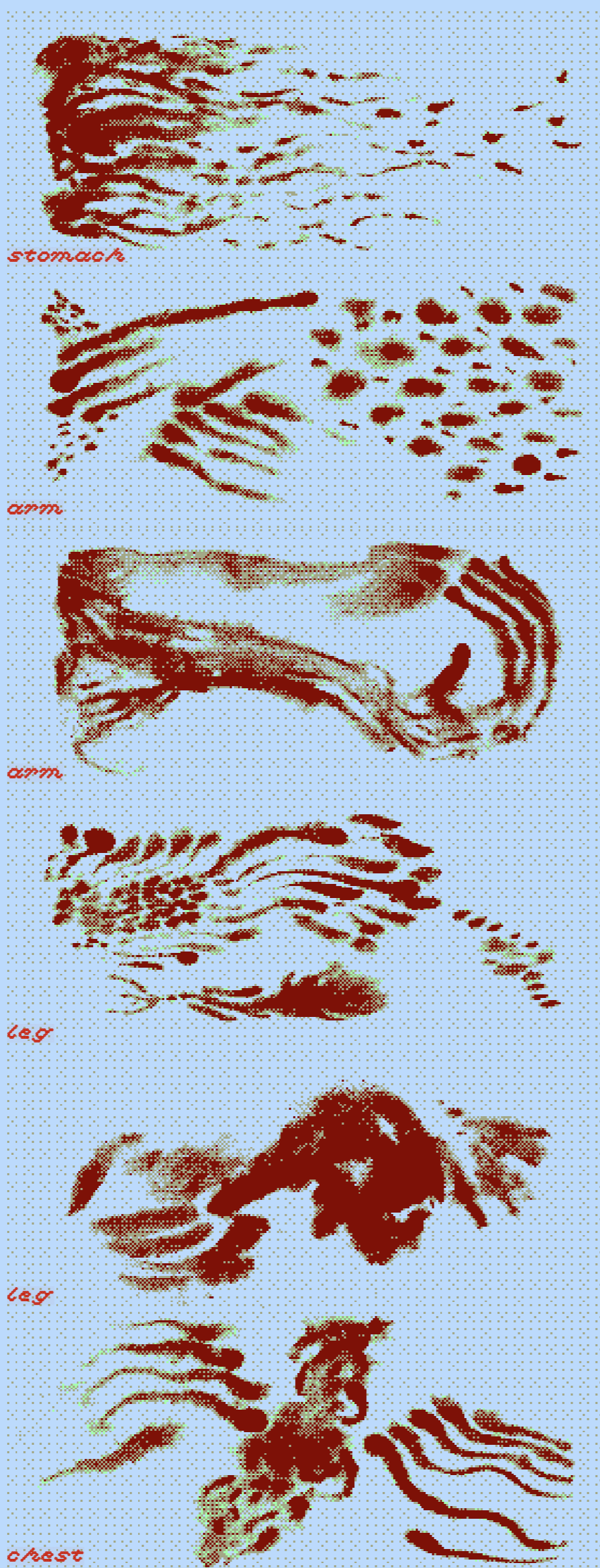
The images were created using acrylic paint, then scanned and converted into monochrome bitmap arrays using *LCD Assistant - image2cpp*, a simple tool used to transform images into byte arrays compatible with monochrome displays. For the display, I used a Waveshare 2.9-inch E-Ink E-Paper Display with four grayscale levels. A tutorial by Brett Hagman titled *Easy ESP32 Waveshare ePaper Display Tutorial (2024)* was particularly helpful in understanding how to begin working with the display.

