

Master in Design for Emergent Futures

Master
Thesis

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Iaac



ELISAVA
Escola Universitària de Barcelona
Disseny i Enginyeria

Master Thesis

*Master in Design for Emergent Futures
Institute for Advanced Architecture of Catalonia*

Christian Ernst
Barcelona, June 6 2022

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Term One

1 An Introduction to Term One

The *Master in Design of Emergent Futures* is a post-graduate program at the *Institute of Advanced Architecture of Catalonia* (IAAC) in collaboration with *ELISAVA Design School*. In the context of this master, 30 students dive deep into the methodologies and tools that are needed to shape the design of the 21st century. From emerging technologies such as machine learning and biohacking to more established techniques such as 3d-printing and biomaterials, this master program covers a lot of ground to help navigate the technological sphere of the next 25 years and beyond. Through that, it equips students with a sound understanding of the design challenges that might be emerging in the future, alongside the methodological toolkit to solve them.

This draft of the master thesis should be viewed in the context of the ongoing program, as it is trying to document the active development of myself during it. Consequentially, this means acknowledging that, while it does not necessarily need to produce a tangible result, the process – and the artifacts produced alongside it – is arguably the most revealing and interesting matter to shed a light on in the context of this master thesis draft.

2 First-Person Perspective

2.1 My Fight

At the start of the academic program, we were asked to create a visual answer to the question "*What is your fight?*". My subsequent poster design was inspired by one overarching motivation: "*How can technology help solve tomorrow's problems today?*". This, of course, begs the question: What technologies are emerging today? What technologies might be part of future solutions? Which technologies should a designer learn today to be literate in navigating tomorrow's challenges? This is why I ended up specifying three areas of inquiry, which span a variety of topics.

2.1.1 Eco2

Eco2, a shorthand for ecology and economics aims at sending a light into the dynamics that drive forward the global ressource crisis, the current sixth mass extinction and, ultimately, the global climate crisis. It aims at understanding the market forces behind these developments in order to leverage them with design to use them as part of the solution. This could mean, for example, to make ecosystems self-governed and self-representative on global markets:

How can we use the global economy to give natural ecosystems an agency – and through that enable them to self-manage in a sustainable way?

2.1.2 AI

A buzzword on everyone's mind, artificial intelligence (AI) is one of the most disruptive, but also most misunderstood, emerging technologies today. From anything between simple chatbots to complex deep neural networks, this generic term encompasses a dozen emerging technologies in itself. For my poster I was interested specifically in the concept of machine learning and how it is able (with the right training of course) to simulate a somewhat realistic projection of what we commonly perceive as intelligent, such as speech and individual agency. This opens up an interesting area of inquiry which blurs the line of what it means to interact with an object, a tool or an entity:

How can we better understand the capabilities and complications of interacting with an AI – when we stop seeing it as a tool, but instead as an entity?

2.1.3 Music

As the third area of professional focus, I chose music as a tool for collaboration and, through that, frequencies as a potentially feasible language for inter-species communication. Since vibrations are universal to all organisms, viewing music and music-making as a way to build bridges between people of all ages, animals and plants – and to foster empathy and collaboration between each other – has a lot of potential as a area of inquiry. This does also include the way music is made and what qualifies as an instrument:

How can we use hardware to excite people to making music collaboratively – when we think outside of the norms of instruments?

01 Eco2

How can we use the global economy to give natural ecosystems an agency – and through that enable them to self-manage in a sustainable way?



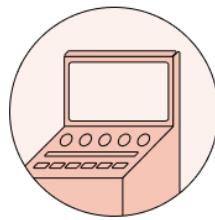
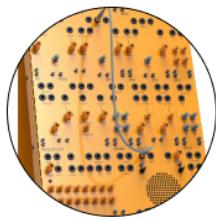
02 AI

How can we better understand the capabilities and complications of interacting with an AI – when we stop seeing it as a tool, but instead as an entity?



03 Music

How can we use hardware to excite people to making music collaboratively – when we think outside of the norms of instruments?



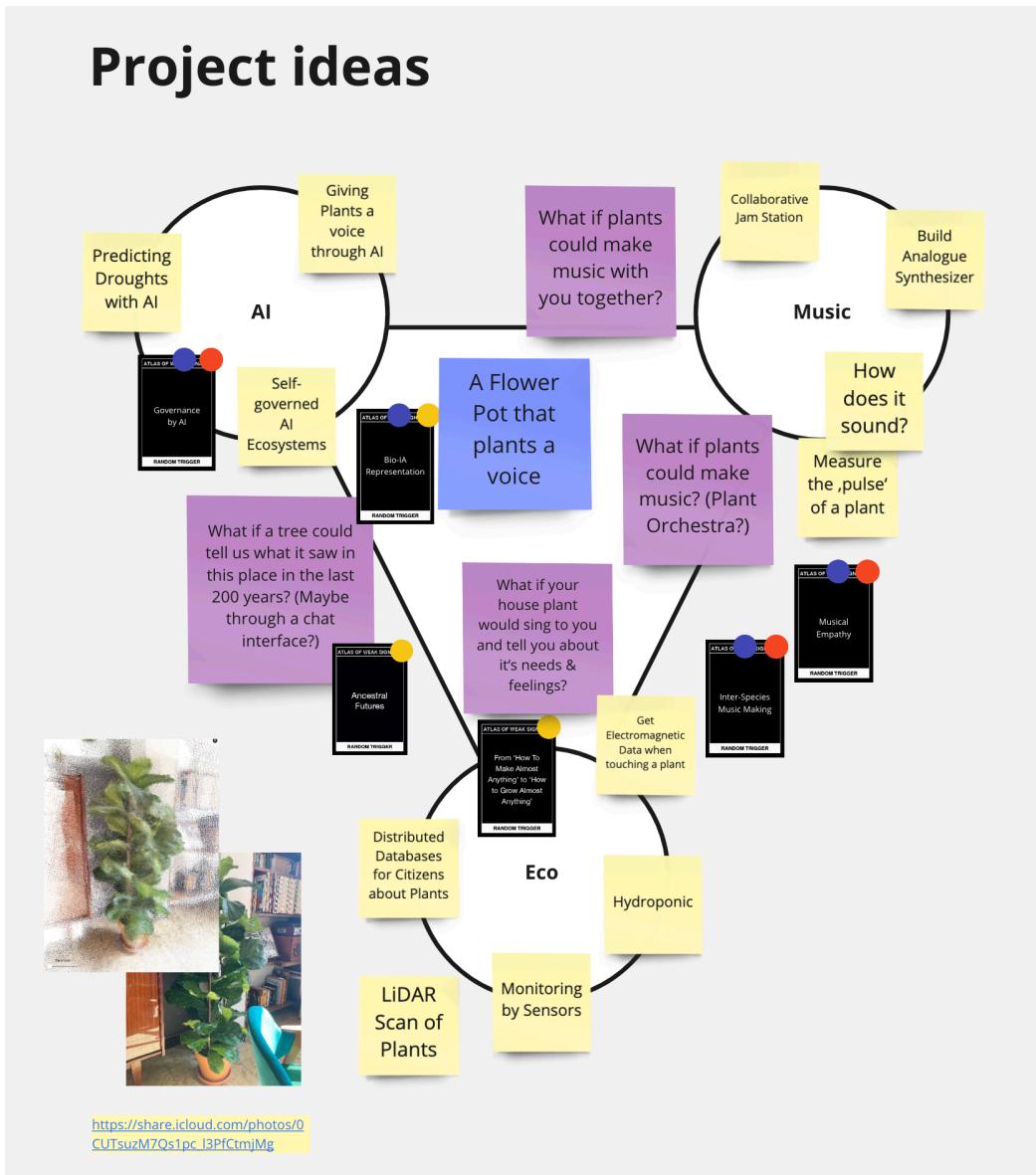
What's your fight?

Christian Ernst MDEF 2021

The original poster designed on October 3rd.

2.2 Vision & Identity

In order to visualize all of these areas of inquiry in a design space and to start gathering ideas, the following canvas was drawn on a personal *Miro* board. Here, key ideas, represented in violet and blue can be identified as the focal points within the intersection of the three topics.



Intersecting areas of interest and different project possibilities that emerge from the combination of them.

All three of these topics operated on different scales in terms of overall scope, idealistic ambition, hands-on work, conceptuality and possibility to take full advantage of the curriculum this program offers. This meant for me that it proved to

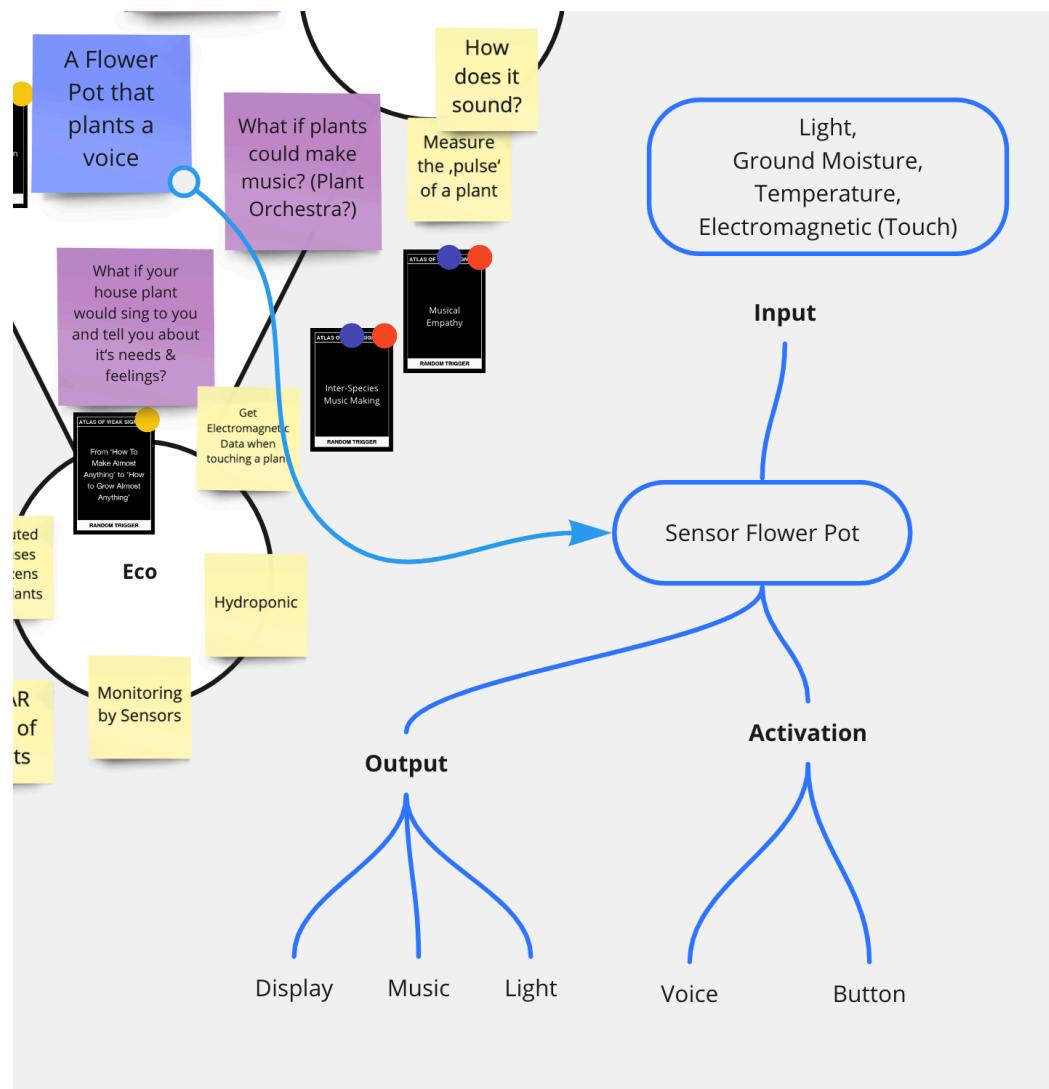
be hard to settle on one idea in particular: If I went for the most abstract one (Eco2), I would lack the possibility to dive into fabrication, while if I chose to build a collaborative jam station I miss the idealistic ambition and scope of other ideas.

In a long talk, Jonathan Minchin reminded me that I was right to think about this in such a strategic way, however I should avoid to think in fixed outcomes, but in rather in iterations of the same concept. This meant aiming at a 'MVP' or prototype level for the end of term one and then iterating on it afterwards to have the project ideas become much more tangible and feasible in scope. Therefore I would not have to necessarily choose between the three topics, but I could try to merge them all in one project. This was a crucial tipping point in my understanding of the projects and their potential in the context of this study.

Methodology

- Start from small scale, scrappy prototype
- Then iterate on it to get to a higher scale of influence and ambition
- Topics of Eco2, AI and Music range from theoretical to practical, from serious to fun
- What if we join all topics together at a very small scale?

Documenting my methodological approach to the conceptual phase after the talk with Jonathan Minchin.



A project idea distilled from the intersecting areas of interest and identified as the easiest entry point into the matter.

5) Research

Conceptual: Making Music w/ Plants



Let Your Plants Play Music, and Gardens of Sound Will Bloom

In 2012, the artists Joe Patricucci and Alex Tyson set up a jungle's worth of tropical plants in the Philadelphia Museum of Art and invited them to perform. People flocked in to stand and listen as the *Data Garden Quartet*, a botanical orchestra, gave its d...

<https://www.youtube.com/watch?v=...>

[v=RBRy2UYzv7o](https://www.youtube.com/watch?v=WWD-BGId0sc)



Do Plants Make Music?
If you find yourself in Turin, Italy, you might want to take a field trip to the eco-community of Damanhur. There you can see the 11-story temple it took the 1,000 residents 16 years to build by hand, inspired by a falling star envisioned by the community...



The Lessons To Be Learned From Forcing Plants To Play Music

Technical: ESP32 Chip Synthesizer



A GitHub repository card for "esp32_basic_synth" by "marcel-licence". The card shows 1 star, 0 forks, and 0 issues. It includes a brief description: "ESP32 based simple synthesizer project. Contribute to marcel-licence/esp32_basic_synth development by creating an account on GitHub." A "Clone" button is also present.



Implementing a Synthesizer for the Raspberry Pi and the ESP32 - Introduction - Phil Schatzmann



ESP8266 polyphonic MIDI synthesizer module for ...

Current Scientific Research



Page 10

<https://www.nytimes.com/2019/08/26/style/can-plants-talk.html>

SOCIAL-EMOTIONAL LEARNING



100

Existing Hardware



100

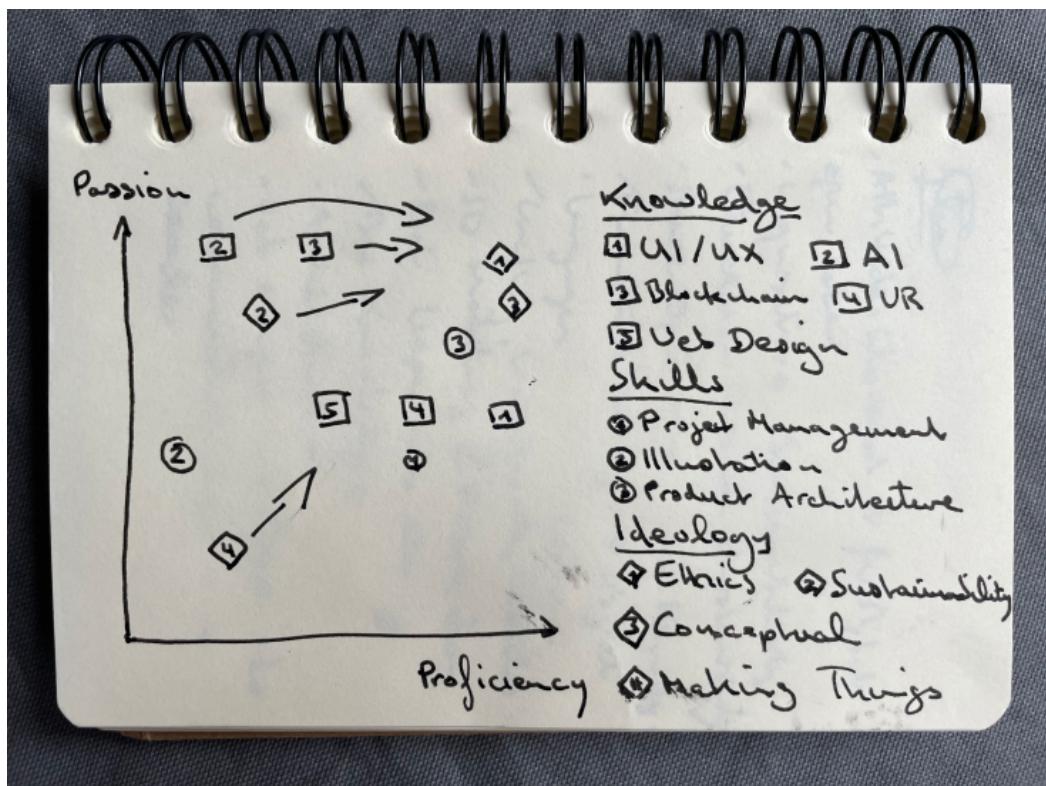
<https://www.plantwave.com/getplantwave/plantwave>

[Wave/Plantwave](#)

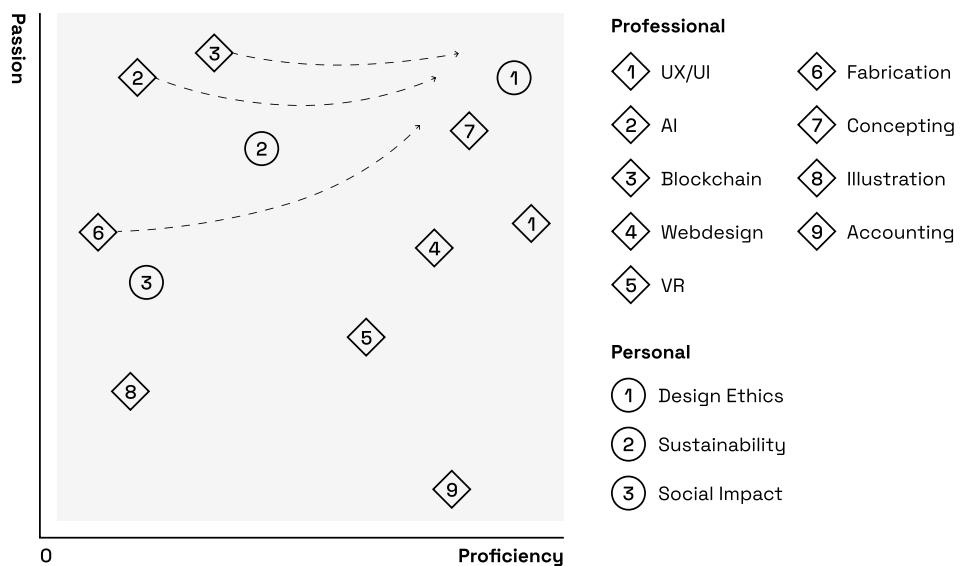
First research overview decided by different levels and entry points.

2.3 My Development & Collaboration Plan

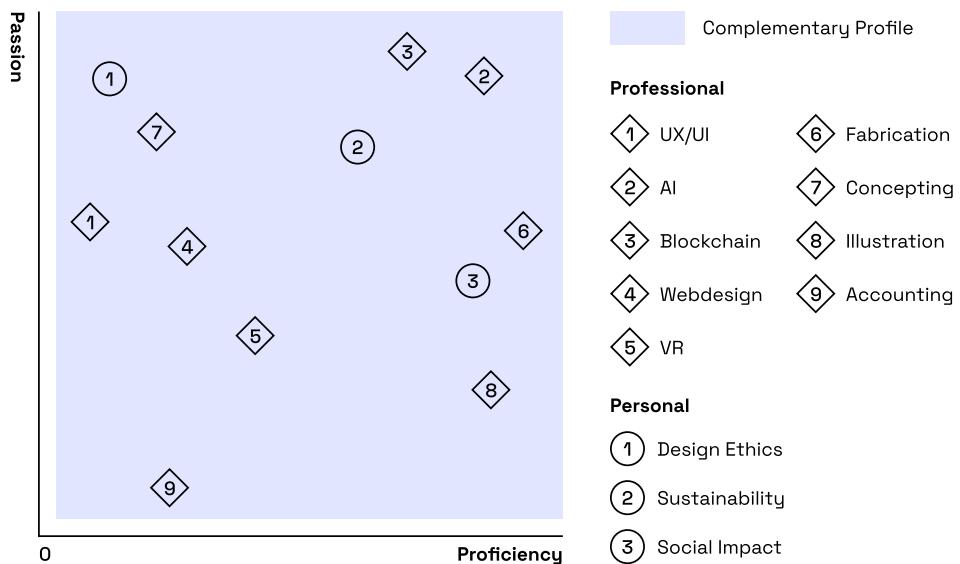
Seen below is a first draft of this overview that came to be in the class. It maps several skills and interests against a two-axis matrix, defined by both proficiency and passion. Within the plotted points, a further differentiation in categories can be found. The arrows hint at professional development opportunities.



