Lighting Design for Lumus Instruments in Gallery/Interior Scale

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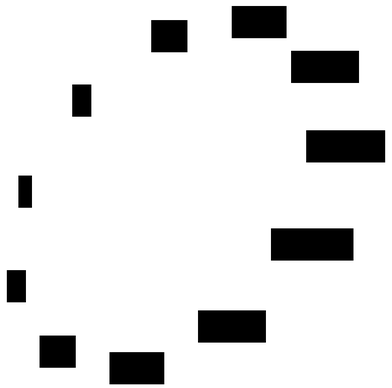


CONTINUUM

GRADUATION PROJECT

LUMUS INSTRUMENTS

Abstract

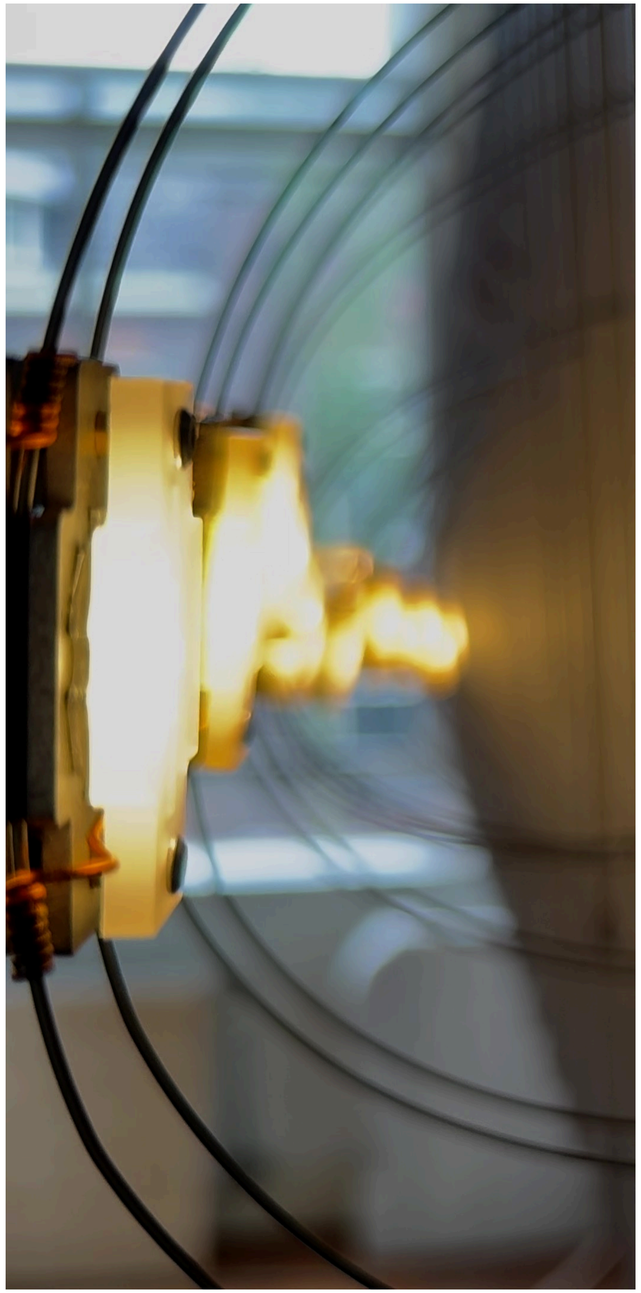
This graduation project presents the design and realisation of a kinetic light installation developed in collaboration with Lumus Instruments. The objective was to explore the experiential qualities of the studio's large-scale work and to gain a deeper understanding of its artistic language. By combining these insights with my own interests, inspirations, and design identity, the project aimed to develop a new direction for a kinetic light installation, one that relates to the work of Lumus Instruments while expressing a distinct personal perspective and creative approach.

This project presents a unique design challenge at the intersection of art and design. There is a clear context for the assignment following from the studio Lumus Instruments and the gallery setting, however the project did not have a predefined conceptual framework or guiding narrative. The direction of the installation remained intentionally open, following a practice-based design process. Guided by the principles of creative experimentation and knowing through making, the installation gradually developed through iterative cycles of sketching, prototyping, technical development, and reflection. Physical experimentation played a central role in shaping both the conceptual narrative and the final design. This approach is positioned in relation to reflective practice, practice-based design research, and STEAM-oriented thinking.

The resulting prototype is a kinetic light installation consisting of twenty repeating elements suspended from the ceiling. Each element contains two stepper motors, a custom-designed PCB, an Arduino Nano, and a double-sided LED module supported by super-elastic wires that allow the light source to move within a two-dimensional plane. A dark diffuse panel positioned behind the array creates two complementary readings of the installation: a front view in which individual light sources form slowly evolving wave-like patterns, and a rear projection surface that visualises their movement through light and shadow. The behaviour of the installation is controlled through custom-developed software that simulates the collective behaviour of the entire array and generates the control code for the physical prototype.

Conceptually, the installation draws inspiration from the fields of architecture, mathematics, music composition, and is based on elemental repetition, where complexity emerges from the interaction of many simple and constrained motions. The design is informed by Stephen Wolfram's theory of emergence through simple rules, the repetitive and continuously evolving structure of Simeon ten Holt's Canto Ostinato, and Buckminster Fuller's principles of structural logic. The final installation is further interpreted through Gestalt principles and aesthetic theory to explain how its visual organisation and experiential qualities are perceived.

The intended outcome is a hypnotic, autonomous object that evolves continuously. Validation focuses on whether these intended experiential qualities are perceived by viewers, comparing the design intention with perceived effect.



Acknowledgements & Declarations

Acknowledgements

This graduation project marks the completion of my Master's programme in Integrated Product Design at Delft University of Technology. It has been an amazing project that truly challenged me as a designer, expanding the limits of a design project and redefining my vision on and understanding of design.

First, I would like to thank Lumus Instruments for providing me with the opportunity to develop this project in collaboration with their studio. In particular, I would like to thank Timo Lejeune and Julius Oosting for sharing their knowledge, offering valuable discussions, and giving me the freedom to explore my own design direction throughout the project.

I would also like to express my sincere gratitude to my graduation supervisors at Delft University of Technology, Prof. dr. ir. Sylvia Pont and ir. Wim Schermer, for their guidance, constructive feedback, and continuous conversations and discussions about interesting inspirations and associations with artistic projects and design theory throughout the graduation process.

Finally, I would like to thank my family, friends, and everyone who supported me during the development of this project. Their encouragement, interest, and practical assistance made it possible to realise a technically demanding light installation with far too many intricate parts and to successfully complete this graduation project.

Declaration

This report presents original work carried out by the author as part of the Master Graduation Project in Integrated Product Design at Delft University of Technology. Unless stated otherwise, all design work, prototypes, drawings, photographs, and written content are the author's own. External sources, images, and references have been acknowledged where appropriate in accordance with academic standards.

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1. Introduction

This report documents the graduation project developed in collaboration with Lumus Instruments. The project explores the translation of kinetic light installations from a large-scale festival context to a gallery and interior scale. It investigates how principles such as motion, repetition, modularity, and scenographic composition can be reinterpreted within a different spatial and experiential setting.

The project is situated at the intersection of industrial design, lighting design, and installation art. It combines conceptual exploration with technical development in mechanics, electronics, and optical systems. Central to the work is the relationship between light, movement, and perception, and how these elements can be organised into a system that creates a hypnotic and timeless spatial experience.

Rather than starting from a fixed problem definition or set of requirements, the project developed through an iterative, practice-based approach. Physical experimentation and prototyping played a central role in shaping both the direction and outcomes of the design process. Ideas were continuously tested, adjusted, and redefined through making, allowing the work to evolve in close relation to material behaviour and observed effects.

The report begins with explaining the project assignment, which leads into the gallery context and its requirements, followed by the personal ambitions that shaped the project. The methodology chapter then explains the two design methods developed during the project — knowing through making and the creative experiment — and relates them to existing theory.

Next, the final design is presented and explained, detailing the components alongside technical CAD drawings, followed by the conceptual narrative and a series of images of the final prototype. This section also describes the software simulation developed to control the array and the design of a custom PCB.

The third section sets out the theoretical framework. It opens with a deep dive into Lumus Instruments, their methodology and identity as a studio, and analyses two of their most inspiring artworks, while also relating these to the installation. The framework then turns to the most influential thinkers who shaped the project: Simeon ten Holt, with Canto Ostinato, the minimal music piece built on continuously evolving repetition, and its relevance to design; Buckminster Fuller, whose thinking shaped how design decisions were made; and Stephen Wolfram, whose work on simple rules generating complexity directly inspired the project.

The fourth section concerns validation. A programme of requirements and wishes is established and used as the basis for a validation study, consisting of interviews with laypeople, followed by the results and conclusions. A reflection then draws out the personal lessons and what I take forward from the project. The report closes with the references and appendices.



1.1 Project Description

Assignment description

My graduation project was conducted in collaboration with Lumus Instruments, a multidisciplinary studio working with light, sound, and structure in the context of installation art and scenography. The studio is mostly known for its large-scale kinetic light installations at festivals, where custom-built modular systems create immersive spatial experiences. The assignment description at the beginning of the project was: “Design and realise a kinetic light installation (or working physical prototype) that translates the aesthetic and technical principles of Lumus Instruments’ large-scale works in a gallery/interior scale context.”

While large-scale light installations create immersive festival experiences, gallery and interior contexts require a fundamentally different approach. The problem lies in how to retain qualities such as repetition, modularity, motion, and spatial composition, while adapting them to a reduced scale with different technical, experiential, and practical constraints. The domain of this project lies at the intersection of industrial design, lighting design, and kinetic art, focusing on the design of physical systems that combine mechanical motion, electronic control, and perceptual qualities of light.

For Lumus Instruments, this project creates added value by expanding their portfolio towards a new audience and application domain, designing a light installation suitable for art galleries and interior environments, while remaining aligned with their existing identity and expertise.

Gallery Context

The gallery context introduces a specific set of requirements that differ significantly from the festival environments in which many works of Lumus Instruments normally operate. Unlike dark or outdoor festival settings, galleries are generally well-lit environments in which the complete structure of the installation remains visible at all times. This means that not only the lighting effect itself, but also the physical construction, material choices, mounting methods, and detailing of the installation become part of the visual experience and therefore require careful consideration.

Another important aspect of the gallery context is that the installation exists in direct relation to other artworks within the same space. The work should therefore function as a self-contained and autonomous piece, without requiring a fully isolated room or heavily controlled environmental conditions such as complete darkness or a specific acoustic environment. The installation should contribute to the atmosphere of the space without becoming disruptive or dominant towards its surroundings.

Additionally, the installation should operate quietly and avoid producing intrusive mechanical or electrical noise. Since the work is intended to create a subtle and hypnotic atmosphere (explained later on), excessive sound or aggressive motion would conflict with its intended experiential qualities. This also becomes increasingly important within a gallery setting, where the possibility arises of the installation existing as a collectible or purchasable artwork. This introduces additional requirements regarding robustness, trustworthiness, and long-term usability. The installation should therefore be designed as a stable and autonomous system that can operate continuously without demanding constant supervision or maintenance.



Personal Ambitions and Motivations

I initiated my own graduation in collaboration with an external partner with one goal in mind, I wanted to combine two of my main interests: hands-on prototyping and the combination of art and technology. Throughout my studies, I have particularly enjoyed exploring physical interactions, material expression, and the perceptual qualities of light, and this project allows me to extend that work to a professional and real-world context. Previously, I have created (DIY) small-scale light installations, but this project provides the opportunity to work on a gallery-scale prototype with professional standards. Collaborating with Lumus Instruments offers insight into the professional field of kinetic light art and audio-visual systems, including workflows, technical challenges, and the translation of artistic vision into functional installations. A key learning goal is to develop and refine my hands-on prototyping skills, exploring mechanical systems, electronics, and light behaviour in an iterative design process.

I also aim to expand my understanding of artistic narratives, aesthetic language, and spatial experience in light-based works. This project challenged me to not only work on the challenge of designing a light installation, it also challenged me to critically think about my personal approach to a creative design project with an artistic element.

1.2 Methodology

The Design Approach

This graduation project approaches design in a way that both aligns with and deviates from conventional industrial design practice. It aligns with conventional design practice because there is an assignment description, a target audience (the audience of Lumus Instruments), and the gallery context introduces a set of practical requirements. However, the project is distinguished by its artistic nature, and open attitude.

Unlike classical industrial design projects, where constraints and target groups are typically fixed, this project prioritises the development of the installation itself as the main focus. New insights or directions can therefore redefine what was previously considered a requirement. While this flexibility can also exist in conventional design processes, it is more pronounced in this project due to the artistic dimension of the work, where intuition and experiential judgment play a central role in distinguishing between constraints and opportunities. In this sense, the project operates with relatively few fixed requirements and more open-ended intentions (wishes).

At the same time, the project retains strong industrial design characteristics. It is positioned within the field of installation art and design with light, where experiential qualities, atmosphere, and aesthetic language are central. Despite its somewhat unconventional framework, it remains grounded in design practice by exploring how light, motion, structure, materials, and how this can be combined to create specific perceptual experiences. In addition to this, a significant engineering component is present in continuous iteration and refinement of electronic, mechanical, and material systems.

The methodology that guided this project can be described through two closely related principles: the creative experiment and knowing through making. These terms are used as personal descriptions of the design approach. Although they originate from reflection on the project's development rather than from a specific design methodology, they closely relate to established concepts within design research. This includes for example: reflective practice, practice-based research, and STEAM-oriented approaches to learning and innovation. The following sections explain the two core design methods and positions them in relation to relevant literature.

The Creative Experiment

The creative experiment is an open and intuitive way of working. Within this approach, ideas emerge through intuition, discussion, sketching, and iterative prototyping, and through repeated cycles of experimentation and reflection, those that 'feel right' gradually evolve into more explicit design principles and directions. Early explorations were informed by themes derived from the analysis of Lumus Instruments and the thinkers that influenced the studio. Concepts such as repetition, a system of simple behaviour rules towards complexity, and translation between media served as starting points for ideation. Translating physical movement into a lighting effect became a recurring theme throughout the project. This way of working aligns with the reflective practice framework described in engineering and design education research, where reflection is understood as an active and ongoing process embedded within design activity rather than a separate evaluative stage. As highlighted in the study on reflective practice in innovative design education, meaningful learning in design contexts arises through repeated cycles of action, observation, and reflection, enabling designers to operate effectively in open-ended and uncertain problem spaces (Currano et al., 2012).

As Boris Müller (2020) argues, intuition is a fundamental aspect of design practice that cannot be fully formalised into methodology. Rather than functioning as irrational decision-making, it enables designers to recognise relationships, qualities, and potentials before they can be explicitly articulated.

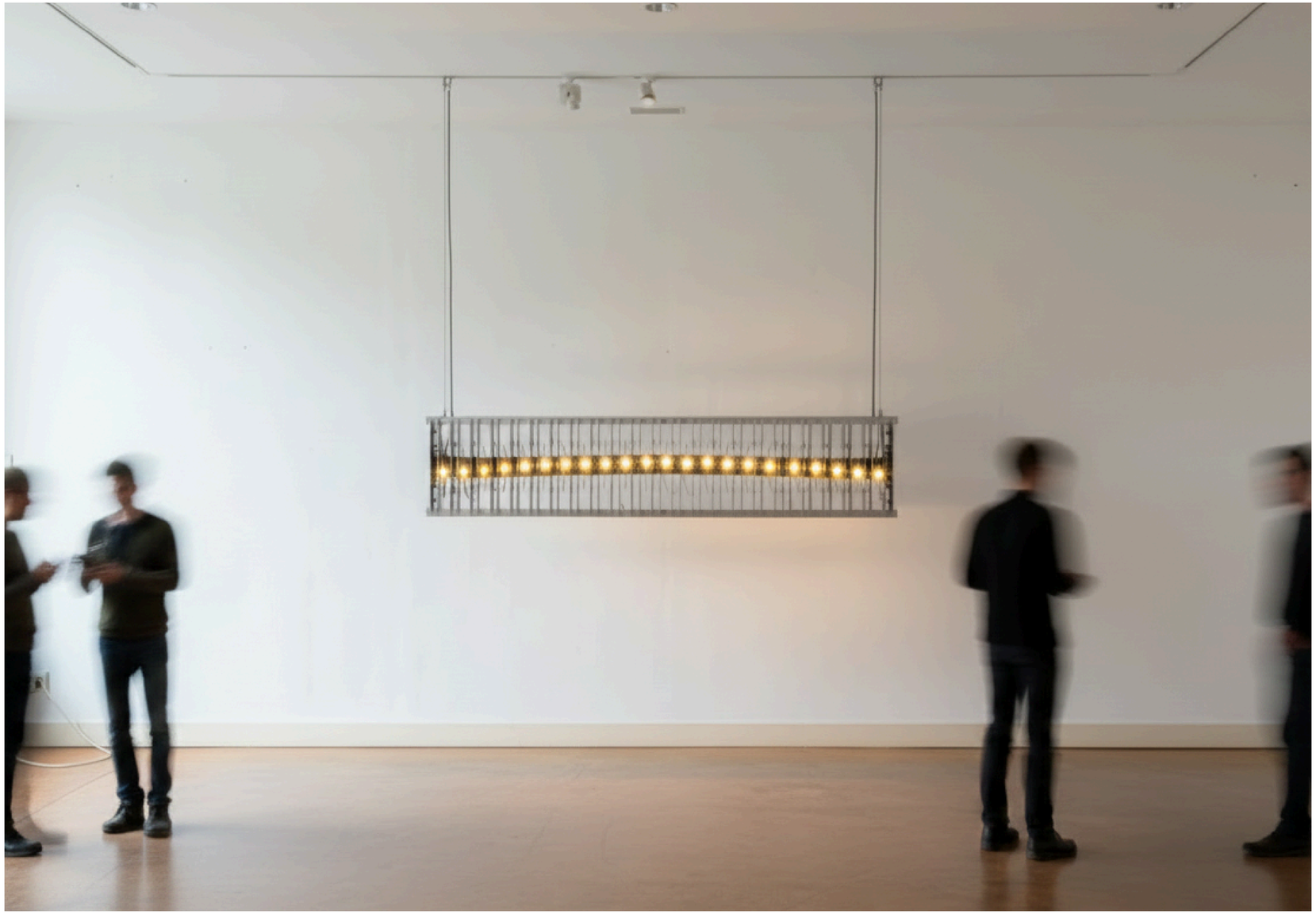
Because such an open process can quickly lead to an overwhelming number of possible directions, a concrete starting point was introduced early in the project: a flying fader, an electromechanical slider capable of moving a pin across a distance of 100 mm. This component functioned as a physical entry point for exploration. The original slider demonstrated strong capability for fast movements between positions, but was less suited for achieving smooth and continuous motion. Following from the analysis of Lumus Instruments' work, where installations often balance moments of abrupt, energetic behaviour with slow, controlled transitions, this limitation became significant. As a result, the system was reconsidered and replaced with a stepper motor-based solution, which allowed for finer control over speed, acceleration, and smoothness of movement, better aligning the mechanical behaviour with the intended experiential qualities of the installation, which will be explained in more detail later on.

Knowing Through Making

A second principle underlying the methodology is that understanding was developed through direct engagement with materials, technologies, and prototypes. Rather than treating making as a final stage in which predefined ideas are realised, the design process relied on physical experimentation as a means of exploration. Sketches, mock-ups, and working prototypes were used to investigate behaviour, movement, light, and material interactions, allowing questions to be explored through action rather than solely through analysis.

This approach was particularly relevant within a project concerned with perception, atmosphere, and experiential qualities. Many of the characteristics that ultimately shaped the design, such as the behaviour of light, the subtlety of motion, or the interaction between materials, could only be evaluated through physical testing. As a result, design decisions emerged through an iterative process of making, observing, reflecting, and refining. The methodology aligns with principles found within STEAM (Science, Technology, Engineering, Arts, and Mathematics) approaches and practice-based design research, where creative inquiry and technical investigation are closely intertwined (Bedewy & Lavicza, 2023). Artistic exploration, engineering, electronics, mechanics, and material experimentation were not treated as separate activities, but as interconnected parts of a single process. Through this continuous exchange between reflection and realisation, the project gradually evolved from open-ended exploration towards a more defined design direction.

2. Final design



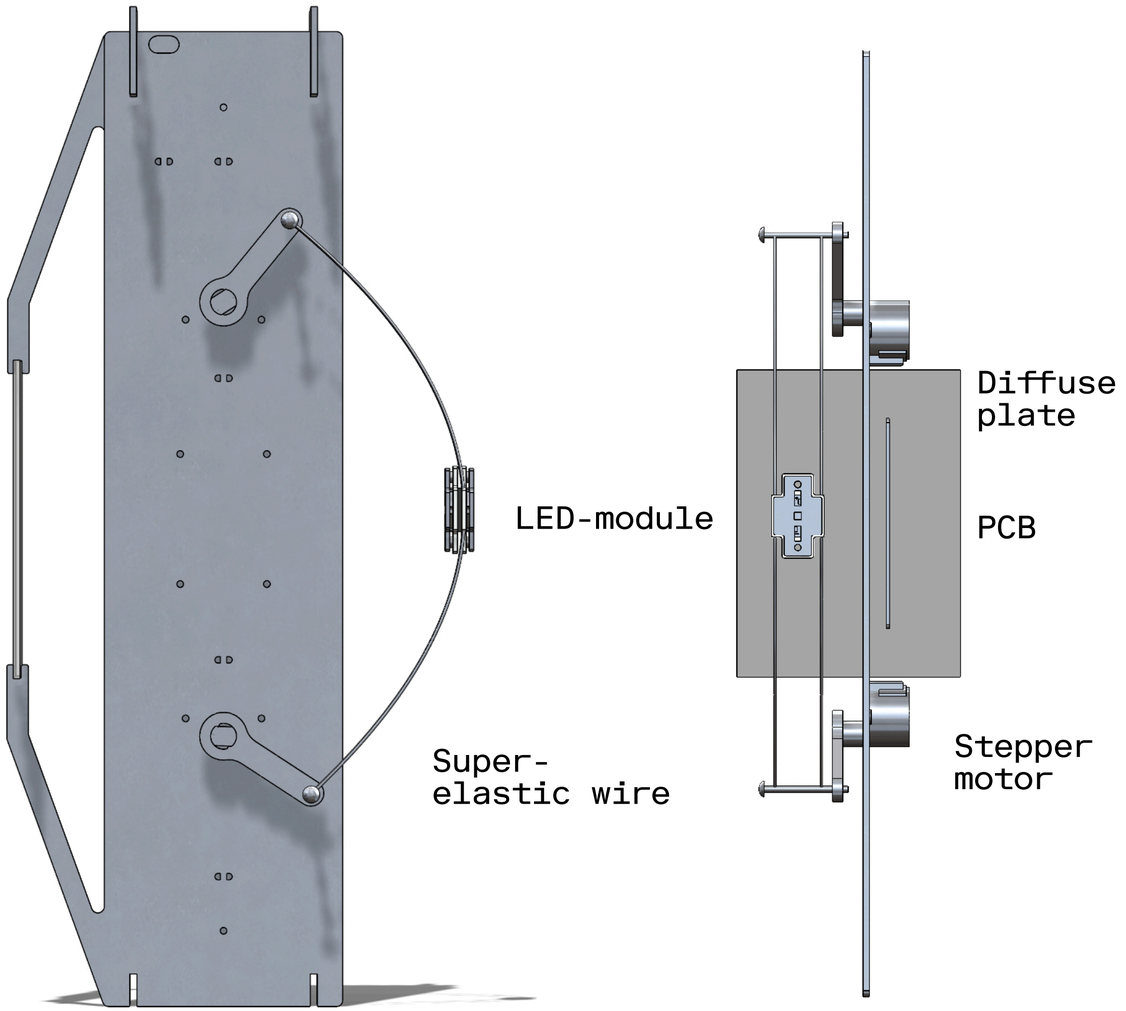
2.1 Materialisation

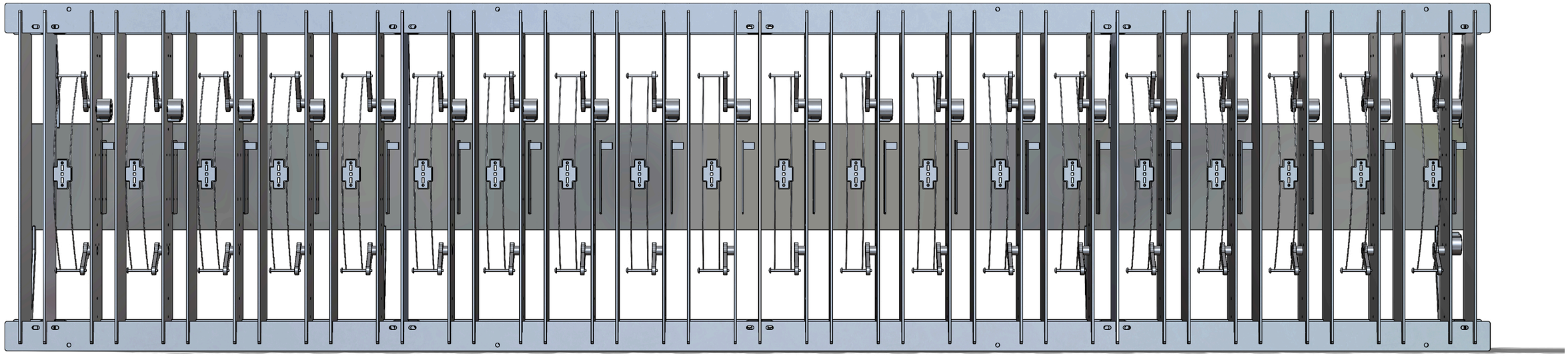
The final prototype is a kinetic light installation consisting of 20 repeating elements suspended from the ceiling using four steel cables. Each repeating element contains two stepper motors, a custom-designed PCB, an Arduino Nano, and a double-sided LED module.

The stepper motors are each connected to two super-elastic wires that support the LED. By rotating the motors, the tension and position of the wires change, allowing the LED to move within a two-dimensional plane. Because the two motors can change their speeds relative to one another, the position and orientation of the light module is constantly changing.

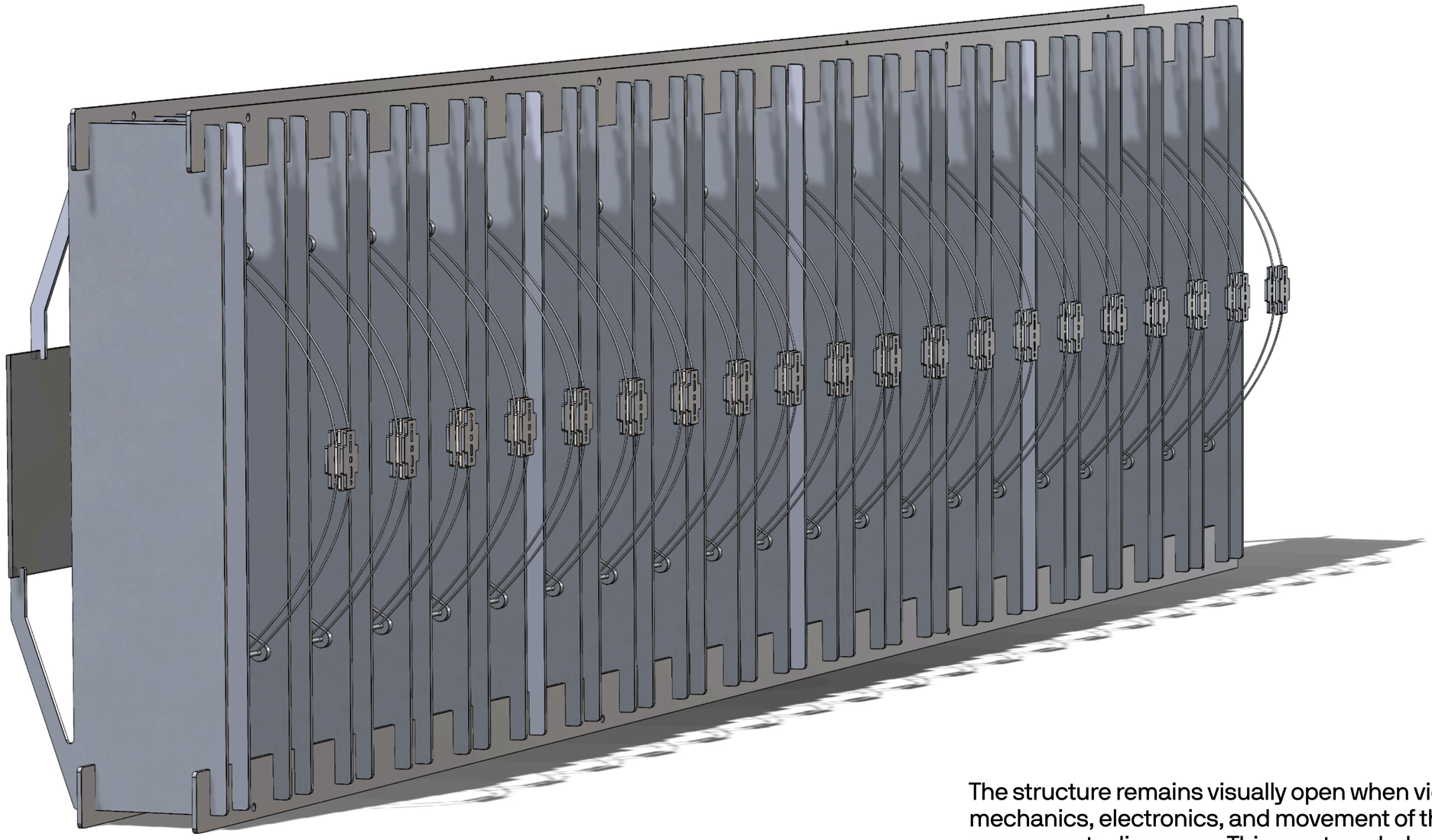
A dark diffuse panel is mounted behind the moving light elements. This creates two complementary visual experiences. On the front side, the light modules remain visible as individual moving points of light that collectively generate slowly evolving patterns and wave-like motions across the array. The front side also displays the reflective side of the diffuse plate, adding a layer of complexity in the visual effect. Through the repetition of identical elements, the movement of individual LEDs combines into larger dynamic compositions that continuously shift over time.

On the back side, the diffuse panel functions as a projection surface. This visualises the position and orientation of the LEDs. As the light sources move, they illuminate the surface, creating complex shadow projections on the wall behind the installation. Because the LED emits light in both directions, the front and back remain visually connected and form a single coherent system.





The installation revolves around elemental repetition, where each element performs a single constrained motion, and complexity emerges through the repeated interaction of structure and light.



The structure remains visually open when viewed from the front, exposing the mechanics, electronics, and movement of the installation. From an angle all components disappear. This creates a balance between structural transparency and a clean, minimal aesthetic.

2.2 Conceptual narrative

A central design challenge within this project concerns the experiential and scenographic qualities of the installation. What kind of feeling should the installation evoke? What atmosphere should it communicate, and what should be the character of the installation itself? The answers to these questions emerge from three interconnected contexts.

The first one is the gallery environment, which introduces specific spatial and perceptual conditions, like low noise and a well-lit environment.

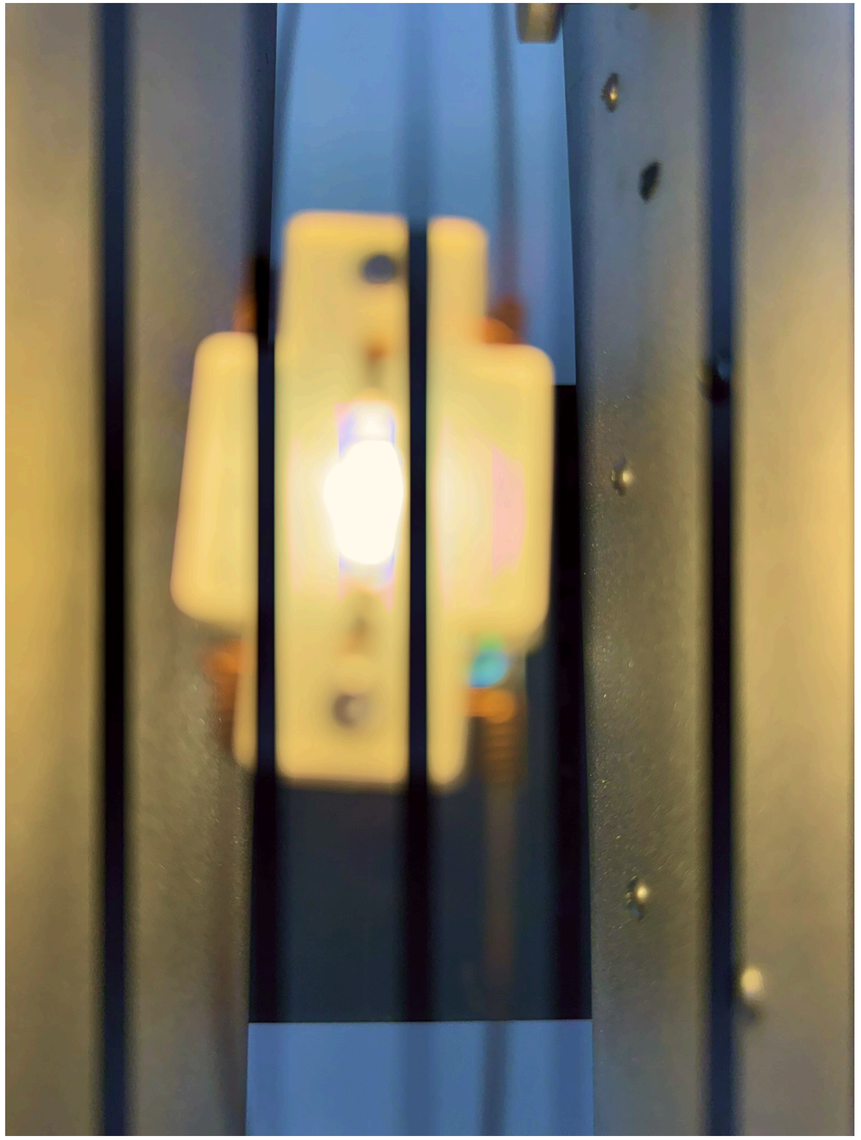
The second context is formed by the artistic language and methodology of Lumus Instruments, introducing core themes such as repetition and functional structural organisation.