The library compatible with this display is `<GxEPD2_3C.h>`, which must be downloaded and included within the Arduino environment. The display

also needs to be defined manually within the code according to the specific display model. The available options can be found inside the “Hello World”

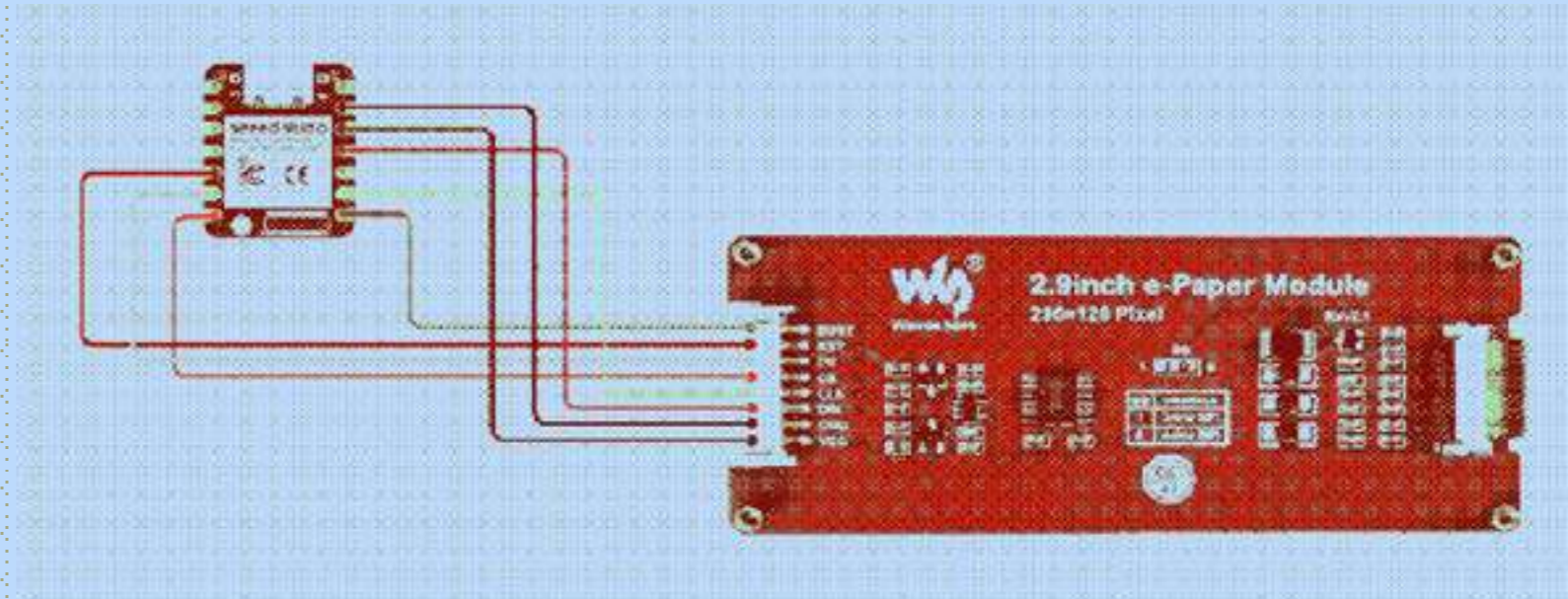
sketch examples provided by the library. In my case, the display was defined as:

```
GxEPD2_3C<GxEPD2_290_C90c,
GxEPD2_290_C90c::HEIGHT>
display(
  GxEPD2_290_C90c(CS, DC,
RST, BUSY)
```



Wiring

GPIO	Signal
9	DIN
7	CLK
43	CS
6	DC
5	RST
44	BUSY



ESP-NOW Protocol

ESP-NOW is a wireless communication protocol developed by Espressif Systems, the company behind the ESP32 microcontroller family.

Characteristics

- * **Wireless communication:** devices can exchange data directly without the need for pairing or joining a Wi-Fi network.
- * **Low latency:** data transmission occurs almost instantly.
- * **Low power consumption:** since the devices do not need a constant internet connection, the ESP32 can enter sleep mode, wake to send information, and return to sleep.
- * **Range:** approximately 220 metres under optimal conditions.
- * **Optional encryption:** ESP-NOW supports AES-128 encryption for protected communication.
- * **Multiple peers:** one ESP device can communicate with up to 20 unencrypted or 10 encrypted peers.
- * **Wi-Fi compatibility:** ESP-NOW can operate simultaneously with Wi-Fi, allowing one device to gather data locally and upload it online if necessary.