Upon further investigation several points for optimization could be seen in the visualization. In the following days, an improved digital version of this chart came to be:



During conversations with classmates it became evident that complementary skills were important in achieving formal success in a future project. But another criteria clearly stood out for me: The crucial matter of not only complementing skills but also complementing personalities. In many conversations, the synergy between working in a more conceptual way versus working in a more spontaneous way played an important role. Since I personally consider myself more a conceptually strong person, I benefit enormously from intuitive, more hands-on project partners at my side, especially in the heat of a project's execution. That was one of the most important takeaways for me in the last years – and the conversations with my classmates doubled down on this.



To summarize all of the above, including the reflection on the future curriculum and my conversations with classmates, it becomes clear that the next nine months offer a plethora of opportunities for self-improvement. It even offers so many possibilities that one inevitably has to be guided by the personal motivations for studying MDEF, otherwise it will feel both too overwhelming and lacking focus. I prefer to carefully select a few main topics and deeply dive into them in the course of this study. Which topics these are exactly depends of a lot of factors; further I am holding myself back from settling on these main focus points too early in order to avoid excluding some interesting opportunities I might not have seen before. Reflecting after the first week of the curriculum, some of these focus points could include: AI, sustainability, fabrication, biomaterials, blockchain and music.

In terms of sharpening my professional profile, my motivations are not guided by a specific career ambition. I do not aim for a certain job profile after the master degree, instead I'm hoping this degree allows me to further grow as a design generalist and enables me to work in a more speculative, experimental and multidisciplinary way than before. In that sense, I perceive this study much more as a creative open-ended experimental field than a stringent and fixed professional training. If everything goes well, it will enable me to sharpen my portfolio as a designer, who can actively shape the way we interact with technology in the next centuries.

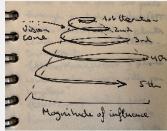
3 Tools of Inquiry

3.1 Research through Design: My first prototype

Although conceptually based on my personal design space and the desired professional profile, the idea for my first personal experiment came in a surprisingly accidental and organic manner. In the Bio & Agri Zero seminar, we were introduced to an algae species named Arthrospira (called in the following Spirulina after its edible biomass and for simplicity), which features remarkable qualities as a food supplement, and entrusted with our very own culture to take care of in a five-liter glass jar. Besides light, nutrients and the correct PH-level, this culture needs a steady influx of O₂ in its medium to grow effectively. This happens preferably through an air pump, which should be switched on approximately five minutes every hour. However, the time-switch for our air pump was broken – which meant a slowed growth for the algae at best, the death of the culture at worst. This is how I decided to prototype a time switch for this air pump based on a ESP32 microprocessor. While the corresponding program was quickly written, assembling the physical high voltage circuitry and building a custom wood enclosure, thus making it safe to run 24/7 without any supervision, took more effort. Below you can find images of the process leading up to and including the final prototype. This pump is now deployed to supply O₂ to the algae in our classroom.

6 First Experiments

- Start from small scale, scrappy prototype
- Then iterate on it to get to a higher scale of influence and ambition
- Topics of Eco2, AI and Music range from theoretical to practical, from serious to fun
- What if we join all topics together at a very small scale?

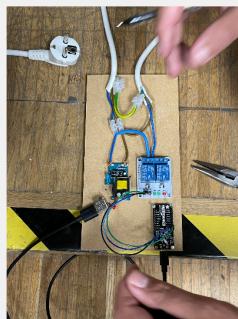
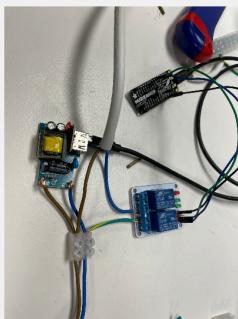
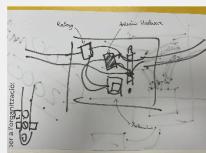


6.1 My Toolset

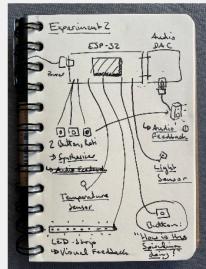
- #### 6.1.1 Materials
- ESP 32
 - Air Pump
 - Standard Relay
 - USB Charger
 - Arduino IDE
 - High Voltage Cables
 - Spirulina Algae

- #### 6.1.2 People
- joachin helped me tremendously with the high voltage circuitry
 - Guru from the Fab lab helped me with reviewing the safety of the circuitry and with building advice for the enclosure

6.2 Timed Pump for Spirulina Algae



6.3 Further Steps: Giving the Algae a Voice



6.2.1 Data Inputs

- Connecting Temperature Sensors
- Connecting Light Sensors

6.2.2 Data Outputs

- 2 Parameter Digital VCO, connected to DAC Chip to create audible Feedback
- LED Strip to give colored Visual Feedback

6.2.3 HMI

- Button to ask: "How are you doing?"

6.2.4 Dev

- Over-The-Air Programming Access

6.4 Types of Prototyping

Role 1 – The Prototype as an experimental component

- How to design a system that both monitors and communicates the health of an algae culture?

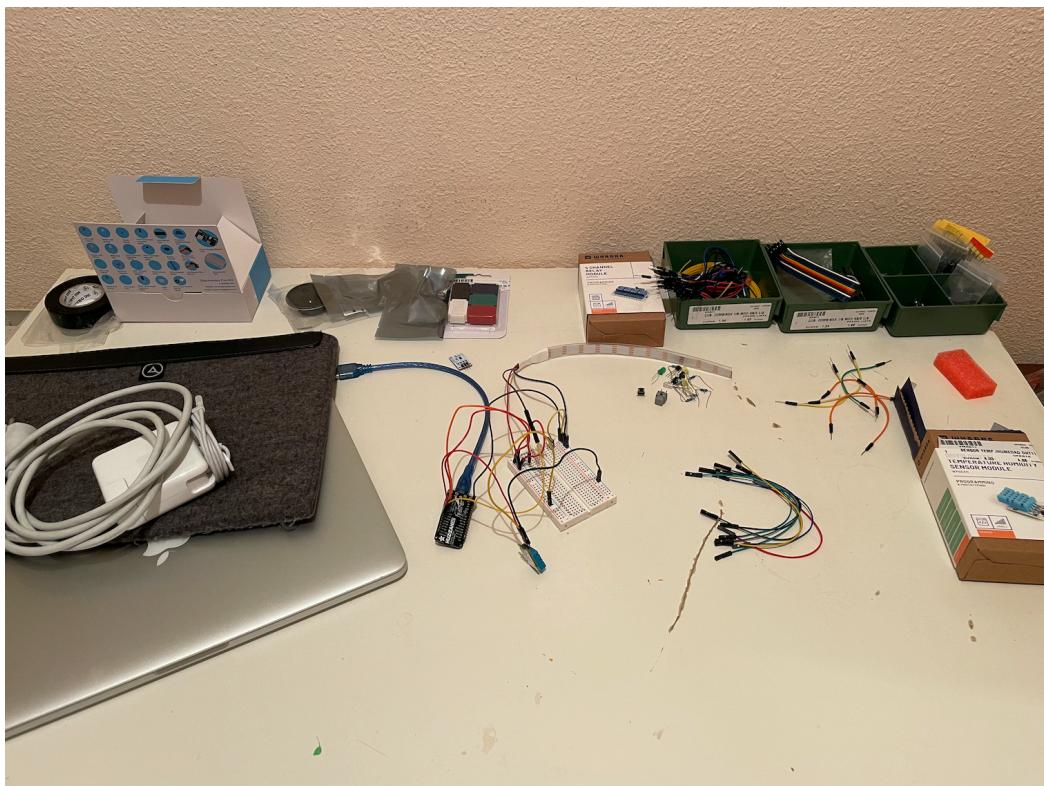
Role 2 – The Prototype as means of technological inquiry.

- Is it possible to regulate the environmental growth parameters via a fully automated system?
- How to effectively design a sensor suite for monitoring these parameters?
- How to implement a web dashboard to communicate the data and make it interactive?

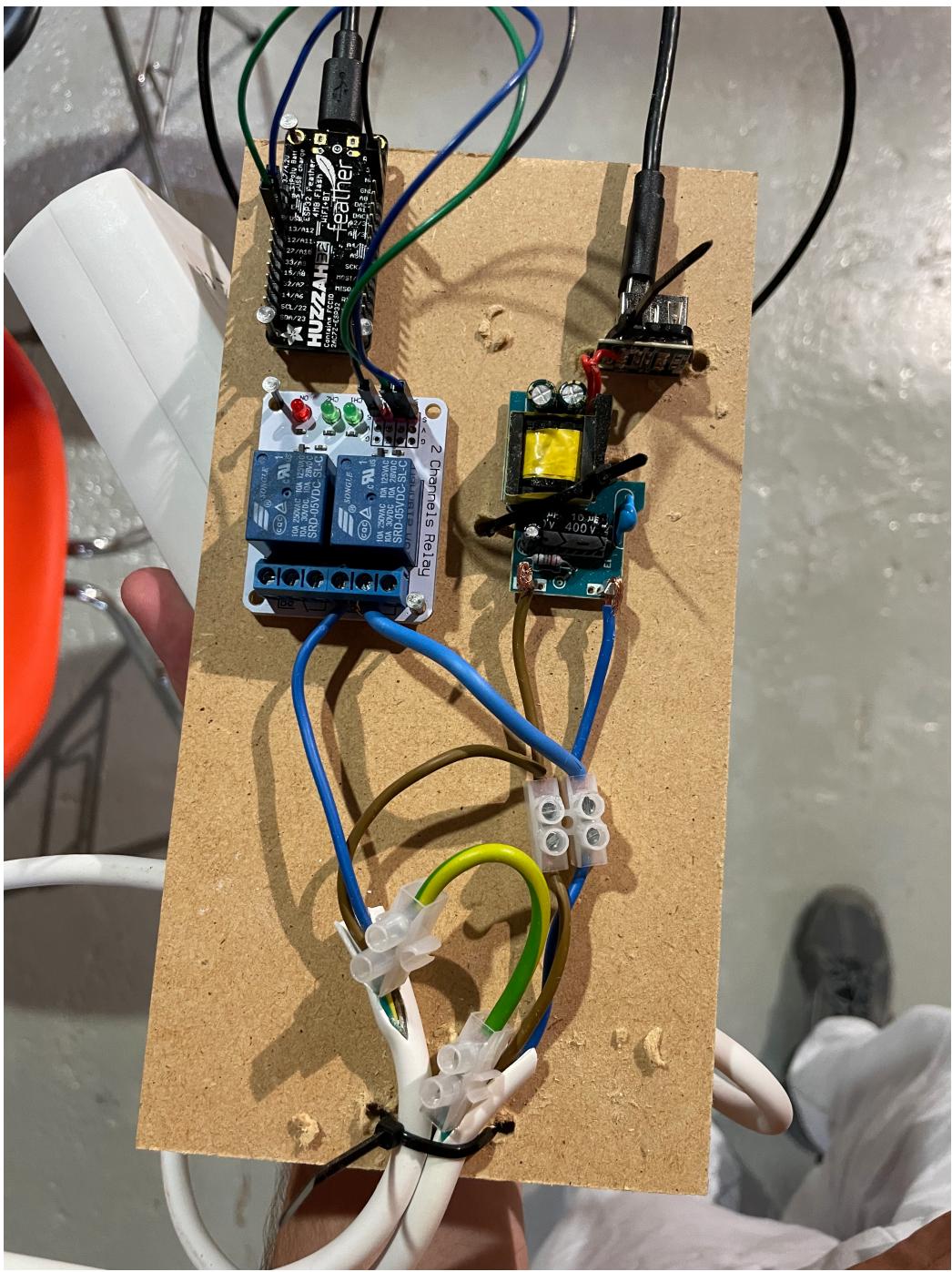
Role 3 – The Prototype as a research inquiry.

- How will people react, if an algae culture "speaks" to them?
- What will it need to humanize the plant effectively?
- How to best evoke emotions in the interactions?

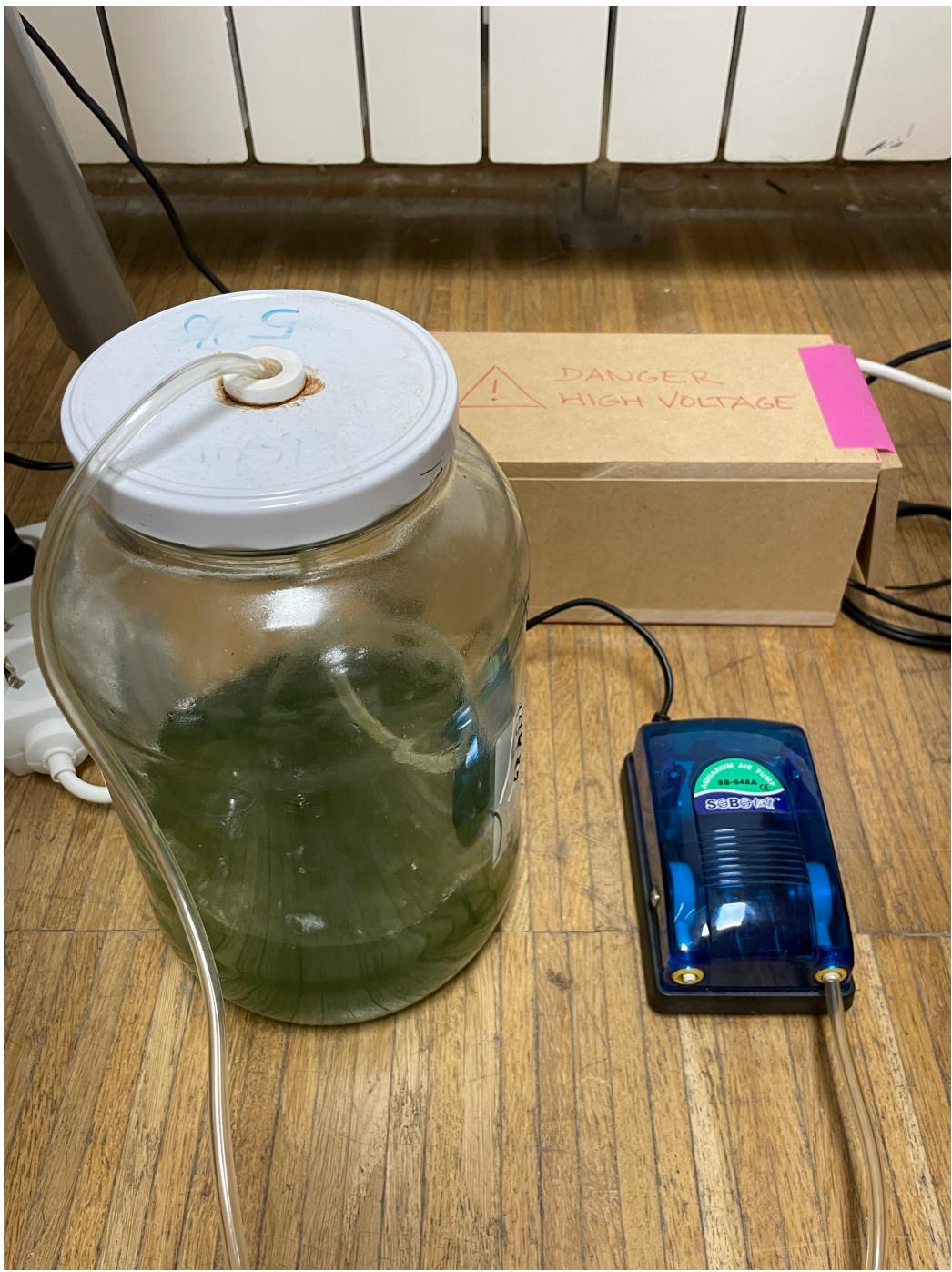
An overview of the documentation of the experiment on Miro.



My personal design toolkit and workspace at home



Work in progress.



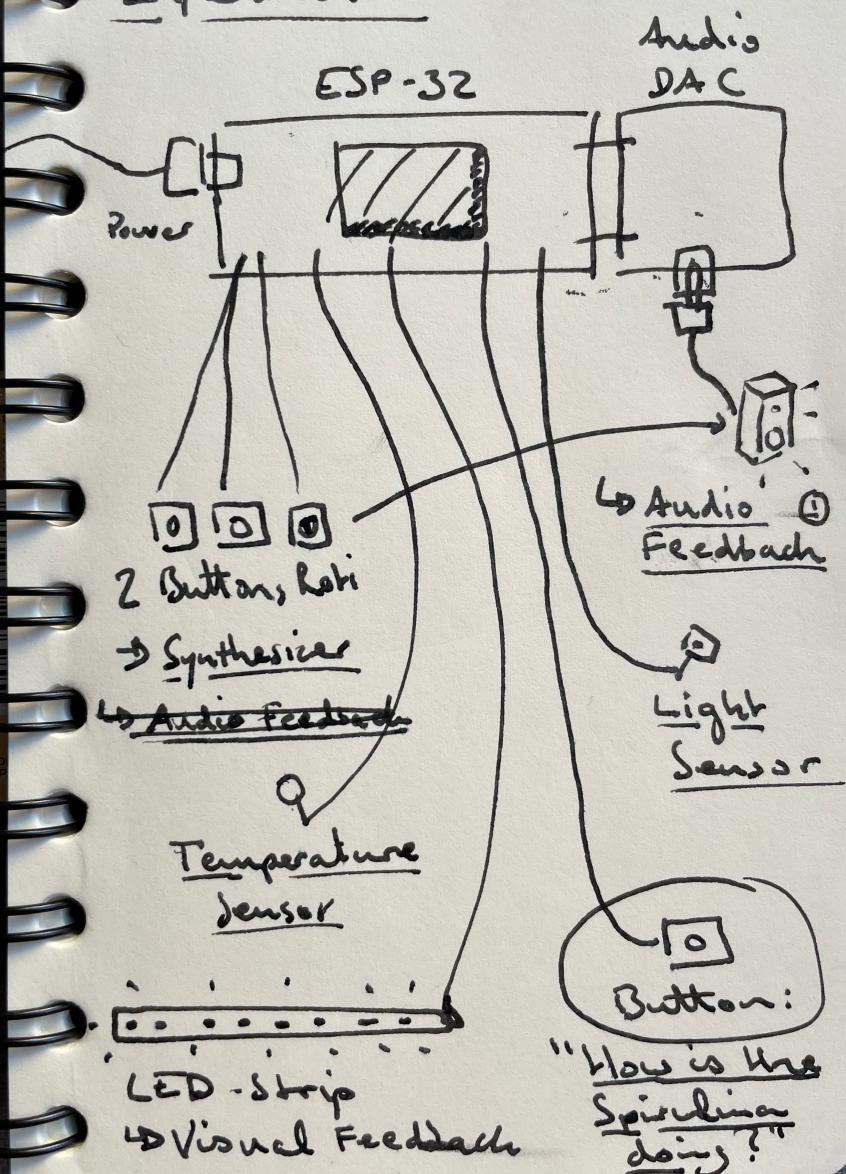
The finished prototype.