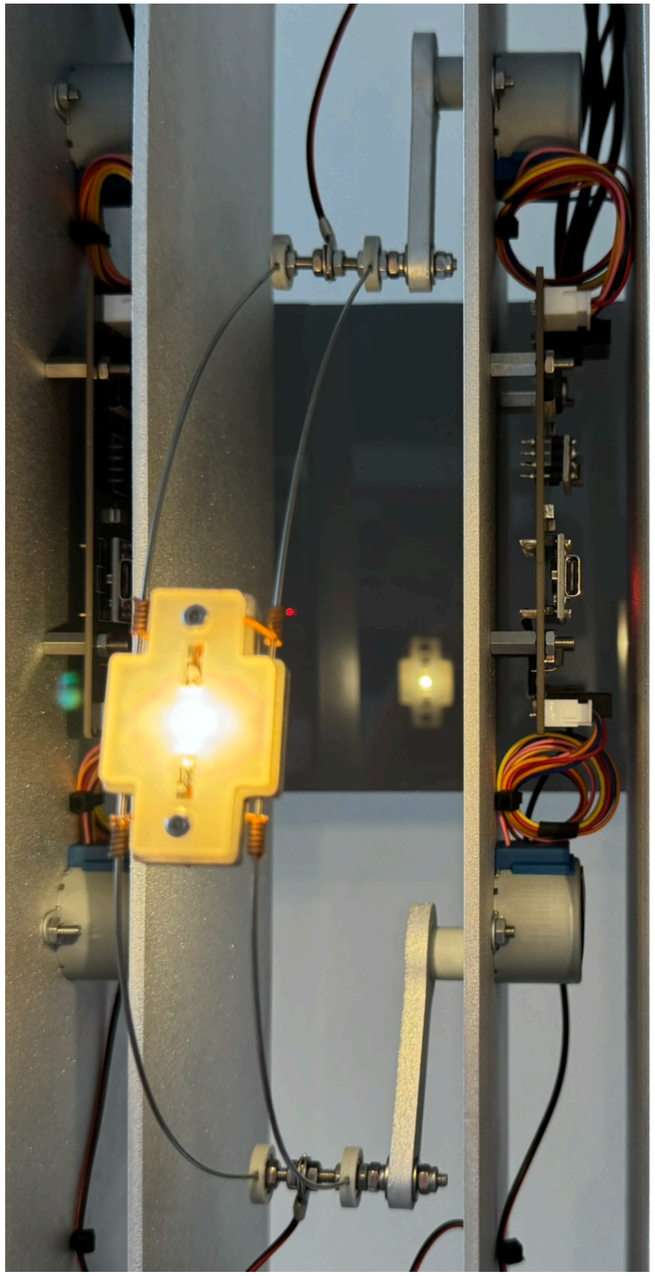
The third context emerges from the design process itself. Through experimentation, prototyping, and reflection, the project gradually revealed its own internal logic and direction.

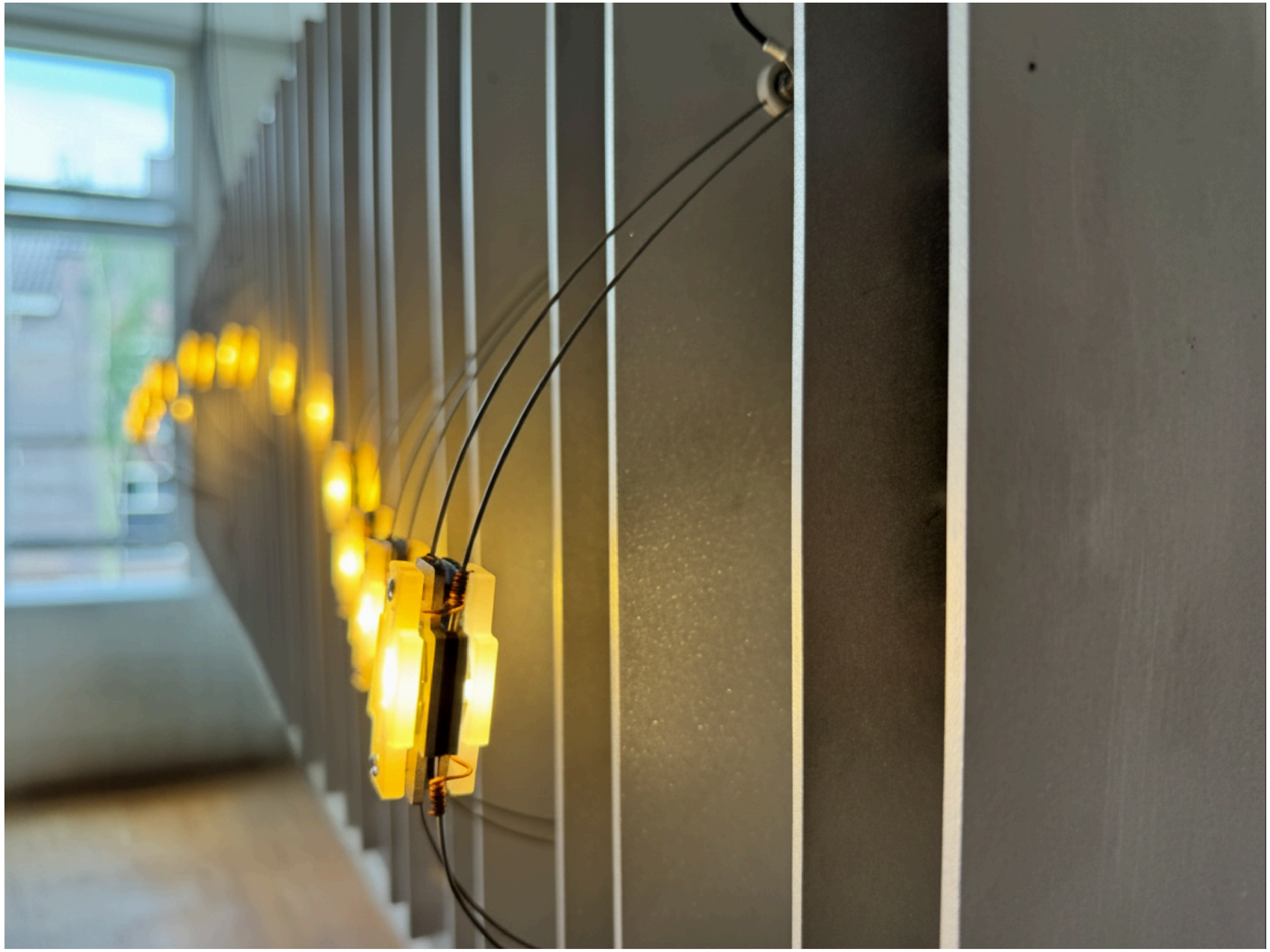
Repetition, Behaviour, and Emergence

Conceptually, the installation builds on principles of repetition and simple behavioural rules reduced to their essence. The aim is not to create a dramatic or narrative-driven spectacle, but rather a hypnotic and autonomous object that slowly evolves over time. The installation should remain visually engaging without demanding constant attention; subtle enough to exist calmly within a space, yet intriguing enough to sustain long-term observation. Rather than relying on complex choreography or expressive gestures, the focus lies on slow and continuous wave-like transformations that move in and out of moments of harmony. Small variations, noise, and imperfections within the system become contributing compositional elements, introducing slight deviations and subtle unpredictable behaviour within an otherwise controlled structure.
Through repetition, even a single subtle motion can generate complex visual behaviour across the installation as a whole. Structured and controlled movement allows patterns to emerge, dissolve, and reorganise over time, creating a spatial composition that continuously transforms while remaining restrained and minimal in its individual actions







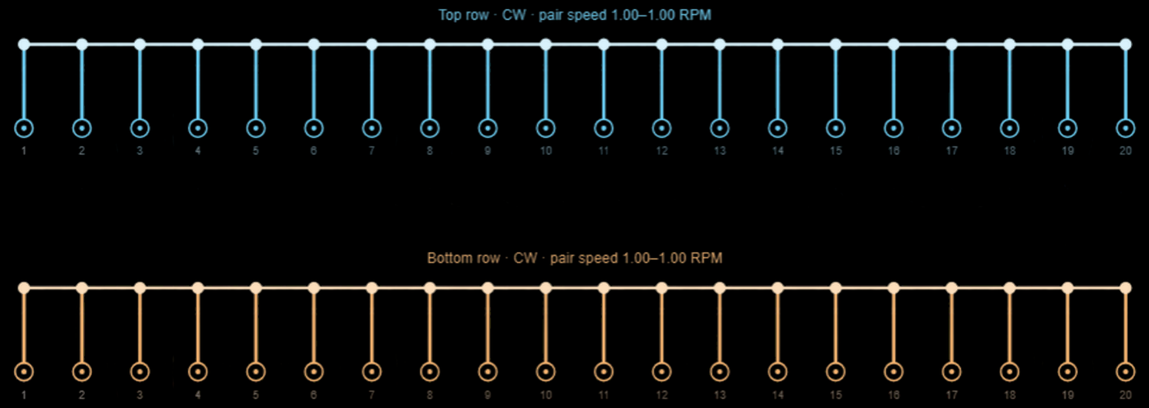


2.3 Software Simulation

To generate the control code for the stepper motor array, a browser-based simulation was developed to model the collective behaviour of the motors before implementing it physically. The simulation represents twenty repeated elements, each consisting of a top and bottom stepper motor. Rather than programming each motor as an isolated movement, the array is controlled through one shared behavioural logic distributed across all elements. This made it possible to adjust key parameters, including rotational speed, wave strength (the steepness of the wave), wavelength, timing, and the phase relationship between the two rows, in order to refine the movement towards the intended visual effect.

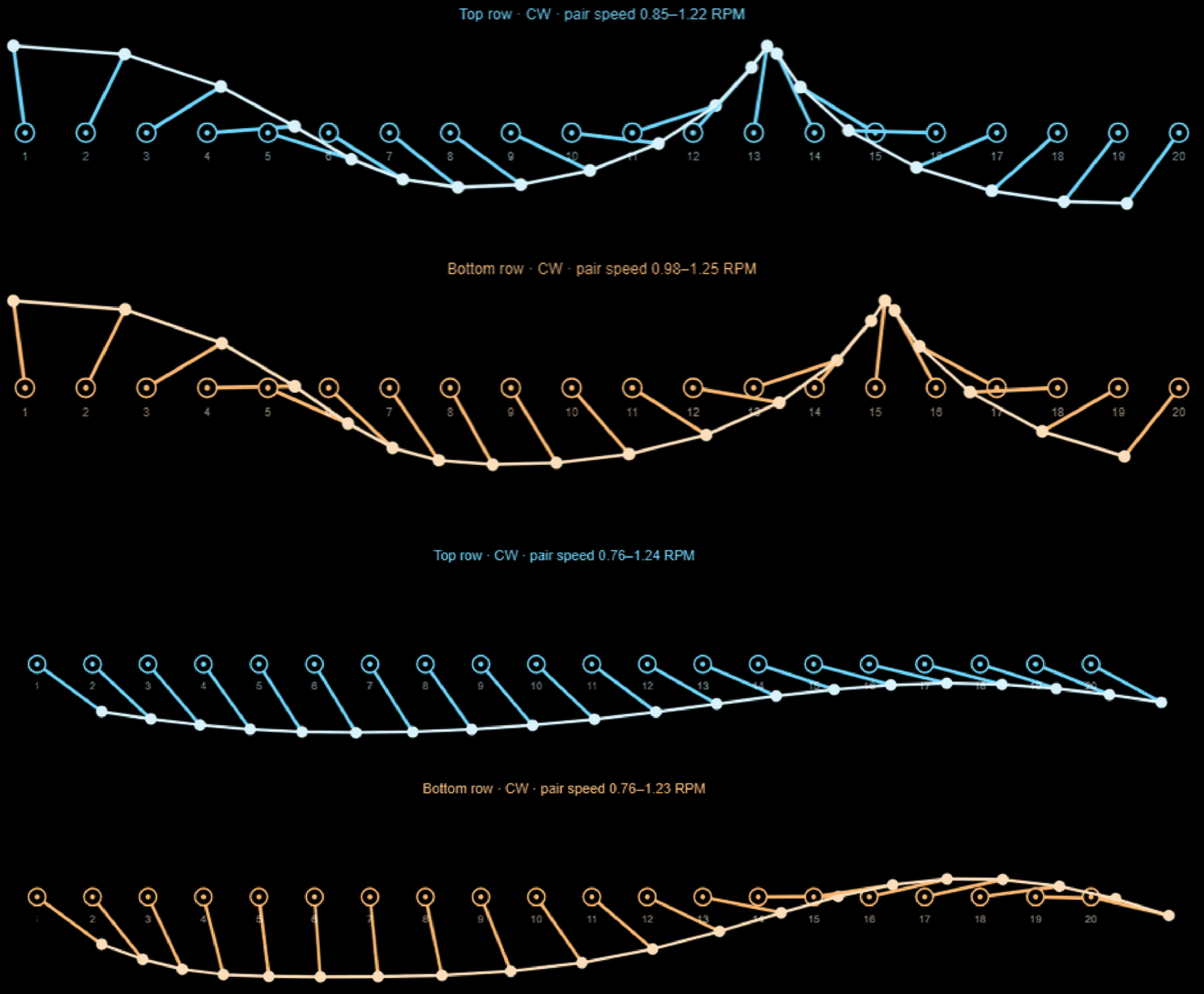
At the start of each cycle, all motor arms are manually aligned to the same forward-facing starting angle. This manual alignment is necessary because the stepper motors do not contain a position sensor. Once powered, all motors rotate at the same base speed. The endpoints of the rotating arms are visually connected so as to form a line. The actual motion of the array of LEDs would be a line extrapolated between the two horizontal lines, referring to the Gestalt principle of continuation: similar separated elements are perceived as part of one coherent form (Aesthetics Theory section 3.3).



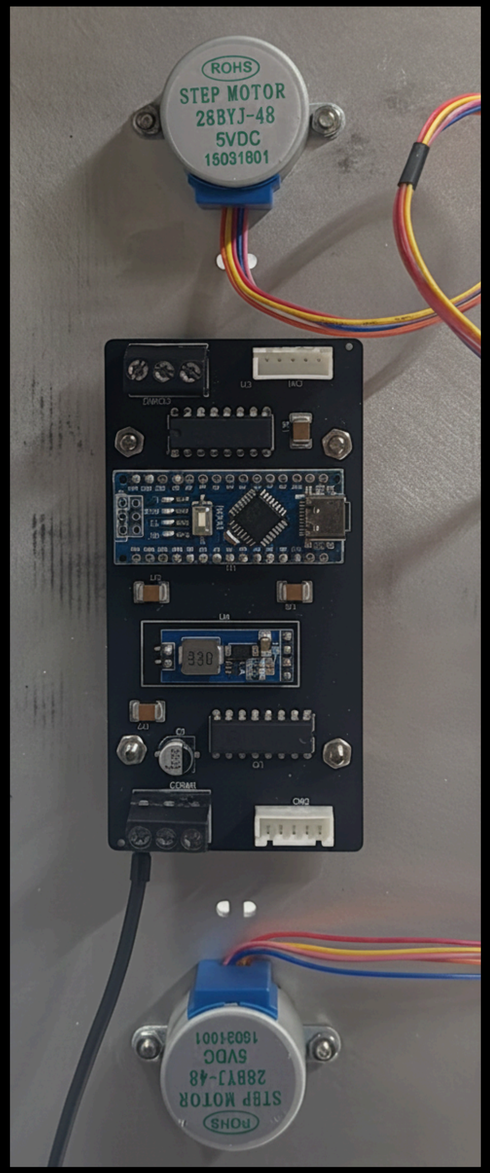


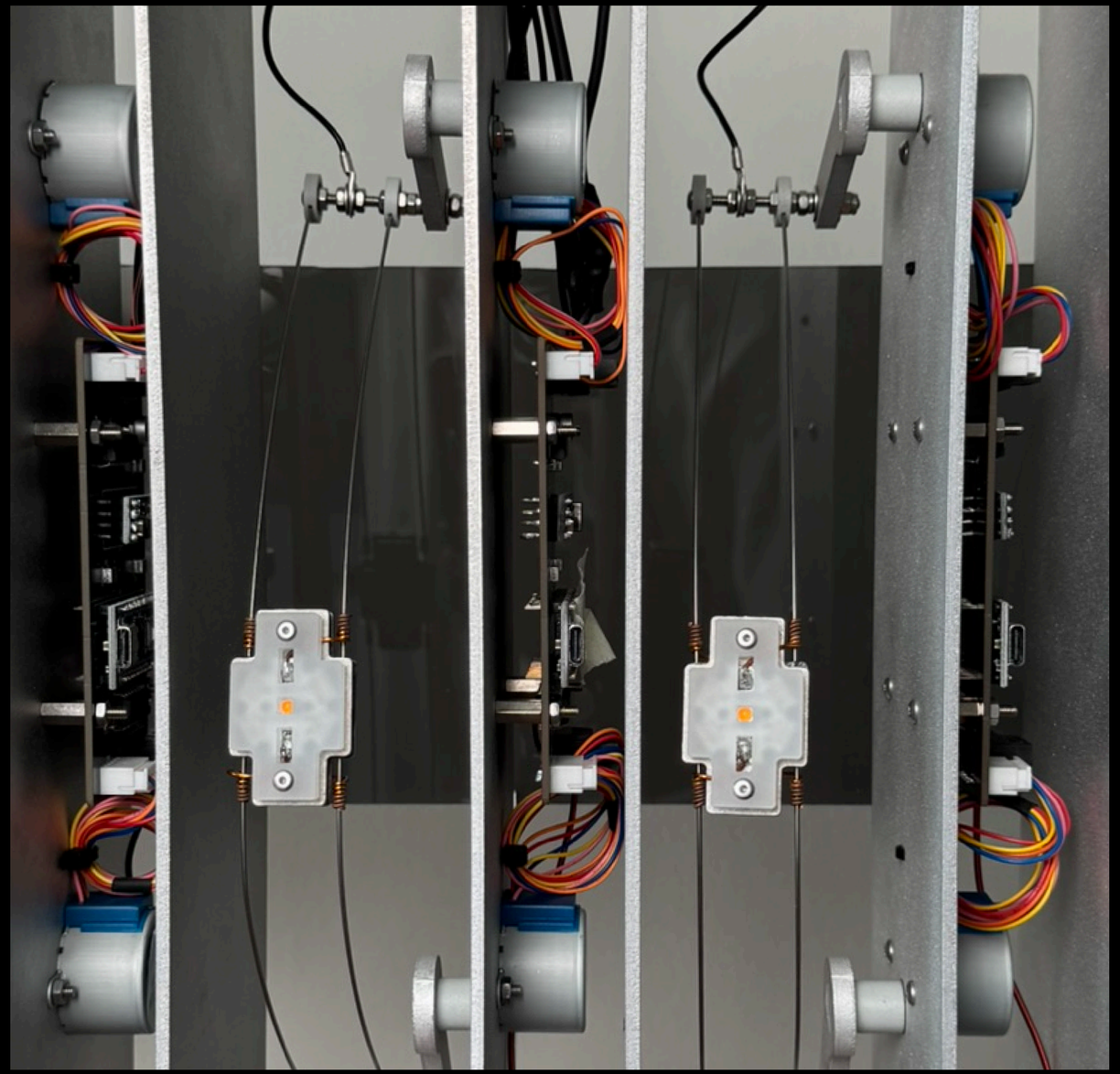
Within each element, the top and bottom motors initially rotate at the same speed, changing the position of the LED, while maintaining a consistent angle between the two rotating arms. A controlled time offset is then introduced between the top and bottom rows. This offset gradually shifts in one direction to a maximum value, returns to synchronisation, and subsequently shifts to the same maximum in the opposite direction. The top image illustrates this phase shift through the changing distance between the peaks of the two wave patterns. As the relative phase between the top and bottom motors changes, the angle of the LED slowly rotates in both directions while the overall wave behaviour remains coherent. The change in angle results in shining light more towards the ceiling or the other way around, towards the floor. Because the offset repeatedly returns to synchronisation, it introduces variation without allowing the two rows to become entirely independent or chaotic.

The simulation functions as both a preview and a translation tool for the physical system. Once a movement behaviour has been evaluated visually, its parameters can be converted into Arduino code for each motor pair. Every Arduino Nano runs the same shared logic, but receives an index corresponding to its physical position in the array. This index determines the role of that motor pair within the larger wave function. The visual pattern emerges through controlled variations in rotational speed, allowing the full array to behave as one collective system.



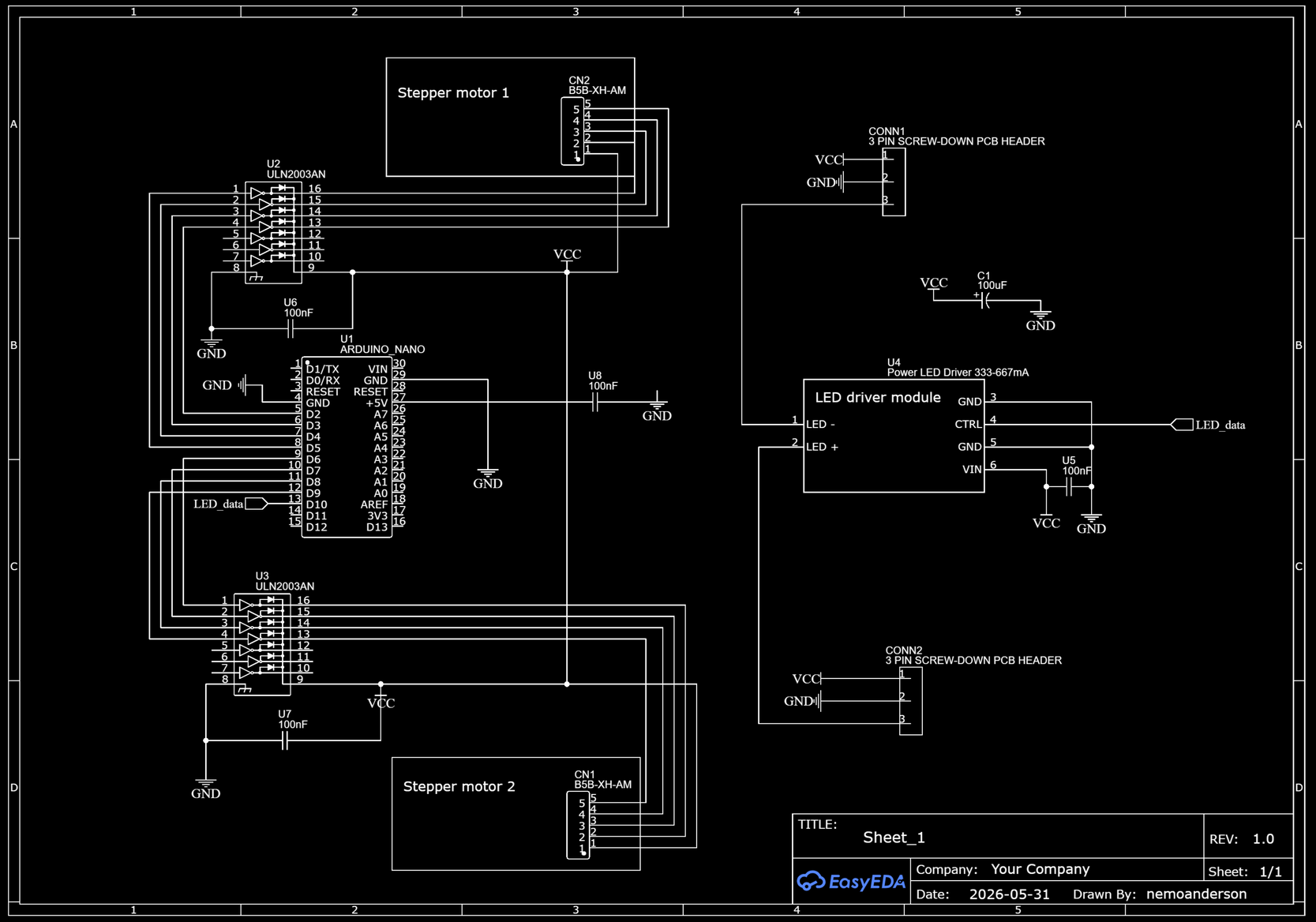
2.4 Custom PCB Design



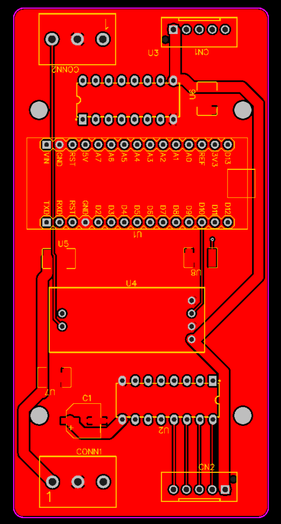


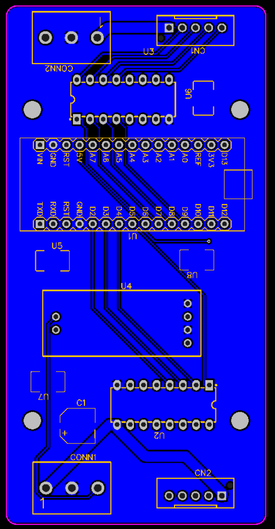
To take the realisation of the installation to the next level, a custom printed circuit board (PCB) was designed and manufactured. Until this stage, the electronics were assembled using separate Arduino boards, driver modules, loose wiring, and temporary connections (see Appendix A). Although this was suitable for testing individual functions, it became increasingly difficult to manage when the system expanded to multiple repeated elements.

Designing the custom PCB marked an important milestone within the project, as it transformed the installation from an experimental prototype into a more integrated and professional system. Although the circuit itself is relatively straightforward, designing a PCB for the first time required careful consideration to ensure that the board would function correctly after manufacturing, as design errors cannot easily be corrected once fabricated.



The custom PCB includes the main electronic components required for one element into a single compact board. It includes connectors for the two stepper motors, two ULN2003 stepper motor drivers, a seat for the Arduino Nano, and a mounting position for the LED driver. Screw terminals were included for power distribution and daisy-chaining the elements. Capacitors were added to stabilise the power supply and reduce disturbances caused by the motors switching on and off. The PCB design translated the temporary breadboard wiring into a compact, repeatable, and robust electronic module. This required decisions regarding component placement, connector orientation, power distribution, copper trace widths, and the practical assembly of the board within each repeating element.





3. Theoretical / Conceptual Framework

Existing artworks by Lumus Instruments were analysed in order to identify and articulate a set of aesthetic design principles. These principles function as a reference framework for understanding the studio's identity and artistic narrative. The two most significant artworks are discussed in this section, while also highlighting their relevance to the project; additional works can be found in Appendix B.

To further understand the studio's design thinking, the analysis is extended beyond the artworks themselves by exploring key thinkers who have influenced their approach. These include Stephen Wolfram and Buckminster Fuller. Together, their work provides insight into the conceptual and methodological foundations that shape how Lumus Instruments develops its installations.



3.1 About Lumus instruments

Lumus Instruments is a multidisciplinary studio that works with light, sound and structure in various forms of installation art and scenography. The studio is directed by Timo Lejeune and Julius Oosting, who find their roots in design, architecture and engineering.

Lumus stems from the Latin words “Lumen” (Light) and “Ludus” (Play). The word “Instruments” points to their identity as makers of instruments, precision tools for playing.

The search for embodiment of computational technology defines one of the principal characteristics of their work. They continually iterate through a variety of technological installations, allowing them to explore synergetic design principles within their artistic landscape. It shapes the physicality of refined digital systems, and investigates how these mostly invisible systems affect our state of being.

Using the notion of ‘experience as the ultimate reality’, Lumus artificially crafts experiences that give rise to a quality of timelessness and radical realism. It creates a sense of future through the experience of now.

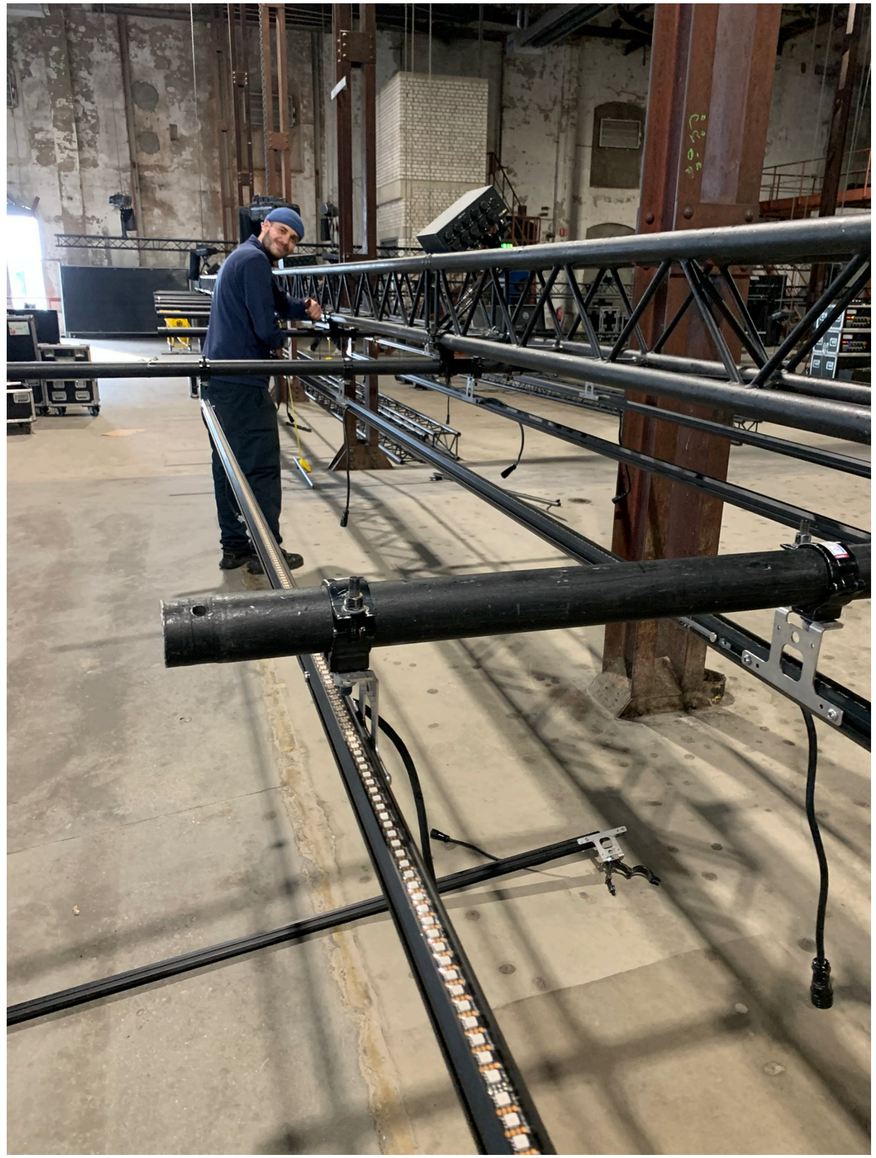


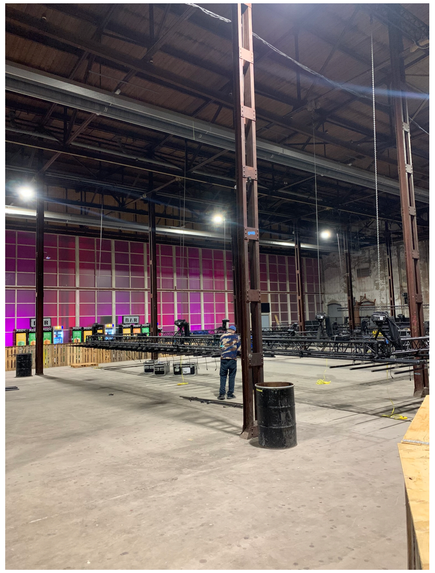
Observations from Practice

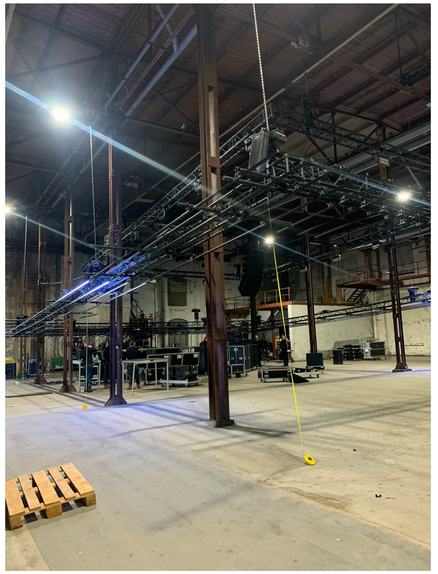
To get a better understanding of the works of Lumus Instruments, I assisted with the build up and build down of a lighting setup for the Zeezout x Paradigm festival in Groningen. It was a really fun experience and I learned a lot about their modular LED system.