Architecture

- * Any ESP32 device can function either as a sender or a receiver. The protocol supports peer-to-peer communication structures, such as:
 - * one ESP32 sending data to another,
 - * one sender communicating with multiple receivers,

- * or multiple devices sending information to a central node.
- * Each ESP32 board has a unique MAC address, which ESP-NOW uses to route messages between devices.
- *

```
#include <WiFi.h>
#include <esp_wifi.h>

void readMacAddress(){
  uint8_t baseMac[6];
  esp_err_t ret = esp_wifi_get_mac(WIFI_IF_STA, baseMac);
  if (ret == ESP_OK) {
    Serial.printf("%02x:%02x:%02x:%02x:%02x:%02x\n",
                  baseMac[0], baseMac[1], baseMac[2],
                  baseMac[3], baseMac[4], baseMac[5]);
  } else {
    Serial.println("Failed to read MAC address");
  }
}

void setup(){
  Serial.begin(115200);

  WiFi.mode(WIFI_STA);
  WiFi.STA.begin();

  Serial.print("[DEFAULT] ESP32 Board MAC Address: ");
  readMacAddress();
}

void loop(){
}
```

To retrieve the MAC address of the sender board, I uploaded a simple code above and checked the serial monitor, which displayed an address similar to:

80:B5:4E:C3:6A:64

The system used in this project consisted of two microcontrollers: one mounted inside the bodysuit acting as the sender, and one connected to the display acting as the receiver.

This setup allowed the bodysuit and the display to communicate wirelessly, transmitting touch-based interactions from the sensors to the screen. The final codes were developed through a combination of AI-assisted prompts and examples found online, which also helped me better understand the logic and structure behind the programming process.

Sender Code

```
#include <WiFi.h>
#include <esp_now.h>

// Define here your touch pins
#define TOUCH1 1
#define TOUCH2 2
#define TOUCH3 3
#define TOUCH4 7
#define TOUCH5 8
#define TOUCH6 6

// paste here the MAC address of the receiver
uint8_t receiverMAC[] = {0xE8, 0xF6, 0x0A, 0x8D, 0x16, 0xF8}; // CHANGE if needed

// Define the treshold of your sensors. In my case they were all quite similar
int threshold[6] = {
  100000, // sensor 1
  100000, // sensor 2
  100000, // sensor 3
  100000, // sensor 4
  100000, // sensor 5
  100000 // sensor 6
};

// States
bool pressed[6] = {false, false, false, false, false, false};
void sendTouch(char c)
{
  esp_now_send(receiverMAC, (uint8_t*)&c, 1);
  Serial.printf("[SENDER] SENT: %c\n", c);
}

void setup()
{
  Serial.begin(115200);
  delay(1000);
  Serial.println("=== FINAL SENDER STARTING ===");
  WiFi.mode(WIFI_STA);
  if (esp_now_init() != ESP_OK) {
    Serial.println("ESP-NOW FAILED");
    return;
  }
  esp_now_peer_info_t peerInfo = {};
  memcpy(peerInfo.peer_addr, receiverMAC, 6);
  peerInfo.channel = 0;
  peerInfo.encrypt = false;
  esp_now_add_peer(&peerInfo);
  Serial.println("=== FINAL SENDER READY ===");
}

void loop()
{
  int val[6];

  val[0] = touchRead(TOUCH1);
  val[1] = touchRead(TOUCH2);

  val[2] = touchRead(TOUCH3);
  val[3] = touchRead(TOUCH4);
  val[4] = touchRead(TOUCH5);
  val[5] = touchRead(TOUCH6);

  Serial.printf(
    "T1:%d | T2:%d | T3:%d | T4:%d | T5:%d | T6:%d\n",
    val[0], val[1], val[2], val[3], val[4], val[5]
  );
  for (int i = 0; i < 6; i++)
  {
    // TOUCH DETECTED
    if (val[i] > threshold[i] && !pressed[i])
    {
      sendTouch('1' + i);
      pressed[i] = true;
    }

    // RELEASE DETECTED
    if (val[i] < threshold[i] - 20000)
    {
      pressed[i] = false;
    }
  }

  delay(100);
}
```