3.2 Prototyping the next steps

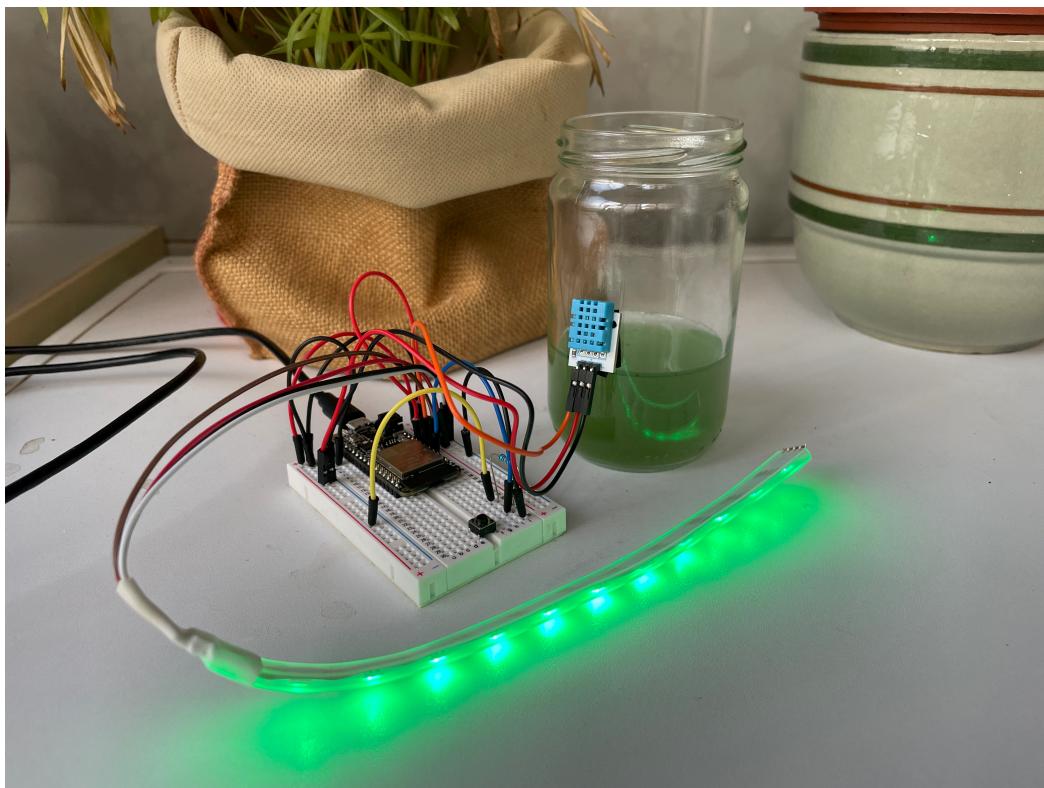
With this prototype done, it serves as a solid base to iterate on: A integrated power supply for the microcontroller, a safe enclose and an access port to connect additional sensors later on and add software updates. To develop this prototype further, I identified a number of individual experiments, for which most of them I have all necessary materials already. These experiments are to be built and executed independently but can be combined at any stage to add onto each other. Piece by piece, this will add up to an integrated sensor suite with audio-visual feedback capabilities. In detail, these experiments include:

- Connecting circuitry for running growth lights (5000 lux+) on a timed relay
- Connecting temperature sensors for monitoring optimal temperature (20°C +)
- Connect light sensors to monitore optimal light conditions
- 2 parameter digital VCO, connected to DAC Chip to create auditive Feedback
- LED strip to give colored visual feedback
- A button to ask the algae: "How are you doing?"
- Enable over-the-air programming access

Experiment 2



How several individual experiments could add up to a full integrated sensor suite with audio-visual feedback.



A further iteration featuring a temperature sensor and a led strip for visual feedback, indicating if growth conditions are within the optimal range.

3.3 Prototyping as a design tool

In this experiment, the following types of prototyping were used:

3.3.1 The Prototype as an experimental component

- How to design a system that both monitors and communicates the health of an algae culture?

3.3.2 The Prototype as means of technological inquiry

- Is it possible to regulate the environmental growth parameters via a fully automated system?
- How to effectively design a sensor suite for monitoring these parameters?
- How to implement a web dashboard to communicate the data and make it interactable?

3.3.3 The Prototype as a research inquiry

- How will people react, if an algae culture 'speaks' to them?
- What will it need to humanize the plant effectively?
- How to best evoke emotions in the interactions?

3.4 Research through Design: Going Further

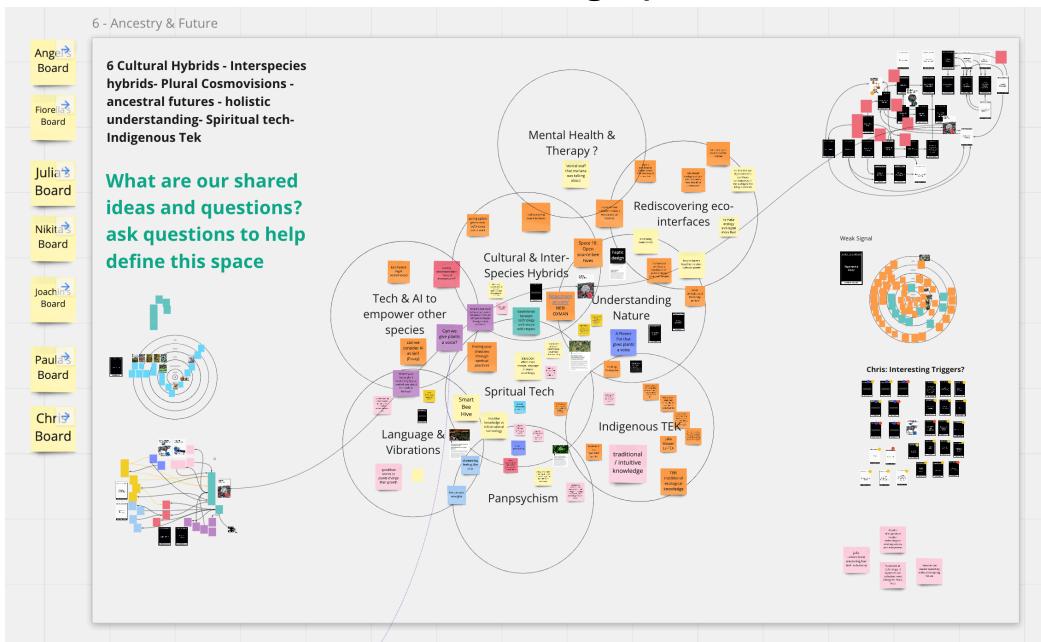
To build on the idea of making organisms able to communicate, to give other species a voice, I decided to go one step further. Specifically I was interested in experimenting with modified interaction parameters between a human and plant. Through that, I would prototype one of my core goals: To experiment what plant-based sentience could feel like interacting with. Due to the time constraints of having only about 30 hours to both conduct the experiment and document it in form of a video, I opted for a dual approach. On the one hand I would script a Telegram-Bot, who would be a stand-in for the plant and with whom I could have an opening dialogue with. On the other hand Open-AI's GPT-3 language generation model would then represent the plant in a dinner conversation about consciousness. This specific instance of GPT-3 was pre-trained to lean into a philosophical text generation in order to make that possible.

Besides the nature of learning a lot of new things about implementing both Telegram Bots in an Arduino IDE and accessing the GPT-3 API, the experiment itself yielded some interesting insights. As for the unscripted, AI-generated dinner conversation, I was surprised how fast I was attributing some concept of sentience or consciousness to the plant. The depth of the conversation and the philosophical content of it would have been more than enough for an entertaining and inspiring evening among humans. Instead, I found myself having this very conversation across dinner with my flatmate's fern – which was a bewildering experience, to say the least. The fact that I quickly perceived this plant to have some concept of itself and the world around it as well as being able to verbalize it adequately, led me on some unforeseen trains of thought. Among them, I was wondering if it would be insensitive to have a vase with cut flowers on the table while having the conversation, let alone the fact that I was having salad for dinner (an absolutely tasteless choice). Further inquiry into this strange feeling of interacting with an intellectually equal plant-based conversation partner is worth pursuing. Additionally, more than a half-dozen new collaboration opportunities emerged within the MDEF course, with many more conversations being sparked around the topic of plant consciousness and fern-related dinner jokes.

In this context, please also refer to 5.2 *Open Spirulina Farm* below.

4 Tools of Collaboration

4.1 Collective Design Space

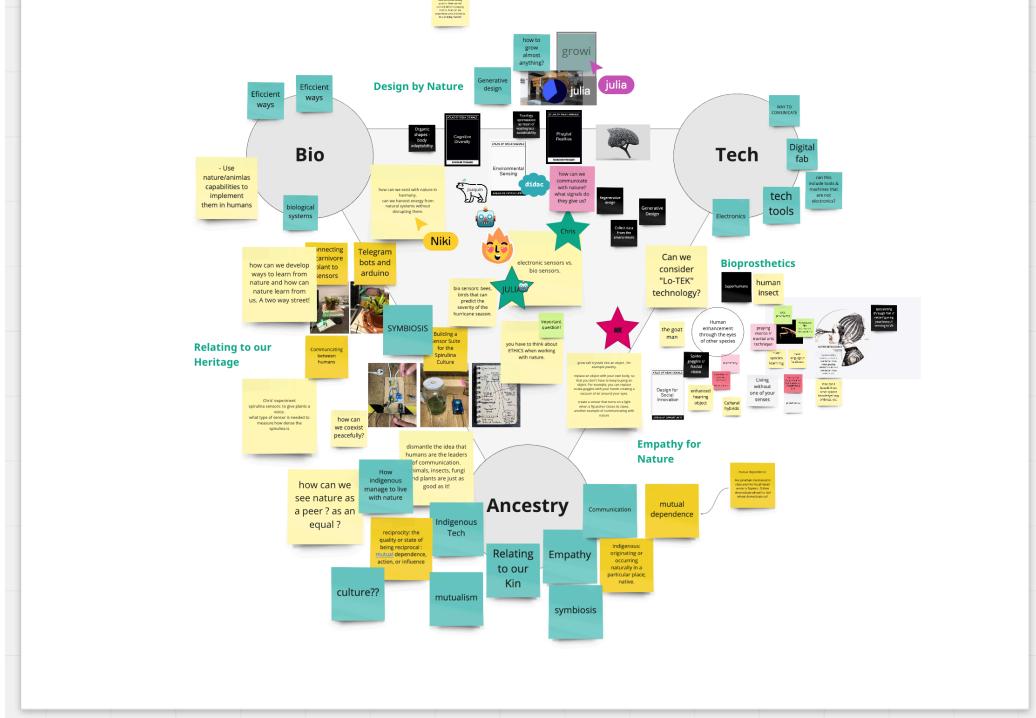


The first iteration of our group's collective design space on Miro.

The experience of finding points of resonance with others felt seamless and natural. After an initial free discussion where everybody shared their view on the topic at hand, we moved on to defining – the admittedly very broad topic – in more detail. To do that in a fluid and collaborative way, we drew overlapping circles of sub-topics which could be filled with sticky notes, links and ideas. This way we managed to create an overview over our entry points to the topic within roughly 30 minutes. While doing so, already a myriad of interesting cross-references, synergies and collaboration opportunities appeared.

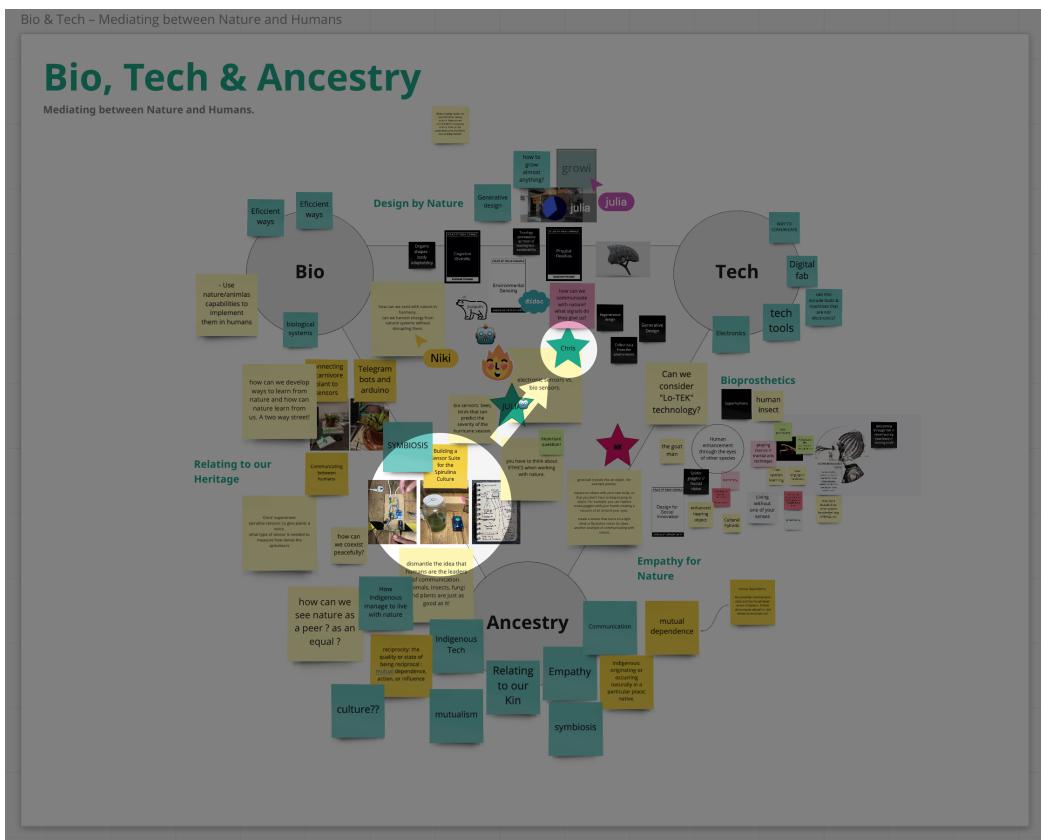
Bio, Tech & Ancestry

Mediating between Nature and Humans.



Second iteration of the collective design space.

As for my consequent steps, I wanted to dive deeper into the topic both from a conceptual and technological angle. For the research part, I was planning to contact former IAAC students who gathered experience working with plants in a similar way. Further, I remembered a few academic projects in Berlin that did something comparable – they are leads worth pursuing. Parallel to that, building a simple sound machine (based of the ESP-32 microcontroller) that can receive MIDI signals and play notes would be the logical primer, since after that, attaching diodes to the plant to receive electric signals becomes feasible. Through that, diving more into hardware making is a skill I strongly aimed to add to my professional portfolio.



Placing myself and my project focus in the collective design space.

5 Second-Person Perspectives and Experiments

5.1 Plant B

5.1.1 Intro

For the final Design Dialogues event at the end of term 1, I teamed up with Joaquin and Didac and Chris for the accompanying design intervention. We were interested in the intersection between music, collaborative jamming, nature and how these things can be combined. Further, we wanted to research how engaging in an intimate collaborative setting with plants could foster a meaningful inter-species connections. Working with a MakeyMakey and Ableton Live, we decided to enable an inter-species jam session, where the plants would be both musicians and instruments.



Engaging in interesting conversations with passersby and colleagues.

5.1.2 Reflection

The response to our intervention was overwhelming and for all of us everything but anticipated. As it can be seen in the pictures above, we were fortunate to witness some very special moments of intimate interactions between passersby and plants to make music together. Especially children were absolutely enchanted by the concept of singing plants and were the most fearless when it came to interacting

with the plants. Often, adults would be shy at first – but after inviting them in to join, they usually lost their initial hesitancy. Throughout all ages and genders, people were amazed by this way of interacting with plants, which was new for almost all of them.

People touched the plants softly, with respect, caressing them to test out the different sounds. Quickly, people understood the basic logic of the setup and how a circuit was closed to trigger the sounds. From there, it often took just a single comment about the conductivity of the human skin in order to start people holding hands while making music. By doing that, they were able to multiply the amount of touch points with the plants and through that, were able to create much more complex soundscapes. These were the moments when we were sure to have enabled a rare moment of collaboration, not just between people but between two species.



Children interacting with the plants in Parc de la Ciutadella.

The sounds the plants made were not fixed – rather, they were changing constantly as we were trying to evolve the music piece that was collectively composed: Changing from major to minor scales, modulating tempo, drum patterns and chords as well as giving people more percussive or atmospheric sounds to play with. This

influenced the interactions with the plants in a very profound way, since the sound each plant made was somehow understood as its 'voice', thus shaping the perception of its character. Through experimentation and iteration with the sounds, we began to understand what worked best in the context of this public performance. A looped drum pattern was integral to giving the collective jam session a rhythmic backbone and was necessary in order to draw people in to interact. On top of that, atmospheric and layered sounds in harmonic chords and re-triggering patterns proved to be among the most accessible samples to make music with in this particular setup, with this particular crowd of participants. Further inquiry into the sound design is needed.

Many people asked about our social media profiles and/or personal contact details, which underlined the need for a good online presence (beyond this website) as well as the potential for professionalizing this intervention as a live performance. We declined any money offered to us by the intervention participants.



Adults interacting carefully and collaboratively with the plants.

Reflecting on the intervention with some distance, our most important goal was achieved, which was placing plants front and center in the interactions. In our experiment they were the integral part, to which the other components, music and

technology, connected. This sparked many interesting conversations, which revolved around connecting to plants, how plants perceive touch, how plants react to the music we play and how plants feel in a profound way. Using music as a vehicle for creating empathy for other organisms to inspire inter-species collaboration proves to be a promising idea.

5.1.3 Next Steps

As far as the next steps of this project are concerned, there is a lot more to discover. The most immediate impulse was, of course, to frame this more as a curated live performance, which can be played in a music venue or club. This also begs for exploring the potentials of an integrated A/V show including generatively produced visuals accompanying the performance. This should be feasible and fairly easy to implement through connecting Ableton with Notch or Touchdesigner.

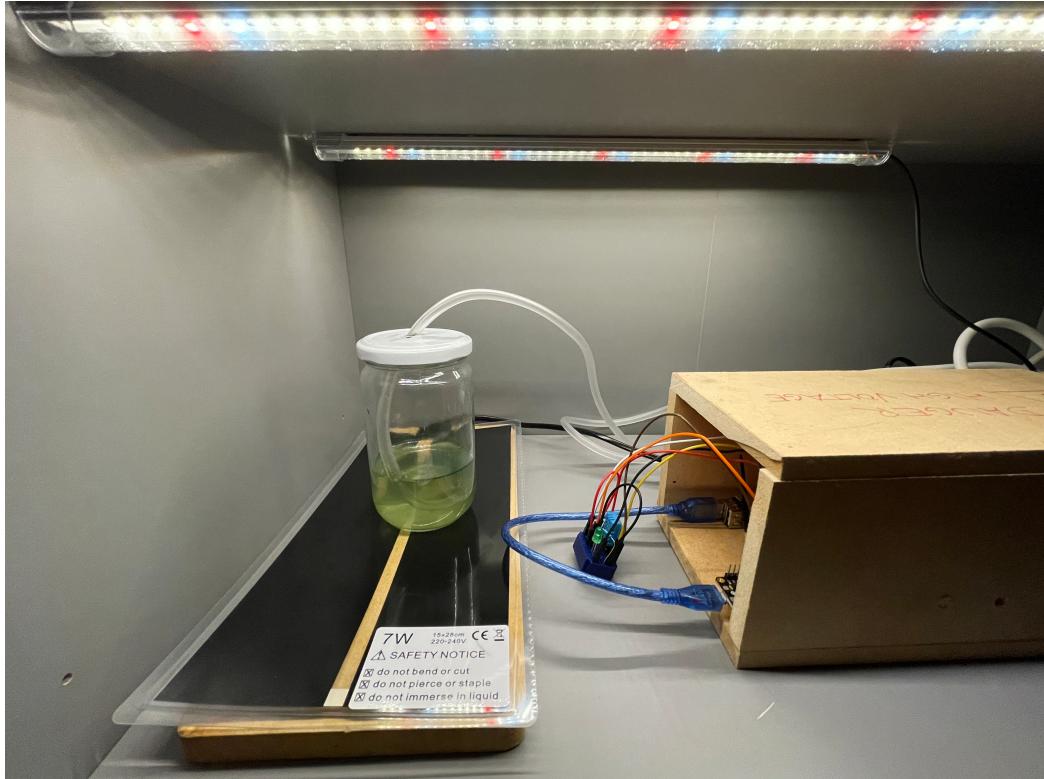
The other interesting conceptual avenue to go down would be, instead of bringing plants to the city in artificial and highly curated environments, to bring the people to the nature to be embedded in the environment the plants originate from. This would enable us to facilitate more spontaneous and less curated interactions with the plants that are found there, to use music to improvise and to meditate with the ecosystem there. Conceptually, this is a very interesting approach to take with this experiment, which is to be regarded the polar opposite of the curated live show described in the paragraph above.

5.2 Open Spirulina Farm

Ever since Nuria Conde introduced us to Spirulina (*Arthrosphaera platensis*) algae and its unique nutritional properties, I have been fascinated by the possibilities of this easy-to-farm algae. Among many of its advantages, it yields 20 times more protein per acre than an other commonly grown crops such as corn while using ten times less water to produce it – so the potential for this as a sustainable future food is immense. This however requires to popularize the algae strain and to give even small households of four people a way of growing and harvesting it. That's why I decided to begin experimenting with small-scale automated Spirulina farming.

With this ongoing project, I was aiming to build a complete sensor suite, monitoring the most crucial growth conditions (light, temperature, aeration), and a microcontroller, regulating these conditions and recording the data into a web-based dashboard. The minimal viable product (short: MVP) would be an implementation of all these things, albeit on a low-tech level. This effort resulted in

the first iteration of my Spirulina farming setup, which can be found below. The long-term goal is to open source not only the codebase (found below), but the hardware construction as well, for anyone to copy and build themselves.