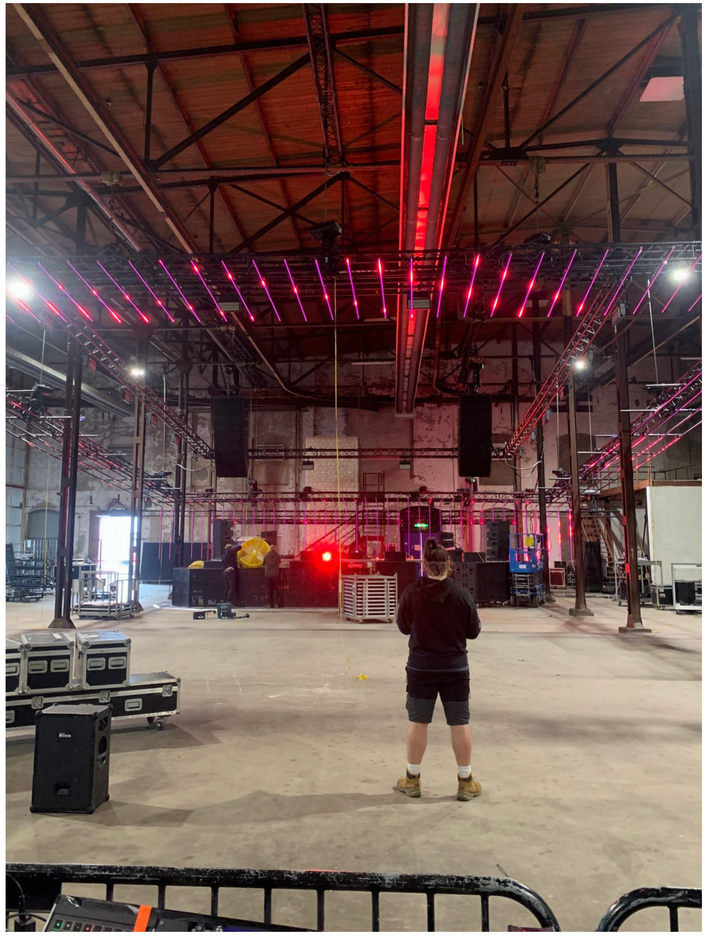
Lumus Instruments has developed a modular LED bar system composed of extruded aluminium profiles with an LED strips mounted on both sides. In combination with various connector plates, these bars can be assembled into an extensive range of compositions and configurations. The resulting structures are mounted onto truss frames, allowing the complete installation to be suspended above the stage or the crowd.

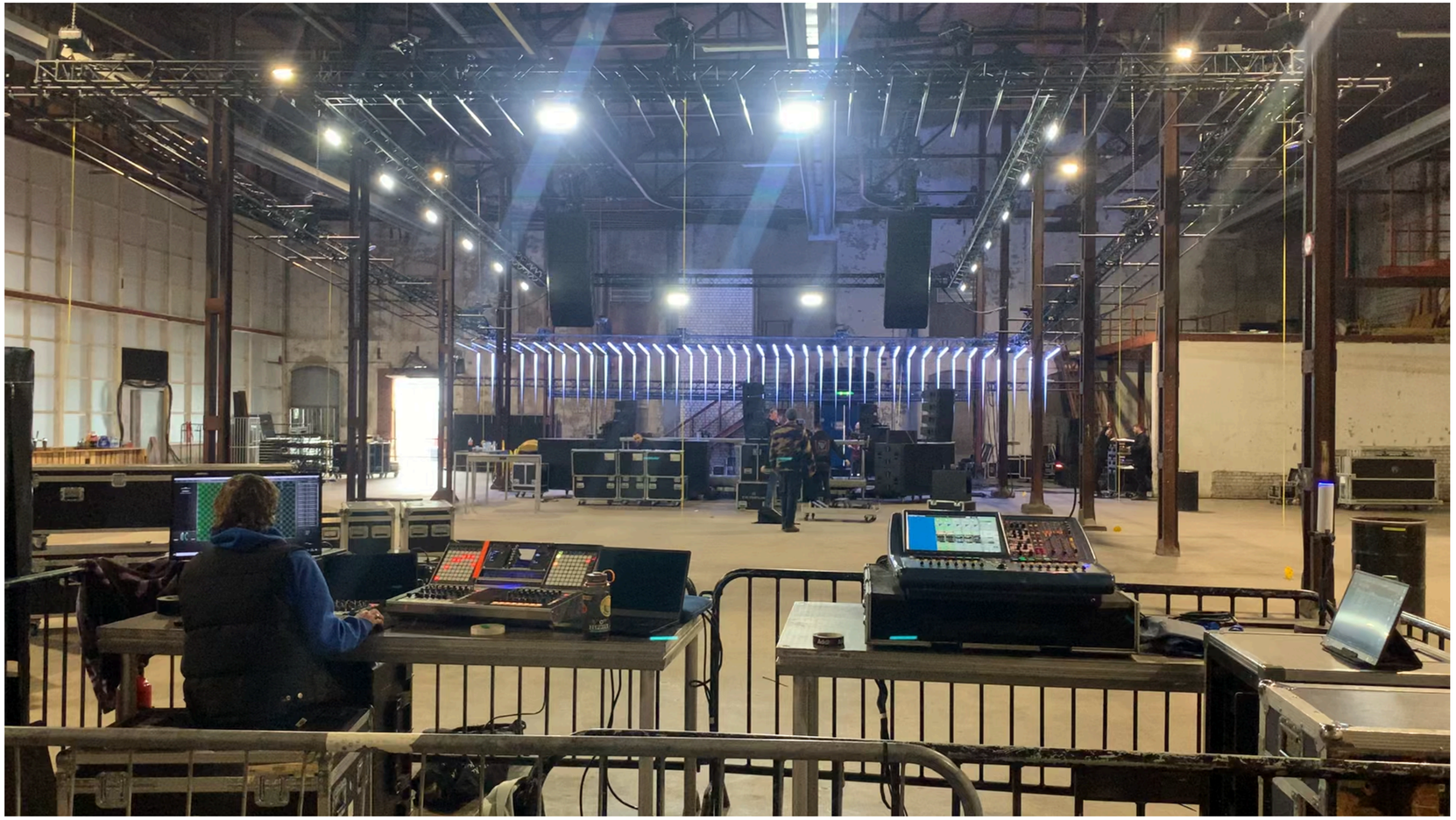
This modular system allows Lumus Instruments to design a custom lighting setup in collaboration with the partner, festival, or club, combining the LED bars with additional stage lighting. The LED system is controlled via Touch-Designer and integrated with the additional lighting to create an integrated and immersive lighting environment. The entire setup is operated through a custom-made MIDI control board, enabling precise manipulation of lighting effects. The lighting control does not simply operate autonomously, instead the lighting effect are controlled and performed live throughout the event. An operator remains at the control station during the event, continuously adjusting the lighting to match with the music being played.











Assisting with build up at Paradigm, Groningen

Polynode VIII (2024) [1]



Polynode is an audio-visual installation by Lumus Instruments that combines light and sound to create a dynamic, time-based experience. The work consists of four linear LED structures suspended from the ceiling, within which virtual nodes generate evolving spatial and temporal patterns. Through the interaction of light and sound, the installation explores the relationship between computational systems and physical space, as well as the way these systems are perceived by an audience. Although users experience the installation as a coherent whole, the underlying system remains partially inaccessible, revealing only its perceptual output.

Aesthetic principles

Self-Interaction Through Light
Movement of light across the installation creates moments of visual self-interaction, where illuminated elements intersect and influence one another.

Transmission of Information
Light functions as a carrier of information, visually transporting signals and movement throughout the installation.

Spatial Directionality
The installation gives direction to the space and redefines the surrounding environment, altering the viewer’s perception and understanding of the three-dimensional space.

Scenographic Composition
The audio-visual composition follows a deliberate scenographic progression, featuring a build up of tension and a climax in sound and light over the course of a 26-minute performance.

Polynode VIII (2024) [2]

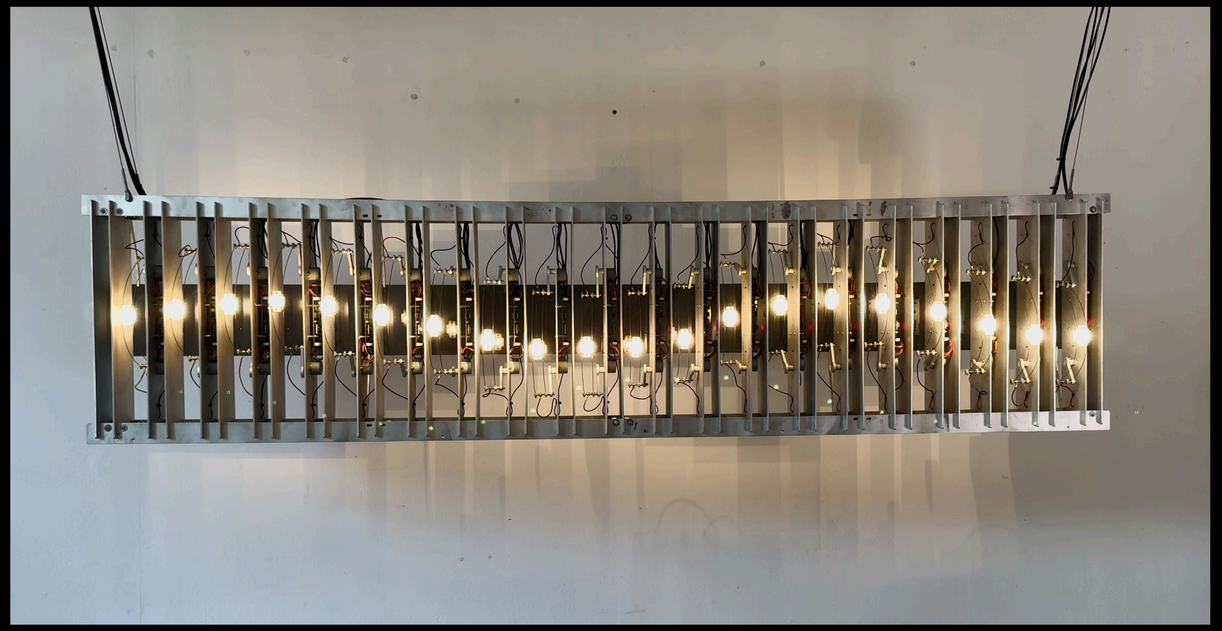


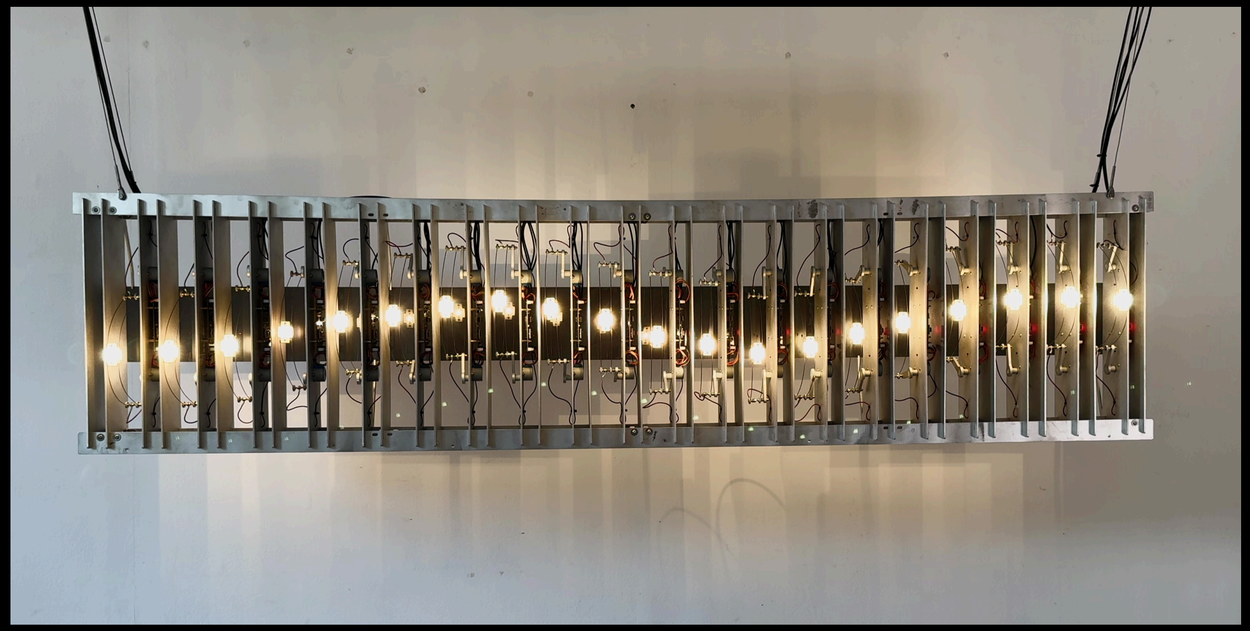
Key Insights for Design

From Polynode, a key insight is that light can be understood as more than a means of illumination; it can function as a carrier of information within a spatial system. At a literal level, light enables perception by revealing form and material. However, in a more abstract sense, it can also be considered an materialised, active communicative element, where patterns of illumination operate as informational signals within a dynamic system.

Within this interpretation, different light states can be understood as interacting nodes in a larger network, in which movement, flashing, and spatial transitions establish relationships between elements. Light is therefore not a static output, but part of an interconnected informational field that evolves over time.

ANALYSIS ARTWORKS





In my own project, this understanding translates into a system of light sources that move within a two-dimensional plane. On a literal level, their shifting positions continuously alter what is illuminated, and therefore what can be perceived. On a more abstract level, the collection of LEDs is perceived as a wave-like pattern, as are the shadows cast on the wall behind it. This means the illumination of the LEDs is no longer only about lighting the aluminium surface, or the wall behind the installation; instead, the illumination itself becomes information, literally conveying the wave function of the pattern, both directly, through the moving lights, and indirectly, as a projection on the wall.

Actualisation II (2024) [1]



“To make actual is to bring into existence. It is the act of applying tension between physical space and one’s cognition, giving meaning to otherwise meaningless patterns.”

The Actualization series plays with our perception of what feels real. In other words, what we internalize as something real in our life. It searches for the quality in an experience that convinces us that something is real and authentic, and allows us experience it in that way.

The Installation is made of small angled mirrors, that move across a sliding rail. A central laser tracks the position of the mirrors and projects a beam onto the mirrors.

Aesthetic principles

Expressive Feedback Loop
A slight imbalance or noise, and delay within the synchronisation between mirror tracking and laser projection reveal the feedback loop between digital control and physical output, producing imperfections that generate dynamic tension and emergent behaviour.

Actualisation II (2024) [2]



Key Insights for Design

An important observation is the role of imperfection in systems that combine physical movement, hardware, and software. In such systems, a certain degree of noise or deviation is unavoidable. Rather than aiming for fully stable or perfectly predictable behaviour, these variations can be integrated as a design feature. Small inaccuracies, delays, and mechanical tolerances contribute to the expressiveness of the system, where these “errors” become part of the visual language and introduce subtle variation and liveliness into otherwise controlled structures.

Actualisation II made me aware that these kinds of behaviours should not necessarily be corrected or hidden, but can be considered at the level of installation design itself. Similar to the imbalance between the laser tracking and the moving mirrors in Actualisation II, the tension of the feedback loop between the mirror and laser makes it even more interesting.

ANALYSIS ARTWORKS

In my own project, this presence of noise becomes visible in the movement of the LEDs. Small amounts of mechanical play in the gearboxes, combined with variations in wire tension, introduce slight deviations in the position of each light source. At certain positions, the tension in the super-elastic wire shifts, causing small, abrupt jumps in the movement of an individual LED.

Because the installation consists of an array of repeating elements, these jumps would theoretically occur in a predictable sequence. In practice, however, the small mechanical variations between elements cause them to occur at slightly different moments, disrupting this regularity. Rather than diminishing the composition, these imperfections enrich it by introducing subtle unpredictability into an otherwise controlled system. Similar to Actualisation II, the expressive quality of the installation emerges from the interaction between programmed behaviour and the unavoidable physical realities of the mechanical system.



3.2 Conceptual inspirations

As a creative design project with a strong artistic component, its development was driven by inspiration, experimentation, and iterative reflection. The conceptual direction gradually emerged through research, prototyping, and reflection. Throughout the process, various artistic and theoretical influences informed and shaped the design. The following section provides a brief overview of the most significant influences that contributed to the conceptual framework.

A strong conceptual parallel can be found in the musical composition Canto Ostinato by Simeon ten Holt. Similar to its musical structure, the installation operates through repetition, minimal variation, and gradual transformation.

In the composition, repeated musical phrases create a sense of timelessness in which time itself becomes almost an infinite landscape instead than a linear progression. Subtle harmonic shifts continuously alter the perception, generating tension and release through minimal change. Rather than following a traditional chord progression, the harmonies are introduced through slow change, resulting in an open and continuously evolving system that remains in a state of unresolved motion.

The installation seeks to evoke a similar experiential quality: a system without a defined beginning or end, existing instead as a continuous spatial condition. Through repetition and subtle variation, it creates a hypnotic and meditative experience in which the viewer gradually becomes aware of small differences, rhythmic relationships, and the evolving patterns over time.

The the physical structure of the installation is influenced by the Buckminster Fuller's notion of structural logic, where form, orientation, and configuration emerge from the constraints and behaviour of the system itself. The final design emphasises the fragile movement of the light sources while integrating a diffuse projection surface that interacts with the emitted light, creating two complementary readings of the installation.

Finally, the project was inspired by Stephen Wolfram's ideas on emergence, in which simple behavioural rules generate complex patterns when repeated across many elements. In his cellular automata, repetition of simple rules leads to unexpected complexity. This principle is materialised in the installation through repeated light modules, whose individual movements combine into larger dynamic compositions.

Together, these influences contribute to an installation that explores repetition, motion, emergence of complexity, and perception. The following sections discuss these influences in greater depth and demonstrate how they are reflected in the final prototype.

Canto Ostinato

A strong conceptual parallel can be found in Canto Ostinato by Simeon ten Holt. Similar to the musical structure of Canto Ostinato, the installation operates through repetition, minimal variation, and gradual transformation.

Musical structure and composition

In the composition, repeated musical phrases create a sense of timelessness in which time itself becomes a landscape rather than a linear progression. Small harmonic shifts continuously alter the listener's perception, generating tension and release through minimal change. The harmonies often exist independently rather than functioning within a traditional chord progression, creating an unfinished and continuously evolving condition, constantly seeking for a new relief.

Canto Ostinato is structured as a sequence of 106 small sections, referred to as "cells," that are interconnected through recurring bass figures and harmonic progressions. These cells form modular building blocks, on which the composition builds upon. This allows for a non-linear progression that emphasizes continuity rather than strict sequence. The score provides a fixed framework of these cells, but performers navigate them with considerable freedom, ensuring that the piece unfolds as an open-ended musical process rather than a rigidly defined narrative.

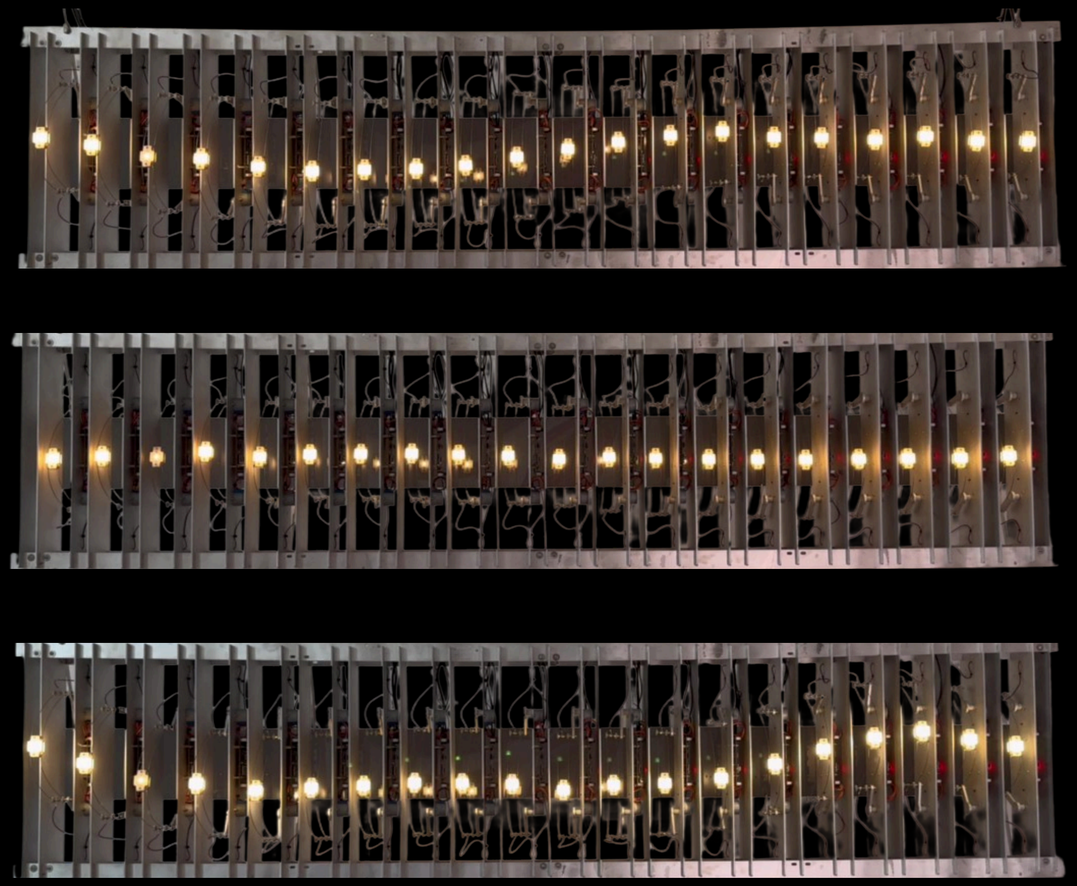
The tempo is set at a constant quarter note 60 beats per minute, creating a steady pulse that runs throughout the entire composition and gives it a continuous sense of flow. This unchanging pace contributes to the work's hypnotic character, as repetition can build up gradually over time. The overall duration is not fixed and depends on the number of repetitions chosen in performance, typically ranging from one to two hours, but in some cases extending to over a day (Klijn, 2019).



Relation to Design

The installation seeks to evoke a similar experiential quality: a system that does not move towards a clear beginning or end, but instead exists as a continuous spatial condition. Through repetition of a single elemental behaviour across multiple units, small variations in movement and light accumulate into larger perceptual patterns over time. The installation creates a hypnotic and meditative experience in which the viewer gradually becomes aware of small differences, rhythmic relationships, and evolving patterns over time. Like Canto Ostinato, meaning emerges not from individual events, but from their repetition and gradual modulation.

The speed of each motor can be controlled independently, allowing for a wide range of compositional possibilities within the installation. Similar to the repeating bass figures that form the foundation of the musical composition, each element continuously performs a rotational movement, repeating the same fundamental behaviour over time.
The gradual modulations present in Canto Ostinato are translated into the installation through slow changes in motor speed. While the underlying movement remains constant, subtle variations continuously alter the relationships between the individual elements. As a result, the overall visual composition slowly evolves, generating new patterns and spatial rhythms.



R. Buckminster Fuller

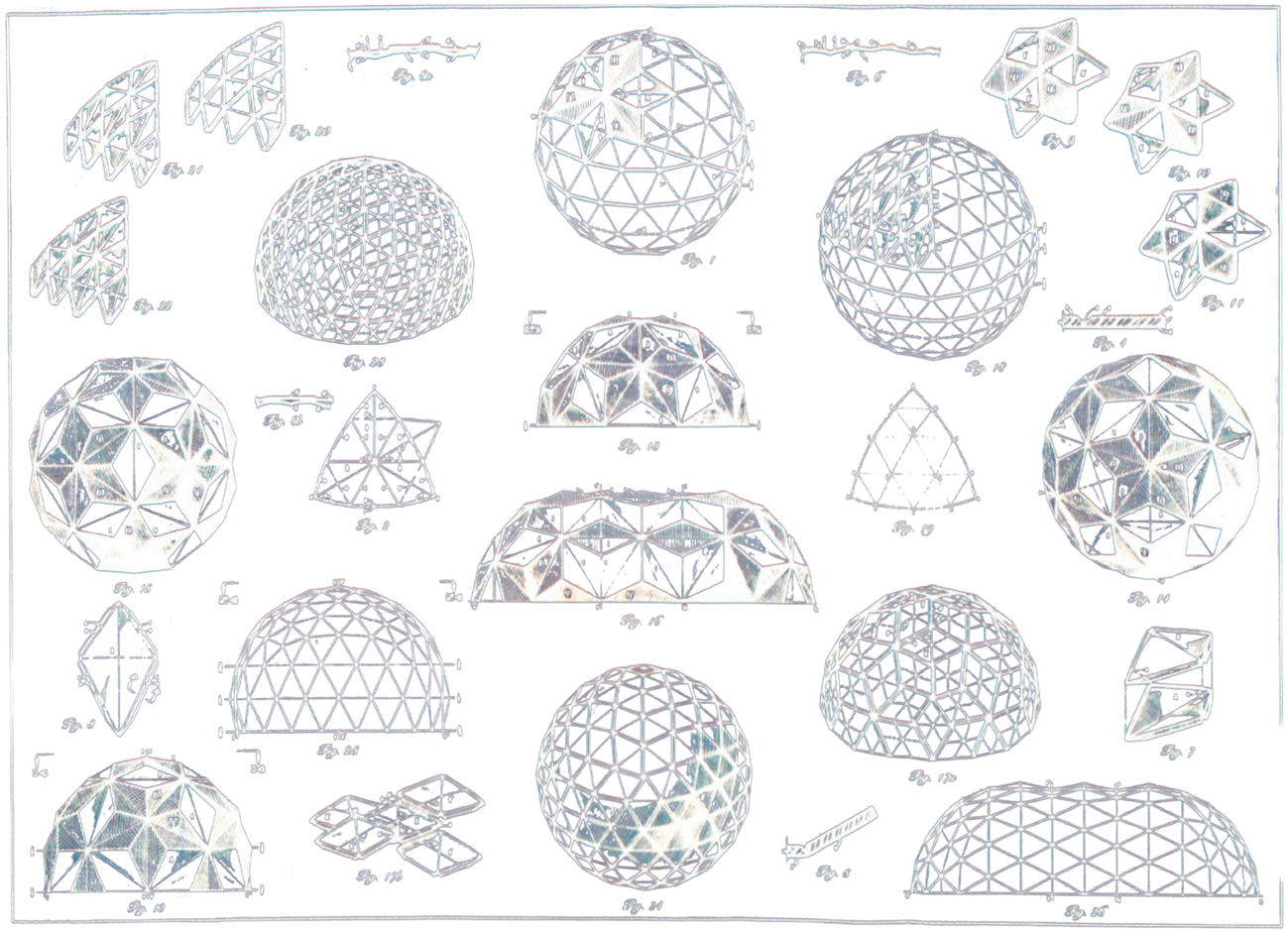
Buckminster Fuller positioned himself as a designer working not under a specific client or supervisor, but in service of humanity as a whole. He proposed a holistic approach to addressing global challenges, beginning from the largest systemic scale, the planet, and working downward toward elemental and structural principles (OASE, n.d.).

For Fuller, design was not about stylistic expression. He deliberately rejected “style” as a primary driver of form. Instead, form should emerge from scientific reasoning, structural efficiency, and optimisation. Aesthetic value, in his view, was not applied but discovered, it arises as a consequence of functional and energetic optimisation.

A key concept he introduced is ephemeralisation, which he described as “doing more with less.” Through technological and structural innovation, humanity could increase performance while reducing material and energy use. Efficiency was not merely technical but ethical: it enabled the possibility of supporting all life on Earth within finite resources.

Fuller was deeply interested in geometry as a fundamental principle of organization. For example, a sphere encloses the maximum volume with the minimum surface area, making it an energetically efficient form. For Fuller, such geometric optimality carries an inherent aesthetic quality: beauty emerges from structural logic.

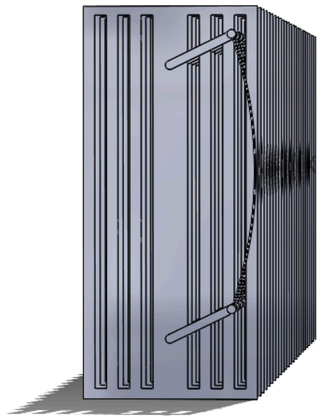
He described his approach as Design Science: a practice that integrates engineering, ecology, and systems thinking. Design Science operates beyond personal authorship or style and instead seeks to develop solutions that function at a planetary scale (Fuller, 1982).

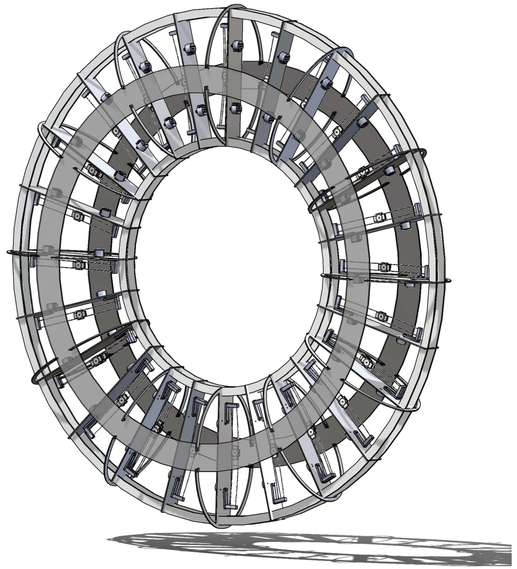


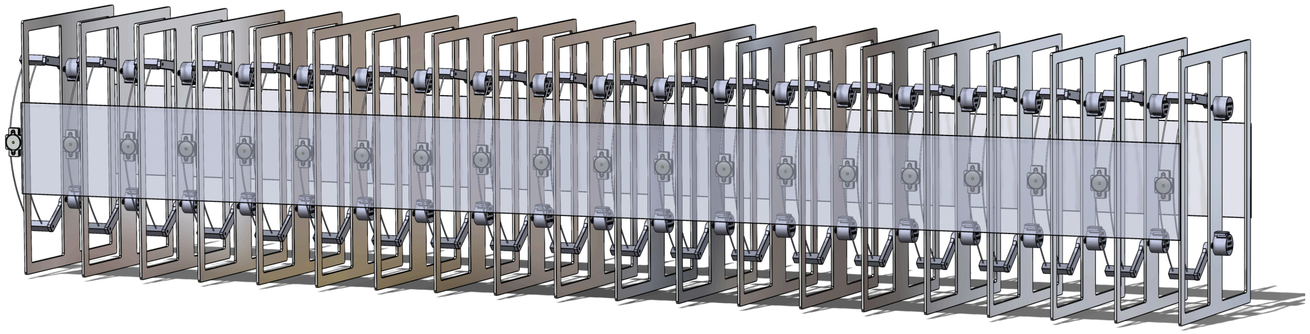
Key Takeaways for Design

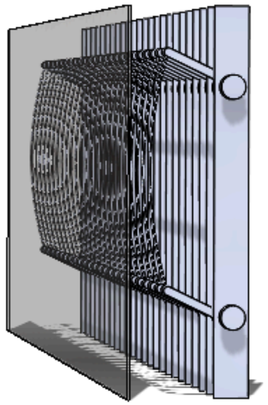
The principle of ephemeralisation and design science became particularly relevant when developing the spatial organisation of the installation. While the concept of some kind of array of repeating elements was established early in the project, the exact configuration remained open. Throughout this process, a series of questions emerged: How should the motors be oriented? What should be attached to the moving wires? How should the light interact with surrounding surfaces? And what overall structure would best support the intended experience?

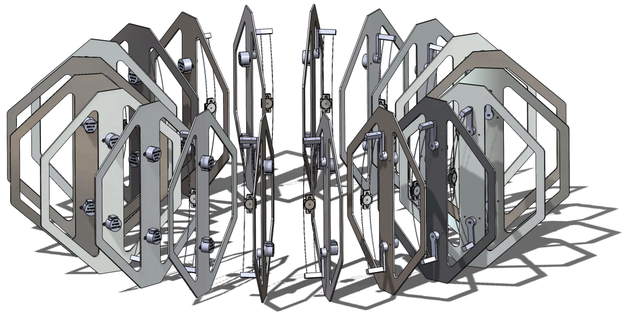
To explore these questions, numerous configurations were developed and tested. Variations included diffuse surfaces on both sides of the installation, different arrangements of slats and openings, large continuous projection surfaces, and alternative overall compositions such as circular, crown-like, and linear arrays. The number of possible configurations proved virtually endless. A full documentation of all prototypes and CAD models can be found in Appendix A.