Receiver Code

```
#include <WiFi.h>
#include <esp_now.h>
// You should check the library for your display
#include <GxEPD2_3C.h>

// Define your pins here
#define CS 43
#define DC 6
#define RST 5
#define BUSY 44

GxEPD2_3C<GxEPD2_290_C90c, GxEPD2_290_
C90c::HEIGHT> display(
  GxEPD2_290_C90c(CS, DC, RST, BUSY)
);

// I used https://projedferi.com/en/tools/lcd-assistant/ to
convert my pictures into byte arrays

const unsigned char leg_left[] PROGMEM = {0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x03,...};
const unsigned char arm_left[] PROGMEM = {0x00, 0x03,
0xf0, 0x07, 0xff, 0x08, 0x00,...};
const unsigned char stomach[] PROGMEM = {0x00, 0x00,
0x00, 0x00, 0x08, 0x00, 0x88,...};
const unsigned char arm_right[] PROGMEM = {0xaa, 0xaa,
0x80, 0x80, 0x00, 0x08, 0xaa,...};
const unsigned char chest[] PROGMEM = {0x88, 0x88, 0x88,
0x88, 0x88, 0x08, 0x88,...};
const unsigned char leg_right[] PROGMEM = {0x00, 0x00,
0x05, 0x11, 0x00, 0x1c, 0x00,...};
const unsigned char leg_right[] PROGMEM = {0xaa, 0xba,
0xaa, 0x00, 0x00, 0x00, 0x00...};

// Image list
const unsigned char* cards[] = {
  leg_left, // sensor 1
  stomach, // sensor 2
  arm_right, // sensor 3
  chest, // sensor 4
  leg_right, // sensor 5
  arm_left // sensor 6
};

int lastCard = -1;

// Display images
bool updating = false;