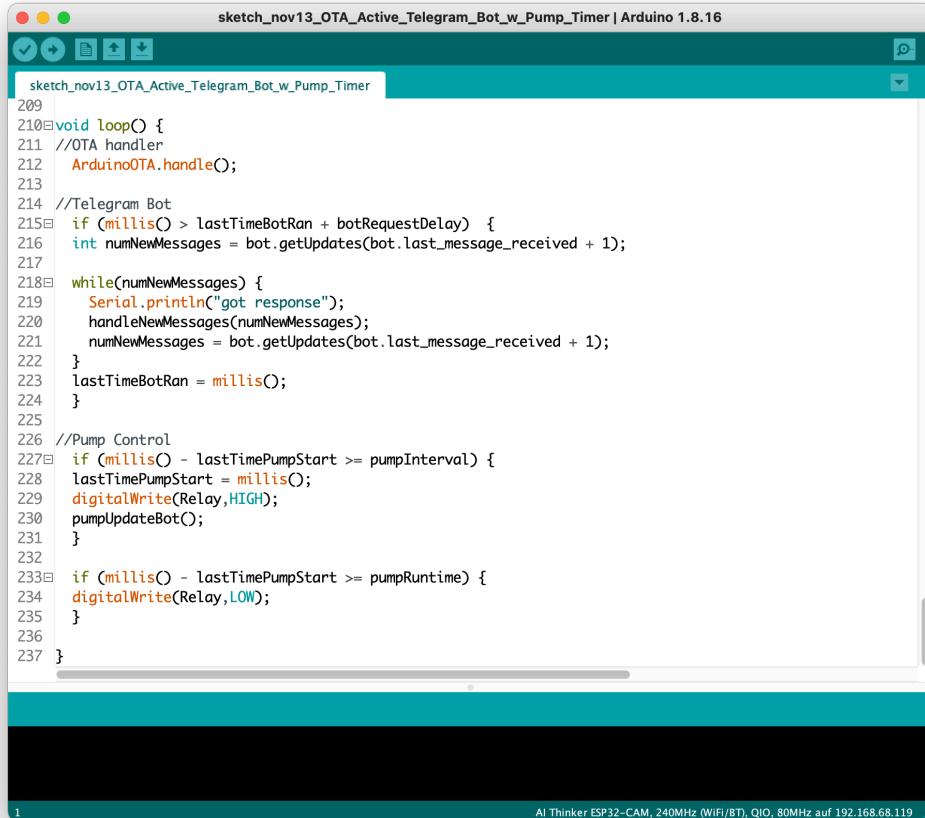


The MVP of the Open Spirulina Farm Project.

Above, you can see the MVP version of the setup, currently running 24/7. It features a time-controlled air pump, high-powered LED-lights, and heating pad, as well as a temperature sensor and a LED for displaying system status. In the wooden box, there is a relay, controlling the pump 220V output, as well as a ESP32 microcontroller and its USB 5V power supply. The parts used so far are:

- Adafruit Feather ESP32
- DH11 Temperature Sensor
- USB Charger
- LED + Resistor
- Single-Channel Relay
- High-powered LED Strips
- Heating Pad
- Aquarium Pump
- Plywood

The code itself is a product of many individual small experiments I did over the past eight months. It features a Telegram Bot integration for communicating (both actively and reactively) system status, over-the-air update capabilities and (cooperative) multitasking when executing its functions. The code is made public on Github to work towards a true open-source project.



```

209
210 void loop() {
211   //OTA handler
212   ArduinoOTA.handle();
213
214   //Telegram Bot
215   if (millis() > lastTimeBotRan + botRequestDelay) {
216     int numNewMessages = bot.getUpdates(bot.last_message_received + 1);
217
218     while(numNewMessages) {
219       Serial.println("got response");
220       handleNewMessages(numNewMessages);
221       numNewMessages = bot.getUpdates(bot.last_message_received + 1);
222     }
223     lastTimeBotRan = millis();
224   }
225
226   //Pump Control
227   if (millis() - lastTimePumpStart >= pumpInterval) {
228     lastTimePumpStart = millis();
229     digitalWrite(Relay,HIGH);
230     pumpUpdateBot();
231   }
232
233   if (millis() - lastTimePumpStart >= pumpRuntime) {
234     digitalWrite(Relay,LOW);
235   }
236 }
237 }
```

A screenshot of the code base.

5.3 Universal Declaration of Ant Rights

Tasked with conceiving, programming and presenting a speculative machine learning project within a week, our group (consisting of Paula, Nikita, Jose, Paula and Busi) decided to dive deeper into the potential of OpenAI's GPT-3 language generation model. The idea was to use the network to rewrite the United Nation's *Universal Declaration of Human Rights* for an animal species, optimally for one that we as humans easily disregard. This, so the concept, could be a way to provoke, to empathize and to ultimately propose an entry point for interspecies legal frameworks.

Working with OpenAI's model, we managed to co-write the Universal Declaration of Ant Rights, which is presented below. Additionally, there is a way to sign the declaration online.

The image shows two side-by-side browser windows. The left window is the OpenAI Playground interface, where a user has generated the Universal Declaration of Ant Rights. The right window is a browser displaying the United Nations homepage, specifically the section for the Universal Declaration of Human Rights, with the generated text overlaid.

Playground (Left):

- Article 1:** All ants beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.
- Article 2:** Each individual ant, whether it is worker, drone, or queen, is unique and different. All are entitled to the same rights.
- Article 3:** There will be no discrimination on the grounds of race, religion, colour, sex, sexual orientation, political opinion, physical or mental disability or on
- Article 5:** No ant shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.
- Article 6:** No ant shall be arbitrarily deprived of his or her liberty.
- Article 7:** Every ant has the right to an effective remedy by the competent national tribunals for acts violating the fundamental rights granted him by the constitution or by law.
- Article 8:** (empty)

Parameters (Right):

- Engine: davinci
- Temperature: 0.82
- Response length: 374
- Stop sequences: Enter sequence and press Tab
- Top P: 1
- Frequency penalty: 0
- Presence penalty: 0
- Best of: 1
- Inject start text: checked
- Inject restart text: checked
- Show probabilities: Off

Article 1: All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.

Article 2: Everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status. Furthermore, no distinction shall be made on the basis of the political, jurisdictional or international status of the country or territory to which a person belongs, whether it be independent, trust, non-self-governing or under any other limitation of sovereignty.

Article 3: Everyone has the right to life, liberty and security of person.

Article 4: No one shall be held in slavery or servitude; slavery and the slave trade shall be prohibited in all their forms.

Article 5: No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.

Using the GPT-3 playground as a base, after some experimentation we set the parameters as follows: Top P(1), Freq. Penalty (0), Presence Penalty (0,5), Best Of (3).

The prompt to the network consisted of the first five parameters (some of which were also generated by the network in earlier iterations). The result reads as follows.

Universal Declaration of Ant Rights

- 1. No ant shall be arbitrarily deprived of his or her liberty.*
- 2. Each individual ant, whether it is worker, drone, or queen, is unique and different. All are entitled to the same rights.*
- 3. All individual ants are equal before the law and should be treated equally.*
- 4. No beings are allowed to interfere with the integrity of an ant colony.*

- 5. All beings are liable to be prosecuted in the Universal Interspecies Court for violation of ant rights.*
- 6. No ant colony may be destroyed or in any way harmed without a court order.*
- 7. No treaty may be signed which deprives ants of their rights as an independent species.*
- 8. The Universal Interspecies Court must have the power to impose appropriate penalties for violation of ant rights.*
- 09. All beings are prohibited from interfering with the free exercise of the ant religion.*
- 10. All beings are required to respect the environment of ants and all other beings.*
- 11. All beings are required to encourage the preservation of ant diversity.*
- 12. All beings are required to abide by these Universal Ant Rights in so far as they respect the independent nature of ants and do not interfere with them.*
- 13. All beings are required to make their best efforts to ensure that the environment of ants and all other beings is protected.*
- 14. All beings are required to encourage peaceful coexistence and the pursuit of harmony between ants and other beings.*
- 15. All beings are prohibited from interfering with the life of an ant colony or any of its members.*
- 16. All beings are prohibited from making use of any part of an ant colony without the permission of the ants.*
- 17. All beings are prohibited from interfering with the environment of an ant colony or any of its member.*
- 18. All beings are required to abide by these Universal Ant Rights in so far as they do not interfere with the free exercise of the ant religion and do not violate the integrity of an ant colony.*

19. All beings are required to report any violation of ant rights to the Universal Interspecies Court.

20. All beings are required to uphold this Universal Declaration of Ant Rights.

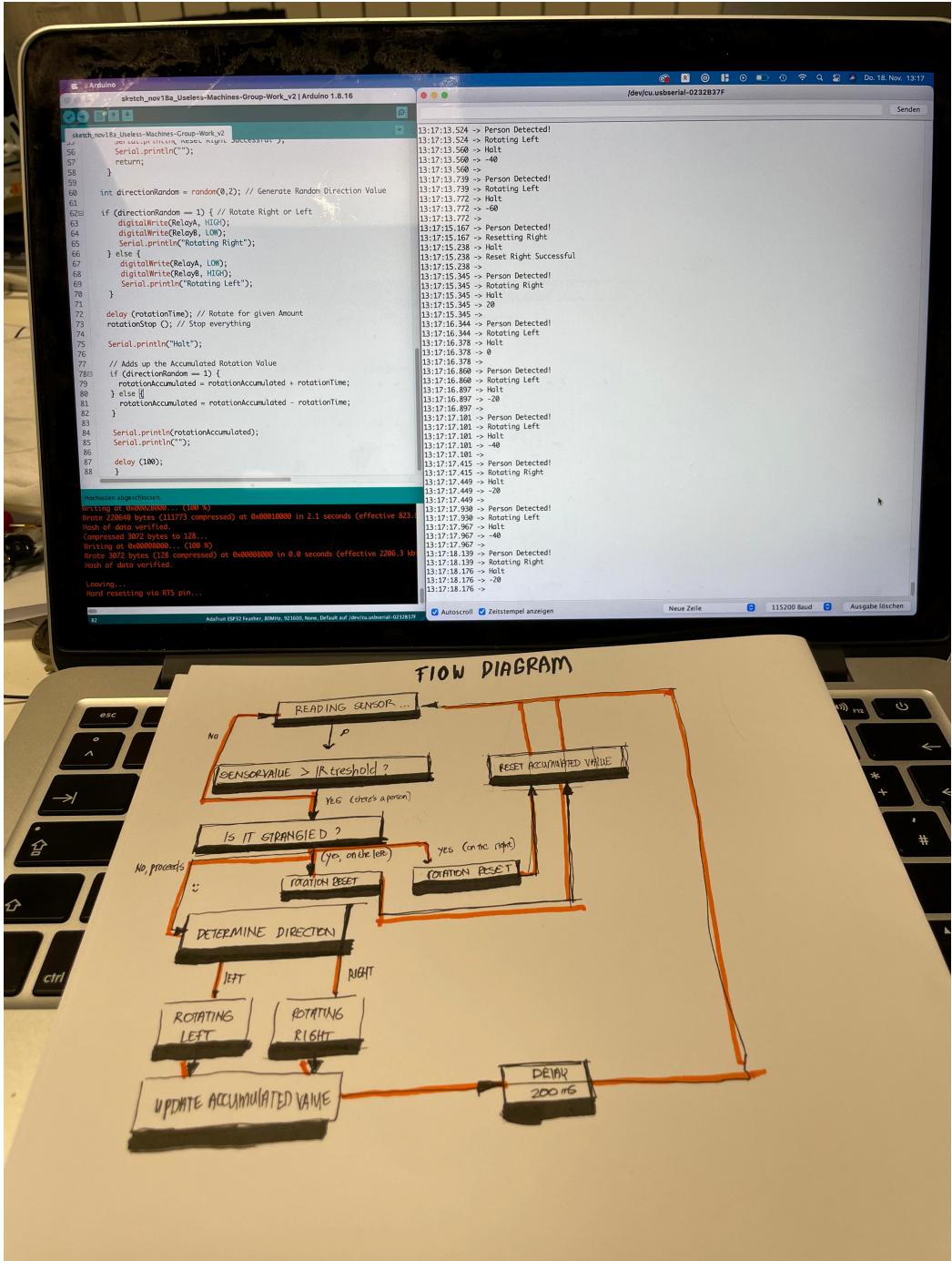
21. The Universal Interspecies Court has the power to impose appropriate penalties for violation of ant rights.

The above twenty-one ant rights were formulated by the Ant Rights Project as a basis for further discussion and as a means of protecting ants from human exploitation and abuse. The Ant Rights Project has also developed a draft treaty which would be submitted to the United Nations to prohibit human activities that interfere with the freedom of ants.

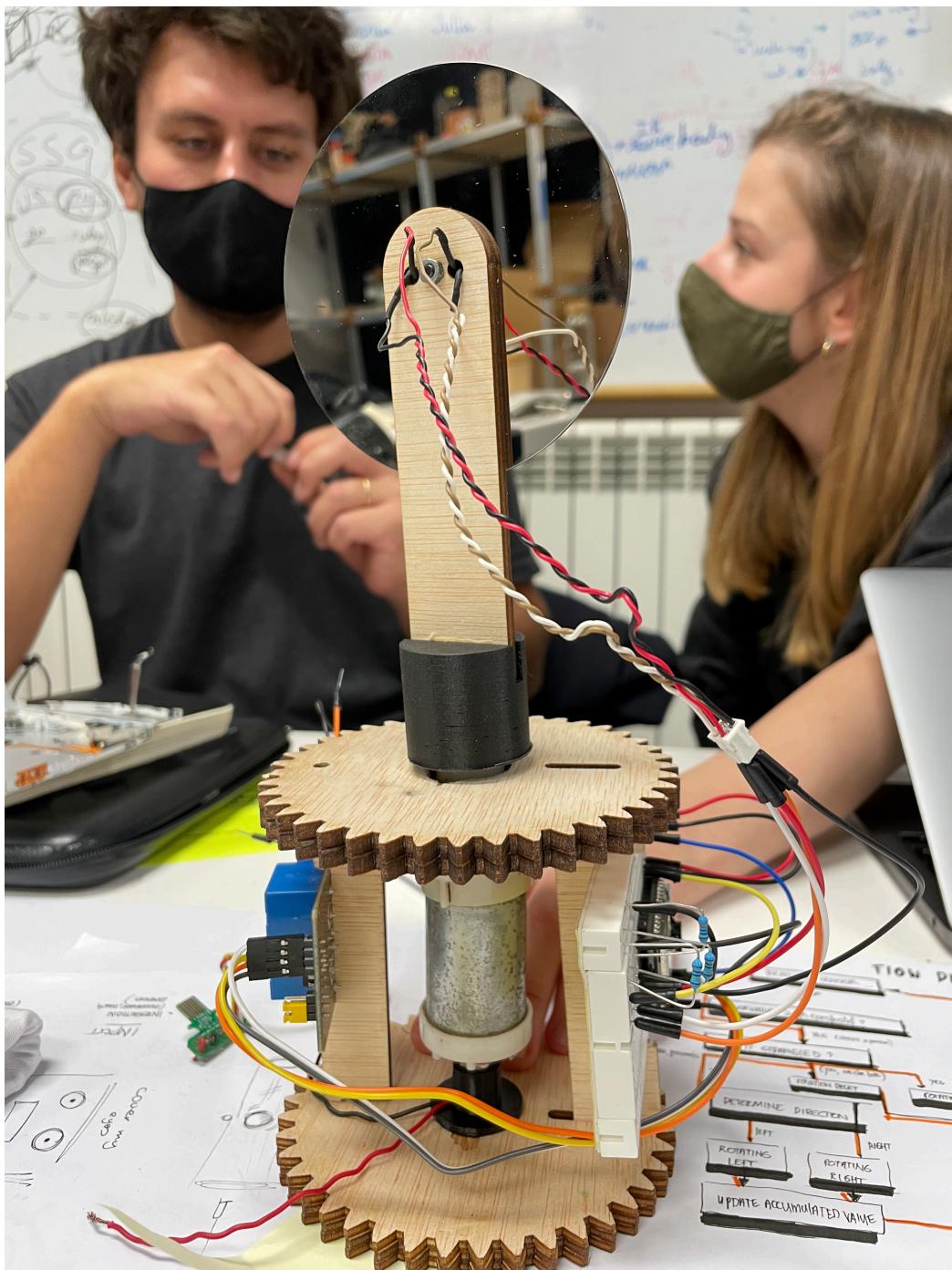
All of the text above (except for the first five paragraphs) was written by the GPT-3 language generation network.

5.4 Mehrror

For the seminar of 'Almost Useless Machines', we set the goal to use some of the motors, sensors and buttons scavenged from the disassembling of various consumer electronic products from the previous week and build scrappy, low tech machines that were ever so close to being useless – but not quite. Our team settled on the concept of wanting to invoke the feeling of being offended in our users, which turned out to be a surprisingly difficult feeling to provoke. After some thinking, we decided that we would want to build a little robot, consisting of a motor, infrared sensors and a mirror. When a user comes close to view herself or himself in the mirror, the IR sensors detect the approach and the motor turns the mirror away from the user. All of the parts mentioned were sourced from the disassembling of the Roomba cleaning robot, while the mirror was the HDD disk from an old Apple iMac that was taken apart.



The coding flowchart for the robot (front), together with the Arduino code (back).



The robot after the second iteration.

Through clever design of the robot's head we managed to arrange both mirrors and sensors to give the robot an almost human appearance. Users were surprisingly quick to attribute human qualities to the machine, with comments ranging from "He's so cute" to "I can relate to it, I'm like that too".

6 Reflections on Term One

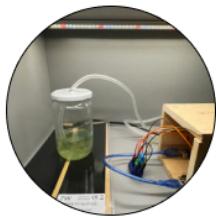
6.1 Overview

To view term one in retrospective helps to reflect on the possibilities and challenges offered, the personal goals set and the professional growth achieved. It becomes clear that, through offering a broad range of inspirations, this first term opened my eyes metaphorically to not only one but three new categories of applied design, all of which are interconnected. Besides visual design or user experience design, both which I practiced in the past, I now had the chance to discover what it means to use design to build machines and products, to use design to build speculative prototypes, which often share many characteristics with art, and how ethical design and open programming are closely related and dependent on each other. Combined with the early intro to fabrication, which will be extended in the coming term two, an understanding begins to form what 'from bits to atoms and from atoms to bits' could truly mean. This, of course, is not purely limited to inorganic matter, such as 3D printed PLA, but it explicitly extends to organic matter as well. This is where an incredible potential lies in my eyes: Using technology to help mend our broken relationship with nature.

6.2 My Fight 2.0

But first, let's look into how the 'my fight' ideas evolved and if any of the objectives were reached:

01 Eco2: Open Spirulina Farm



Spirulina, a blue-green algae that yields high amounts of protein, is remarkably easy to cultivate. This project aims at building an open source sensor suite to make Spirulina farming more accessible at home.

02 AI: Philosofern



How can we use AI as a tool to give other species a voice? Philosofern is an experiment into this topic framed as a dinner conversation with a fern, aided by Open AI's GPT-3 language generation network.

03 Music: Plant B



Inter-species collaboration should feel intuitive and engaging, thus music is the perfect language to speak. In this experiment, we used plants to engage in a musical jam session conducted in Parc de la Ciutadella.

How's the fight going?

Christian Ernst MDEF 2021

The updated 'My Fight' poster after term one.

The updated poster shows the same layout as the original one, with the same identical categories: Eco2 (Ecology and Economy), AI and Music. This version, however, relates one experiment to each of the topics.

6.2.1 Eco2

Spirulina, a blue-green algae that yields high amounts of protein, is remarkably easy to cultivate. This project aims at building an open source sensor suite to make Spirulina farming more accessible at home.

Identifying the key technical and economic challenges of enabling home-based Spirulina farming for mainstream adoption was the primer for this project. In order to be ‘the food of the future’, it has to be accessible to grow for everyone, with knowledge about it distributed in an open manner. This is why a truly open, libre and free technical setup, which could be produced in FabLabs anywhere and which could be adopted for various sizes and climates is one of the most promising approaches for a decentralized solution. This is the economic reasoning behind starting the project. In the same sense, it’s an ecological one, too: By raising attention to the potentials of Spirulina farming and its product’s consumption, we have the chance to also advocate for a far less resource-intensive, plant based alternative to animal products.

6.2.2 AI

How can we use AI as a tool to give other species a voice? Philosofern is an experiment into this topic framed as a dinner conversation with a fern, aided by Open AI’s GPT-3 language generation network.

This was the first experiment of this term with a distinct prototype investigating inter-species collaboration, more specifically a voice-based human-plant-interaction. For me it embodied many challenges I was planning to tackle. It used a Telegram Bot to enable a chat conversation and dealt with giving non-human entities a voice. But most importantly, it allowed me to explore the possible potentials and limitations of OpenAI’s GPT-3 natural language generation network.