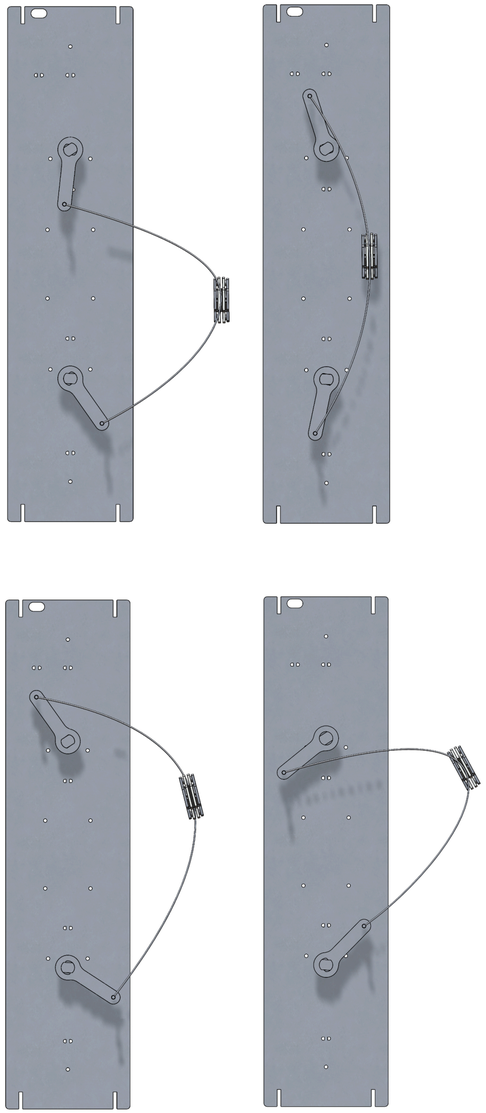


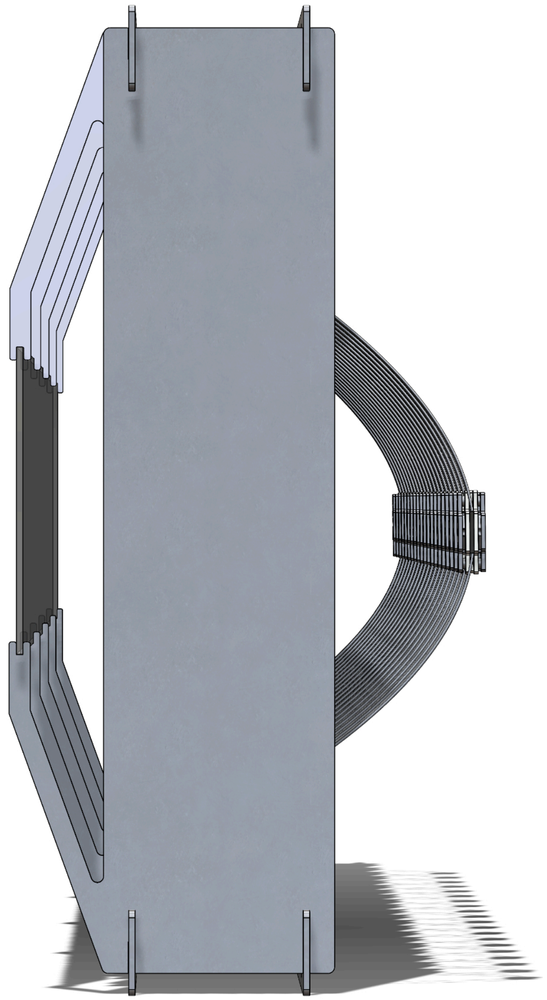


CONCEPTUAL INFLUENCES

To answer these design questions, I set out to apply the logic of Buckminster Fuller in my design choices. The question therefore became not which configuration looked most appealing, but which configuration most clearly expressed the inherent qualities of the system itself (design science). The first and most distinctive characteristic of the prototype was the fragile and constrained movement enabled by the super-elastic wires. The movement of the light sources enabled a subtle and delicate quality. Another observation is that due to the mechanical constraints of the super-elastic wire, the wires naturally bend forward during movement, giving each element an inherent front and back orientation (see images). Rather than treating this as a limitation, the installation should adopts this characteristic.

These two observations provided a logical basis for making design decisions. Rather than concealing the movement behind diffuse materials or complex structures, the final design was organised to reveal and emphasise the experiential quality of the fragile movement. The front side of the installation therefore remains visually open, allowing the motion of the light sources to be clearly perceived. At the backside, a diffuse surface is placed behind the moving elements, enabling the light to interact with the structure and generate projected shadow patterns on a wall behind the installation.





The mechanical constraints of the system naturally orient the LED forwards.

Stephen Wolfram

Stephen Wolfram is known for his research into computational systems, particularly cellular automata, and for founding Wolfram Research, the company behind Wolfram Alpha.

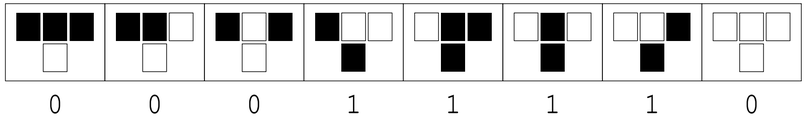
A cellular automaton is a computational model in which a grid of cells evolves step by step according to very simple, local rules. Despite the simplicity of these rules, the system can generate highly complex and unpredictable patterns. Through extensive study of these systems, Wolfram demonstrated that complexity does not necessarily require complex causes.

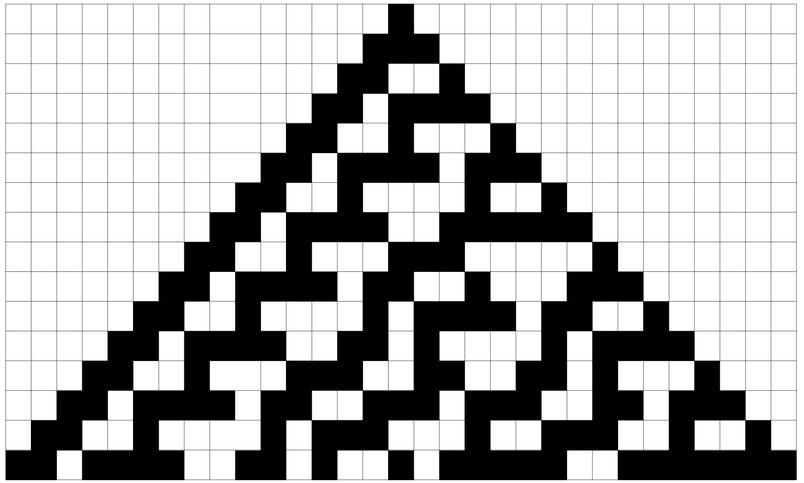
In his book A New Kind of Science, Wolfram proposes that traditional mathematics may not always be sufficient to describe natural phenomena. Instead of relying solely on continuous equations, he suggests that nature itself may operate through discrete computational processes. According to this view, the universe can be understood as a rule-based system in which simple programs, when iterated over time, produce the complexity we observe.

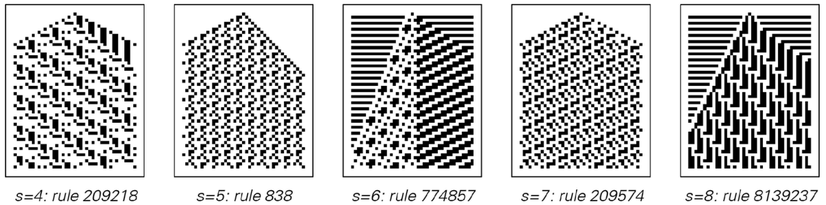
A central idea in his work is that many systems are computationally irreducible: their future states cannot be predicted analytically and can only be determined by running the system step by step. This reframes scientific understanding from solving equations to simulating processes.

Wolfram therefore introduces a “new kind of science”, one that studies simple programs as models of natural law. Rather than seeking increasingly complex formulas, this approach investigates how structured behaviour and emergence arise from minimal sets of rules. (Stephen Wolfram: A New Kind Of Science | Online—Table Of Contents, 2002)

rule 30







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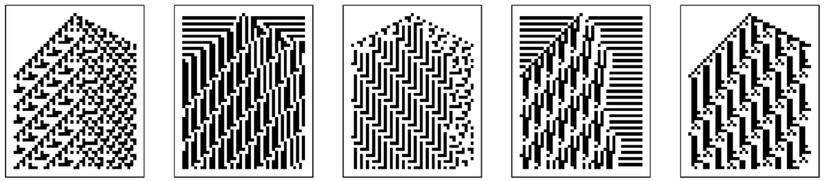

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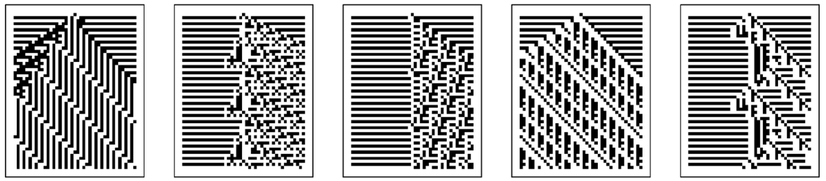

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Key Takeaways for Design

The concept of repetition of simple rules towards complexity, informed the design approach throughout the project. Rather than composing predetermined visual effects, the installation was conceived as a behavioural system in which complexity emerges from the interaction of many simple elements. The central idea is therefore not to carefully choreograph every movement, but to define the behavioural rules from which larger patterns could arise.

The most evident manifestation of this emergence can be observed in the shadow projection created by the diffuse panel positioned behind the moving LEDs. As each light source changes position, the panel partially obstructs and diffuses the emitted light, producing overlapping shadows and illuminated regions. Although the movement of every individual LED is governed by a relatively simple rule, the interaction between the twenty moving light sources generates continuously evolving shadow patterns that were not explicitly designed or programmed. Similar to Wolfram's cellular automata, the visual complexity of the installation emerges from the repeated interaction of simple local behaviours rather than from a predetermined global composition.







3.3 Aesthetics Theory

Unity in Variety

The previous chapters describe the conceptual and theoretical influences that informed the development of the installation. However, it is equally valuable to analyse the final work through the perspective of aesthetic theory. Aesthetic theory provides a framework for understanding why the installation is perceived as visually coherent and engaging.

Although the installation was primarily developed through experimentation and intuition, many of the resulting design decisions can be related to established theories of visual perception and aesthetics. The visual language of the installation is characterised by a balance between repetition and variation. The repeated aluminium slats establish a strong structural unity, while the continuously changing positions of the LEDs generate subtle variation over time. This corresponds closely with Hekkert's principle of unity in variety, where aesthetic appreciation emerges from the balance between coherence and diversity (RAG, 2016).

Tectonic Expression

The installation can also be understood through the concept of tectonic expression, in which aesthetic qualities emerge from the clear expression of structure, function, material, and construction rather than from applied decoration (Leatherbarrow, 1997). Instead of concealing the mechanics, the installation deliberately exposes the components within the aluminium frame. The construction therefore becomes part of the visual language. The movement of the light sources is understood not only through the emitted light, but also through the visible mechanics that produce it. As a result, the aesthetic of the installation emerges directly from its structural logic and physical behaviour, closely aligning with the influence of Buckminster Fuller discussed earlier.

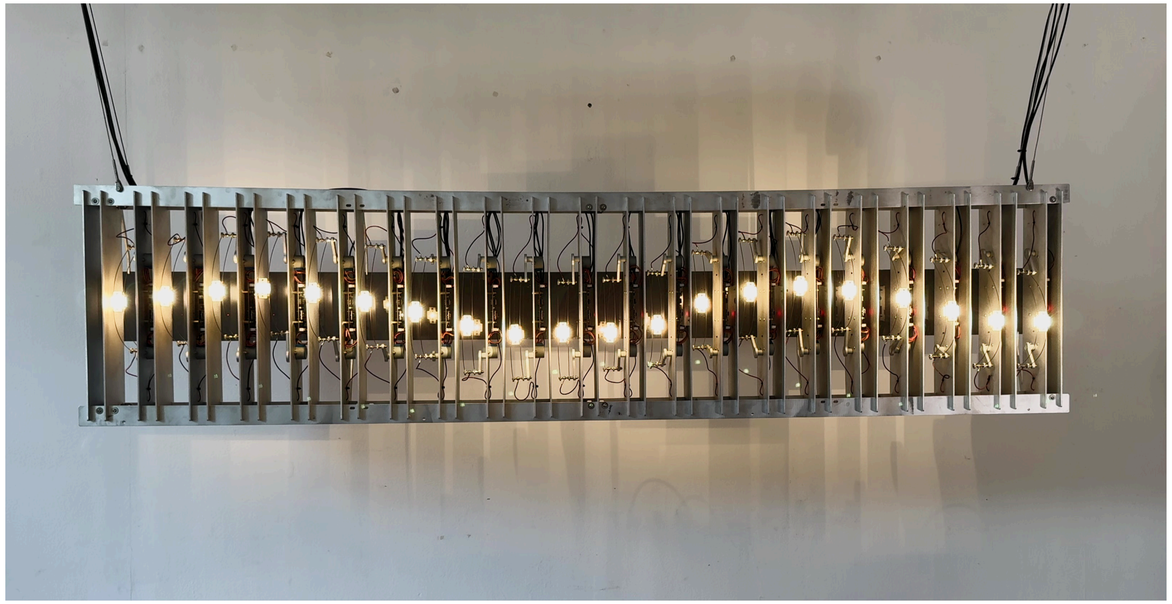


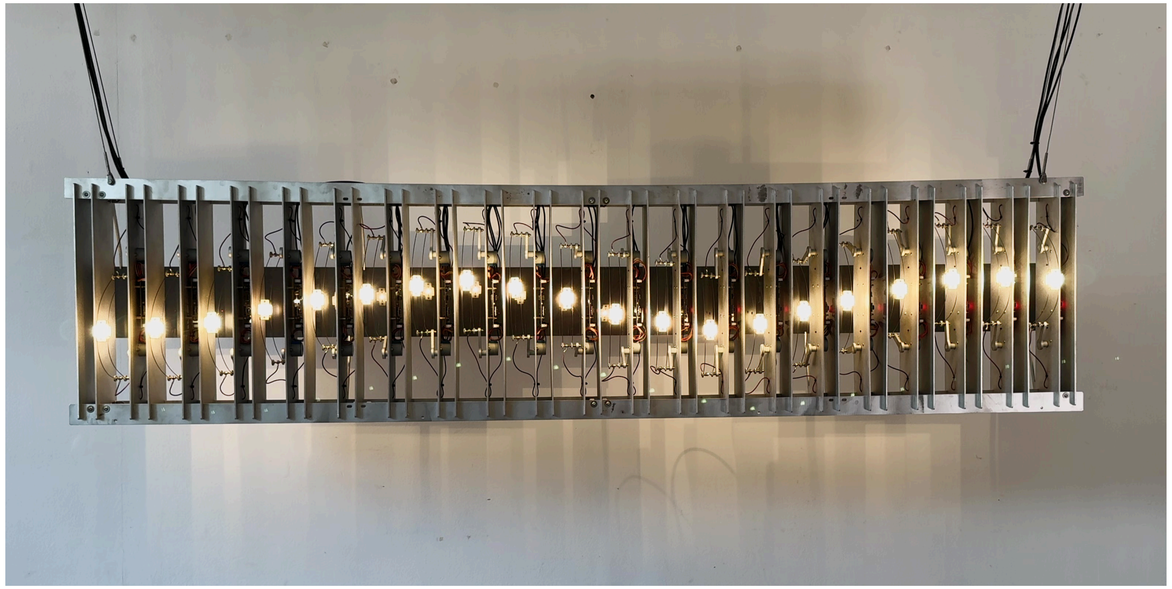


Gestalt theory

Several Gestalt principles (Wagemans et al., 2012), help explain how the visual complexity of the installation is perceived. The principle of similarity and continuation causes the repeated light modules to be recognised as belonging to a single coherent system. Although the individual LEDs are physically separated by the aluminium slats, the eye naturally connects them into continuous wave-like trajectories and rhythms that extend across the installation.

FINAL DESIGN ANALYSIS





The principle of figure-ground organisation explains how attention shifts between the moving LEDs and casted shadows created by the diffuse projection surface behind them. Rather than functioning merely as a background, the diffuse panel becomes an active part of the composition by revealing overlapping projections and shadow patterns.



The reflective side of the diffuse backplate introduces an additional perceptual layer to the installation. It creates a secondary image of each moving LED through diffuse reflection and projection. Although this projected light module looks the same as the moving LED, you actually see the backside, as it moves synchronously with the source. This relates to the Gestalt principle of common fate, which states that elements moving in the same direction and with similar shapes are perceived as belonging together. Consequently, the observer interprets the physical LED and its projected image as a single coherent visual entity.

Together, these Gestalt principles explain how a collection of simple repeated elements is perceived as a coherent, continuously evolving visual composition.

4. Validation

Validation in an Artistic Design Project

In a conventional industrial design project, validation tests assumptions against a defined user group and set of requirements. This project differs: it carries a significant artistic component, where intuition, personal judgement, and authorship are legitimate grounds for design decisions. A creative choice does not require external approval to be valid, and the aim here is not to declare the installation "successful" or "unsuccessful."

Validation nonetheless remains valuable, because it makes the gap between intention and perception visible. Throughout the project, design decisions rested on assumptions about how repetition, movement, light, and rhythm would be experienced, assumptions that were largely evaluated through my own perception while making and discussing the ideas and prototypes with my supervisors and Lumus Instruments. Validation externalises these assumptions, reformulates them as explicit hypotheses, and examines whether others perceive what the design intends. Where intention and perception align, the underlying principle is reinforced; where they diverge, the discrepancy points to aspects that are unclear or that could warrant refinement. In this way validation functions not only as assessment but as a method for generating transferable design knowledge: by relating specific design decisions to perceived effects, individual observations can be abstracted into more general principles that inform future iterations.

Method

The installation was evaluated through structured observation followed by a semi-structured interview. Each participant viewed the running installation individually for a fixed period (approximately 5 minutes) without prior explanation of its concept, so that first impressions would not be primed by the intended reading. Participants were then asked a set of open questions, followed by targeted probes and a small number of semantic-differential scales. To reduce bias, open questions were always asked before the scaled items, so participants described the experience in their own words before being offered the project's own vocabulary. Responses were recorded as anonymous written notes and analysed by comparing them against the intended effect. Because the sample is small and qualitative, the results are treated as indicative rather than statistically generalisable. The complete written interviews can be found in appendix C.

The validation study was very low-risk: all three participants took part voluntarily and with their informed agreement, the questions and recorded responses were fully anonymous, no personal data was collected, and the task involved nothing more than observing a light installation for five to ten minutes and answering questions about the experience. On this basis, the study falls within the low-risk category that HREC approval is intended to confirm. The HREC documentation can be found in Appendix F.

The validation is based on the Programme of Requirements & Wishes, which was developed throughout the project. This programme translates the project's technical, functional, and experiential objectives into a set of criteria against which the final installation can be evaluated. The validation is divided into two parts. The first investigates whether the intended experiential and conceptual qualities of the installation are perceived by viewers. The second evaluates the remaining technical and functional requirements of the programme through measurements, observations, and performance testing, which can be found in Appendix D.

Three central assumptions were translated into hypotheses, each grounded in the conceptual framework (Section 3): the hypnotic, timeless atmosphere derived from Canto Ostinato; emergence of complexity from simple repeated behaviour derived from Wolfram; and sustained engagement without demanding attention derived from the gallery context and conceptual narrative.

4.1 Programme of Requirements & Wishes

Contextual Requirements (Gallery Environment)

1. The installation must function within a gallery or interior exhibition context rather than a festival environment.
2. The work must remain effective in a well-lit space, where ambient lighting cannot be controlled.
3. The installation must operate as a self-contained artwork, without requiring spatial isolation (e.g. separate room, blackout conditions, or sound enclosure).
4. The work must coexist with other artworks without visually or spatially overpowering them.

- The installation could also function in alternative spatial conditions (e.g. darker exhibition spaces).
- The work could be made in different versions to adapt to different spatial configurations (wall, ceiling, or suspended arrangements).
- The installation must be suitable for semi-permanent or permanent exhibition conditions (ability to turn off/on)

Experiential & Scenographic Requirements

1. The work must produce a subtle, non-intrusive visual presence.
2. The installation must avoid aggressive or dominant sensory output.

- The installation should evoke a hypnotic or meditative atmosphere.
- The work should remain engaging over long durations without requiring active attention.
- The experience may gradually reveal patterns over time rather than immediate spectacle.

Conceptual / Design Philosophy Requirements

1. The design must be grounded in elemental repetition and reduction to essence.
2. The system must maintain a clear relationship between motion, light, and spatial perception.
3. The system must allow gradual transitions between different patterns of motion.
4. The design must remain consistent with the conceptual framework of:
   a. Repetition (Canto Ostinato)
   b. Emergence (Wolfram)
   c. Structural logic (Buckminster Fuller)

- The system could express a sense of timelessness or continuous becoming.
- Small variations or imperfections in motion may contribute to the expressiveness of the system.
- Light could function as both object and information carrier, not only illumination.
- The system could allow light to appear, disappear, or be partially obscured within the structure.

Technical Requirements

1. The system must be electronically controllable (microcontroller-based system such as Arduino Nano or equivalent).
2. The installation must operate reliably with repeated motion over long durations.
3. The system must be structurally stable when suspended.
4. The installation must be robust enough for repeated exhibition use.
5. The system must require minimal maintenance during operation.

Wishes

- The system could support modular scalability (e.g. increasing or decreasing number of elements).
- The system could allow parameter-based control of motion behaviour (speed, phase, synchronisation).
- The installation could be suitable for collection or purchase as an artwork.
- The system could allow relatively easy assembly/disassembly for transport.

Acoustic & Operational Requirements

1. The installation must operate with minimal mechanical and electrical noise.
2. Noise must not interfere with the intended calm experiential quality.
3. The system must be safe for continuous unattended operation.

- Motion could remain perceptible but not intrusive.
- The installation could feel “self-operating” or autonomous in behaviour.

4.2 Hypotheses & Interview Questions

Hypothesis 1: The installation evokes a hypnotic, meditative atmosphere and a sense of timelessness.
Grounded in the parallel to Simeon ten Holt's Canto Ostinato: timelessness through repetition, subtle variation, and gradual transformation, rather than dramatic events or climaxes.

Open questions:

- How would you describe the atmosphere of the installation in your own words?
- Did your sense of time change while watching? If so, how?
- Did the installation seem to have a beginning, a middle, or an end — or did it feel like an ongoing state?

Semantic-differential scales (ask last; 1–7):

- Hypnotic - Not hypnotic
- Calming - Stressful
- Meditative - Stimulating
- Constant - Evolving

Hypothesis 2: Simple repeated movements generate complex, emergent visual patterns.
Grounded in Wolfram: complex behaviour arising from the repetition of simple local rules; here, simple per-element rotation interacting across twenty elements.

Open questions:

- What is more dominantly present, the individual light points, or larger patterns across the whole work?
- Did the way the lights moved seem related to each other, or independent?
- Were you able to predict what would happen next? What made it predictable or unpredictable?
- How would you describe the way the lights moved — random, structured, or something in between? What made you say that?
- Did the installation feel simple or complex to you — and did that change the longer you looked?

Hypothesis 3: The installation remains engaging without demanding constant attention.
Grounded in the gallery context and conceptual narrative: an autonomous object remains interesting over longer periods of time.

Open questions:

- How did your attention behave while watching: steady, drifting, coming and going?
- Did the installation become more interesting, less interesting, or about the same over time?
- Where could you imagine encountering a work like this, and for how long?
- Did it ever feel like it was demanding your attention, or competing with the surroundings?
- How would you describe the noise levels?

4.3 Validation Results

The validation involved three participants and should be read as indicative rather than conclusive. Within these limits, the responses showed strong agreement on the core experiential intentions, while also revealing some unexpected findings.

Hypothesis 1: hypnotic, meditative, timeless: strongly supported.
This was the clearest result of the validation. All three participants described the installation as calm, fluid, and rhythmic, and all three perceived it as a continuous, ongoing state with no real beginning or end, only the upright starting position (when turning the installation on) could be seen as a beginning. The scale ratings reinforced this: hypnotic ratings of 1, 2, and 2. One participant spontaneously lost track of the interview while watching, which shows the captivating, absorbing quality the work aims for.

Hypothesis 2: emergence of complexity from simple repetition: strongly supported.
All three participants read the larger patterns as more dominant than the individual lights, while still finding the single element interesting enough to examine, confirming that the work attracts the attention to individual LEDs as well as to the collective patterns. All three described the motion as structured and coordinated rather than random, and all three found the whole unpredictable while the individual behaviour was predictable. One participant captured the intended Wolfram principle almost exactly: predictable local rules, unpredictable global result ("unpredictable what happens to the whole, but predictable what an individual light does relative to its neighbours"), and summarised the work as "complex in its simplicity."

Hypothesis 3: engaging without demanding attention: partially supported.
All three participants reported that the installation became more interesting over time as the range of movements revealed itself, a good result for a work meant to reward prolonged observation. However, the duration of attention is mixed. One participant said they could not look at the installation for hours, and would realistically look for only "a few minutes" in a gallery, which fits a public exhibition context but does not align with the ambition of an autonomous object that holds interest over long periods. On competition with surroundings, the responses agree that the work did not dominate, but all noted this depends heavily on what else shares the space, something this test could not assess.

The most interesting unexpected finding came from the third participant: they would watch the shadow projection on the wall longer than the moving LEDs themselves. This suggests the projected shadows may hold sustained attention more effectively than the direct light sources, which was unexpected, but does complement the intriguing aesthetics of the projected shadows.

Every participant independently described the sound as unobtrusive: "minimal and rhythmic," "not bothersome, it adds something," and "vibrating but not disturbing." This is notable, because I had regarded the motor noise as a flaw to be minimised. The viewers did not experience it as a problem at all, one even saw it as a positive contribution. It echoes the insight from Actualisation II: an imperfection does not necessarily come across as a flaw to those experiencing the work.

5. Conclusion

This graduation project set out to explore the aesthetic and technical principles of Lumus Instruments' large-scale light installations and translate these into a kinetic light installation suited to a gallery context. The result is a fully functioning prototype consisting of twenty repeating elements, each moving a double-sided LED through a two-dimensional plane by means of two stepper motors and super-elastic wires, controlled through custom-developed software simulation and a custom-designed PCB. Through repetition and the interaction of many simple movements, the installation produces slowly evolving wave-like patterns alongside a complementary shadow projection through the diffuse surface behind it.
The project began with a clearly defined starting point—a 100 mm electromechanical slider—and developed through an open and exploratory design process. The direction of the project emerged through iterative cycles of experimentation, prototyping, reflection, and making. The analysis of Lumus Instruments provided the initial framework, while inspirations from Simeon ten Holt (Canto Ostinato), Buckminster Fuller, and Stephen Wolfram gradually shaped the conceptual foundation of the project. This resulted in a design that creates a hypnotic atmosphere achieved through the repetition of elemental behaviour, form emerging from structural logic, and complexity arising from simple rules.

Assessed against its intended objectives, the project successfully achieves its central aims. The validation demonstrated that the primary experiential qualities of the installation were consistently perceived by participants, indicating that the intended atmosphere was successfully translated into the final design. In terms of desirability, the installation creates an immersive, contemplative experience that viewers described as engaging while remaining calm and unobtrusive, qualities that align with both the gallery context and the artistic identity of Lumus Instruments.

From a technical perspective, the prototype demonstrates the feasibility of the concept. Although several aspects remain open for refinement, the installation operates reliably over extended periods and is sufficiently quiet for use in an interior environment. In terms of viability, the use of repeating modules, relatively simple mechanics, and low-cost electronics provides a credible foundation for a scalable, exhibitable, and potentially collectible installation. Nevertheless, a fully exhibition-ready version would benefit from further technical refinement and long-term testing.

Several opportunities remain for future development. The installation has not yet been evaluated within a gallery alongside other artworks. Additional technical improvements identified during the project, including reducing the long-term deformation of the super-elastic wires, developing a dedicated LED PCB, refining the wire-clamping mechanism, and implementing a daisy-chained control architecture for live adjustment across the array, would further increase the robustness and flexibility of the system. Validation with a larger and more diverse group of participants would also strengthen confidence in the findings.

Taken as a whole, the project delivers a fully functional kinetic light installation that successfully resonates with the artistic identity of Lumus Instruments while expressing my own ideas and design decisions. More broadly, the project demonstrates how an open, intuition-led, practice-based design process can generate meaningful design knowledge through iterative making, reflection, and abstraction. It visualises how simple behavioural rules, carefully translated through mechanics, light, and material, can give rise to rich and continuously evolving spatial experiences.

5.1 Vision on Design / Reflection

This graduation project has fundamentally changed my understanding of design. Looking back, the most valuable outcome is not the installation itself, but the way in which the project has changed how I think about developing ideas, making design decisions, and generating knowledge through design.

Perhaps the most important lesson has been recognising the importance of formulating the reasoning behind design decisions. Throughout the project, many intuitive choices were made regarding movement, composition, materials, and behaviour. Initially, these decisions often felt difficult to explain, even though they intuitively felt appropriate. Gradually, I realised that articulating why a particular decision is made is one of the most challenging and valuable skills within the field of industrial design. By making the reasoning behind a decision explicit, it becomes possible to extract the underlying principle from the specific solution. Rather than describing what a design does, the challenge is to identify why it creates a particular effect and why that effect is desirable or undesirable. Once these principles are formulated, they can be questioned, refined, and applied in entirely different contexts. I have come to see this process of abstraction as one of the core strengths of design practice. Even in this project, despite consciously trying to formulate these principles, I believe there is still room for improvement. Continuing to challenge myself to identify and abstract these underlying assumptions is something I will carry with me throughout my career as a designer.

This project has also changed the way I think about installations. I increasingly learned to think in terms of relationships and translations between different media. A rotating motor is not simply a rotating motor; its movement is translated through a super-elastic wire, altering the orientation of a light source, which in turn projects light and shadow into space and ultimately changes the viewer's perception. Thinking at this level of detail helped me identify the simple behavioural rules that define the installation and understand how complex experiential qualities can emerge from relatively simple interactions. This perspective will strongly influence how I approach future design projects.

Another important insight concerns optimisation in design. Inspired by Buckminster Fuller, I increasingly learned to ask not how can I add more? but what is the essential feature of this design, and how can everything else support it? Throughout the project, many design decisions became exercises in identifying what truly deserved attention and allowing the structure, mechanics, and composition to reinforce that central quality. This way of thinking has given me a much better understanding of how a design can be optimised by allowing its form to emerge from its underlying logic rather than from stylistic decisions alone.

From a technical perspective, the project significantly expanded my capabilities. Designing and manufacturing my first custom PCB has been one of the most rewarding aspects of the project, providing me with the confidence to integrate custom electronics into future designs. I further developed my skills in CAD modelling, 3D printing, laser cutting, and the fabrication of precision aluminium components. Through extensive prototyping, I gained a much deeper understanding of manufacturing tolerances and assembly strategies. These practical insights will undoubtedly influence the way I design and manufacture future projects.

The iterative nature of the project also strengthened my intuition for materials, proportions, and spatial composition. By continuously alternating between digital models and physical prototypes, I developed a much better sense of how shapes, dimensions, and materials translate from a CAD model into a physical object. Experimenting with LEDs, optical components, diffusers and reflective materials has created a personal reference library of material behaviour and optical effects that I expect to draw upon throughout my future design career.

With the initial goal of creating a well-developed and detailed prototype, I came to realise that this project has been just as much an exploration of design thinking as it has been the development of a kinetic light installation. More than learning new technical skills or producing a final prototype, it has taught me to consciously move between intuition and analysis, between making and reflecting, and between concrete design decisions and abstract design principles. This improved ability to translate intuition into explicit design knowledge is, for me, the most valuable outcome of the project and something I intend to continue developing throughout my career as a designer.