void showCard(int index)
{
  if (index == lastCard || updating) return;
  updating = true;

  Serial.printf("DISPLAY CARD: %d\n", index + 1);

  display.firstPage();
  do {
    display.fillScreen(GxEPD_WHITE);
    display.drawBitmap(0, 0, cards[index], 296, 128,
```

```
GxEPD_BLACK);
  } while (display.nextPage());

  lastCard = index;
  delay(2000); // VERY IMPORTANT for e-paper recovery
  updating = false;
}

// Callback Function
void onReceive(const esp_now_recv_info_t *info,
  const uint8_t *data,
  int len)
{
  if (len != 1) return;

  static char lastMsg = 0;
  char msg = (char)data[0];

  if (msg == lastMsg) return; // ignore spam
  lastMsg = msg;
  Serial.printf("GOT: %c\n", msg);
  showCard(msg - '1');
}

void setup()
{
  Serial.begin(115200);
  delay(1000);

  Serial.println("=== FINAL RECEIVER STARTING ===");

  // Display
  display.init();
  display.setRotation(1);
  display.setFullWindow();

  display.firstPage();
  do {
    display.fillScreen(GxEPD_WHITE);
  } while (display.nextPage());

  // WiFi + ESP-NOW
  WiFi.mode(WIFI_STA);

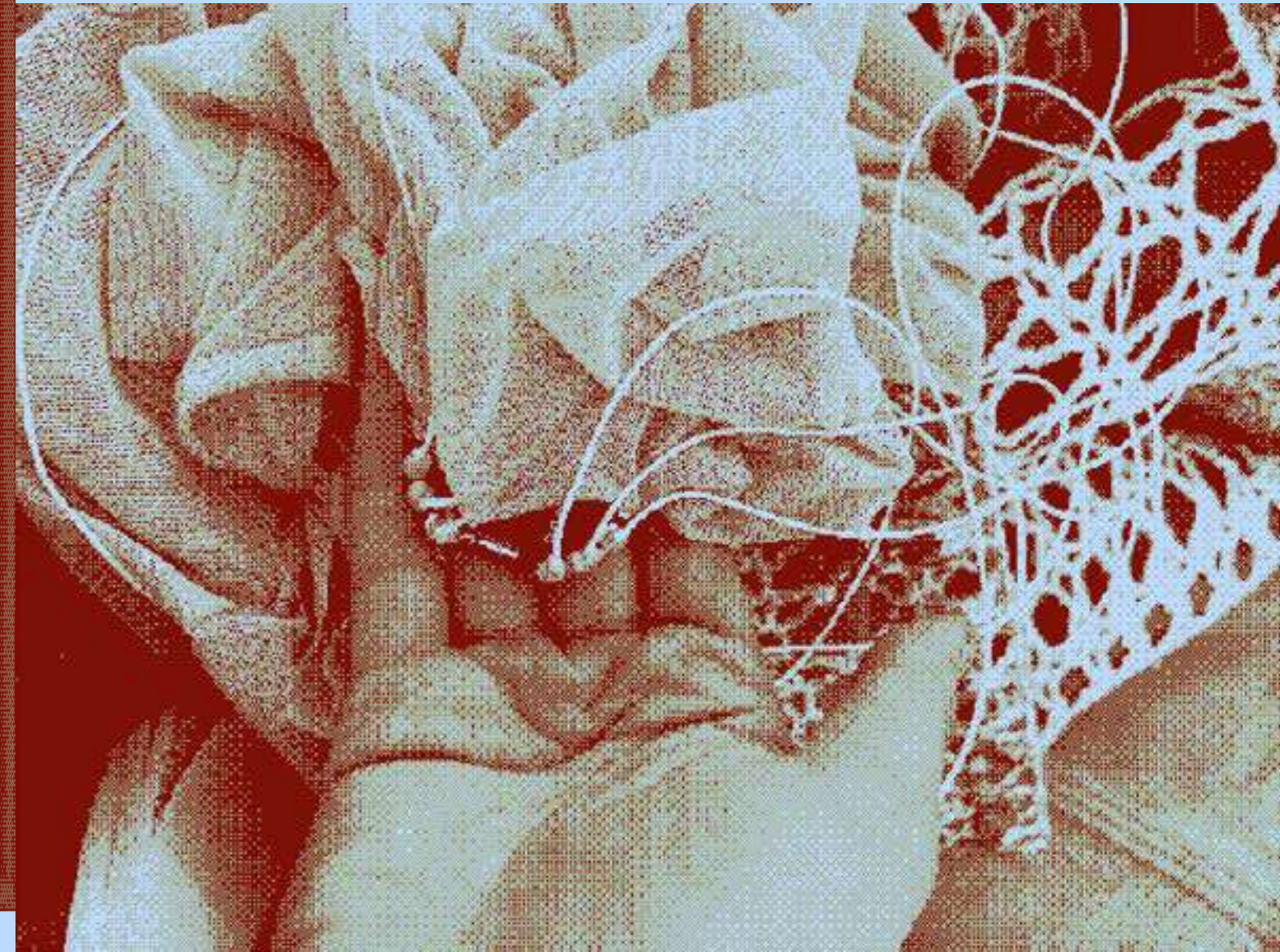
  if (esp_now_init() != ESP_OK) {
    Serial.println("ESP-NOW FAILED");
    return;
  }
  esp_now_register_recv_cb(onReceive);
  Serial.println("=== FINAL RECEIVER READY ===");
}

void loop()
{
}
```