6.2.3 Music

Inter-species collaboration should feel intuitive and engaging, thus music is the perfect language to speak. In this experiment, we used plants to engage in a musical jam session conducted in Parc de la Ciutadella.

For the final intervention we took music as a topic and medium and put it in the center of an experiment into collaboration between humans and plants. Collaborating with two fellow musicians, we brought enough to the table to make

the regulating collaborative jam session feel natural and organic. It highlighted how effortless and natural it feels for people to touch and empathize with plants, only that there needs to be a formal justification to do it. This for me was the natural progression of experimenting within term one, as it combined many topics to become a successful intervention: Electronics, fabrication, design presentation, plants and finally – music.

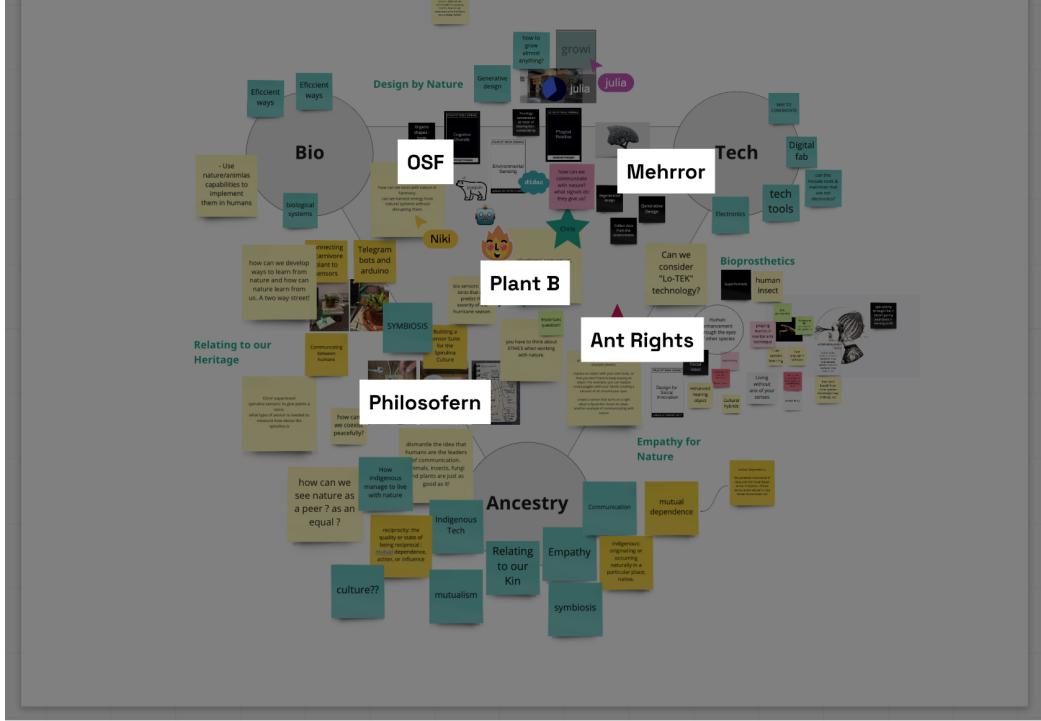
6.3 Collaboration and its Context

Reflecting on the collaboration within the first term and especially in the context of the final term one intervention, the potential of working together among a shared set of ideas and ideals is undeniable. The group projects during the regular seminars were very fruitful and fun – with the final intervention project being no exception. Working together with Joaquin and Didac was a pleasure all around and the final product shows how much effort and passion went into producing it. It became clear, that within the goals of our intervention, to enable an inter-species jam session, every one of us could engage in what he could do best, while exploring what each of us wanted to dive into deeper. Didac for instance, was keen on going further with fabrication technologies and exploring the intersection of natural and technological design solutions. Joaquin on the other hand, wanted to immerse himself into the potentials of music-making in combination with technology. Together with my interests for hardware and the conceptual possibilities of the project idea, a wonderful collaboration came to be.

To evaluate the collaborations that were and the collaborations that could be, it's important to also view it in the context of the collective design space built and expanded during the design studio seminars and classes. There a strong relationship with other intersecting project ideas highlights the potential of future collaborations within the group and within the whole class.

Bio, Tech & Ancestry

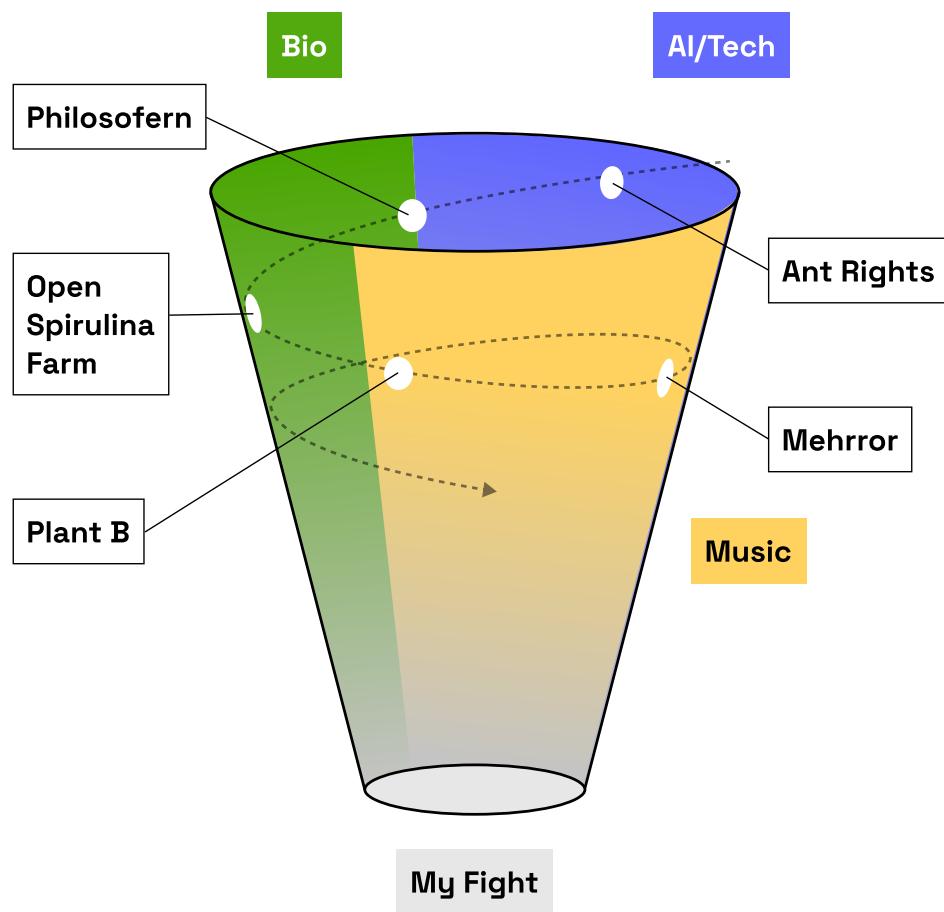
Mediating between Nature and Humans.



Placing my term one experiments within the collective design space.

6.4 Seeing Iterative Prototyping as Spirale Development

Another interesting contextualization of the experiments is to visualize it as spiral development. This shows, to some degree, that all the efforts made within the first term are strongly relating to each other, as they play in a shared contextual field. They inform each other, they form strange symbiosis and magnify each other's potentials. By reflecting on the first term's experiments that way, a possible leading idea can be isolated, which is shared amongst all projects.



Illustrating this year's experiments in a spiral development context.

6.5 The Leading Idea

This core idea revolves around our relationship with nature, while being part of it, and how technology could help mend this broken relationship. By default, this relationship is symbiotic. However throughout the course of the last centuries, we managed to turn it into a one-sided, dysfunctional and rather abusive relationship. It could go for like this for many centuries more if it weren't for the simple fact that we are not exclusive from the system we're tampering with, but we're part of it. Guided by the misconception, that we, as humans, did somehow rise from our modest evolutionary origins as animals and ascend to something higher, we are disregarding and exploiting the interlinked ecosystem we stem from and are embedded within.

But if the reason for this tragedy lies (in the western world) in our culturally-fueled inflated sense of self as a species, is there a chance it can be healed by invoking empathy for others organisms? May the answer be to foster inter-species collaboration in order to perceive other animals or plants as equal kin, rather than subordinates? The answer is complex, however one thing can be said with certainty: We, as humans, have a much harder time empathizing with organisms we cannot communicate with. This has been the major hurdle for understanding and thus, empathizing with all parts of nature and arguably, animals that developed a shared communication protocol, receive more attention and protection (e.g. dogs).

However, therein lies a massive potential. If organisms are unable to communicate in a shared protocol with us, be it through sound, touch or voice, can technology jump in as a translator? Can a machine learning text-generation network be an advocate for animal rights? Can a chatbot be a representative surrogate for a plant? Can a microcontroller communicate the health status to be the voice for an algae colony? Looking at the experiments conducted in the past quarter, I would argue, yes. Technology has the potential to act as an empathy machine. Thus, I am fascinated by the idea of *bewitching* or *enchanting* organisms that traditionally have never had a voice to make them able to speak for themselves, to be perceived as emancipated and equal. In this metaphor, technology acts like a magic wand as it can bring the illusion of intelligence for any species, setting, goal or language we choose. This is a fascinating idea, because, put bluntly, it doesn't need much to fool us as humans. We're just mere animals after all.

6.6 Looking into Term Two and Beyond

My expectations for term two are very fluid, not because I don't expect much from the curriculum, but quite the opposite: I want to allow myself to be surprised as much as possible. Coming into the new term with fixed or overly rigid expectations is the best way to disregard or just blatantly overlook new inspirations and possibilities. This is why I look toward this second third with a relatively light heart and mind. However, there are two goals I want to achieve in the next three months.

First off, I want to dive deep into fabrication. The world of 3D design, 3D printing, manufacturing materials, distributing and open-sourcing designs as well as a whole plethora of tools and methods are foreign to me. This is what I hope to get to know within the Fab Academy track.

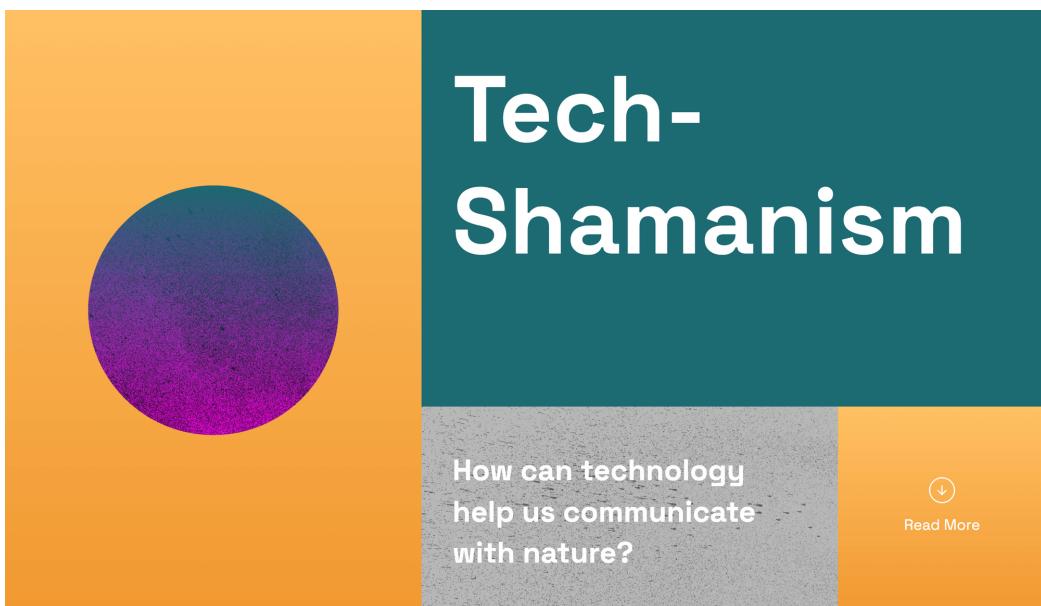
The second goal for me personally is to be able to work more in a self-guided manner on personal projects and experiments, instead of being restricted by a tight curriculum. I found myself with many, many project ideas last term, with nowhere near enough time to dive into the vast majority of them. This is hopefully possible in term two, as the curriculum opens up a bit more to include personal projects and specialization of interests, workflows and collaboration opportunities. In that sense, I'm more than eager to head into the next term.

-----BREAK-----

Term Two

7 An Introduction to Term Two

Our second term started off with a thorough reflection of the first term's learnings. These learnings were already discussed in *Chapter 6 – Reflection on Term One*, but will be expanded on further here. To wrap up the first term's explorations in a conceptual framework, I established the term of *Tech Shamanism*. It draws heavily on the key concepts laid out in *Chapter 6.5 – The Leading Idea* and is structured and presented on the website tech-shamanism.com. It refers to the idea of using technology as a translator, a medium, an empathy machine, to facilitate communication and collaboration between human and non-human actors. In that sense, we can use technology to *enchant* organisms or even objects, enabling them to speak the same communication protocol through the voice of the machine.



Screenshot of tech-shamanism.com

After discussing this concept with many of my class mates, teachers, friends, colleagues with various professional backgrounds as well as strangers, I see the shortcomings of the naming choice I settled on to signify the idea. I used the term *shamanism* as a vehicle to communicate the idea of playful enchantment of non-human actors. I, through my western-centric perspective, disregarded the multitude of cultural and religious dimensions that the concept carries. From *Santeria* to *Korean Shamanism*, it describes a very powerful, multi-layered and

culturally complex relationship with the World. For a white male born in Central Europe I very quickly found myself feeling insensitive for thoughtlessly choosing the term to employ it for something far from its cultural roots and in consequence feeling guilty of cultural appropriation.

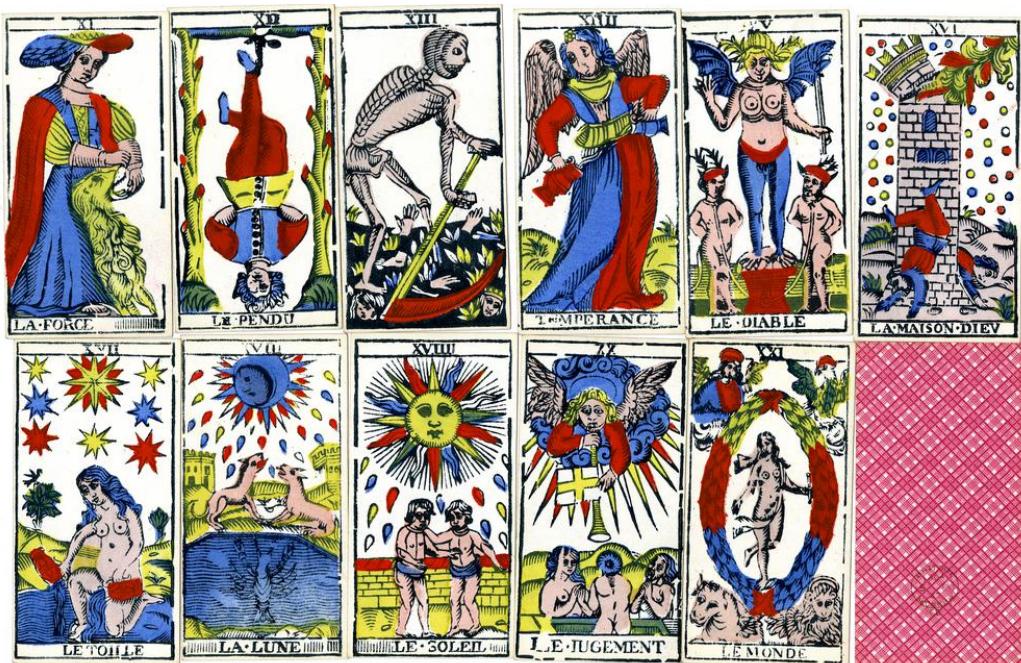
Thus, I am trying to correct this discrepancy between my initial concept and the way I chose to communicate it. For the introduction to my term two, I instead want to frame my projects in the light of what should instead be understood as investigating *algorithmic agency*. Consequentially, many of the projects of term two exist within the primary objective. Specifically the revolve around investigating AI as a design tool, the implementations and implications of different web protocols and employing generative design tools to produce audio-visuals. All of these projects explore and navigate the feedback loop between digital technological tools, human system design and the system reflecting the design consequences back onto the architects themselves. The intervention *Deep Tarot Cards* in the following Chapter (8.1) serves as a prime example.

8 Term Two Interventions

8.1 Deep Tarot Cards

Expanding on the initial concept idea of investigating algorithmic agency, this project came to life within the first weeks of term one. The goal was to reimagine tarot cards through the ‘eyes’ of a deep learning image GAN (Generative Adversarial Network).

I'm neither a superstitious nor especially spiritually inclined, but still I find myself strangely attracted to Tarot cards. I'm not interested in their supposed power to tell one's fate, however, they are ripe with culturally charged symbols, each drenched in complexity and spiritual meaning. As a designer, trained in the craft of navigating and leveraging the world of visual symbols, I am fascinated by that.



Selection of trumps from the Tarot de Marseilles, a typical 18th-century pack (© The Trustees of the British Museum, released as CC BY-NC-SA 4.0)

By virtue of the abundance of symbolism and the possible associations it provokes in the viewer, Tarot can be understood as a procedural algorithm generating an endless stream of narratives:

"Tarot, then, is a procedural algorithm: cards are drawn and placed into position according to the system the reader has chosen. The results are then read as a whole, both meanings of individual cards and the interplay of patterns coalescing to form the final impression of the reading."

– Cat Manning, 2019, “*Tarot as Procedural Storytelling*” in “*Procedural Storytelling in Game Design*”

So, what if we would rethink the motives and symbols shown on each card? Better yet, what if we let an image generation network reinterpret them? A ML-network (more precisely a GAN) can use the card title (e.g. 'The Magician') as a prompt to generate an image associated with it. Consequentially, the GAN would offer its own interpretation of what the card title signifies in the eyes of the algorithm. In other words, this means offering its very own set of associations with the meaning of the card. Ultimately, this provokes new creative connections in us as the observer, leading to a recursion of interpretations. Venturing into this recursive loop of creative associations was the goal of this project.

For the technical foundation, I used VQGAN+CLIP by Katherine Crowson. The original BigGAN+CLIP method was created by advadnoun. Tweaking settings like the initial weights, the step size, the iteration count and the starting seed, I slowly worked my way to settings which created desirable outcomes, both in terms of aesthetics and variety of associations found. The final result is based on the idea of 'cutting off' the image generation early, in order to preserve and amplify a dream-like ambivalence of the visuals, before the GAN iterates to something too concrete and specific.



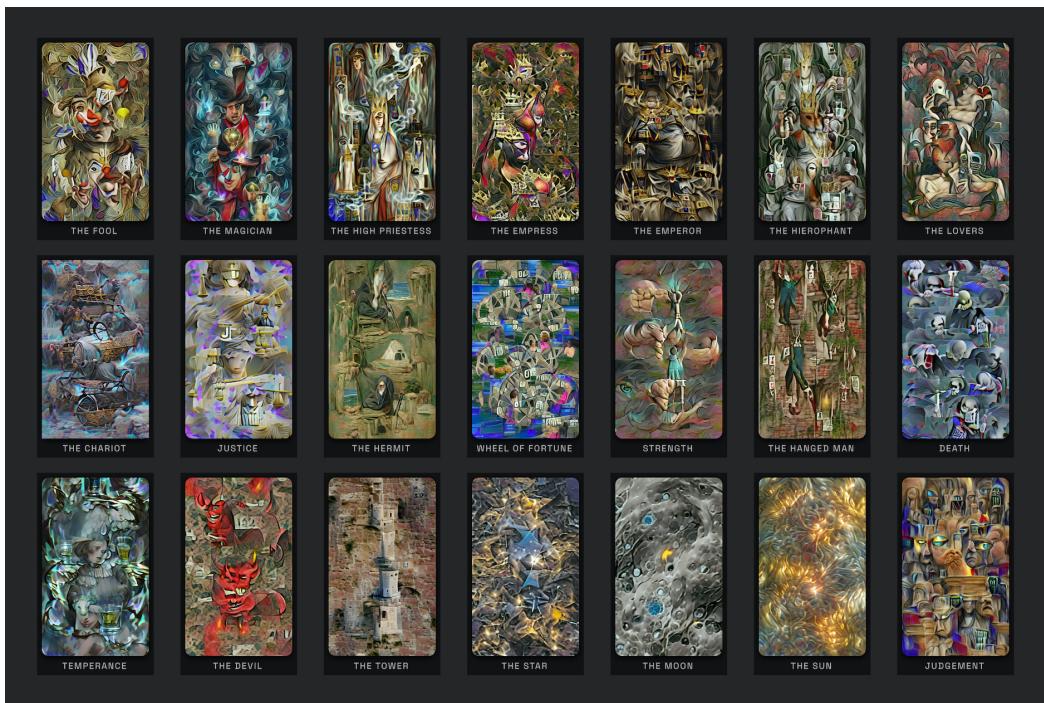
Two vastly different styles produced by tweaking settings within the same seed.