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Appendix

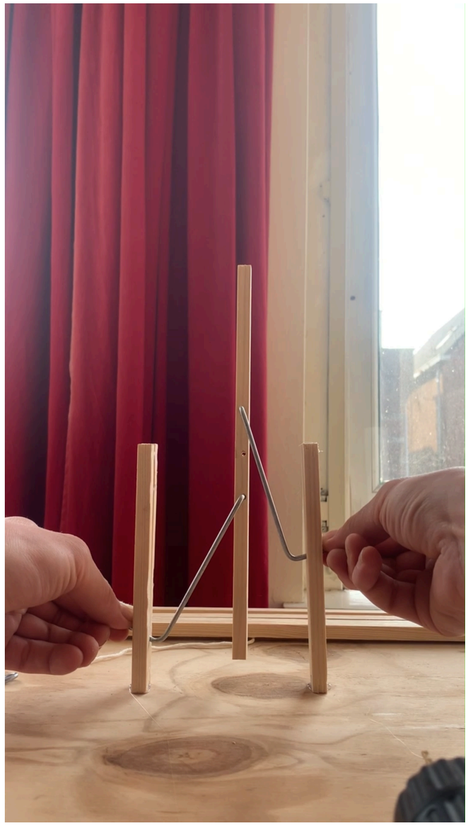
Appendix A: Images of prototypes & process
Appendix B: Analysis of Lumus Instruments
Appendix C: Validation Interviews
Appendix D: Technical Validation
Appendix E: Expert Advice
Appendix F: HREC Form



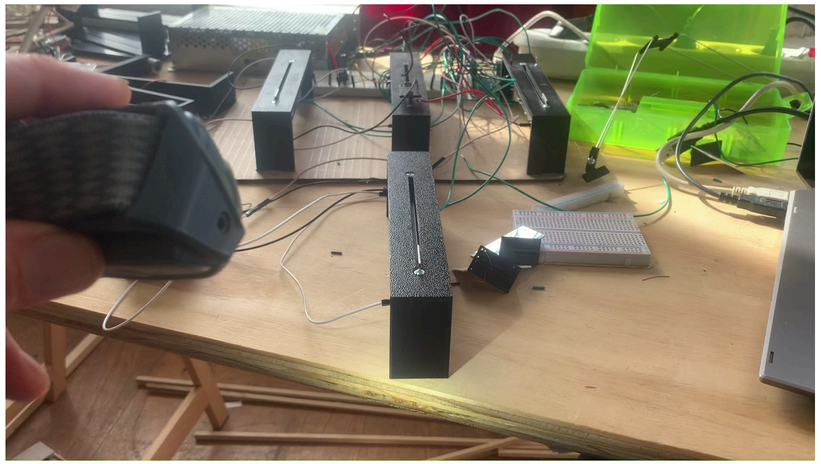









CRITICAL PATH





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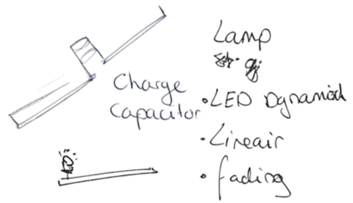
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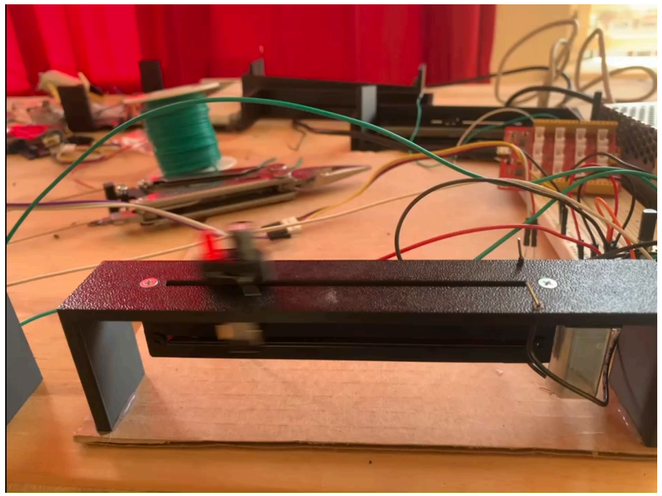
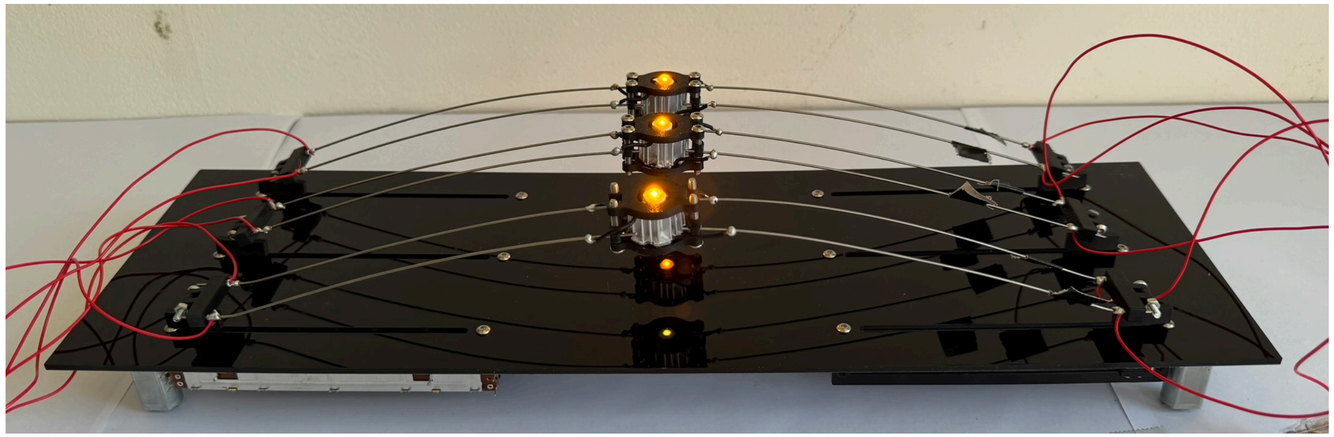
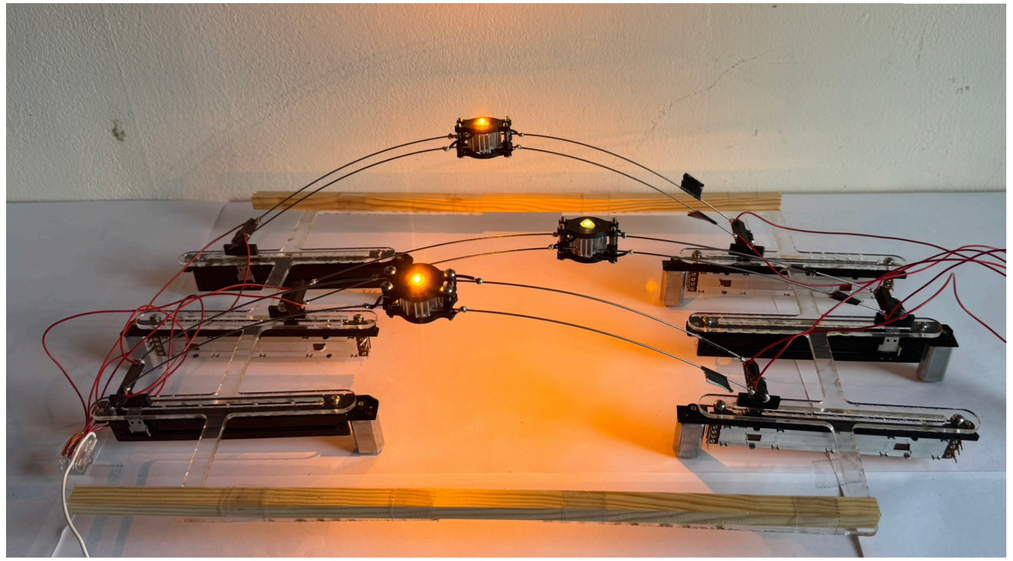
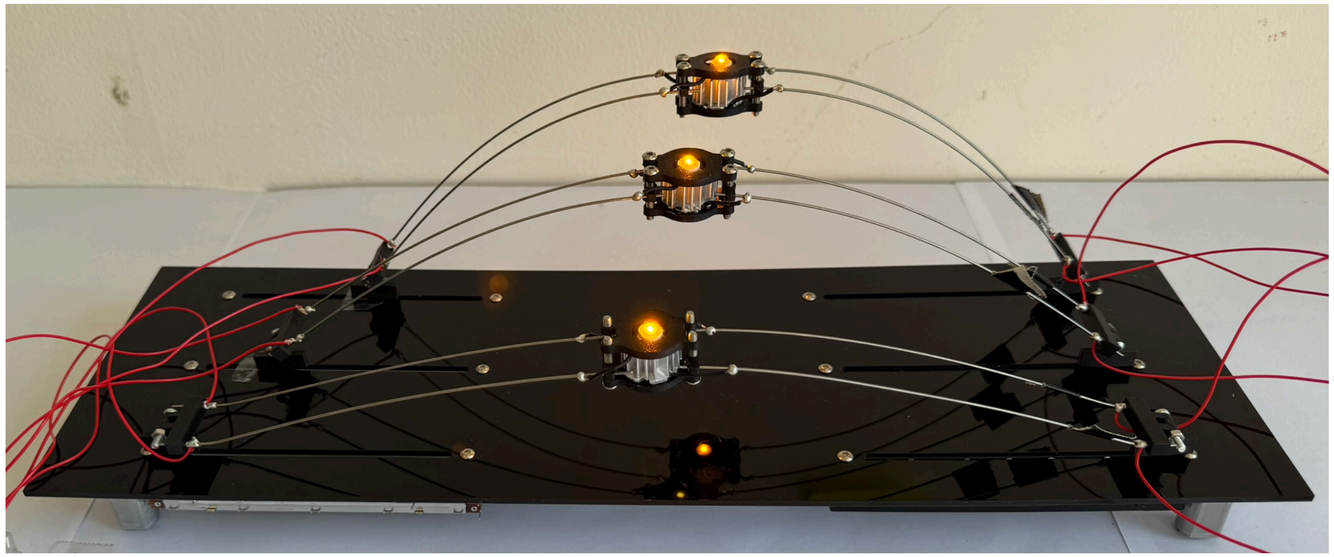
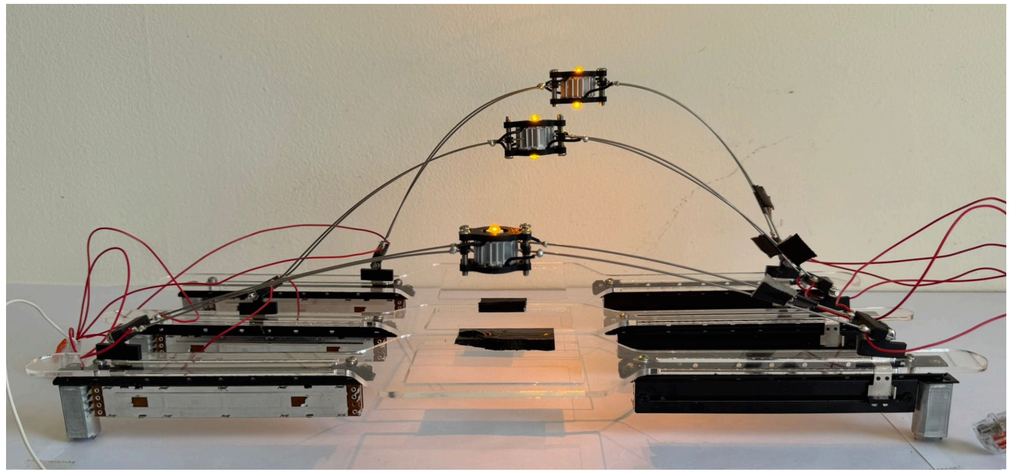