Inconveniences and Troubleshooting

In the days leading up to the exhibition, I tested the system several times while the bodysuit was still at home. I kept the suit open so I could easily access the cables and make adjustments if necessary. At that stage, everything appeared to function correctly. I had also initially planned to use the sensor's analogue readings to display different images based on the touch intensity.

Once the installation was set up at Waag for the exhibition, however, the receiver connected to the display stopped receiving messages. The sender microcontroller printed "message sent" together with the name of the activated sensor, but the display remained unchanged and only showed "Receiver ready." I tried adjusting the threshold values multiple times and modifying the code following AI suggestions, but nothing changed. I then simplified the program further, testing a version where touching a sensor would trigger only one image



per body part instead of multiple outputs. Still, nothing happened. The night before the opening, I tested the ESP-NOW communication again at home using the display and another XiaoSeed ESP32S3 I had laying around. I uploaded the sender code onto this second microcontroller and attached two

jumper wires to simulate touch sensors. The system worked correctly again. At that point, I began suspecting that the issue might be related to the microcontroller mounted inside the bodysuit. I wondered whether I had accidentally caused a short circuit or whether the USB cable powering the system was insufficient.

The following day at Waag, I showed Henk, the FabLab lead, the functioning test setup. He suggested connecting one of the bodysuit sensors directly to the

new microcontroller I had tested at home. If that worked, I would need to replace the entire microcontroller setup on the bodysuit, which also meant soldering and stitching everything again, only seven hours before the exhibition opening.

I laid the bodysuit on the floor, opened the suit to reach the electronic layer, cut one wire, and connected it to the new microcontroller. It worked. I therefore decided to replace the whole setup.

After soldering and stitching everything back together, I hung the bodysuit again, powered both

microcontrollers, and once again, nothing worked. At this point, there were only two hours left before the opening.

Henk, Cecilia, and I laid the bodysuit on the floor and began touching different parts of the system to identify possible issues. At some point, the display suddenly reacted. I noticed that Cecilia was touching the microcontroller itself, so I tried pressing different areas of

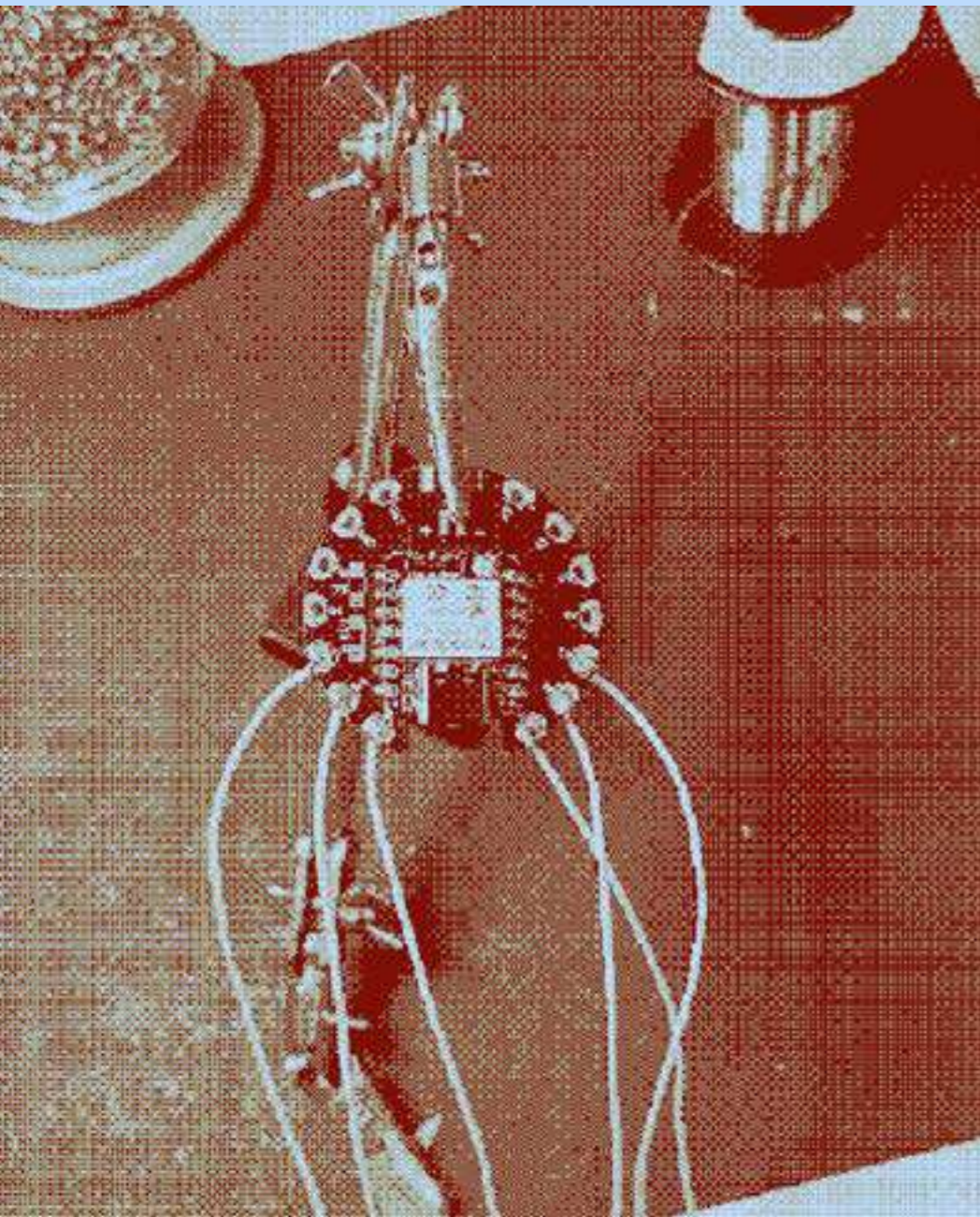
the board and cables. The communication started working again, but stopped as soon as I moved my hands slightly.