The alternative present created by Deep Tarot offers a provocative view into what might happen when we start treating AI algorithms as entities rather than tools. To me it is a thrilling exploration into understanding the way generative networks interpret abstract prompts, echoing our own associations and inspirations in ways that are perceived by humans as creative. It not only raised questions around the topic of creativity being something uniquely attributed to humans. In the particular context of Tarot cards it also plays with the notion of symbolism. This is a worthy exploration of the implications of this interplay between culturally charged symbols, their complex co-relations and re-combinations, the algorithm as an interpreter and us as viewers, involuntarily provoking a recursive loop of associations in the process.



Presenting the cards at Design Dialogues II, in conversation with Ramon Sanguesa.

Ultimately, all 22 Major Arcana Cards of the classic tarot deck were designed. The project is continuously developed and will eventually result in a print run as well as digital distribution.



The (almost) complete set of the 22 Major Arcana cards.

**Tarot Cards,
Reimagined.**

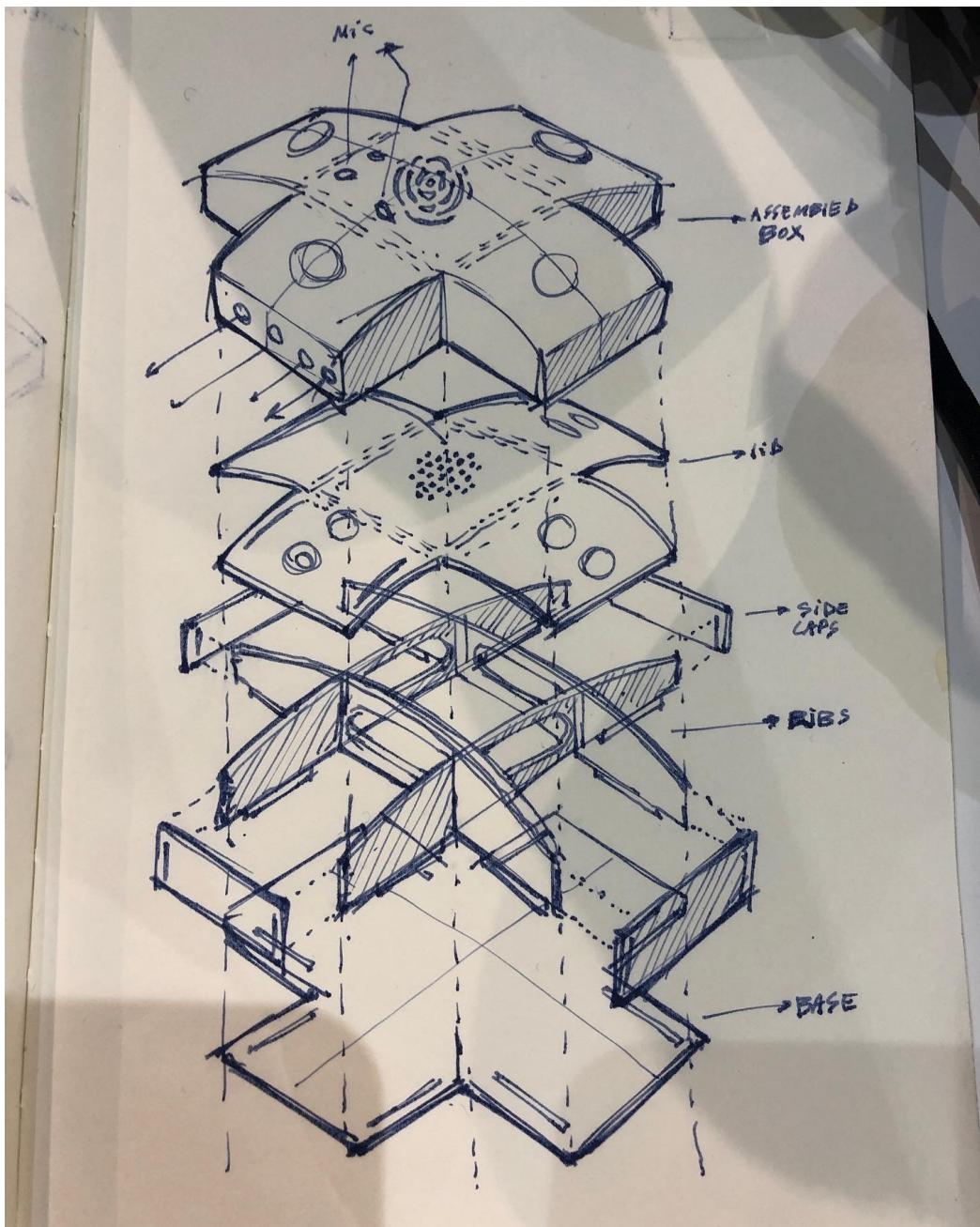
It's a game ripe with mystical symbolism and full of creative associations. What would an AI do with this?

↓

Select cards are presented on deep-tarot.cards.

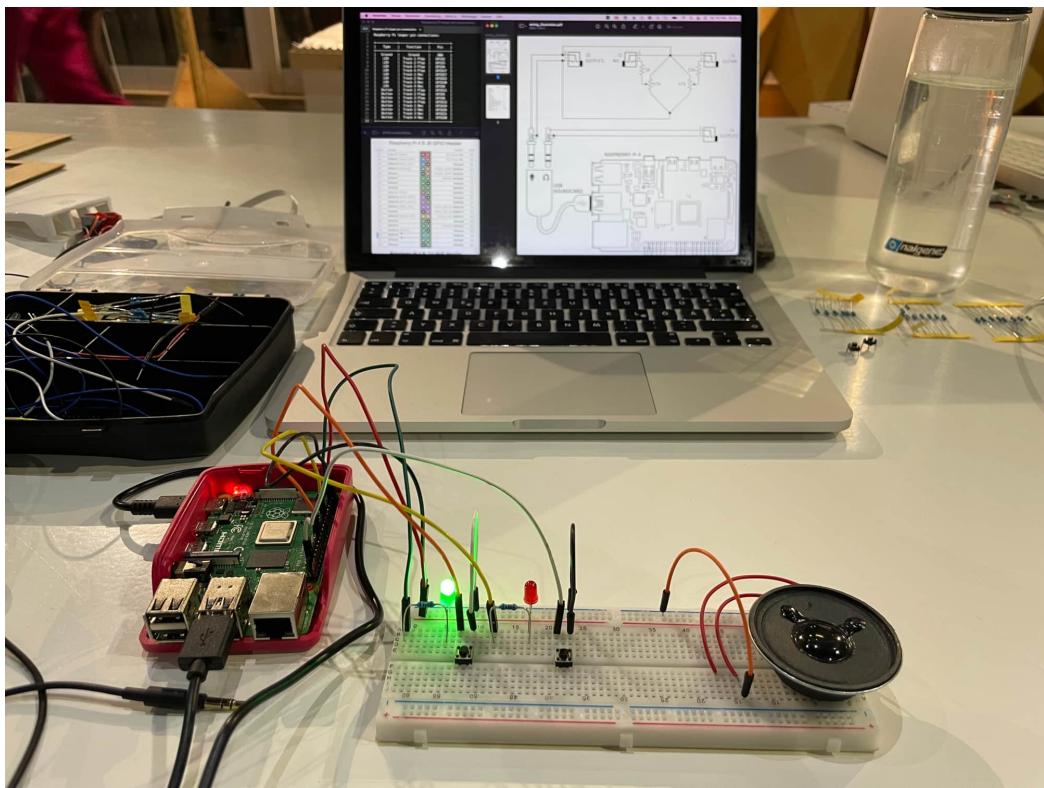
8.2 Open Jam Box

At the beginning of term two, the idea quickly materialized with Joaquin to build on last term's intervention to further investigate the musical side. For that we were planning to build a modular, open-source loop station called the *Open Jam Box*. The starting steps were centered around defining the concept, mapping out inspiration and stakeholders, exploring the technical feasibility of different technical setups and sketching hardware designs, both on paper and as 3D models for later digital fabrication. Due to the project's potential to accompany us throughout most of FabAcademy, as there are a multitude of connection points to the rest of the curriculum.

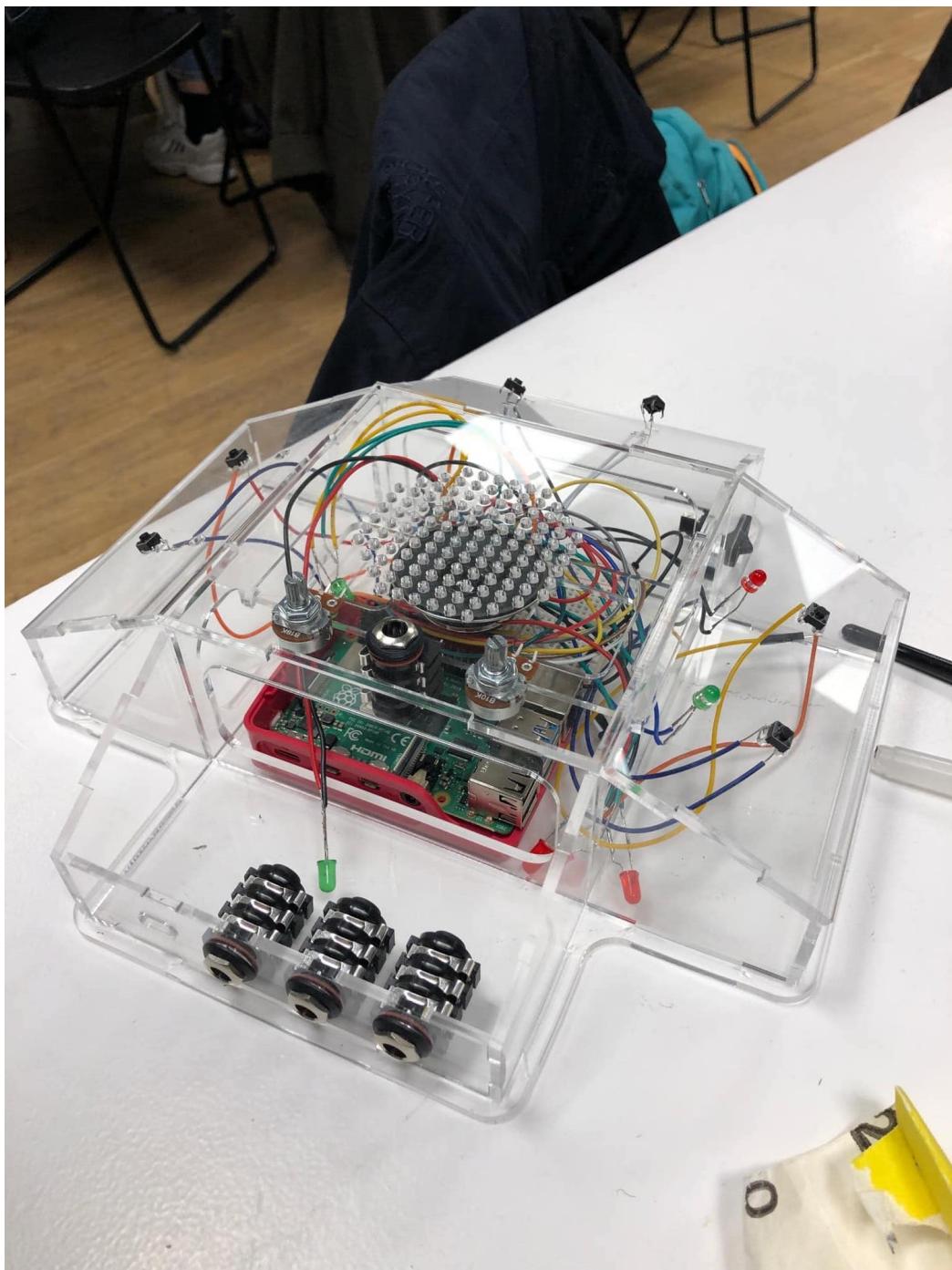


Early sketches by Joaquin

In the context of the first Fab Challenge Week in February, we built the first iteration of the Open Jam Box in the form of a 4-track loop station that is meant to be played collaboratively by up to four people. In order to ensure the collaborative nature of the hardware, the looper has four sides with four identical interfaces. It consists of two buttons each, one for recording a loop and one for playing it. The tracks can be layered indefinitely, which is enabled by the Raspberry Pi 4 acting as the heart of the instrument.



Connecting the first track interface elements after installing the necessary libraries on the Raspberry Pi.



The loop station shortly before completion.

8.3 GPT-3 Investigations: Co-authoring with AI

8.3.1 Requiem for a Mass Extinction

For this project I followed the observations of Bernie Krause, a musician and soundscape ecologist recording the sounds of natural environments for more than thirty years. In a documentary shown to us by Jose Luis de Vicente, Krause compares audio recordings from the rainforest in 90s Costa Rica to recordings from the same place in the 2010s. The difference is striking: While one recording is a rich cacophony of animals, the most recent one was almost completely silent. Pointing to the current 6th mass extinction caused by dramatic human intrusion into natural ecosystems, he contextualizes these recordings as evidence of a disaster unfolding in real time. He also used the term *silent spring* (originally coined by Rachel Louise Carson in her 1962 book 'Silent Spring') to describe the eerie experience of witnessing the busiest season for insects - the spring - being almost completely quiet in many places on the northern hemisphere. This inspired me to experiment with writing prose in collaboration with GPT-3 to explore the topic further from the perspective of one such insect.

Requiem for a Mass Extinction

I wonder how the springs became so hauntingly silent.

It used to be a feast for the ears, a cacophony of voices sung by all the little six-legged beings, the feather-winged and the small mammals. Now, there only is an empty void where an ecosystem used to be.

I was once part of that world.

I, too, contributed to the chorus of life.

I sang my songs of love and survival, and in return, the world nurtured me and allowed me to thrive.

But now...now I'm just a fragment of a memory, an echo of what used to be.

The silent springs are here to stay, they have created a world without song.

It is a sadder place for it.

A place where the world falls mute in the loudest of times.

A place where the only voice left to be heard is their own.

And in that silence, they will be the only ones who can hear their own destruction coming.

This text was co-authored with GPT-3, a text generation model by OpenAI.

8.3.2 Making Sense and Meaning Essay

To investigate further into long form writing with AI, I decided to co-author the *Making Sense and Meaning* essay with GPT-3. Here is an exemplary paragraph from the 2500-word long text:

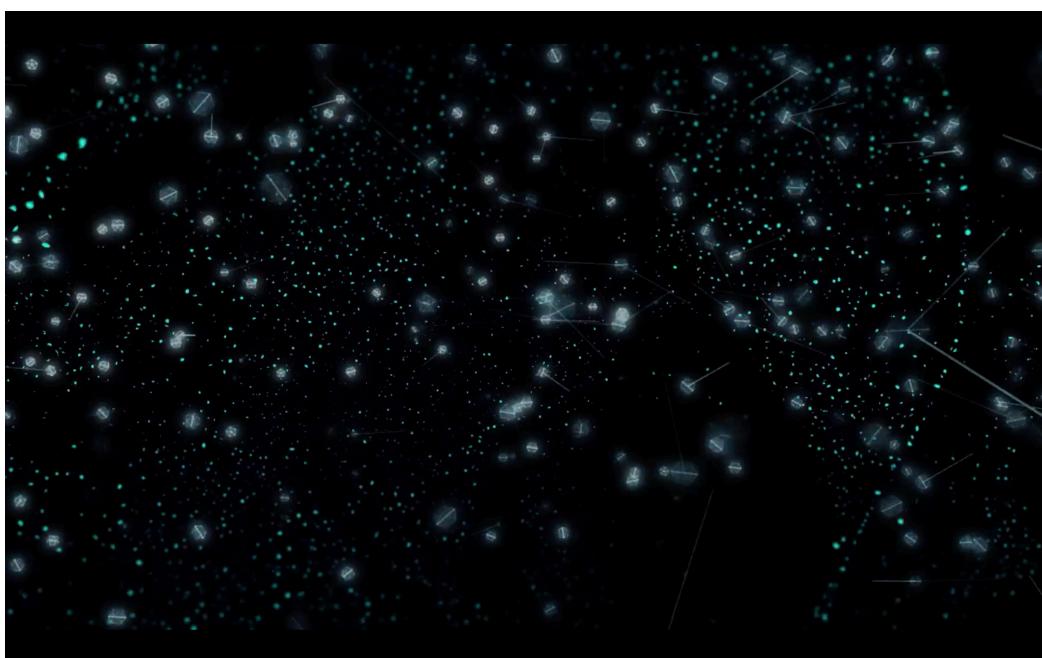
There are also limits on how much we can consume without damaging our planet or depleting its resources. The ecological footprint is a measure of human demand on the Earth's ecosystems. It compares the amount of biologically productive land and sea area an average person uses with the planet's biological capacity to regenerate. In other words, it tells us how much nature we have and how much nature we use. The average ecological footprint was 2.8 global hectares per person in 2010 [3], or about the size of two tennis courts. The Earth's biological capacity is about 1.6 global hectares per person, which means that we are using up nature at a rate that is nearly twice as fast as it can regenerate. The ecological footprint has been increasing for decades and is now about twice what it was in 1961 [4].

This excerpt was co-authored with GPT-3, a text generation model by OpenAI.

8.4 Artificial Constellations

I was always fascinated by generative visuals, especially when being sound reactive. To merge music and visual design together to create an immersive experience was an intriguing concept to me that combined two of my creative passions, and one that I had never explored before. Together with Tatiana, we chose to embark on such a collaboration, called *Artificial Constellations*.

For our conceptual starting point, we chose to investigate the contemporary phenomenon of *light pollution*. Since our urban and industrial areas are emitting an increasing amount of light, we successively seeing less and less of our stars and constellations in our night sky. That is, despite the fact that the firmament played such a pivotal role in forming us as a species, from our ancestral legends to high-sea navigation of the renaissance. Even today, our fascination with the stars is unbroken as we reach beyond our solar system in the conquest for ever-expanding frontiers. So, how might our intimate relationship with constellations and celestial bodies change, when we have more and more trouble seeing them at all? Do we change our relationship with technology or do we change our cultural narratives around the night sky by reinterpreting what we see up there? *Artificial Constellations* was an exploration into these open-ended questions.



A still frame from the video.

Based on melodies of Tensorflow's Magenta plug-in, which uses a pre-trained network to generate harmonic variations, I produced a 4-minute long audio track in Ableton Live. The sound design aimed to take the viewer from idyllic clear skies to shifting constellations, which are increasingly disintegrating while revealing new symbols between them. Based on the drone-heavy, atmospheric track, Tatiana built a generative visuals pipeline in Touchdesigner by separating the individual frequencies to trigger different dimensions of the animated particles. After heavy post-processing in After Effects, the result was an immersive journey through the cultural significance of our nighttime sky and the symbolism that is tied to it.

As for the time and place to show this result, we chose a rain-free evening at the end of March, where the screening happened in candle light under the bare sky on the rooftop terrace of IAAC's Pujades 102 building, which resulted in a wonderfully atmospheric setting.



A special kind of gathering.

After the screening, we asked the participants to engage in drawing new constellations on the floor together, using candles as a stand-in for stars and white chalk as the lines connecting them. The result was a mosaic of culturally and spiritually significant symbols, as well as some contemporary objects of worship.



A part of the new constellations that was collectively drawn after the screening.