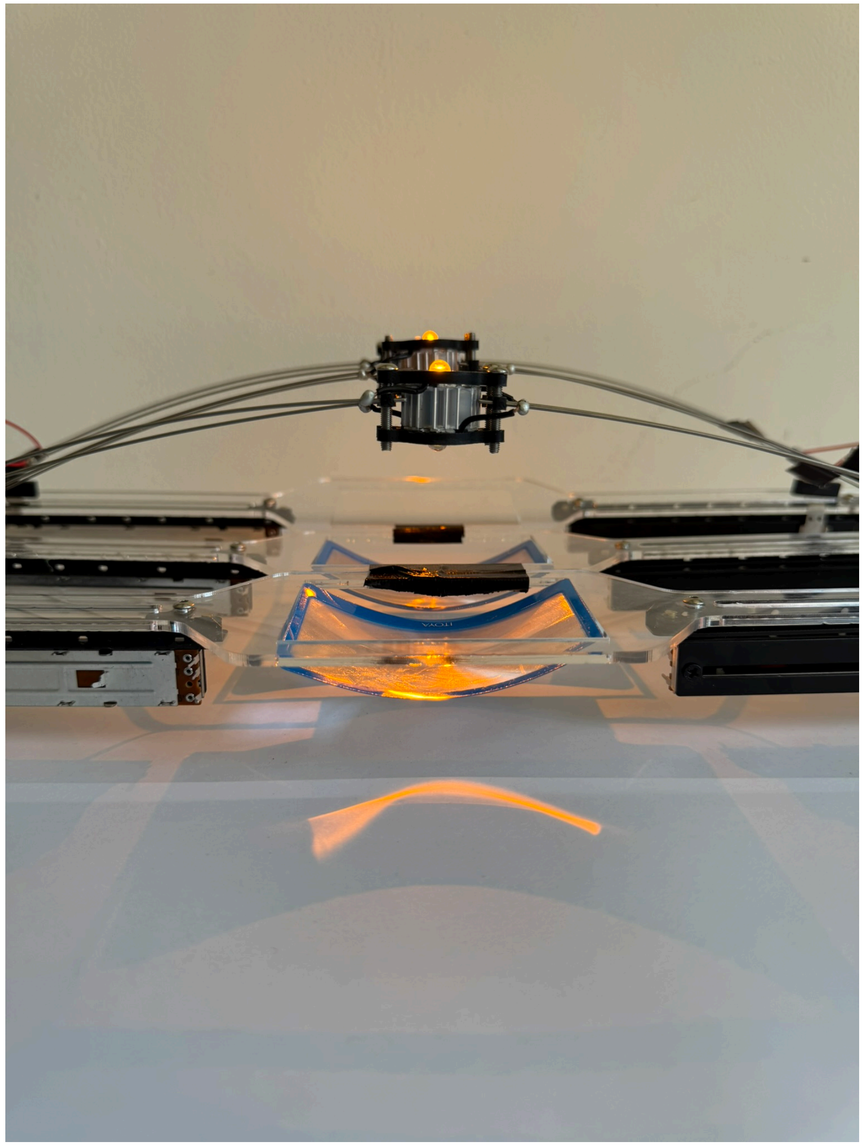


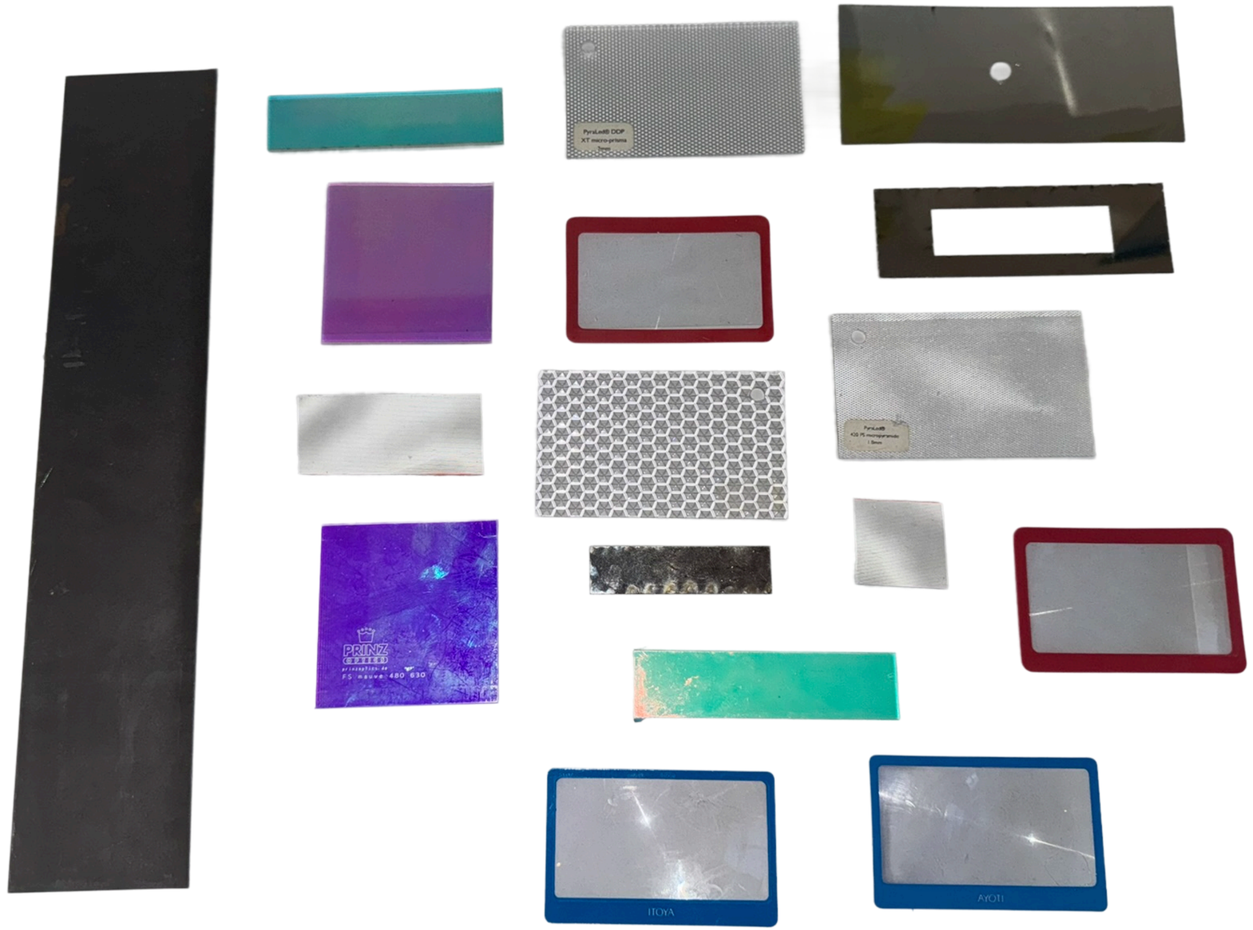


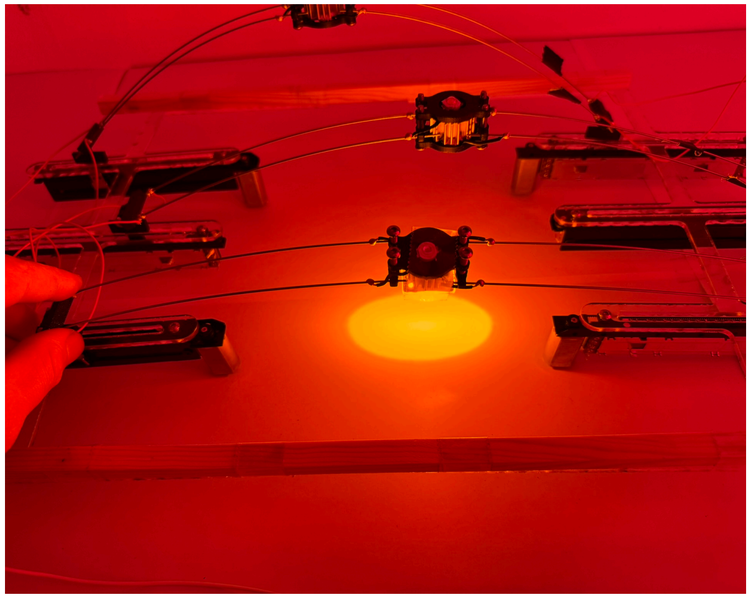


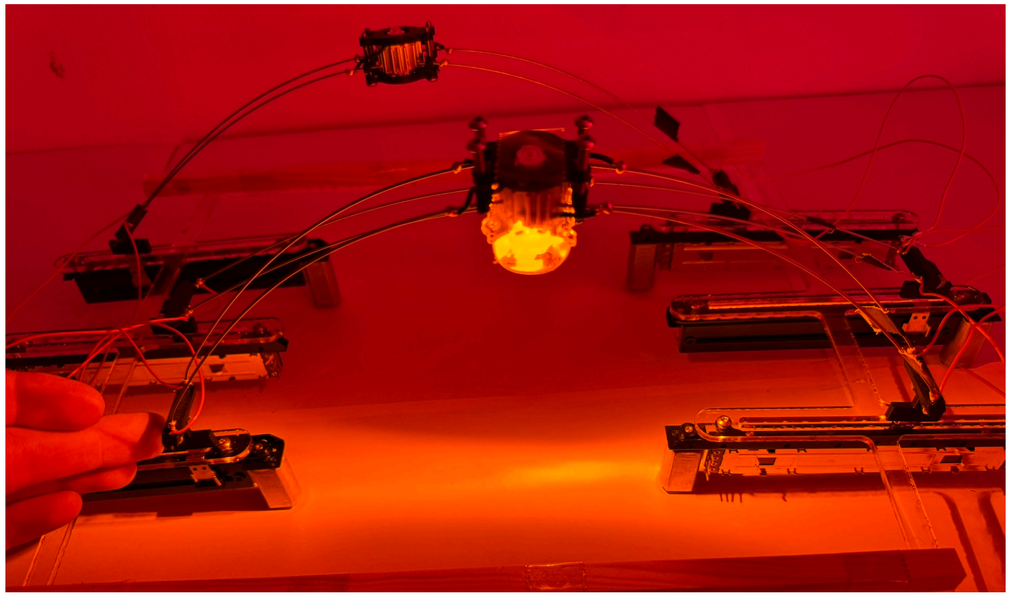
ITERATION 4 - EXPERIMENTING WITH LIGHT

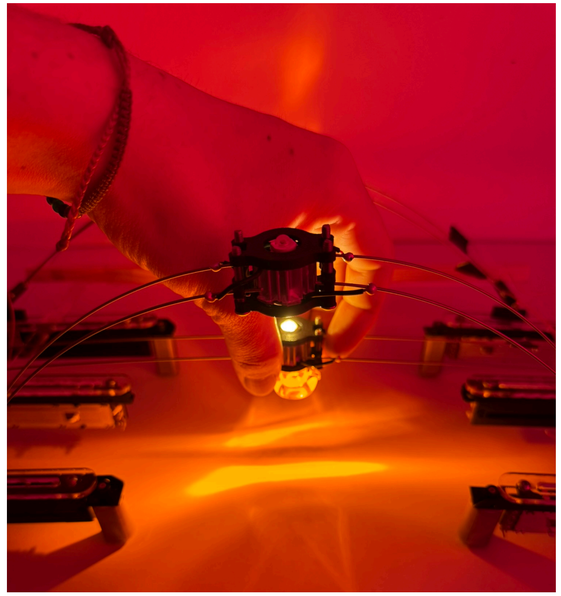
APPENDIX A

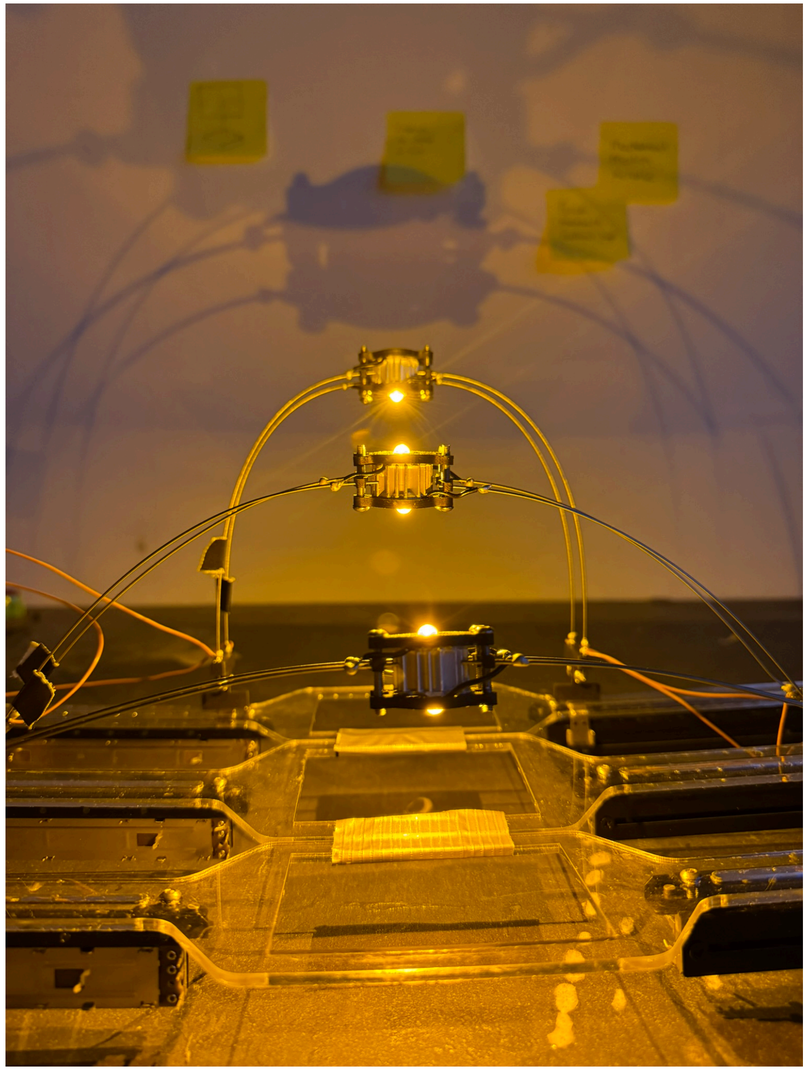


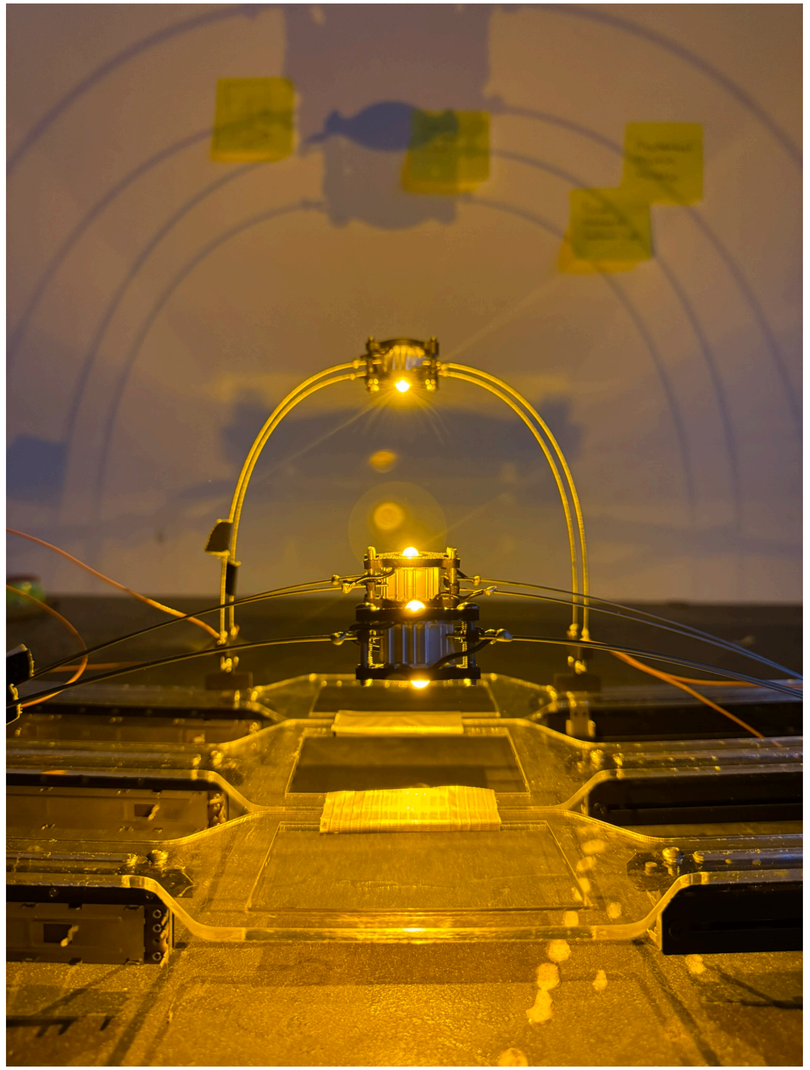


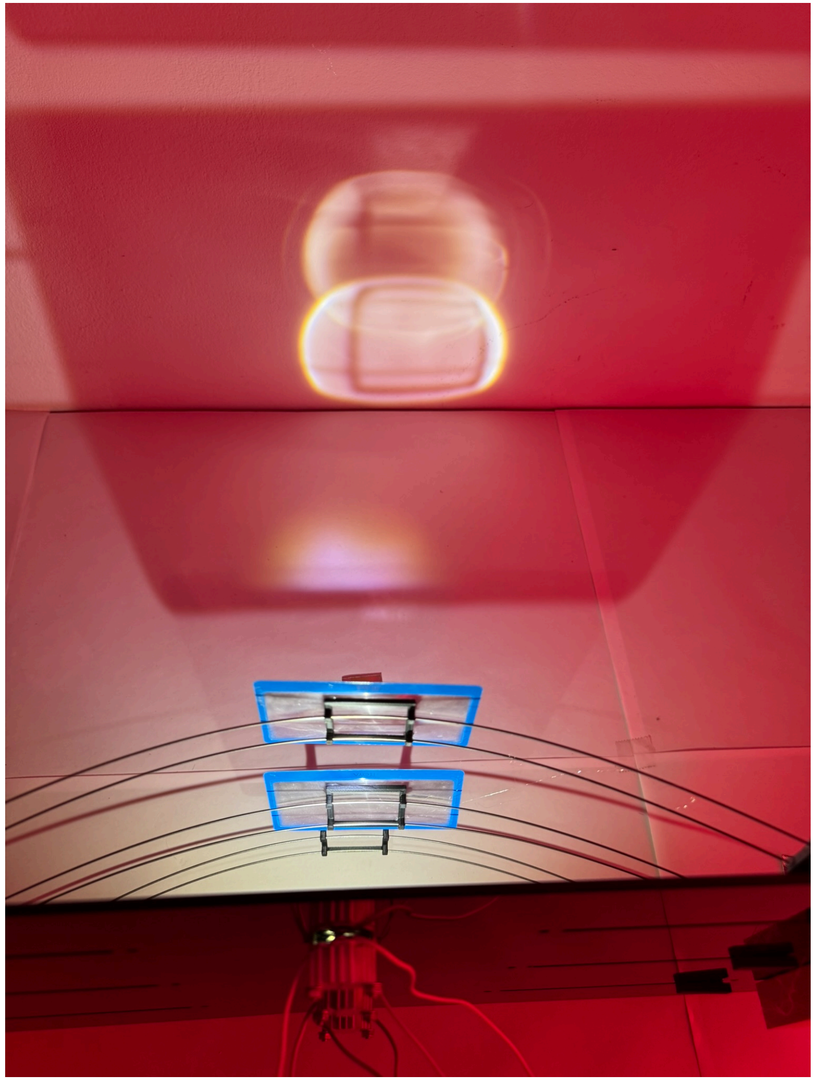


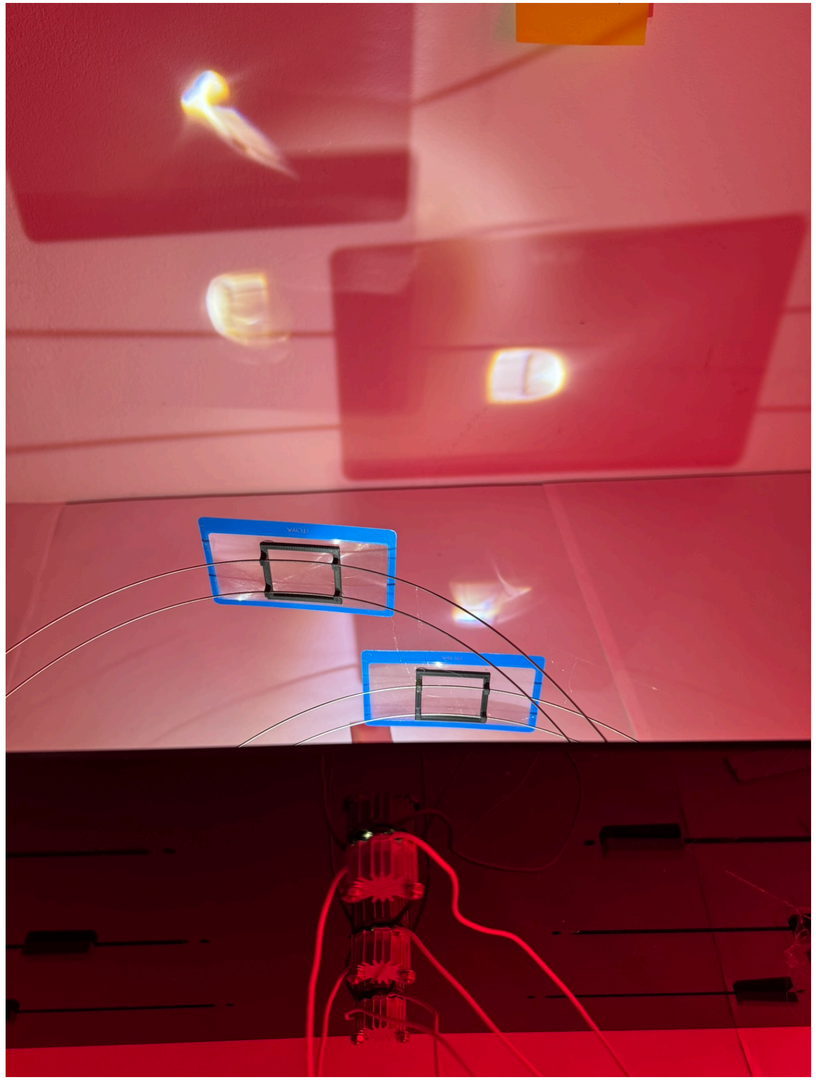


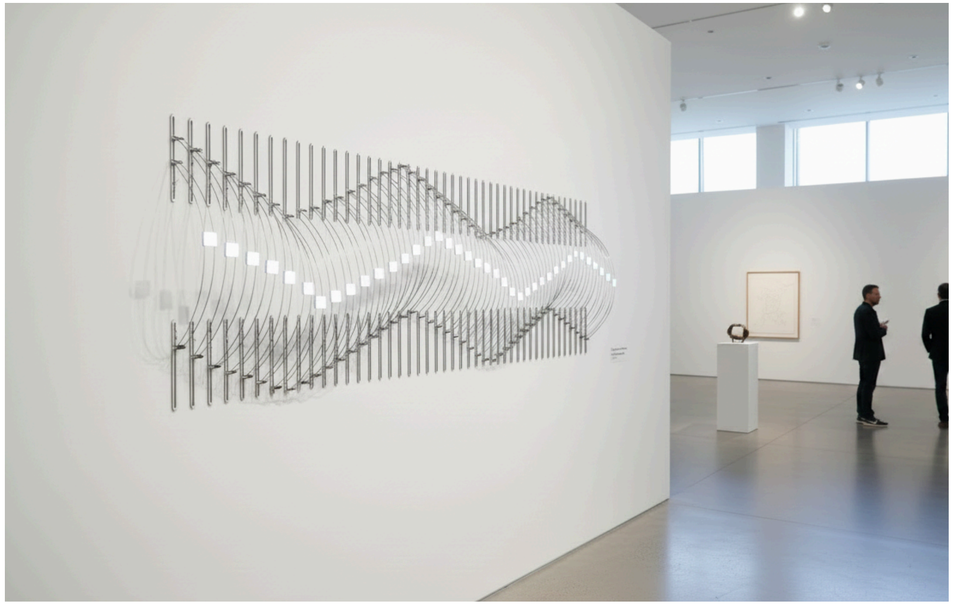


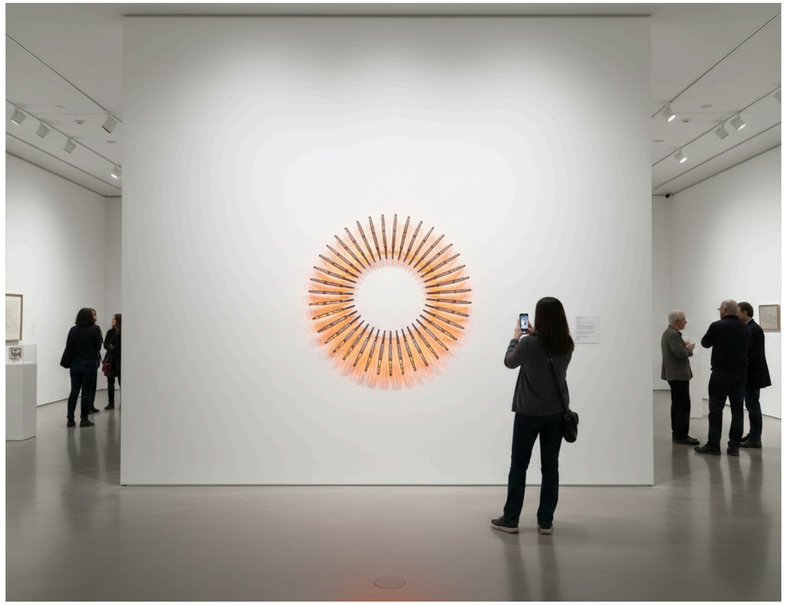


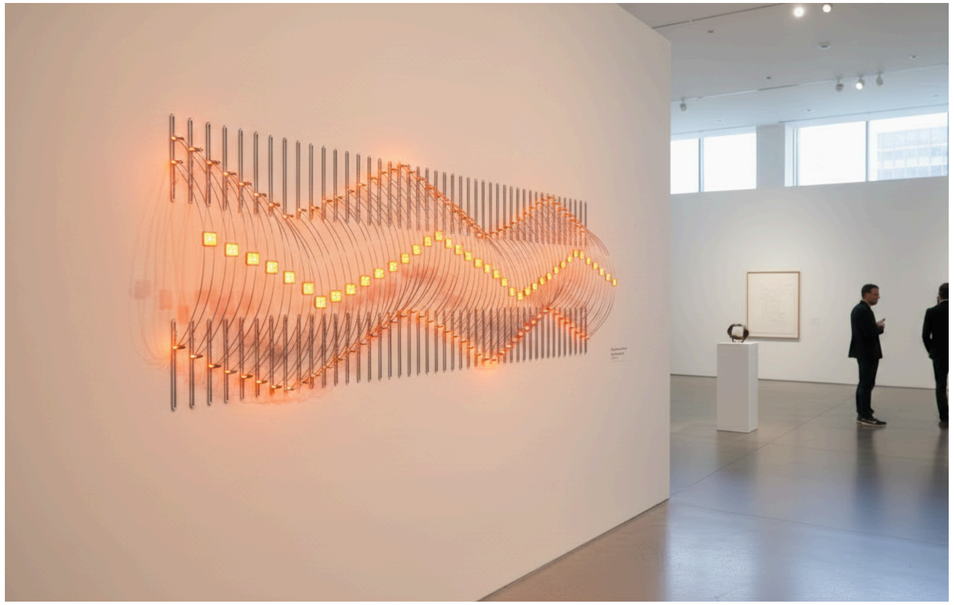


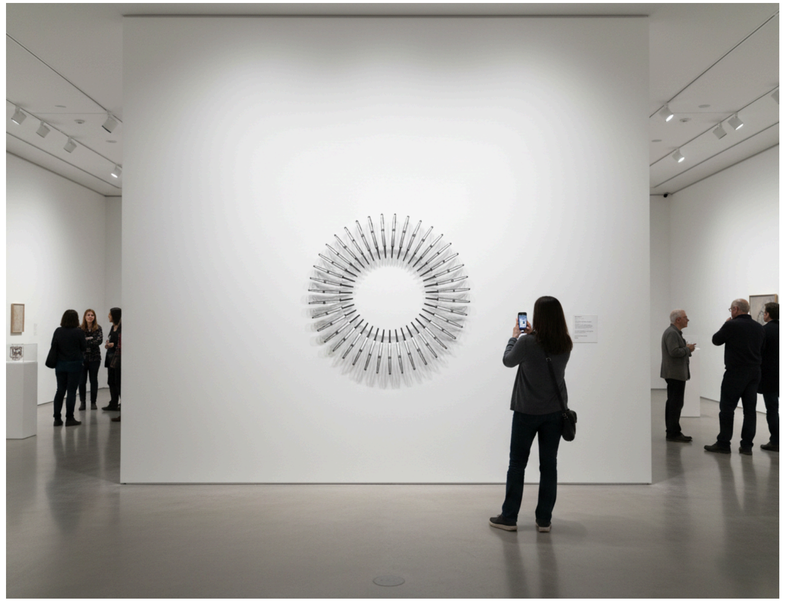


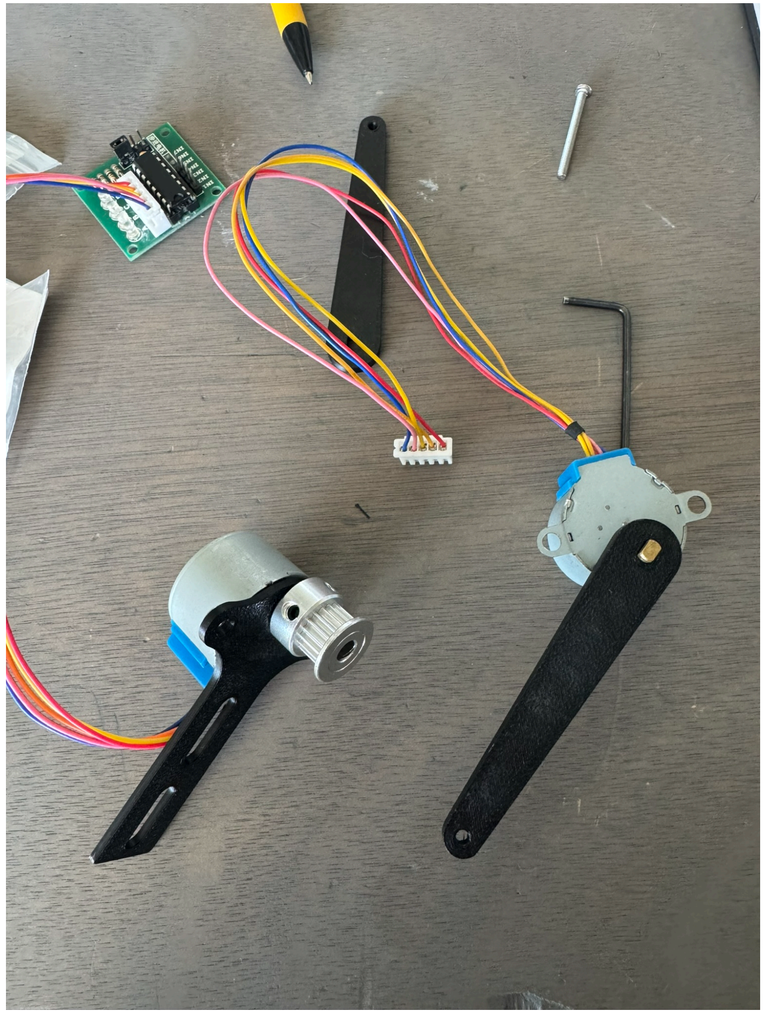


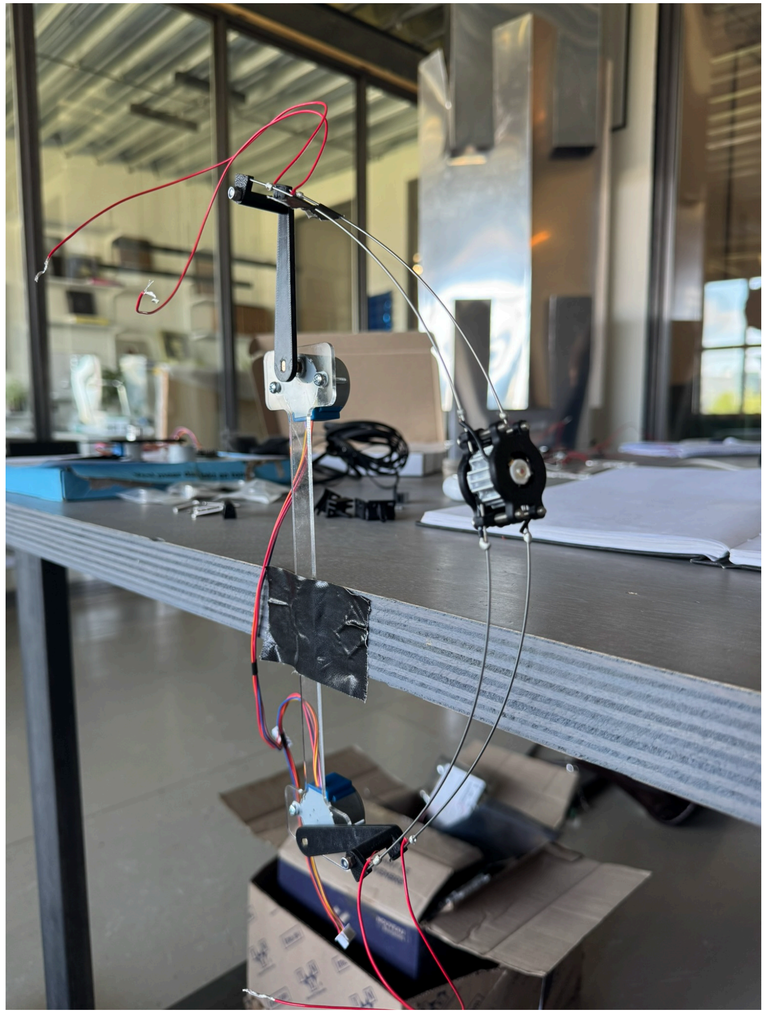










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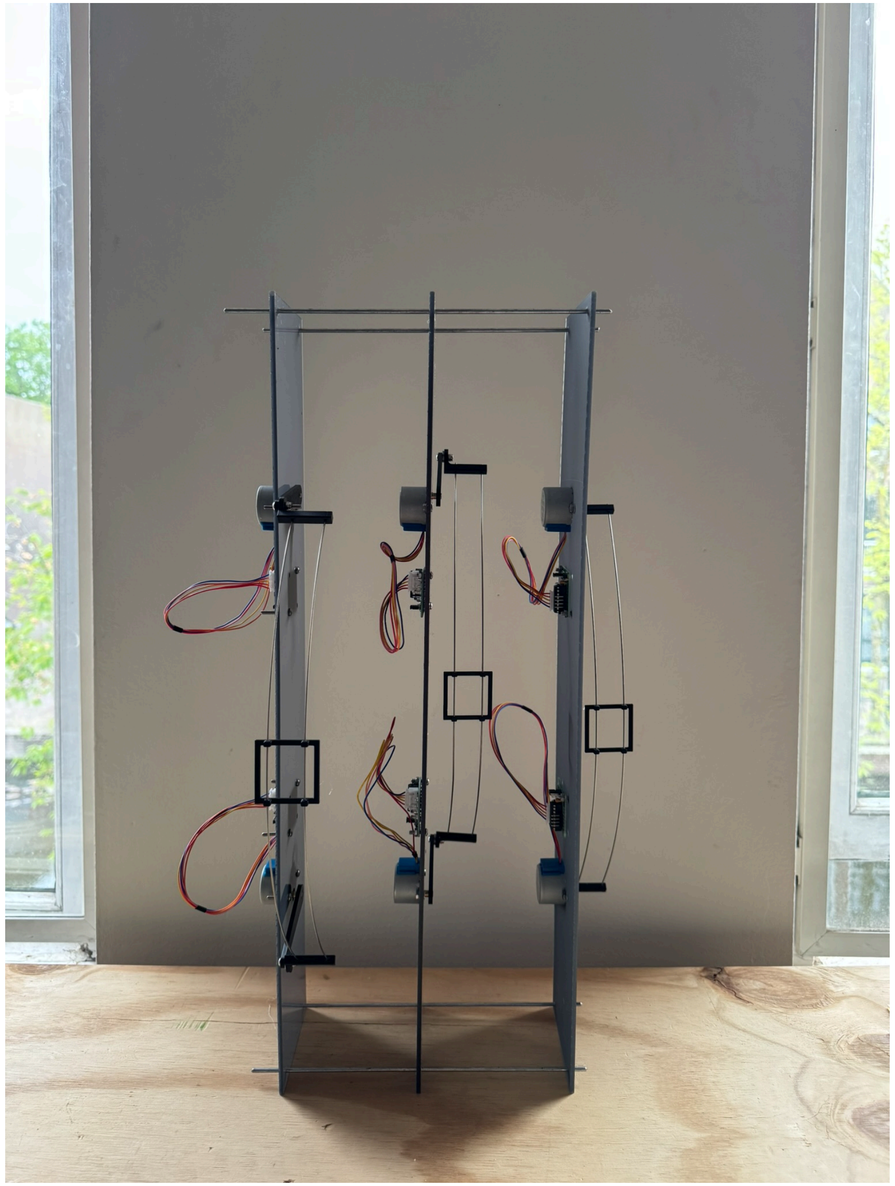
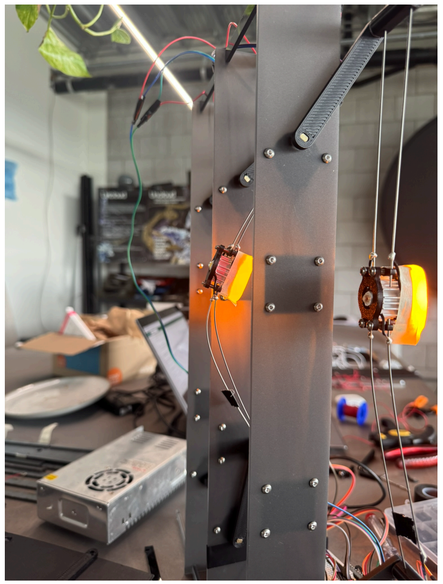
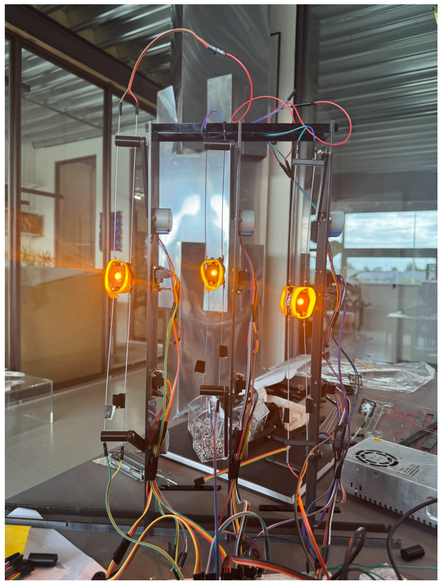








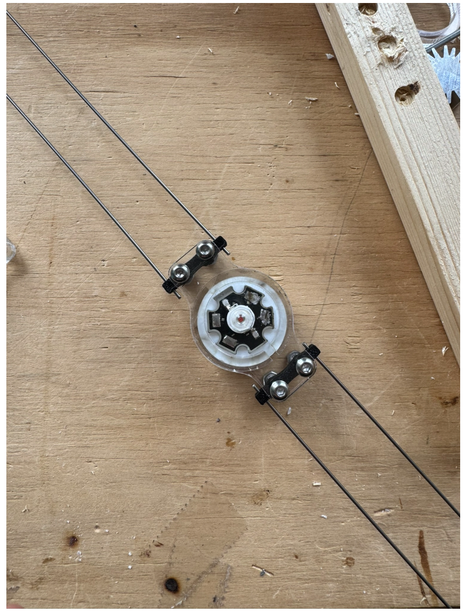


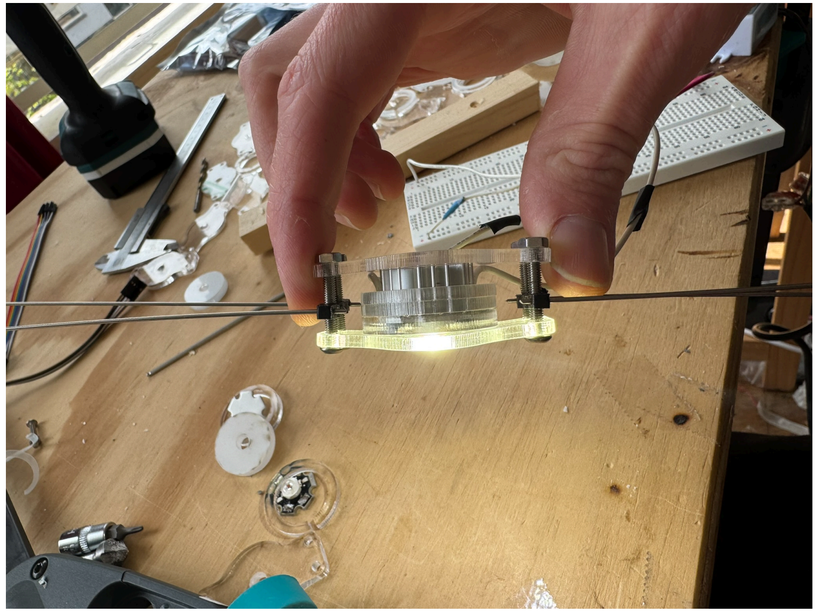


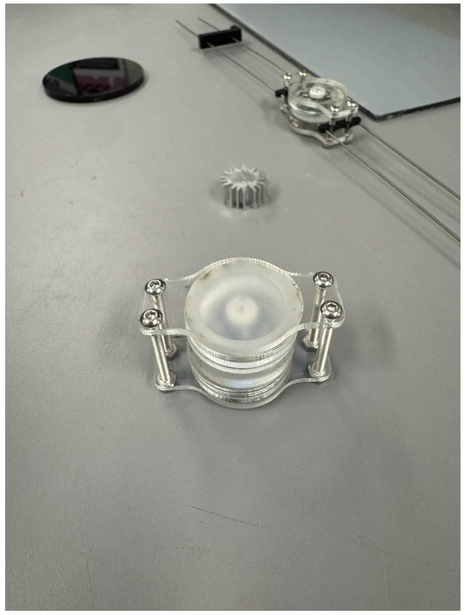


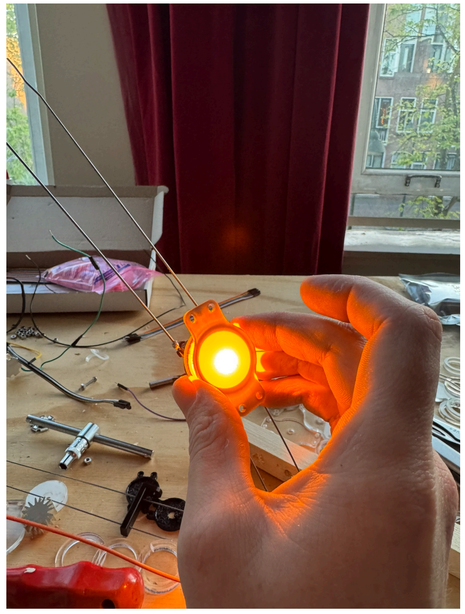
ITERATION 4 - EXPERIMENTING WITH LED

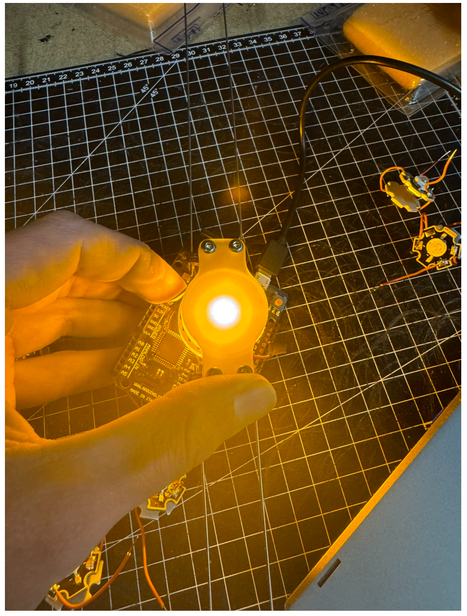
APPENDIX A



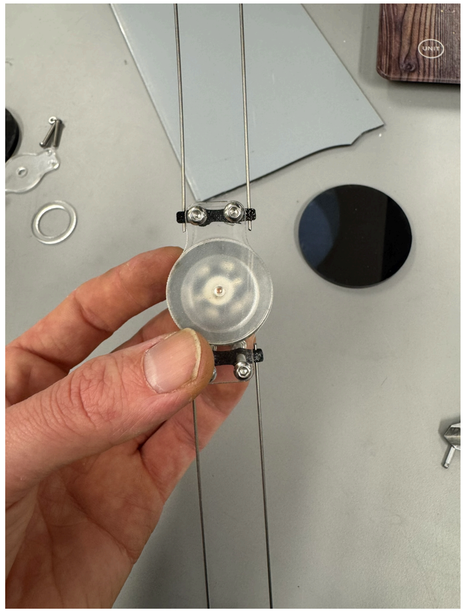












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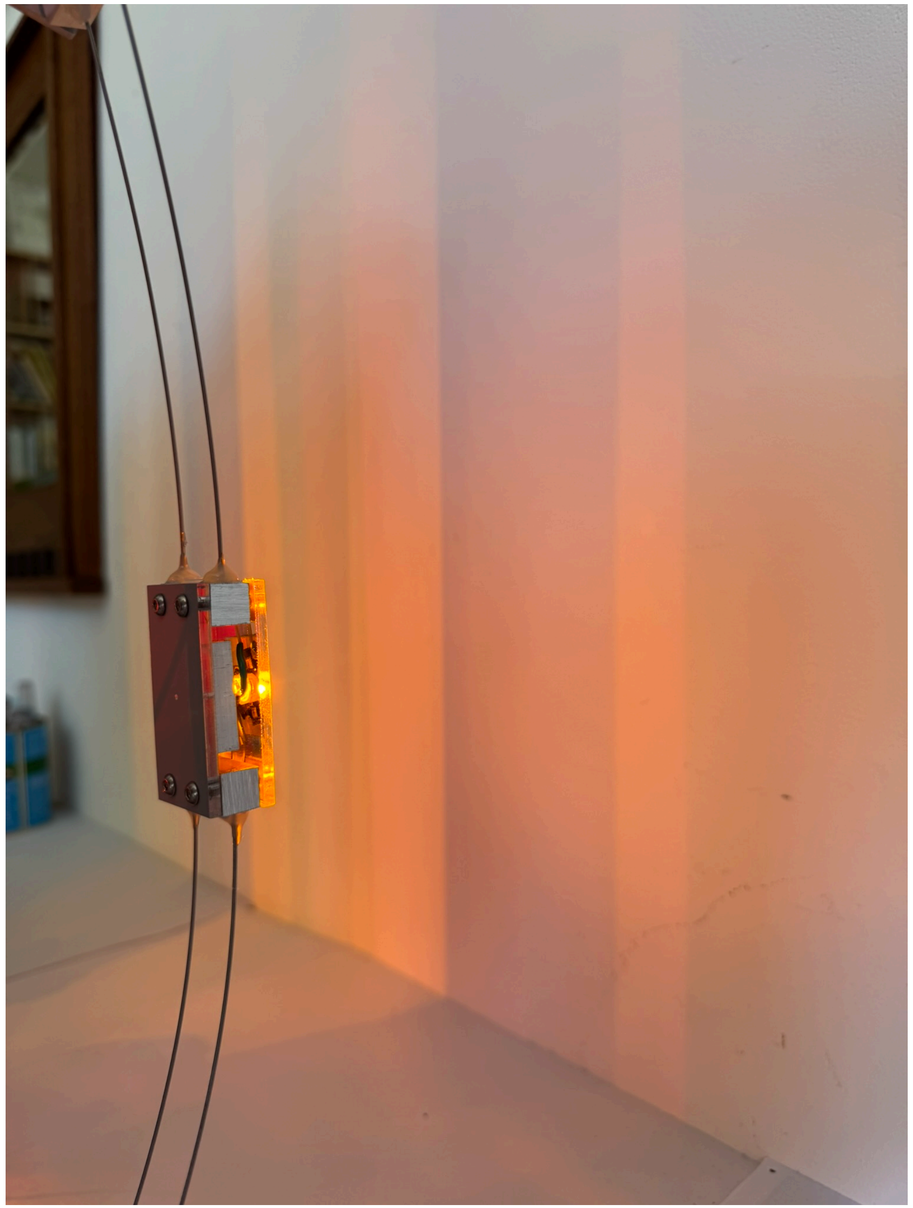