Eventually, we realised that the system only worked when touching a very specific point on the microcontroller: the Wi-Fi/Bluetooth antenna connector.

Henk suddenly shouted: *“It needs an antenna!”*

We attached the small antenna included with the XiaoSeed ESP32S3, and the communication immediately became stable. The system finally worked without interruptions.

We closed the electronic layer, rehung the bodysuit, and I briefly rested before the exhibition opening.



The Installation

The installation was presented at Waag during the Fabricademy graduation exhibition within the Makers' Guild space. I displayed the bodysuit on a transparent mannequin consisting only of the torso and upper thighs and positioned the installation close to a window so that natural light could pass through the bioskin, emphasising its texture, transparency, and irregularities. The display was placed adjacent to the bodysuit, allowing visitors to directly observe the relationship between touch and image activation. Initially, I had imagined using the long-range capabilities of the ESP-NOW communication system to separate the display from the bodysuit, potentially placing the screen in another room. Due to time constraints and the exhibition setup, however, I decided to keep both elements within the same space.

Above the installation, I suspended circular elements from which threads hung, forming a semicircular curtain-like structure. These threads were used in some parts of the bodysuit, creating a softer spatial environment around the work. The interaction between fragile organic materials and responsive technology reflected the project's central themes: the body as an archive of emotional experience and as an interface capable of translating internal sensations into visual form.



Reflection and Future Development

This project allowed me to explore the relationship between emotional memory, materiality, and wearable technology through an embodied and highly personal process. Throughout the development of the installation, I became increasingly interested in how biomaterials and electronic systems could function not only as technical components, but also as narrative and emotional tools.

The fragility, instability, and responsiveness of the biomaterials became conceptually important to the project. Like memories and emotions, the material continuously changed over time: drying, shrinking, cracking, reacting to humidity, touch, and environmental conditions. Rather than seeing these transformations as imperfections, I began to understand them as part of the language of the work itself.

In future iterations, I would like to expand the narrative space of the installation beyond the bodysuit and display. One of my intentions is to transform the images and emotional memories explored in this project into physical objects or “tokens” connected to specific areas of the body. These objects could respond to touch through sound, light, or tactile feedback using analogue sensor readings. I am currently experimenting with materials such as clay, crochet, soft sculpture, and even my own hair as possible components for these future objects. I am particularly interested in how personal materials and handcrafted techniques can carry emotional and ancestral significance within interactive installations. This project has also influenced my relationship with painting and image-making. Returning to painting after this experience, I am interested in continuing to work with natural pigments and biomaterial processes, integrating them into my artistic practice as a way of further exploring embodiment, memory, and material transformation.

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