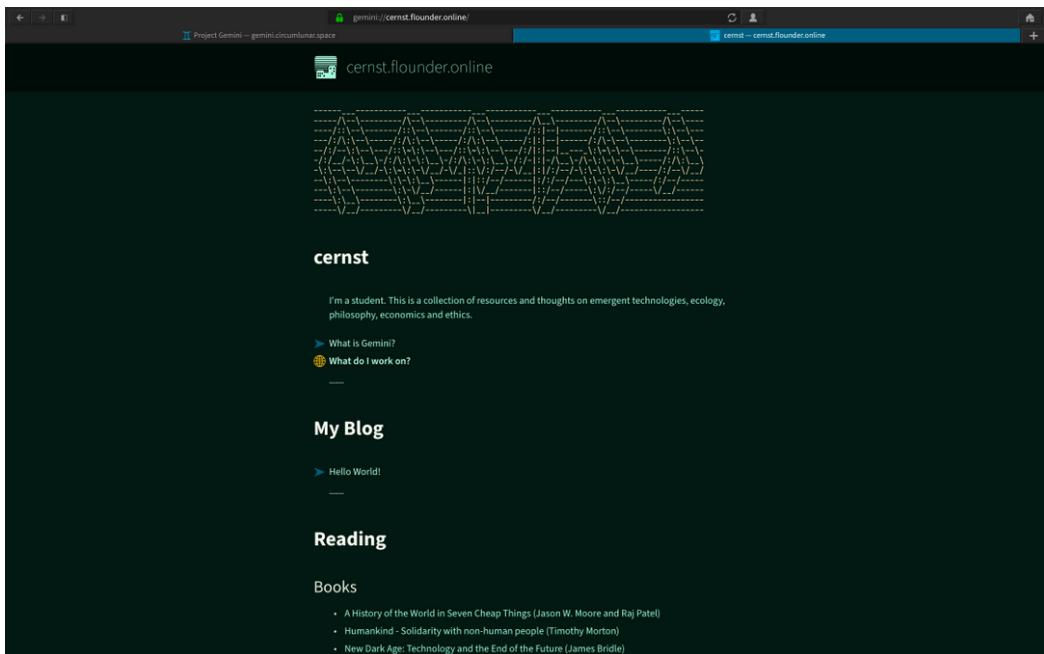
8.5 Protocols of the Web: An Introduction to Gemini

To understand how today's internet came to be, it's important to look at how the web evolved as a protocol. Since its invention in by Tim Berners-Lee at CERN in 1989, HTTP (Hypertext Transfer Protocol) served as the backbone for the ever evolving, modern web. HTTP handles the communication layer between (local and globally) networked computers by transmitting text and hyperlinks. It is acting as a protocol for requests and responses between instances (like a client and a server), it allows these to transfer HTML or CSS files, among other data types, that allow a browser to render a website.

But HTTP is not the only protocol for networked computers and it has, through its open architecture, allowed the web to mutate into something further away from the vision of their creators. Slow loading, JavaScript-heavy, multimedia websites with tracking cookies that enable a plethora of advertisements result in a debatable user experience.

This is why in the last years, many people have wondered how the web would look like if it was a more stripped-down, solely text-based protocol. Simple, restricted and fast by design, Gemini protocol is a proposal brought forward in 2019 by anonymous Solderpunk. (It is not meant to replace neither HTTP or Gopher, but coexist with them). With many open-source browsers, such as Lagrange (Mac) and Elaho (iOS) and a very active development community, the geminispace offers a different experience of browsing the web. Lightning fast and reduced to the bare essentials, namely text and links, it reminds me of the early days of the web in the late 90s and early 2000s. Further, it's values privacy by design and is much lighter on the ecological footprint, due to file sizes which rarely exceed a few dozen Kilobytes. Further it highlights the sheer potential of links, which is the very heart of how the web started out – by drawing connections.

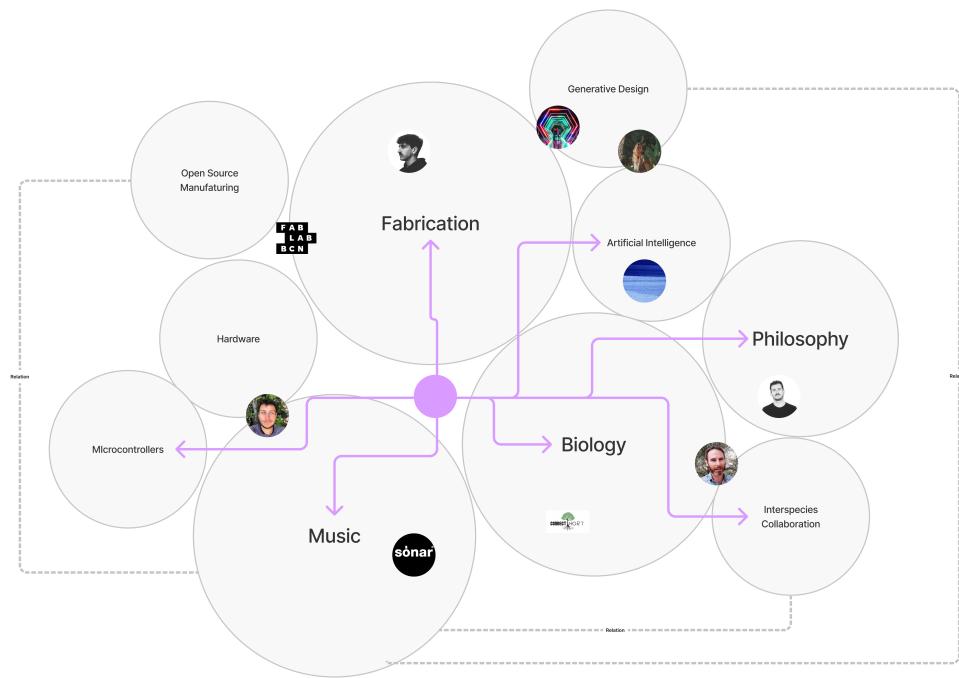
I decided to try out the Gemini protocol by setting up my own capsule (similar to a webpage). For that I used the free hosting service / community Flounder, which also offers an automatic HTTP-proxy of its sites. The site can be found in the geminispace at <gemini://cernst.flounder.online/> and in HTTP under <http://www.cernst.flounder.online>. I have moved all of my important links and references there, to serve as a browser-independent bookmark list for me and for others. My next step is trying to host my own capsule on a gemini server running on the Raspberry Pi Zero.



First viewport of my Gemini capsule.

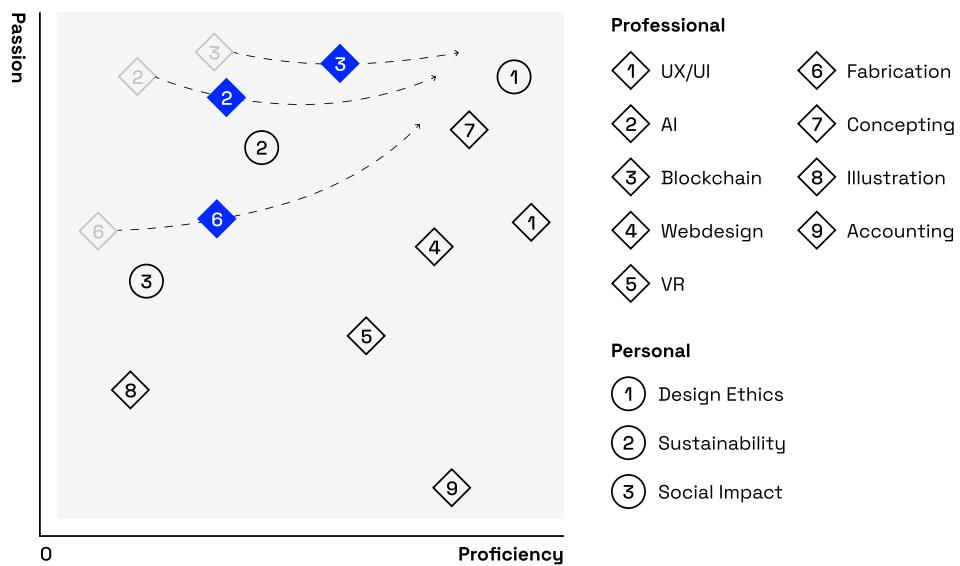
9 Evolution of my Design Space

At the beginning of term two, I took inventory of my individual and collaborative projects. Instead of planning singular, stand-alone efforts with predetermined artifacts as interventions, I reframed the format of design interventions as snapshots of a work in progress, as an entry in the metaphorical design diary. This, I hoped, would enable a different kind of working. Since I detached from wanting to produce fixed results with my projects, a process engrained in my thinking by a decade as a design professional, I planned to free myself from solutionist thinking and let myself be led more by the process itself than anything else. This, of course, didn't mean getting rid of making intentional design decisions or even strategic planning – it just emphasized a playful exploration over it. Thus, I was able to fully embrace in practice what I came here to do in the first place: Experiment more.



My Design Space 2.0, at the beginning of term two.

This is why this terms projects are indeed many separate big and small interventions, such as the collaborative exploration with Tatjana on audiovisual storytelling, a joint effort with Joaquin into making open-source modular synthesizers a reality and a solo investigation into the associative power behind Tarot cards and what they would look like reimagined by an AI network. Additionally I embarked on personal explorations into alternative web protocols, automated bot programming in python and co-writing with GPT-3, which were technologically guided first and foremost. They allowed me to expand my understanding of these emerging and ever-evolving technologies, which shape our web and, through that, *every single part of today's society*. To understand the context of this, let's revisit the professional profile drawn at the beginning of term one:



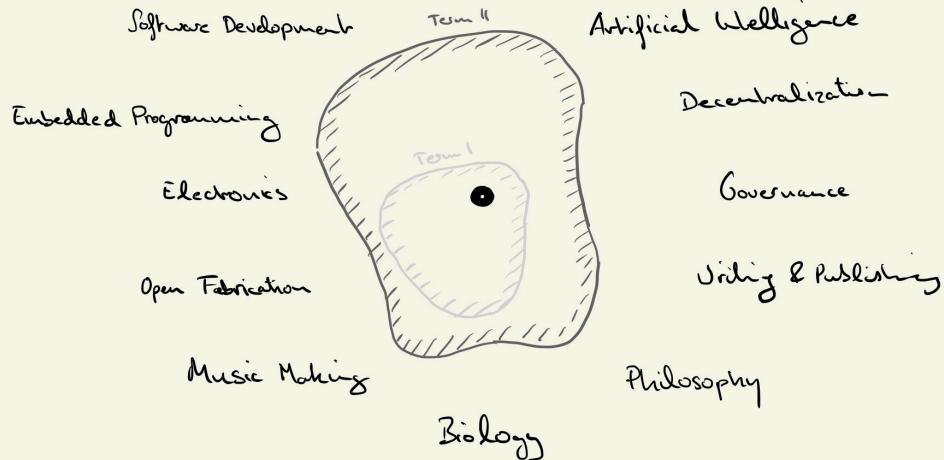
Updated Professional Profile after Term 2.

Here, we can see that my primary objective for this master program is on track to materializing – to foster a deeper understanding and literacy in deploying emerging tools such as ML-networks, Blockchain-based decentralization and digital fabrication. But this visualization is only able to capture a part of my learnings as it disregards large parts of the curriculum. Therefore I visualized my progress and personal growth along a radial diagram, where expanding outward means a deeper dive into the respective topics.

Design Space 3.0

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Generative Design



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Design Space 3.0

Throughout the projects, investigations and interventions, I had the chance to let a few alternative presents emerge, one of which was particularly prominent. It is the concept of *Algorithmic Agency*, which I extensively discussed in Chapter 7. Within this alternative present, we attribute agency to algorithms by letting them resume roles that make it easy for us to humanize. It is a glimpse into the future where we might interact with lines of code in a similar fashion we are interacting with humans today. A world where those programs, consisting of not more than one's and zero's, have rights and duties, not unlike ordinary citizens. A world where they out-scale the majority of professionals on their respective fields. A world where we are faced with the single-purpose tool we built becoming a self-optimizing entity.

10 My Professional Vision

Building on the previous chapter, my desired professional profile becomes clear: A multidisciplinary, technologically literate designer that is able to break down boundaries between digital disciplines in order to navigate the waters between design and art. This enables me to provoke, take part in and facilitate societal discussions around emerging technologies, their direct implementations as well as their indirect implications. In that sense, the *Future Talks* series was helpful to position myself in this professional latent space, differentiating my self-understanding from some of the speakers we heard from the strictly academic research context.

It follows that for term three, I want to continue venturing into co-designing and co-writing with neural networks to further expand on the idea of algorithmic agency. Secondly, I am planning to explore and implement solutions around autonomous decentralized organizations (DAOs), digital governance and choice architecture. Finally, translating data gathered by hardware sensors into digital generative designs is a topic necessary to investigate if I want to remove barriers between the physical and digital world and to establish interfaces between the two. This will eventually allow me to link and re-combine these modular technology stacks to ultimately build self-sustained, autonomous and decentralized interventions, systems and communities.

-----BREAK-----

Term Three

11 An Introduction to Term Three

In order to understand the outlook for Term Three, it's mandatory to first reflect back on Term Two. Term Two saw me dive into machine intelligence (*Deep Tarot Cards, Co-writing with GPT-3*), fabricating hardware (*Open Jam Box*), open protocols and languages (DAOs, Python, Gemini) and audiovisual experiences (*Artificial Constellations*). All of these had the objective in common to investigate the agency of technology and to find out what that means to design and interact with these systems. It also meant that Term Two to me was a breathless whirlwind of different interventions, intuitively connected in a loose fashion, which only retrospectively reveal their common denominator: The critical look at technology, specifically its power to invoke and manipulate emotions. Part of that approach was experimenting with the concept of *Tech Shamanism*, although - as described in chapter 7 - this term itself is unfortunately too sprawling in its associations to be useful in this context. *Algorithmic Agency* is the term I propose in its stead.

What I've learned from Term Two, is the importance of finding and engaging with communities that share common goals and interests. It can be incredibly powerful to realize that the efforts made in the academic bubble we inevitably found ourselves in for the past nine months are not disconnected from the rest of the world. There are many individuals, communities and initiatives pursuing the same purpose as you. Joining them, sharing knowledge and learning from first-hand experience can be a true enabler for the scale and impact of one's projects.

Putting this into practice as well as sharpening my future professional profile were the main focus of my Third Term.

12 Term Three (Final) Interventions

12.1 Hybrid Ecosystems (Akasha Hub x MDEF)

For my final MDEF project I teamed up with Tatiana and Joaquin for an interactive audiovisual exhibition at Akasha Hub in Barcelona on June 28 2022. It will feature five separate exhibits (detailed below) and an opportunity to engage with the community through activities that persist after the event finishes.

12.1.1 Exhibition Concept

Natural and technological ecosystems are closely related, however counter-intuitive it might seem at first. Investigating these overlapping areas through our senses, we venture in hybrid worlds of sounds, visuals and haptics. Between self-mutating algorithms and recursive patterns in nature, we draw similarities and aim to provoke questions about a more sustainable and tangible view of technology.

12.1.2 Exhibited Works in Detail

12.1.2.1 Hybrid Spaces

Exhibit one will be a live and interactive audiovisual installation on the main screen featuring a set of biomaterials and plants as physical triggers.

Audiovisuals related to nature + algorithms are generated by participants touching buttons, like a VJ/DJ set. There will be a panel with various unconventional buttons, including plants, biomaterials and other artifacts related to the theme. Various visuals and sounds will be triggered at the same time, overlaying on top of each other depending on the buttons chosen.

12.1.2.2 Fractals at different scales

Our second artifact will consist of a video loop exploring recursive forms in nature and mathematics.

This project investigates how fractals and other mathematical patterns appear both in the natural and digital world. It would be a video which morphs a mix of algorithmically created fractals & “natural” fractals without any sound and interactions. The loop would be a few minutes long and displayed on a screen.

12.1.2.3 Sonic Ecologies

An interactive experiment distributed across six small stations, inviting participants to shape clay from Collserola park inspired by audio recordings taken there. These clay artifacts will give sonic feedback while being touched.

From the concept of Joaquin:

Exploring the Relation between sound, technology, nature and the physical world.

When was the last time that you played with mud? Why are objects designed to last forever? Why have we lost our connection with nature? What is the relationship with sound and our physical world?

These are some of the questions that will be explored with this intervention. Sonic Ecologies is a series of specific designed interventions that will be happening in the city of Barcelona and its natural surroundings, Ending with MDEFest trail road in the natural park.

The intervention is designed to work as a cycle, with human intervention opening and closing the loop, and It's divided in x stages.

Stage 1: Collect the Clay from Collserola Park, or el Garraf.

Stage 2(at Akasha Hub): The Clay will be installed in different metallic and conductive totems, these totems will be connected to an electronic system that will be throwing sound signals when the clay is touched, so it will be modeled in a collaborative way by people that will be participating in the expo. It's expected that the resulting shape will be abstract like sculptures.

*Stage 3: For the final act, there will be a hike organized to Collserola park, where every participant will take a piece of the clay that was made by different people the day before. The pieces of clay will be set up for a music performance that will be played there. After the performance, all of the clay pieces will be returned to the park as little sculptures, as **nendo dango** seeds, or as traces of human intervention.*

12.1.2.4 Interactive Particles

A live and interactive visual installation inviting participants to move particles through motion inputs.

Gathering motion data input from either Kinect (movement, postures) or Leap Motion (hands, gestures), we can let visitors interact with a particle simulation running in Touchdesigner, or Processing. The particles will move according to natural laws, akin to snowflakes, water, microorganisms or smoke (tbd).

12.1.2.5 Unnamed NA.B3 Project

NA.B3 is an artist collective working with audiovisual installations and multimedia art. After reaching out to them, we communicated that we would love to invite them to participate in the exhibition. After thinking about it for a good week, they confirmed their involvement stating that they identify a lot with the vision and concept of our planned exhibition. A draft of their exhibit hints at a “metal installation involving plants and possibly sensors” and states, that they will have it ready until June 28. We are excited to find out more about their ideas forward to bringing this collaboration to fruition. This presents a unique chance to engage with the artist community in Barcelona and set the stage for a future professional network.

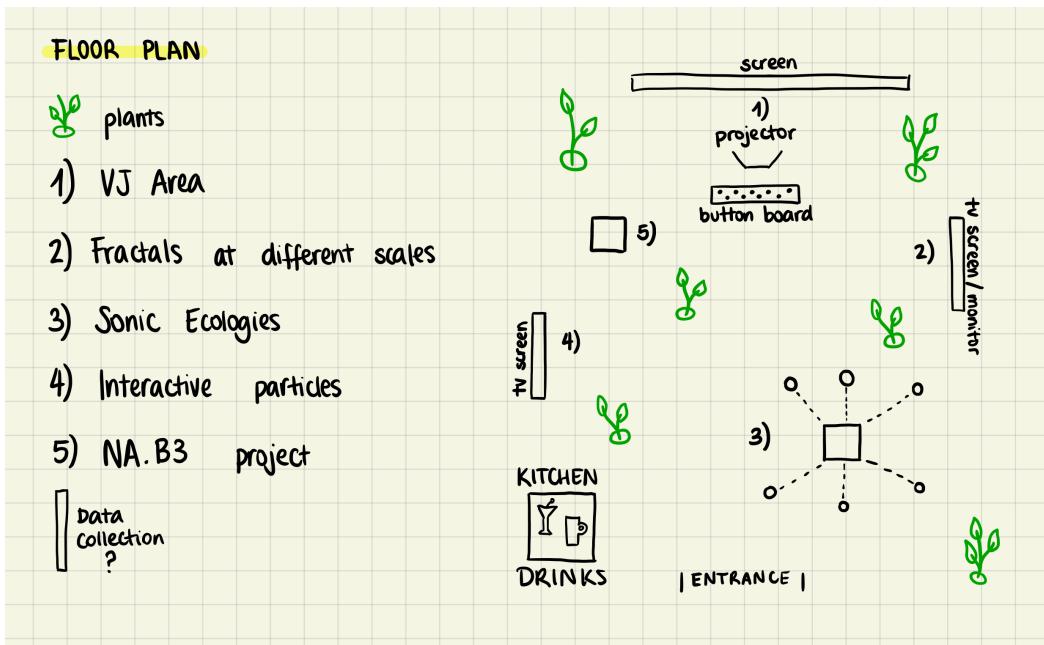
12.1.3 Data Collection & Feedback

Exhibit number one, three and four will be interactive, so there is a substantial amount of visitor interaction provided. Beyond that we are thinking about collecting thoughts and inputs regarding the exhibition matter itself through a QR-code that leads to a web form. There are two possible ways to continue:

- **live feedback:** set up an online form that, when submitted, could trigger an audio sample and potentially display the words on the screen
- **sequential feedback:** QR code linking to a online form, collecting data to analyze & visualize it at the end of the event

12.1.4 Floorplan

This is a possible layout of the exhibition space. It aims to let people move throughout the space in an organic way and interact with the different exhibits over time. We hope that this distributed way of arranging the pieces will also enable conversations to form dynamically as people interact with the objects and each other.



Our preliminary floor plan for the exhibition

12.1.5 Timetable

Since the screening and the gathering part would no longer need to be separated, we could have everything happen at the same time: Gathering, exhibit interaction and the networking of the visitors. This way, the guests could organically move throughout the distributed exhibits and form conversations naturally.