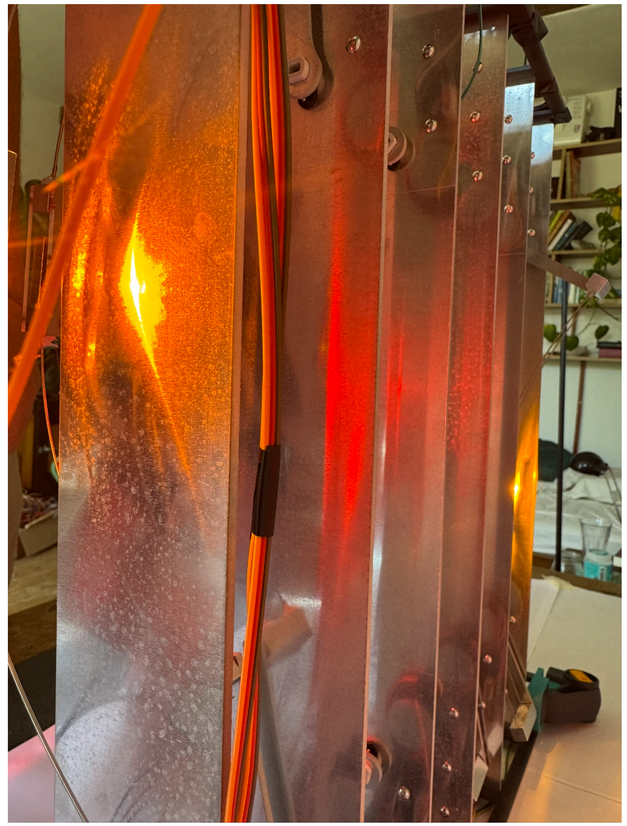

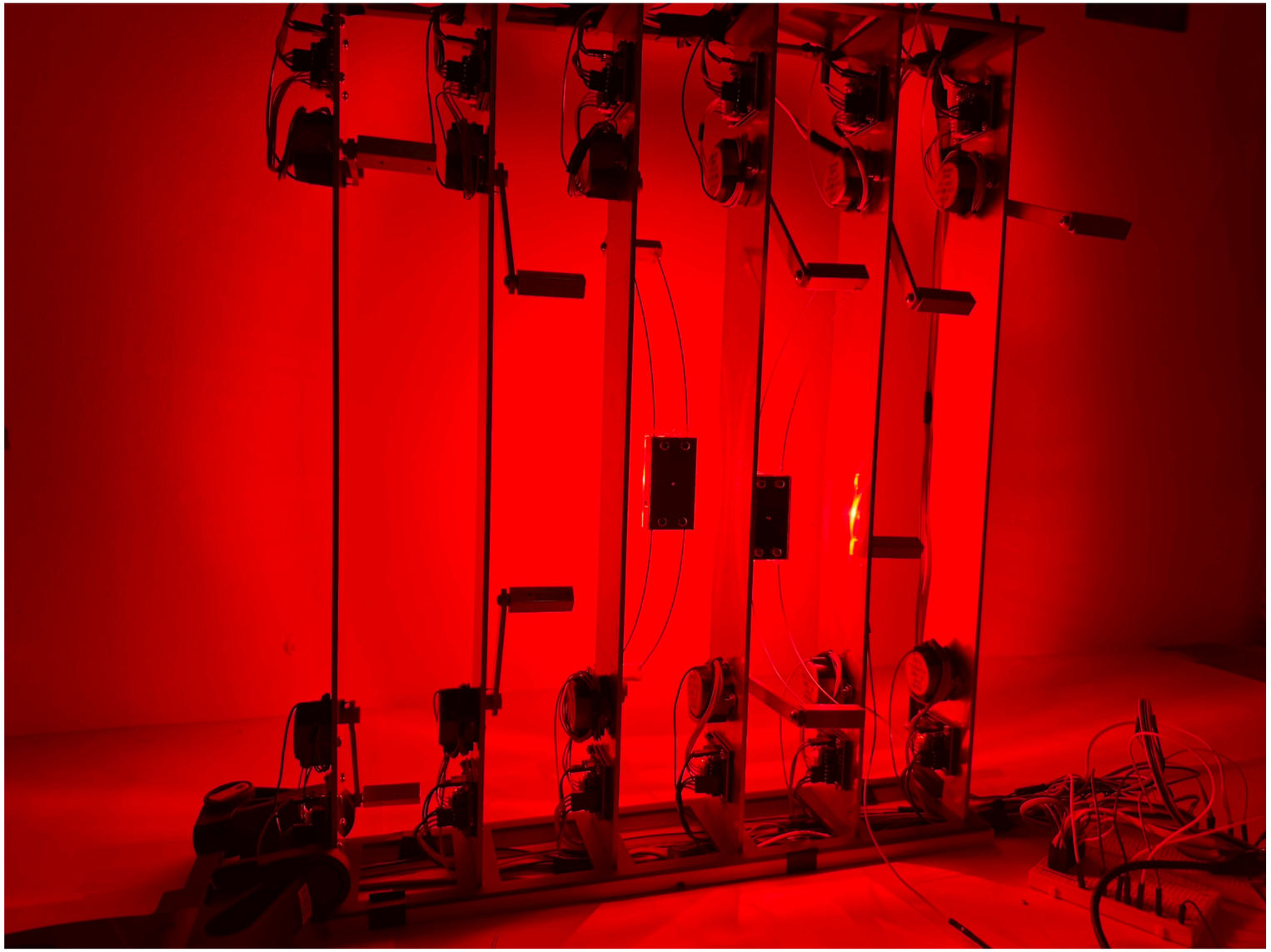

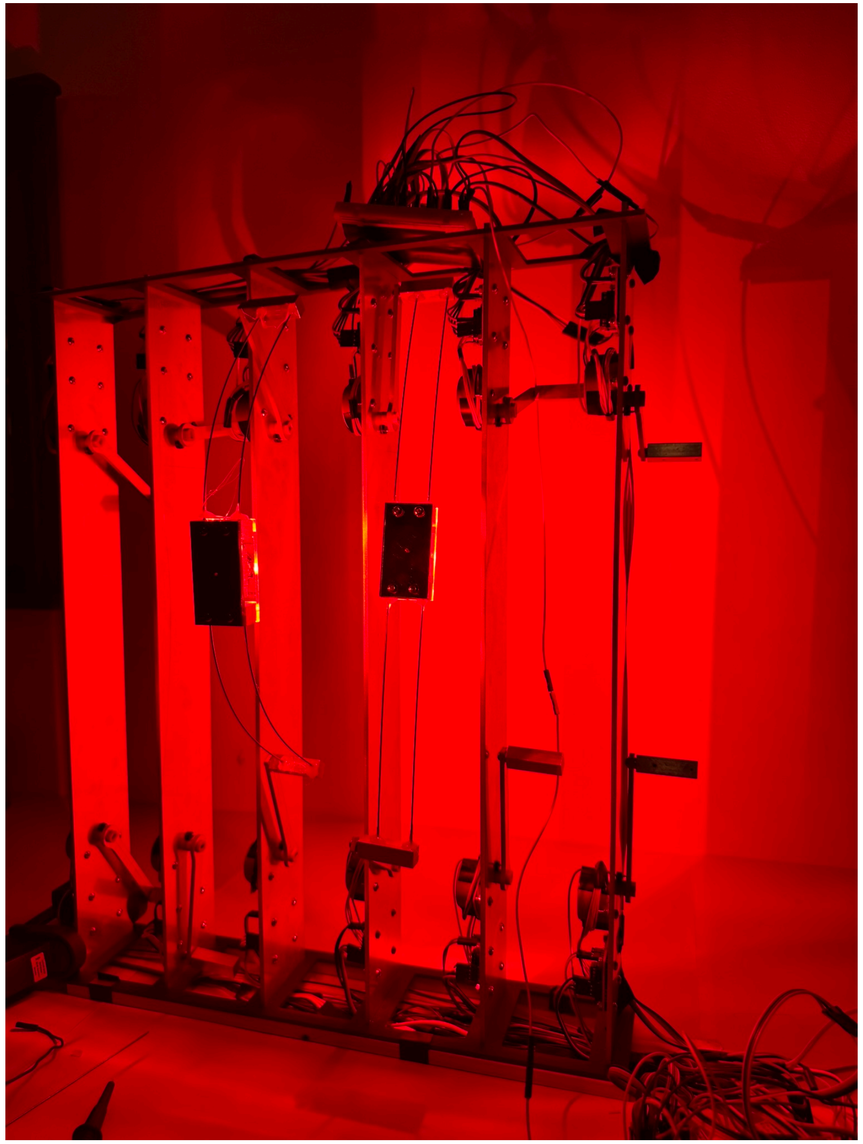

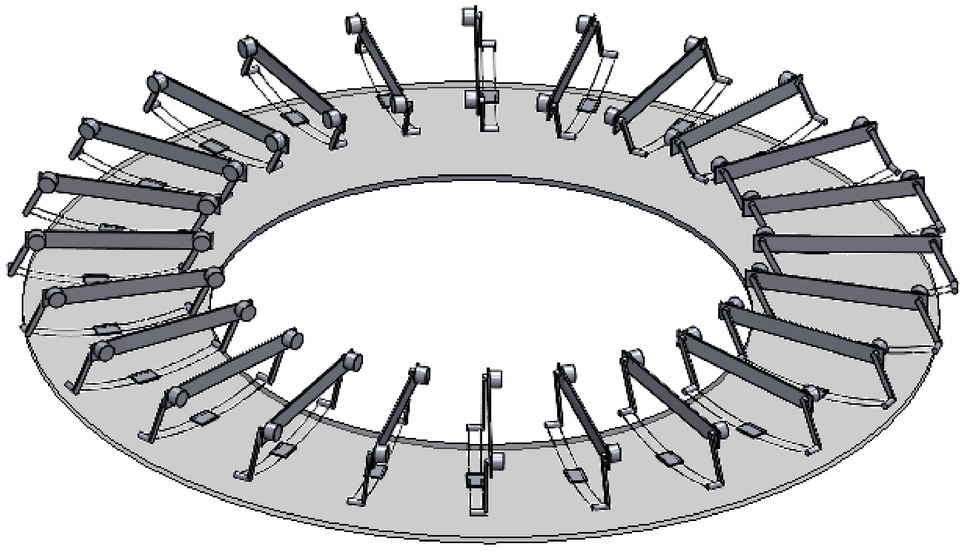

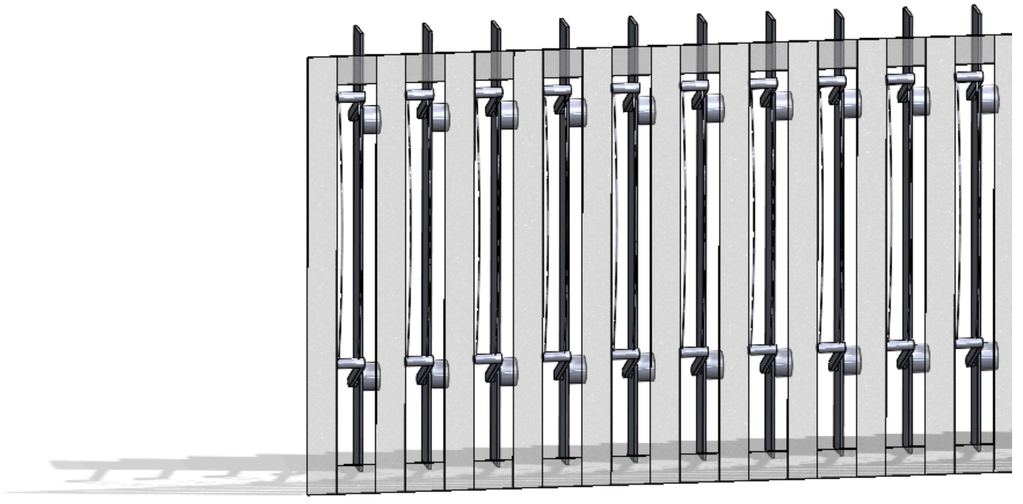



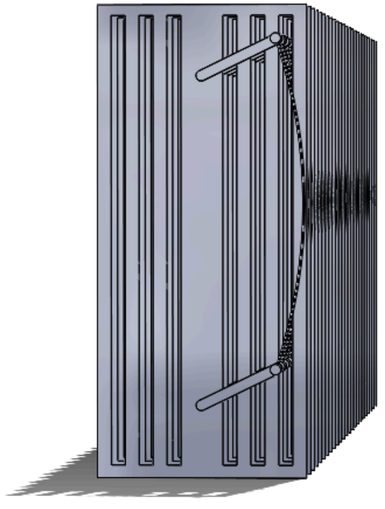

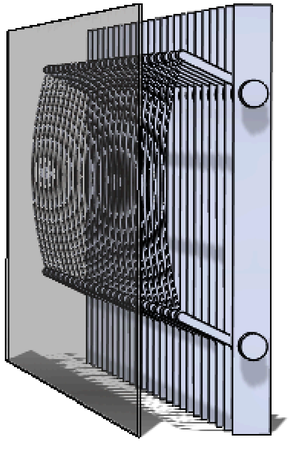

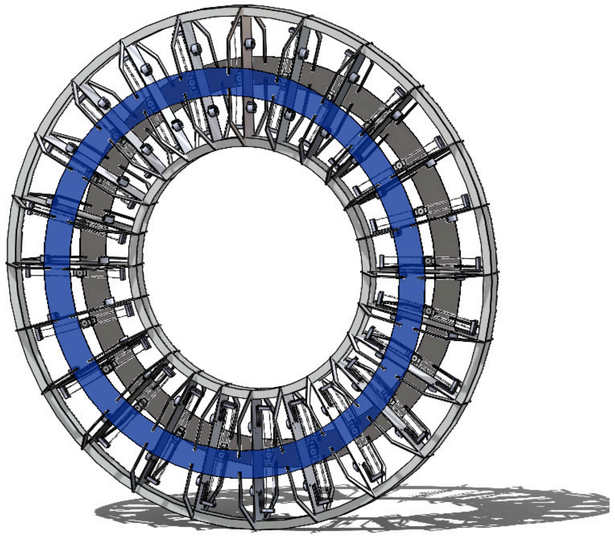

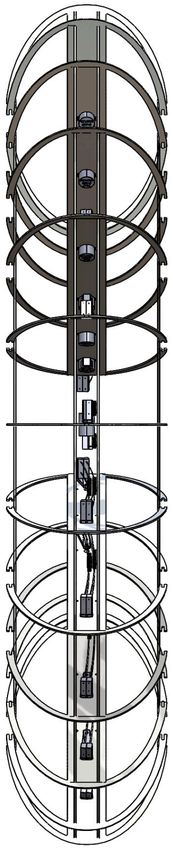

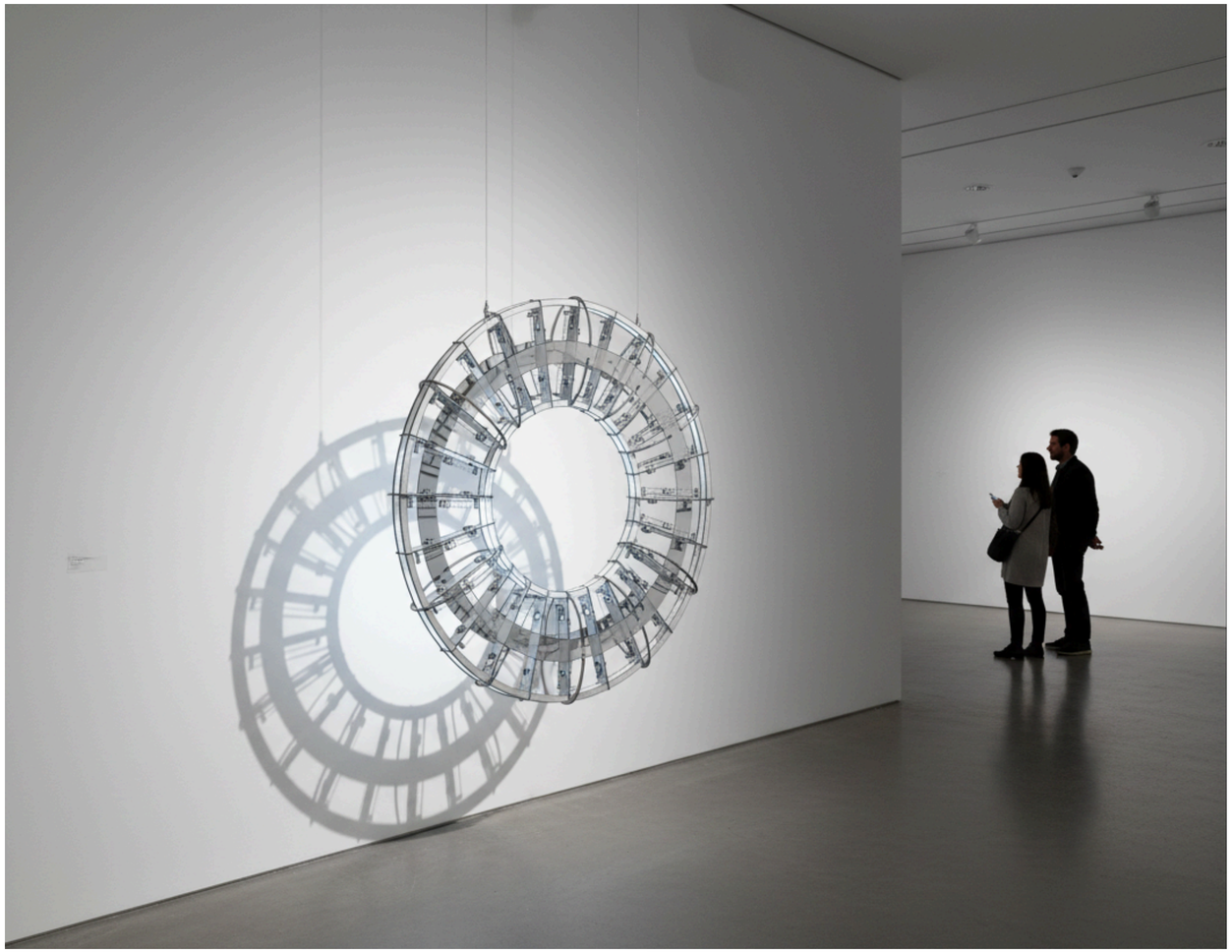

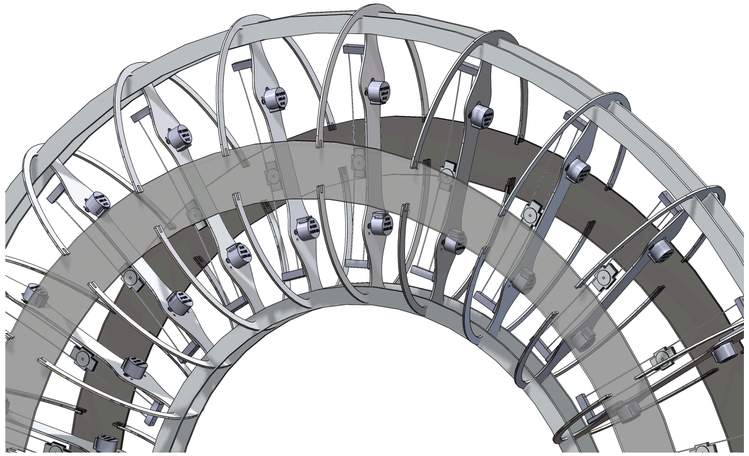

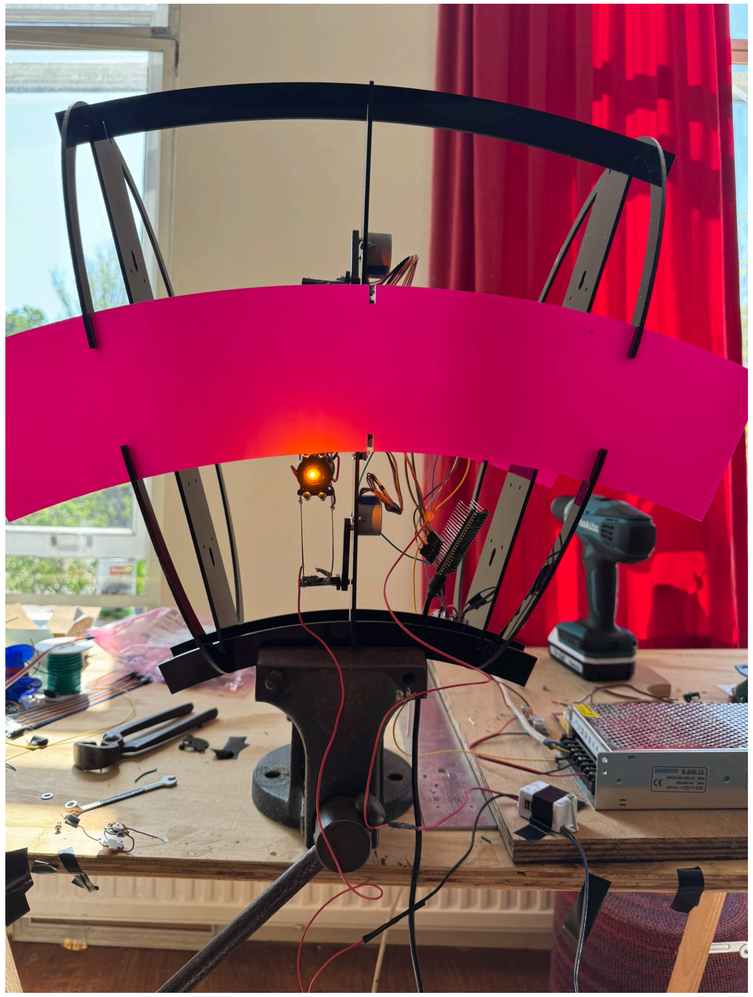

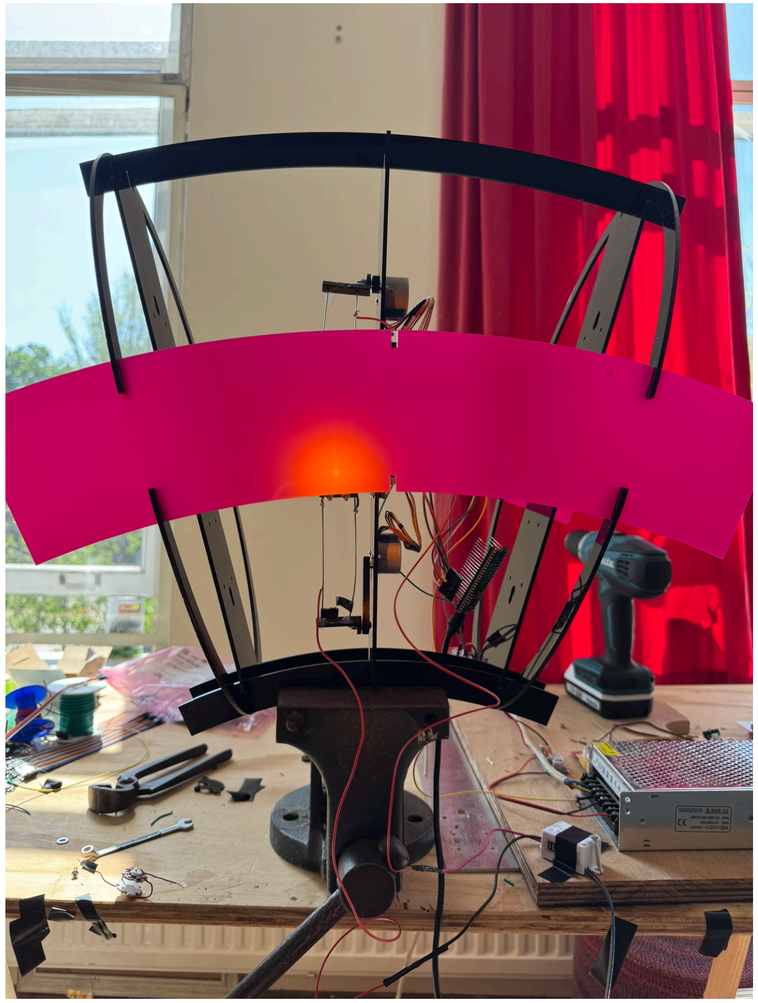


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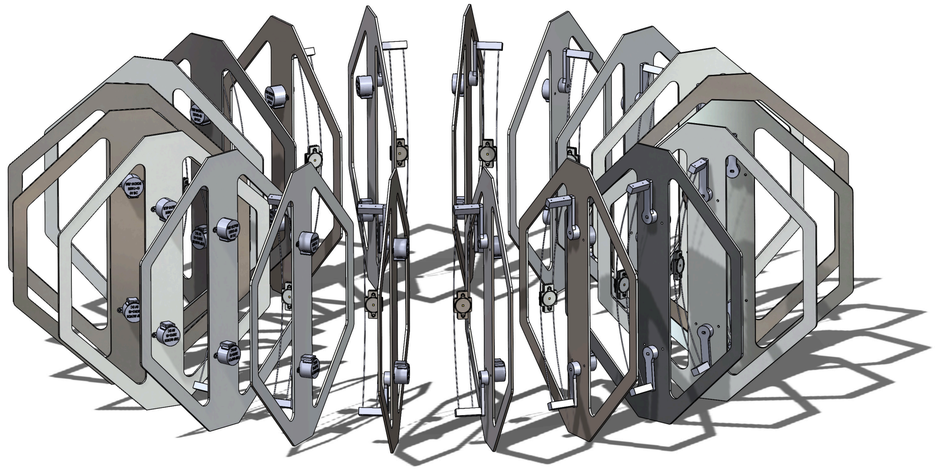