12.1.6 Goals

With this exhibition, we want to inspire people to move through the world with open eyes and see nature in a new way. Experiencing how tech and nature are not two separate entities, but ones that can co-exist and benefit from each other, is an important mission of ours. Visitors should have the chance to engage in conversations around the topic and to connect with both Akasha and the community. We want people to leave inspired and encouraged that every one can make an impact.

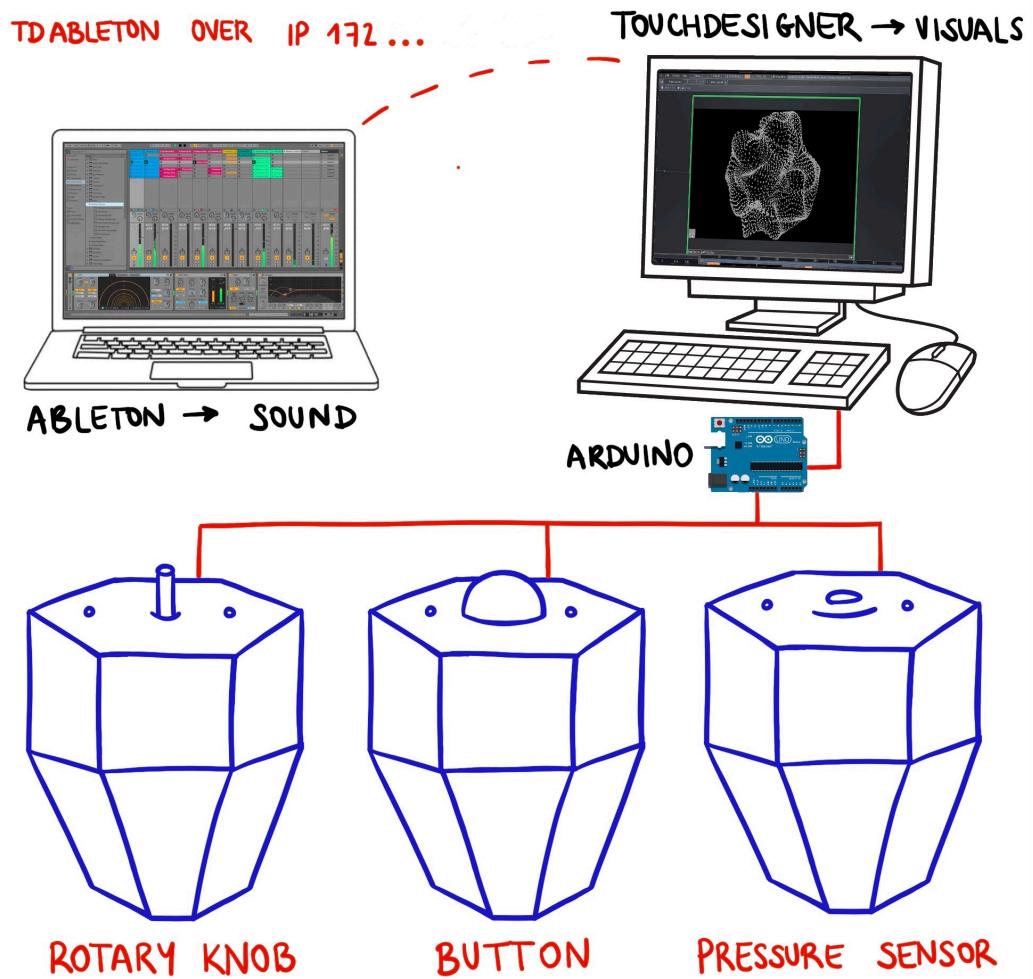
12.1.7 Progress

In the weeks leading up to writing this paragraph (June 6 2022) we managed to achieve substantial progress towards letting this exhibition become a reality. So far we planned the exhibition (see above), confirmed the details with the location, manufactured prototypes for our main exhibit and connected the software stack to power it. Additionally, we are producing visuals and sounds for the various exhibit

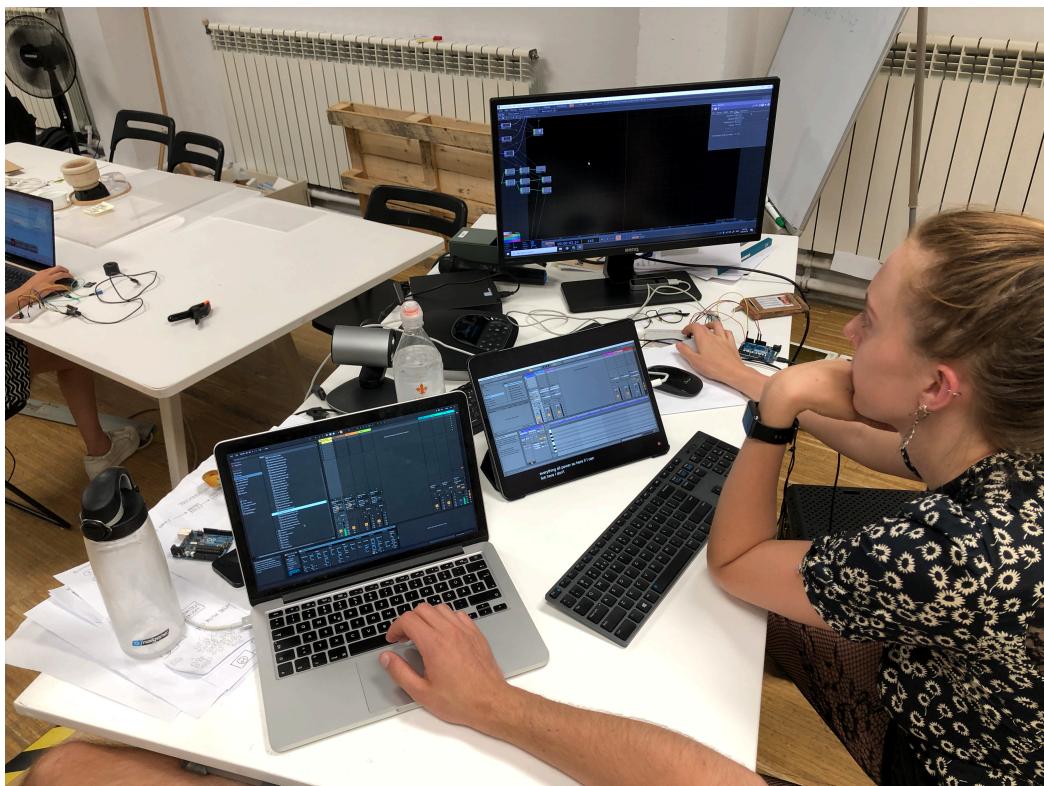
pieces, as well as refining our key visual for promotional purposes. Below, some impressions of our technical progress - without spoiling too much about the final exhibition.



Our first controller iteration (featuring biomaterials) for exhibit one.



Our main exhibit's technology stack visualized in a schematic way.



Controlling Ableton through Touchdesigner over MIDI over IP, while reading Arduino sensor data.

12.1.8 Next Steps

Our next steps are prioritized by designing, polishing and expanding the current technical prototypes that we built so far. Further, promoting the event in a fashion that sets the right expectations and assumptions is critical for us.

12.2 Web Geist

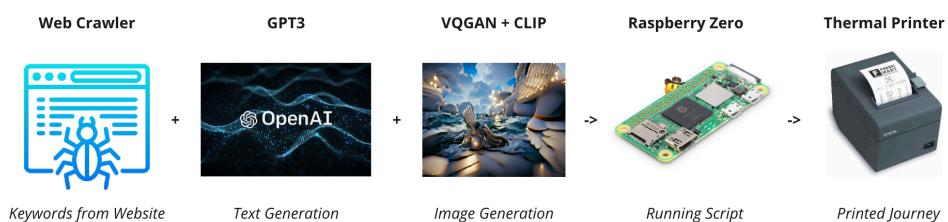
A second intervention that materialized this Term was an investigation from Term Two into (almost) autonomous web crawlers in conjunction with natural language generation systems.

After developing the crawler myself to work as a prototype and connect to GPT-3, I teamed up with Jeremy to interface the resulting output to a thermal printer via a Raspberry Pi Zero.

12.2.1 Concept

The idea was simple to begin with: What if an algorithm moved through the web, autonomously, picking important metadata as well as the next random organic external link (excluding social media links). The gathered metadata for each URL would then be sent to OpenAi's GPT-3 natural text generation network to write a short story featuring the respective URLs main topic. Illustrated by images provided by DALL-E mini (an altered, lightweight version of OpenAI's image generation network) and generated using the same keywords as prompts, this algorithm would then become something like a autonomously navigating storyteller that lives on the web. A fascinating tale.

Sketches



The data flow visualized in a simplified way.

12.2.2 Storytelling Generator

The story generator consisted of a python script employing BeautifulSoup4 to crawl websites and extract HTML data from it. By going through all the `<a>` elements on a website, it extracts all external links and filters it for undesired ones (such as social media and Google links). After extracting the first `<h2>` element, it chooses a random external link and navigates to it. This way the script can autonomously navigate the web and jump from page to page, as long as he visited websites have at least one external link.

This way, every website will provide a couple keywords that can be used as prompts for GPT-3, a natural language generation network by OpenAI. We send the keywords via an API call to the network, prompting a short story to return. After an average of five seconds, a multi-line, sometimes multi-paragraph short story is returned, revolving around the provided keywords. This is an example, based on 'books' and 'dolphins':

"Once upon a time, there was a beautiful kingdom made entirely of books. The shelves were lined with all sorts of stories, from classic fairytales to modern-day adventures. The people of this kingdom loved to read, and they would often spend hours curled up with their favorite book. One day, a terrible storm swept through the kingdom, destroying everything in its path. All of the books were blown away, and the once-lively kingdom was left in ruins. The people of the kingdom were heartbroken. They didn't know what to do without their beloved books. But then, one day, a strange woman appeared and said she could help them. She had magical powers that could bring the books back to life. With the woman's help, the kingdom was soon restored to its former glory. And everyone lived happily ever after surrounded by their favorite stories once again."

Based on this relatively simple structure, a procedural storytelling algorithm evolves.

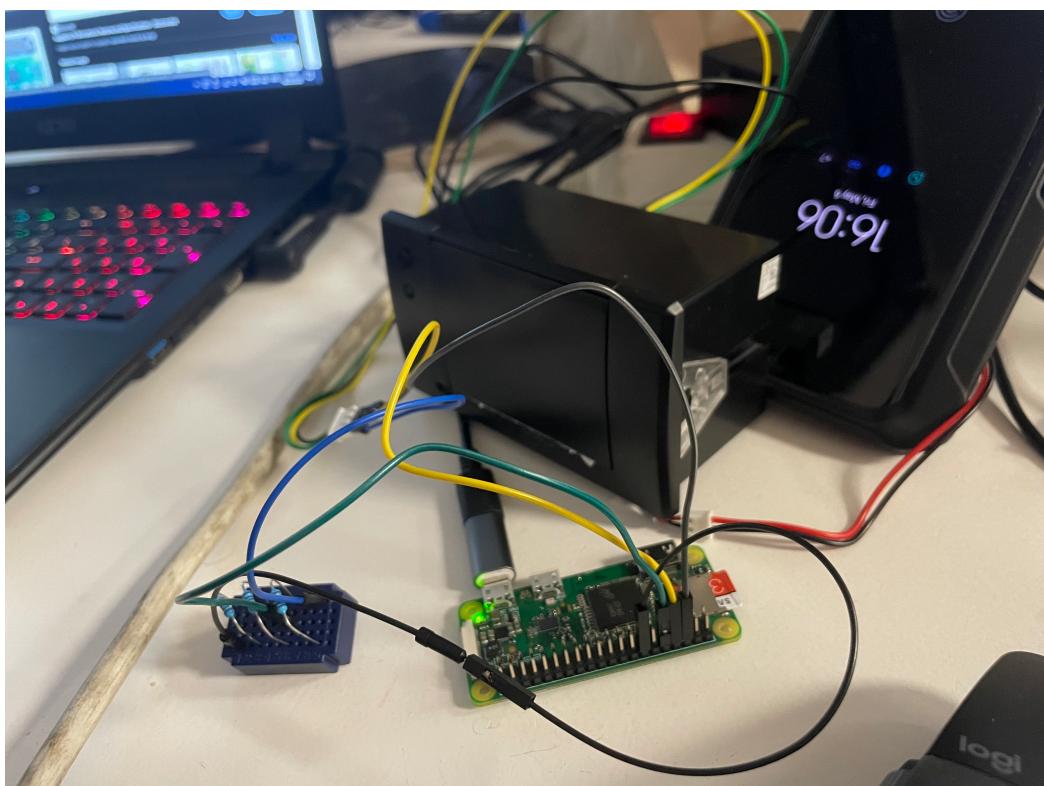
The Python script running (left) and an exemplary output by GPT-3 (right).

12.2.3 Image Generator

The image generator consisted of a Dalle-E mini instance running on Google Colab. This was accessed through an API to prompt the network for the image generation and then receive the raw image data back. To limit data throughput and speed up the generation, we fixed the resolution to 256x256 pixels. By doing this, we managed to keep the response time consistently below ten seconds. The data stream back consisted of encoded in base46 raw image codec. With the help of Pietro, we then transformed that into *png* format and then into *bmp* format in order to be integrated in the thermal printout.

12.2.4 Hardware Output

To interface with the real world, two tools were chosen: Input via the command line and a physical printout via a thermal printer, normally used for printing receipts. Through the command line, the user can specify the number of jumps and the starting URL. This is the primary input the user can do. As for the output, the links, keywords and generated story are printed out via the thermal printer, providing a continuous log of the procedural storytelling. To interface with the printer is the next immediate step to take. Right now, the text output happens via the command line.



Interfacing the thermal printer with a Raspberry Pi Zero W.

12.2.5 Next Steps

Ultimately, the image generator should be integrated in the storytelling algorithm to provide pictures on the basis of the keywords extracted by the web crawler. This would effectively wrap all of these components into a single content producing program. To get there is my personal mid-term goal. This might be achieved until the end of the semester, but it might as well be finished only after it. Regardless, it will be finished eventually this week and hopefully grown into a published project.

Isolated from the fact that this project was not completely finished within a single week, this Fab Challenge was of critical importance for me personally. It was the first time writing Python in a bigger scale and structuring it into dedicated objects. This implied an understanding of software architecture, which I didn't have any other touch points with before. Additionally, doing API calls and processing JSON replies in Python, was a new thing for me.

In this sense this week's challenge was hugely inspirational for me, since for the first time, I could see how Python could serve as a bridge between different systems, interfacing between them and post-processing data. This way, software platforms increasingly reveal themselves to me not as silos with isolated environments, but simply as inputs and outputs to be combined.

13 Alternative Present

The alternative present I want to create with my final intervention - and as a continuation of all previous interventions - is to bridge the gap between natural and synthetic environments. Nature and technology have been, for centuries, seen as adversaries. One discovers upon closer inspection, however, a remarkable amount of organic behavior in algorithms and vice versa a substantial amount of algorithmic representations in nature. With algorithms exercising more and more agency and flexibility (machine intelligence, i.e. unsupervised learning), as a causal observer one cannot shake the feeling of these systems being 'animated'.

While the purpose of this text is neither to dive into philosophical debates about what it means to be alive or animated, nor draw scientifically unsound parallels between genes and lines of code, I want to highlight how much these worlds have in common. How changing our understanding of both can help us survive as a species. How we, as humans, are wielding technology in our conquest of this planet, but in reality are turning that weapon against ourselves. How realizing that we, and therefore all technology, are embedded in a complex organic ecosystem that

we have yet to fully comprehend. Therefore, bridging the gap between synthetic and natural worlds is an alternative present I want to invoke, in order for communities to question their understanding of both and help mending a deeply broken relationship.

14 Designing yourself out

The question that poses itself when looking further, past the end of the master program, is: How dependent is your final project on your direct involvement? Delegating responsibility is a crucial skill to avoid burning out, but completely removing oneself from the project you conceived is a harrowing thought – after all you were the person that brought this solution into existence. Despite this it's important to stress that designing yourself out, to make the maker obsolete, is a very powerful step in the evolution of every project, if done right.

It has to be done with care, however: Do it too early and the initiative will not carry itself forward without the founder's energy. Do it too late and it will restrain the intervention from organic growth and hinder its scalability, effective locking out relevant communities to shape and adapt it to their own needs. So how do we determine the correct point in the lifecycle of each intervention when it's time to start saying goodbye and gradually removing yourself from the process?

For my final intervention, this point clearly is not reached yet and won't be in the mid-term future. As an audiovisual experience, it relies heavily on the curation of the individual artist that is able to give it its unique look, feel and message. Despite this fact, we can speculate about possible alternatives. One is to create a community around the technological investigation of organic ecosystems to decentralize the project early and enable future events to be organized with the community. This can be done in form of a traditional online community or even as a web3-native decentralized autonomous organization. If done correctly, the latter would directly limit the amount of influence of me, the original founder through an egalitarian voting architecture (e.g. quadratic voting, reputation tokens).

Furthermore, a promising idea is to integrate the final exhibition in the broader context of an existing community that is already engaged with these sort of topics. Generative NFT communities, audiovisual artist collectives and computer artists with a strong mathematical background are loosely organized via Twitter, Discord and Instagram on these topics. These communities often exist within larger web3 tribes. The step to exhibit our four installations at Akasha Hub was therefore the

intuitively right one: As a crypto-centric community hub and co-working space run by a blockchain non-profit it is connected with these communities in a myriad of ways. This makes me hopeful, that there are very exciting things to come.

15 Final Reflection

When looking at the last nine months of MDEF it shows clearly that this master enabled me in a host of new ways and will continue to do so for many years. In the last three terms I was introduced to a myriad of new skills, technologies and paradigms, ranging from agriculture to open source, from decentralization to biomaterials, from computer-aided design to curation, from machine-learning to community engagement. In a neck-breaking pace I peeked into the routines of disciplines I had previously no contact points with. By doing so, I broadened my understanding of what design and technology are, can be and should be. It allowed me to start cultivating a curious but critical view on technology and its interplay with science, society and nature. This is a very profound evolution in my professional understanding and it would be an understatement not to call this a career-changing paradigm shift.

However, I strongly believe that the program would benefit from a additional time to exercise and experiment. It is in the very nature of the program, and I assume it is designed as such with intention, to give only but a brief introduction into all these topics, however small or expansive they might be. This serves only as a appetizer for what is in most cases truly a vast professional cosmos in its own right. Combined with the rapid-fire pacing of the curriculum and its deliverables, further investigation of these fields was only possible in the most restrictive fashion. Therefore I think about this program as more of a showcase of these metaphorical tools, than an actual workshop on how to use them. This includes the MDEF FabAcademy program, which despite involving real and non-metaphorical tools, allocated not nearly enough time to become proficient with them.

This is why I would characterize the last months as an introduction to a lot of new skills, technologies and paradigms in a horizontal fashion, without giving meaningful time and space to explore them further vertically. Comparable with a painter showing you the color palette, but not allowing you to paint, or hungrily browsing a buffet of comically small appetizers, this one-year master program shifts the professional heavy lifting onto the students *after* they finish. Only after

the graduation there is time for a further pursuit of these inspirations and a deeper investigation of the technologies shown. Despite clearly understanding why the curriculum has been structured this way, I think this is problematic in twofold ways.

First off, it leaves students with the newly learned skills and worldviews in a fragile state, when they, without having had the chance to solidify new mental and professional routines, enter the market and they encounter the full might of the capitalist system and the incredible conformist forces it exercises. We are expected to face this fight woefully underprepared. I refuse to believe that one is be able to defend more than a fraction, if any, of the ideals learned in the academic shelter of MDEF out there on the market, where professional and personal financial pressure mounts high.

The second problematic aspect is characterized by the fact that if alumni succeed in defying the current market to continue in the spirit of MDEF, this critical professional maturing process happens outside of IAAC, outside of the Fab Lab Barcelona and outside ELISAVA. This is suboptimal for a host of obvious reasons, the principal being that potential synergies with these ecosystems are much weaker than if these students were still embedded in a research position, just to name one example. Further, a more gradual transition would help ease what I can only imagine – and anticipate – being a paralyzing shock when confronted with the free market realities.

Mastering these two very challenges will be my primary objectives for the coming year. I plan to keep close to the Fab Lab/IAAC and ELISAVA ecosystem (as I did with my former university in Berlin) in order to ease the transition from the unique world of academics to the market. This, together with my existing freelance business, will hopefully allow me to purposefully and with time craft my professional identity, test it, implement it, exercise it and scale it. Additionally, I plan to continue to teach in Berlin (as I did before the master) and possibly in Barcelona, too – so it only makes sense to stay close to the people that helped me to profoundly evolve personally and professionally these last nine months. In that sense, MDEF felt less like a journey and more akin to being catapulted into a new professional dimension. I can't wait to find out where I'll land.