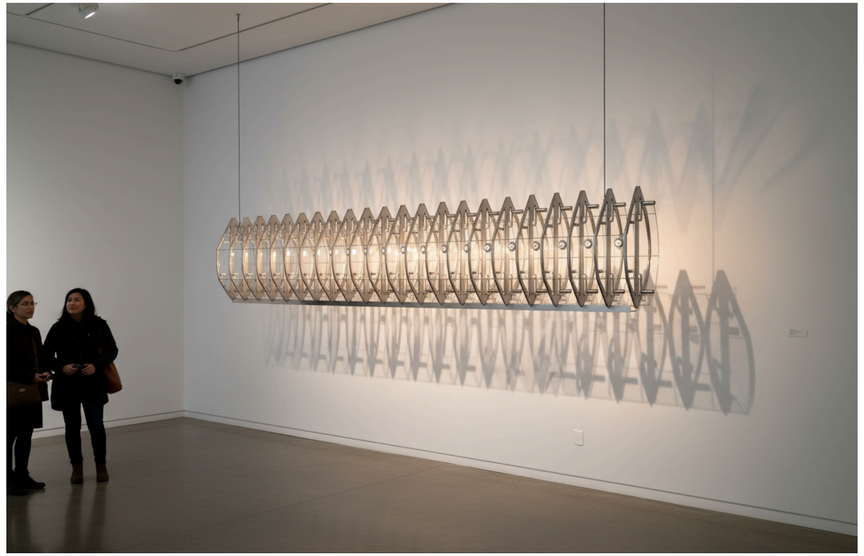

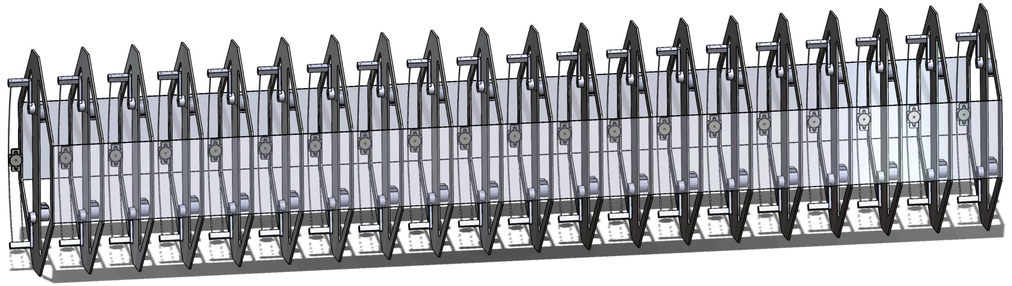



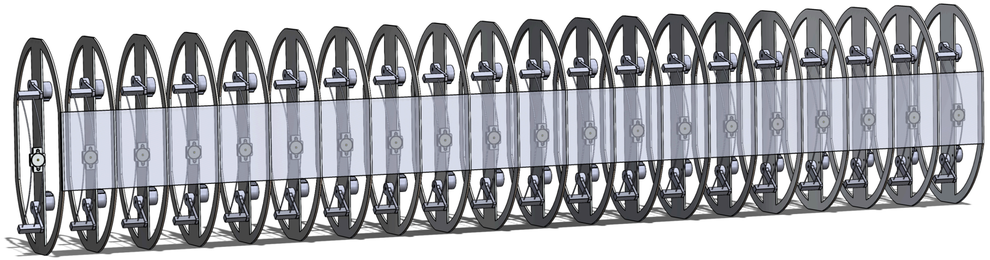

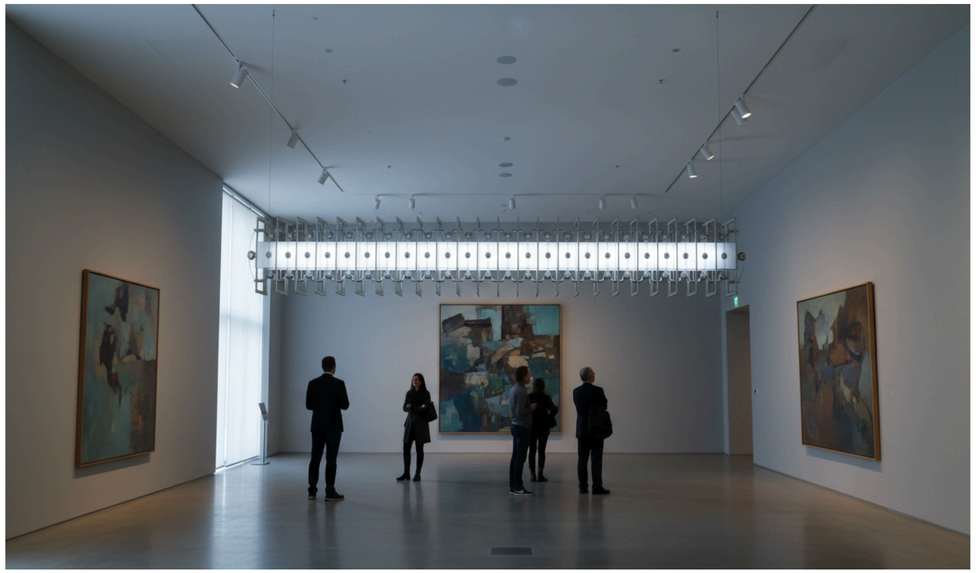

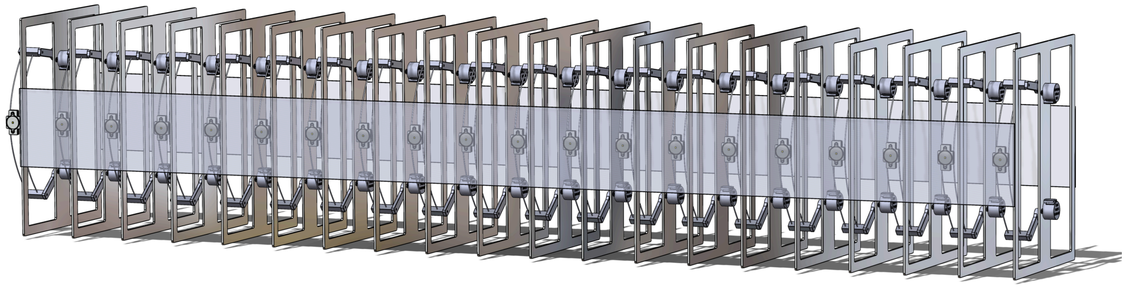

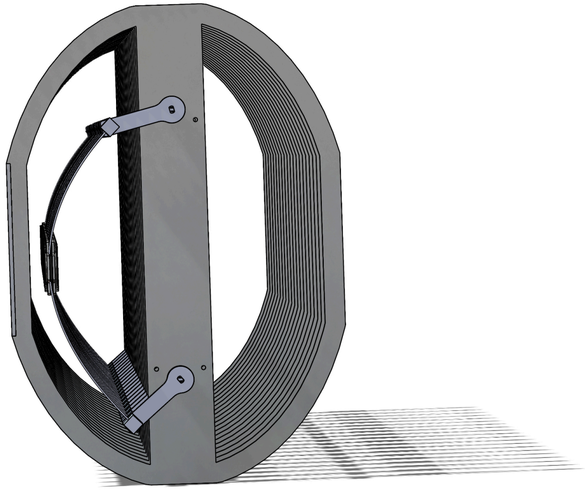

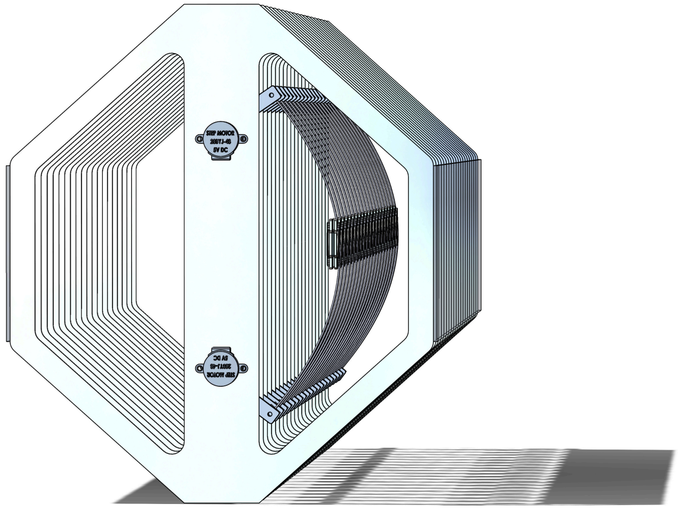

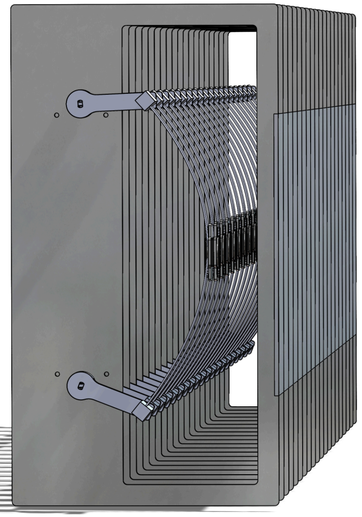

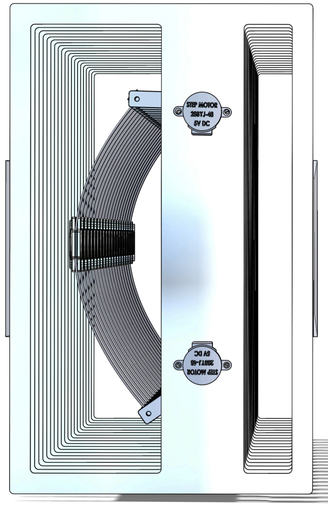

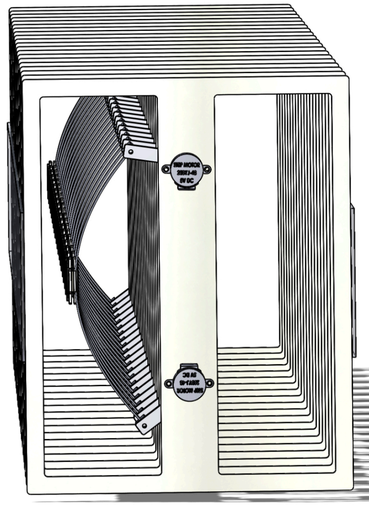

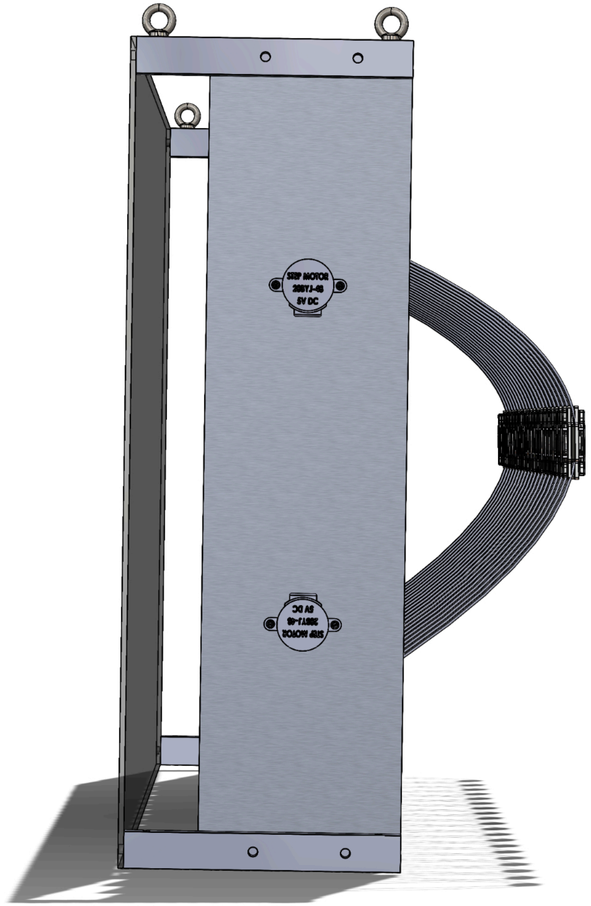
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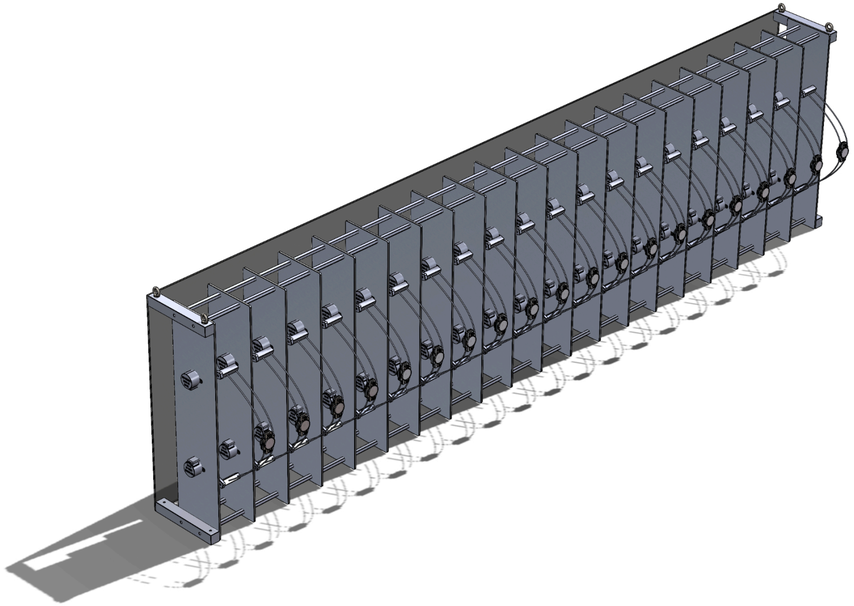
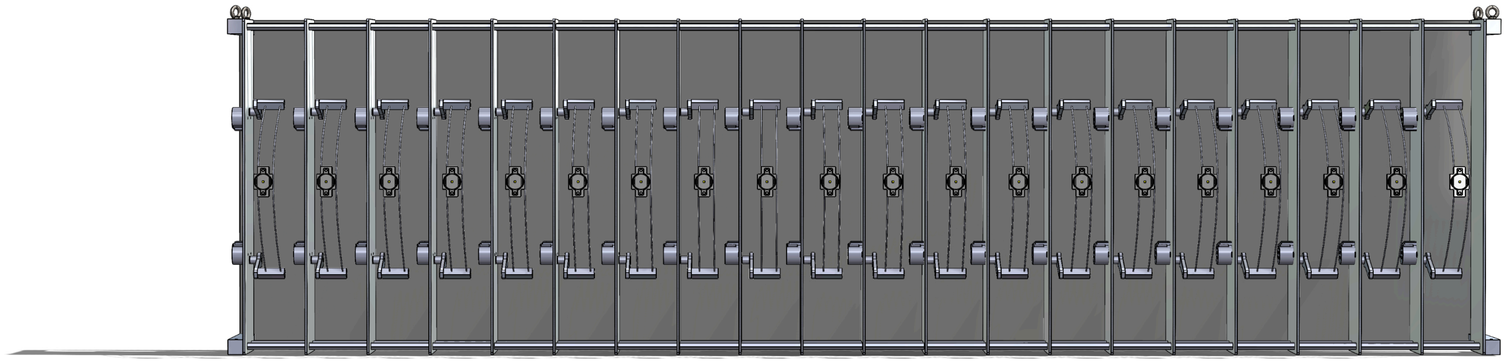
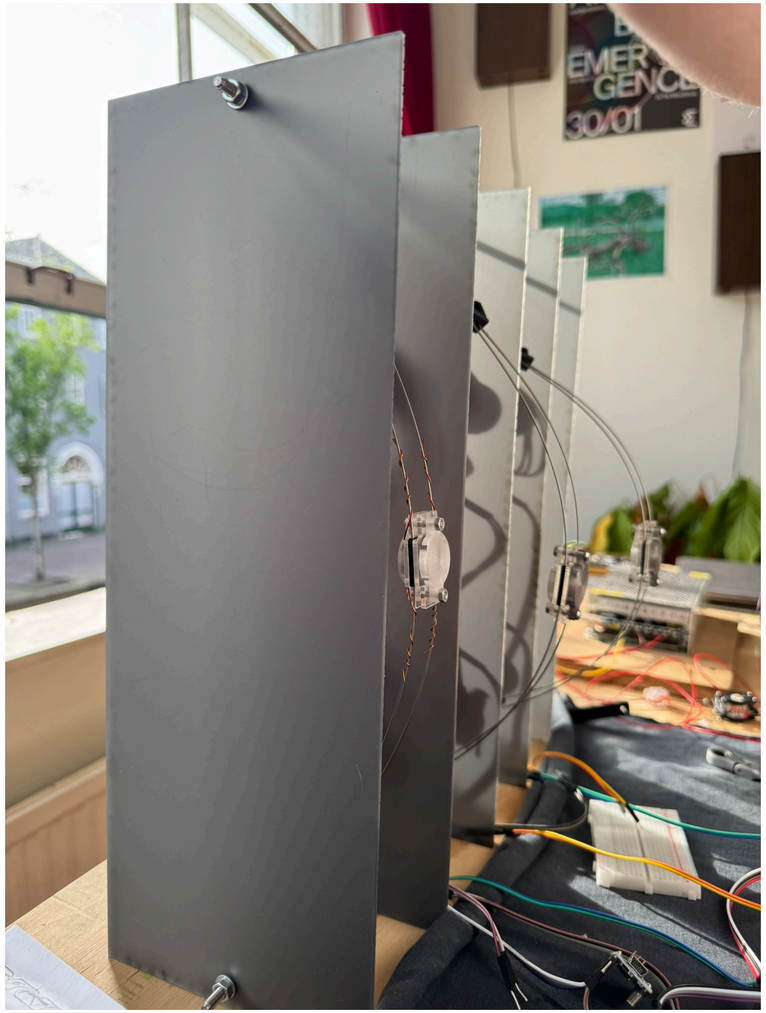
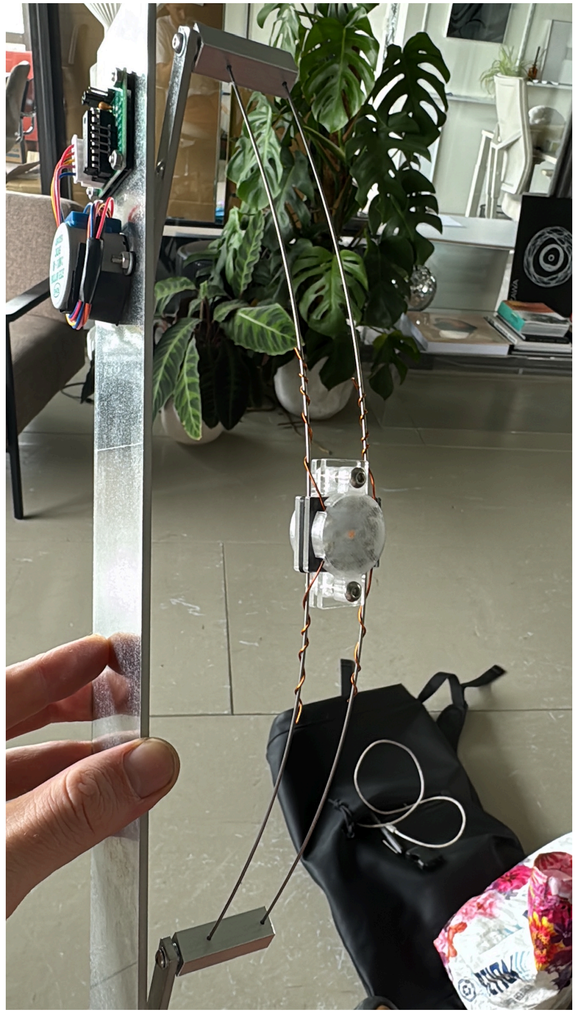
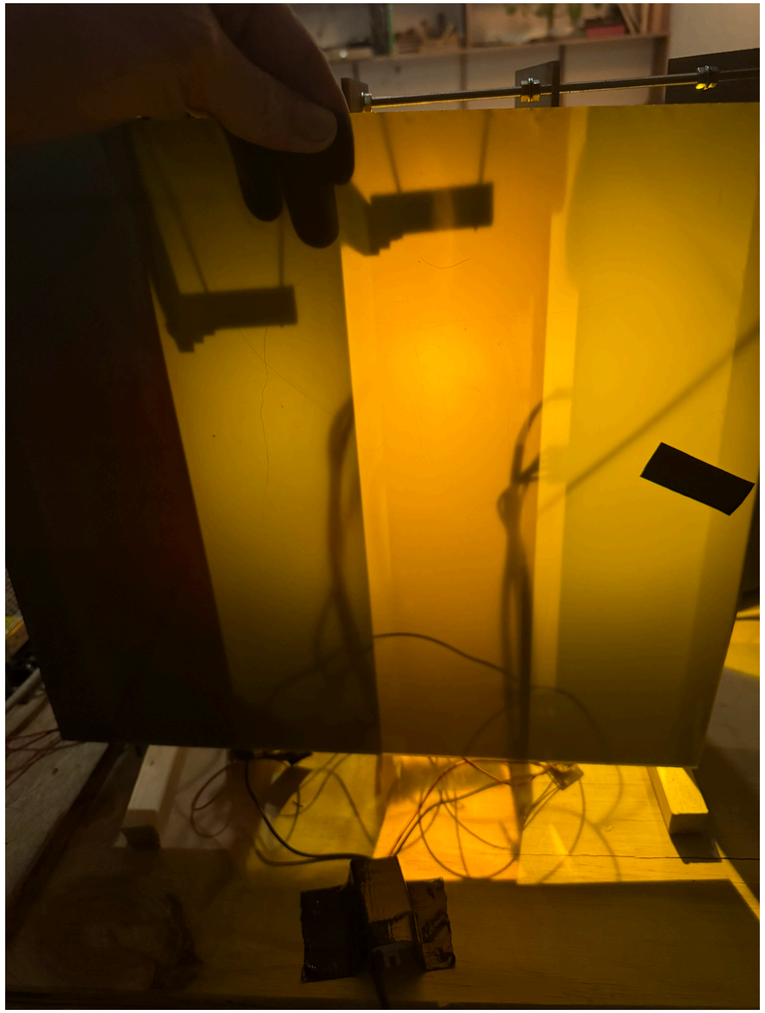




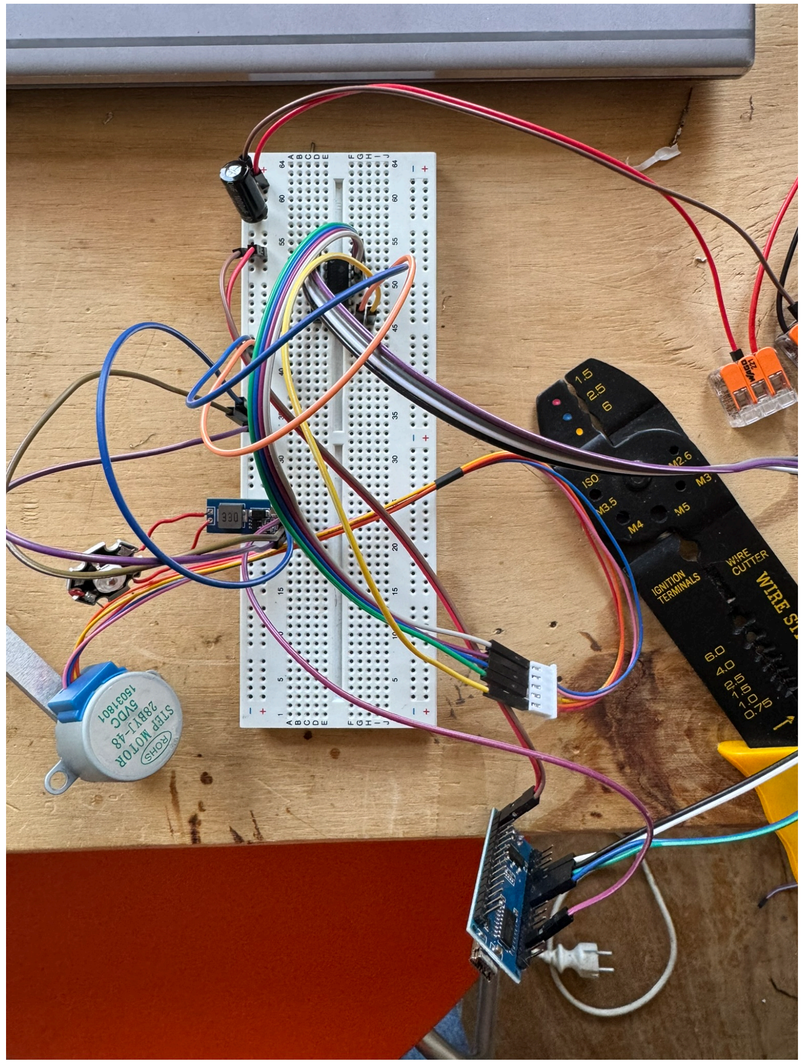


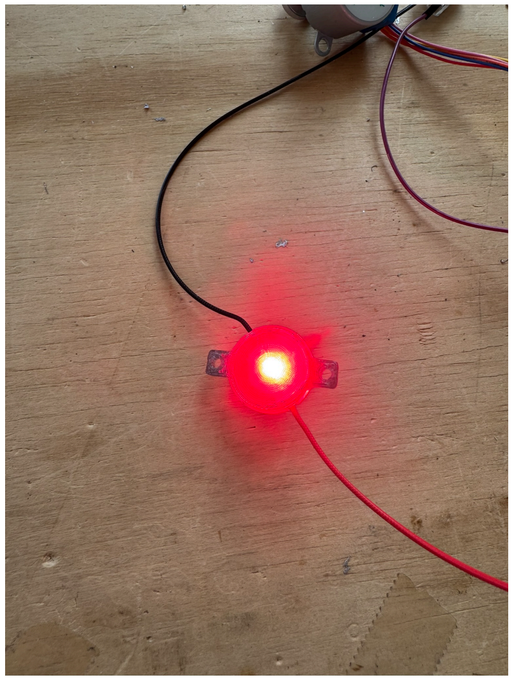


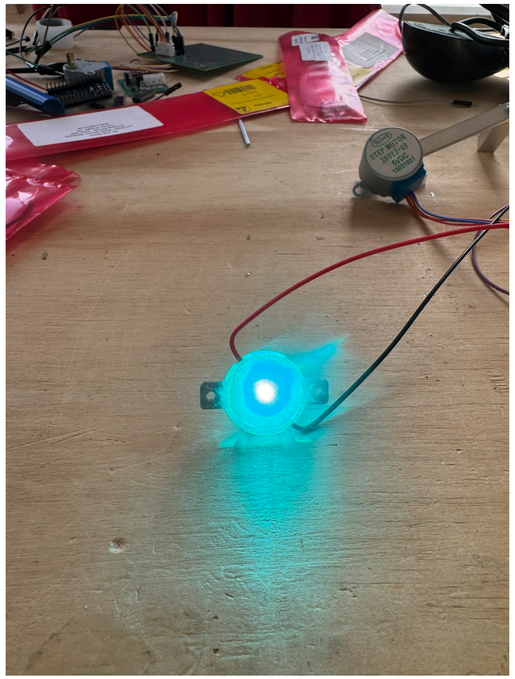


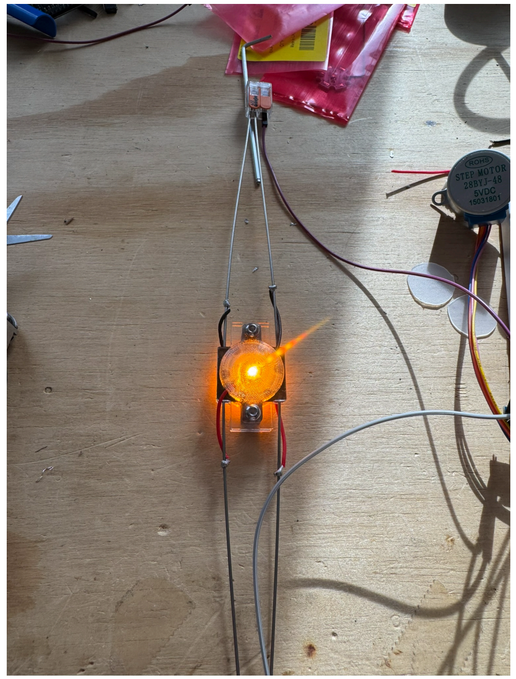
ITERATION 6 - ARRAY PROTOTYPE

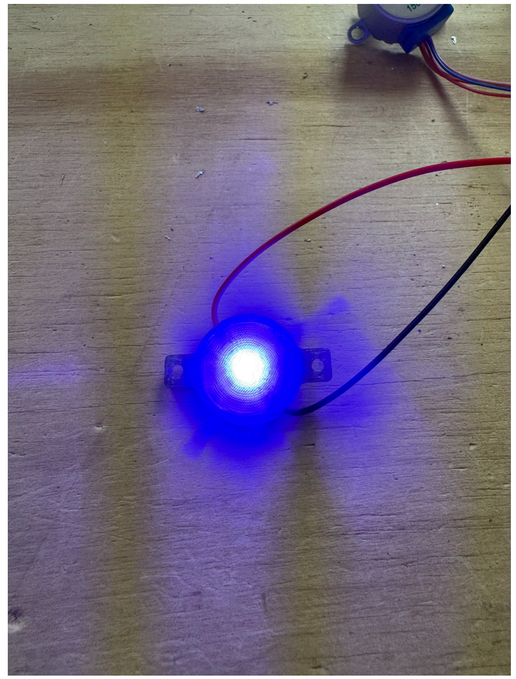


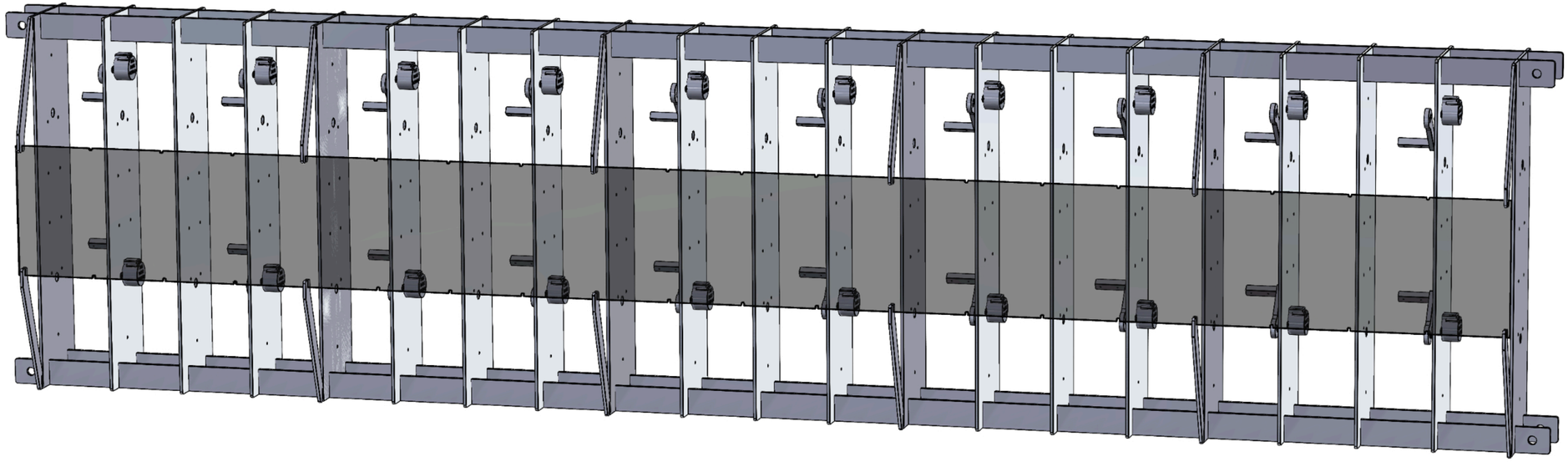


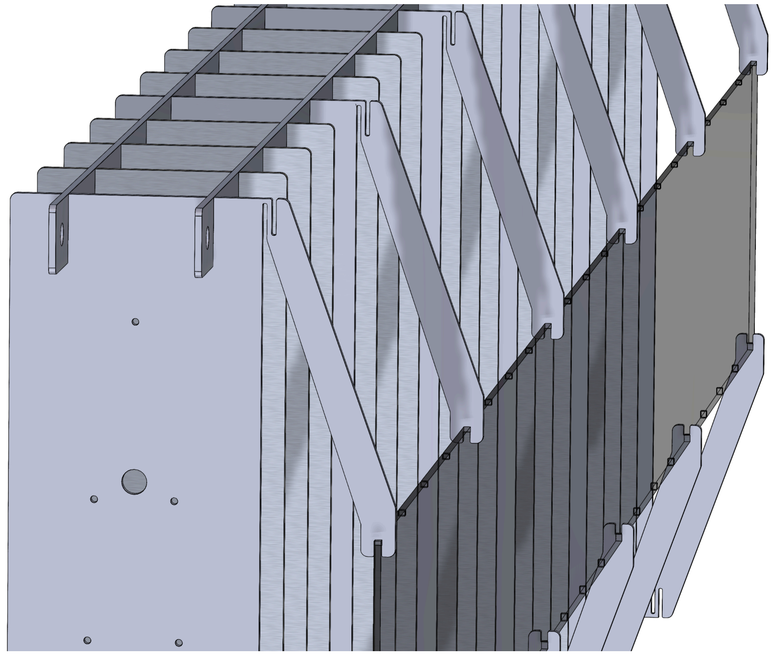


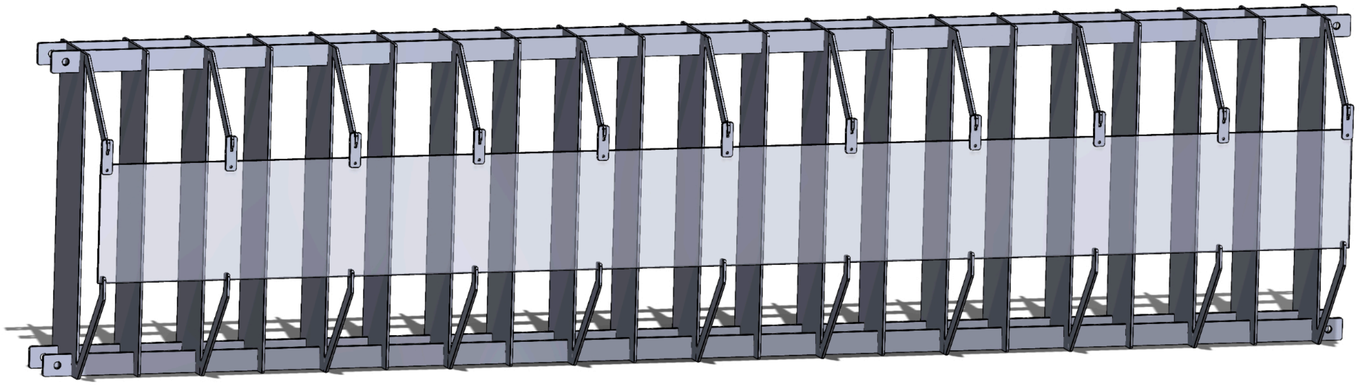


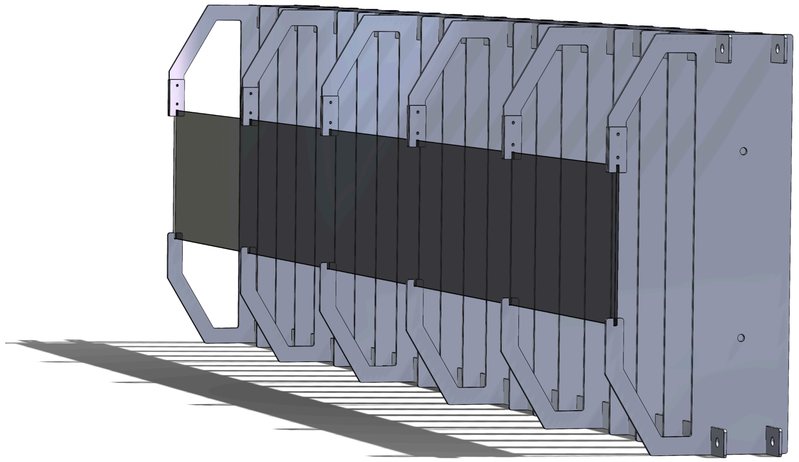


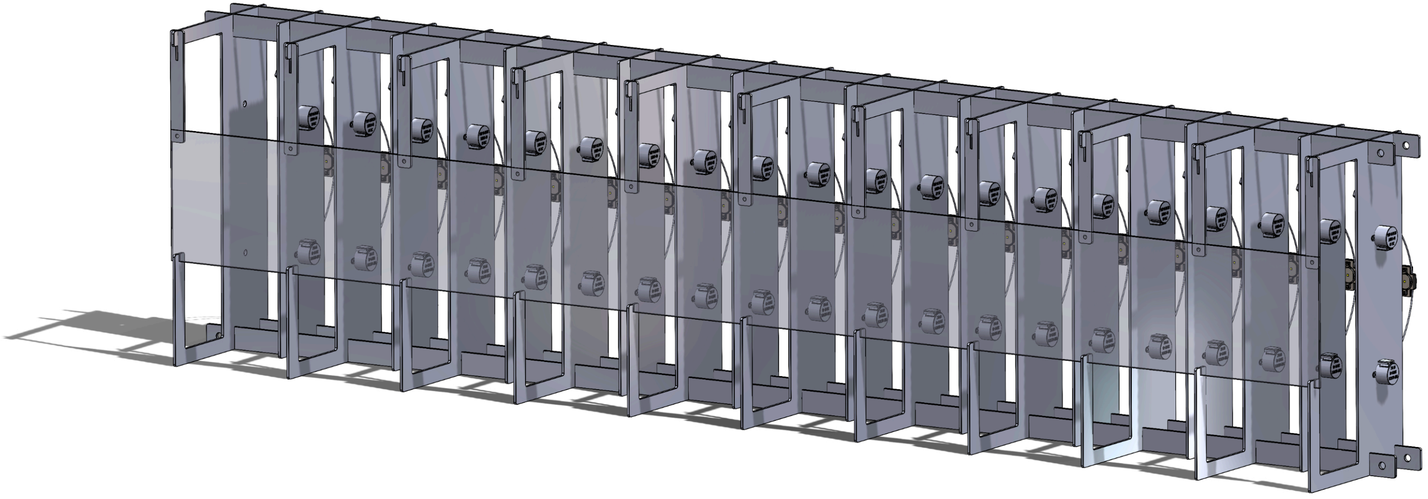


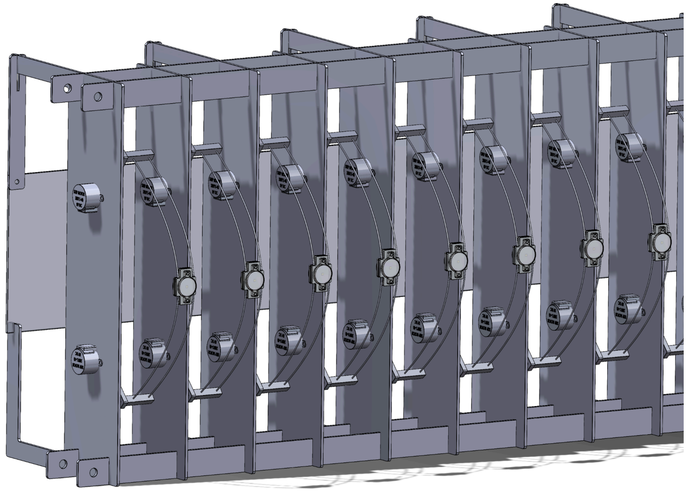


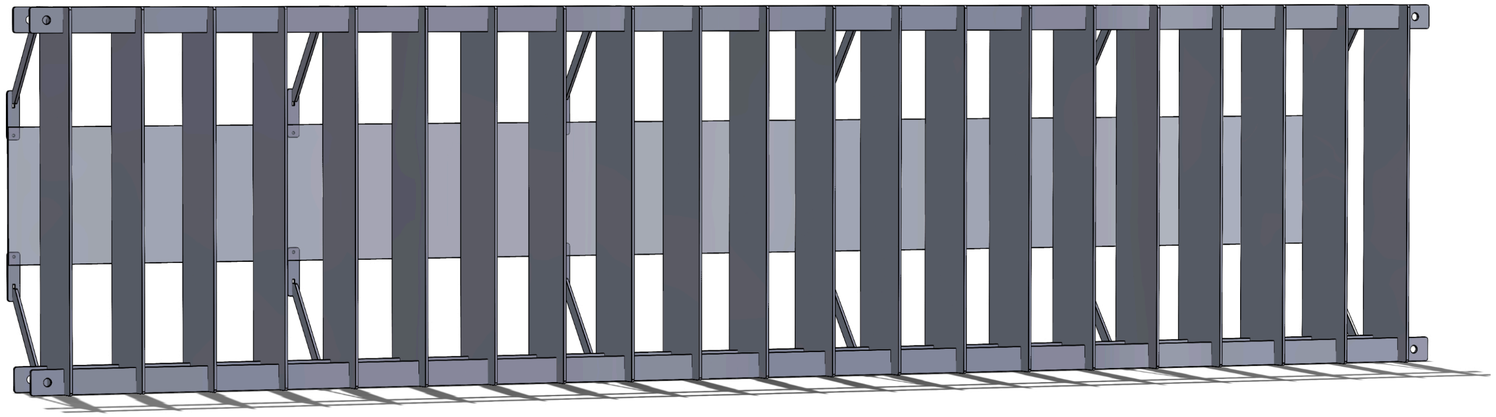


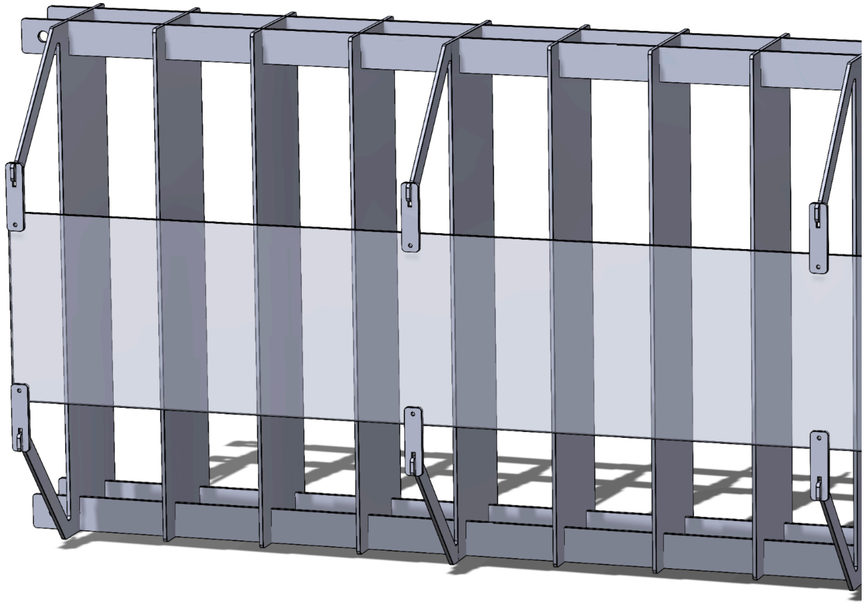


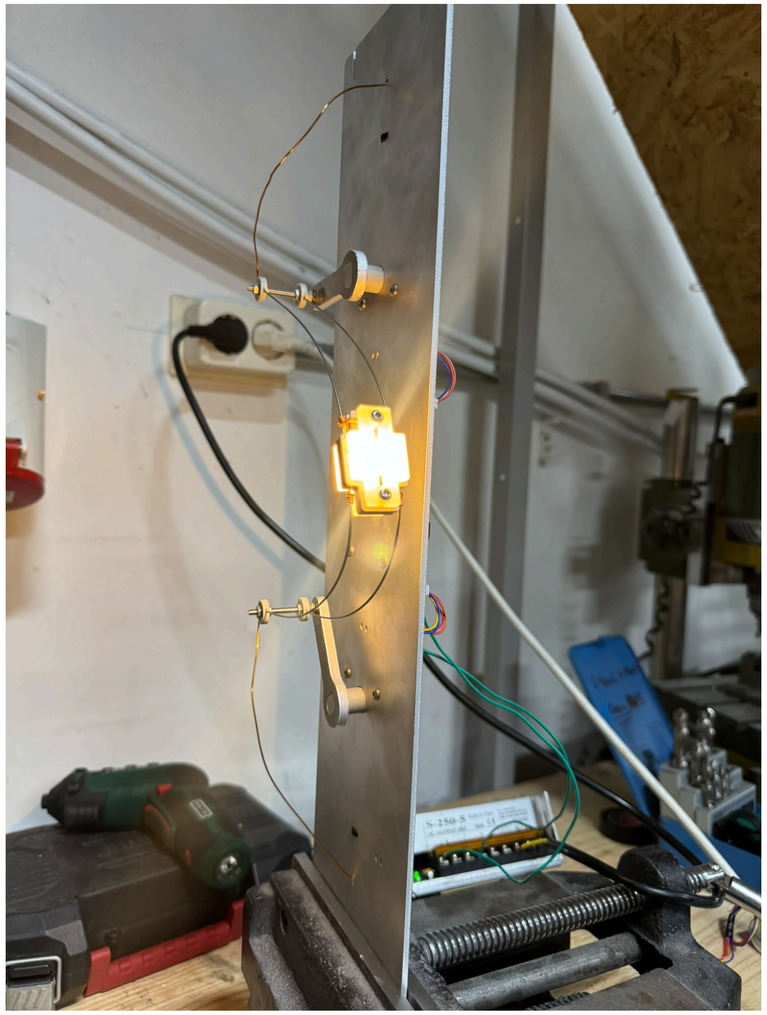




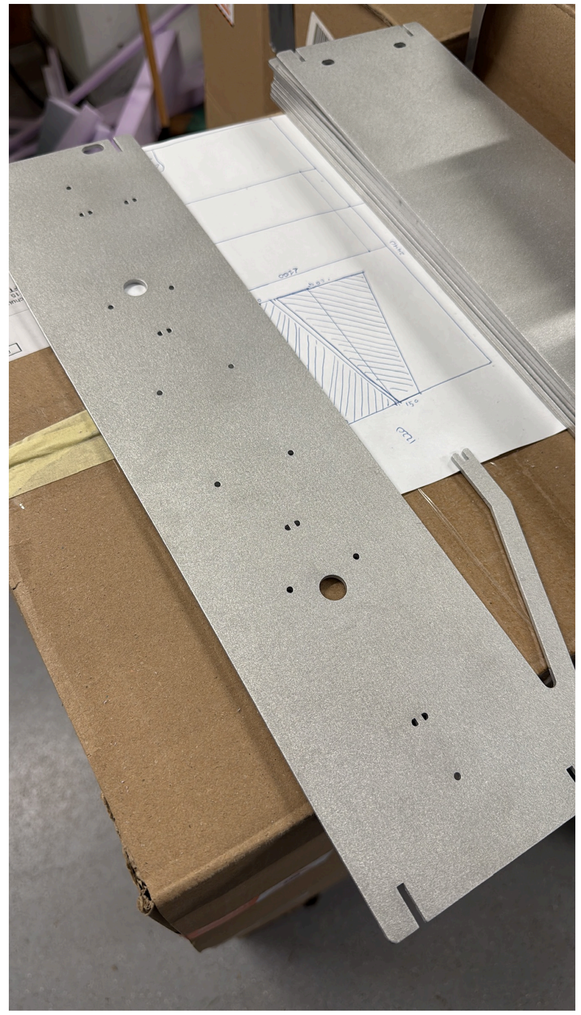


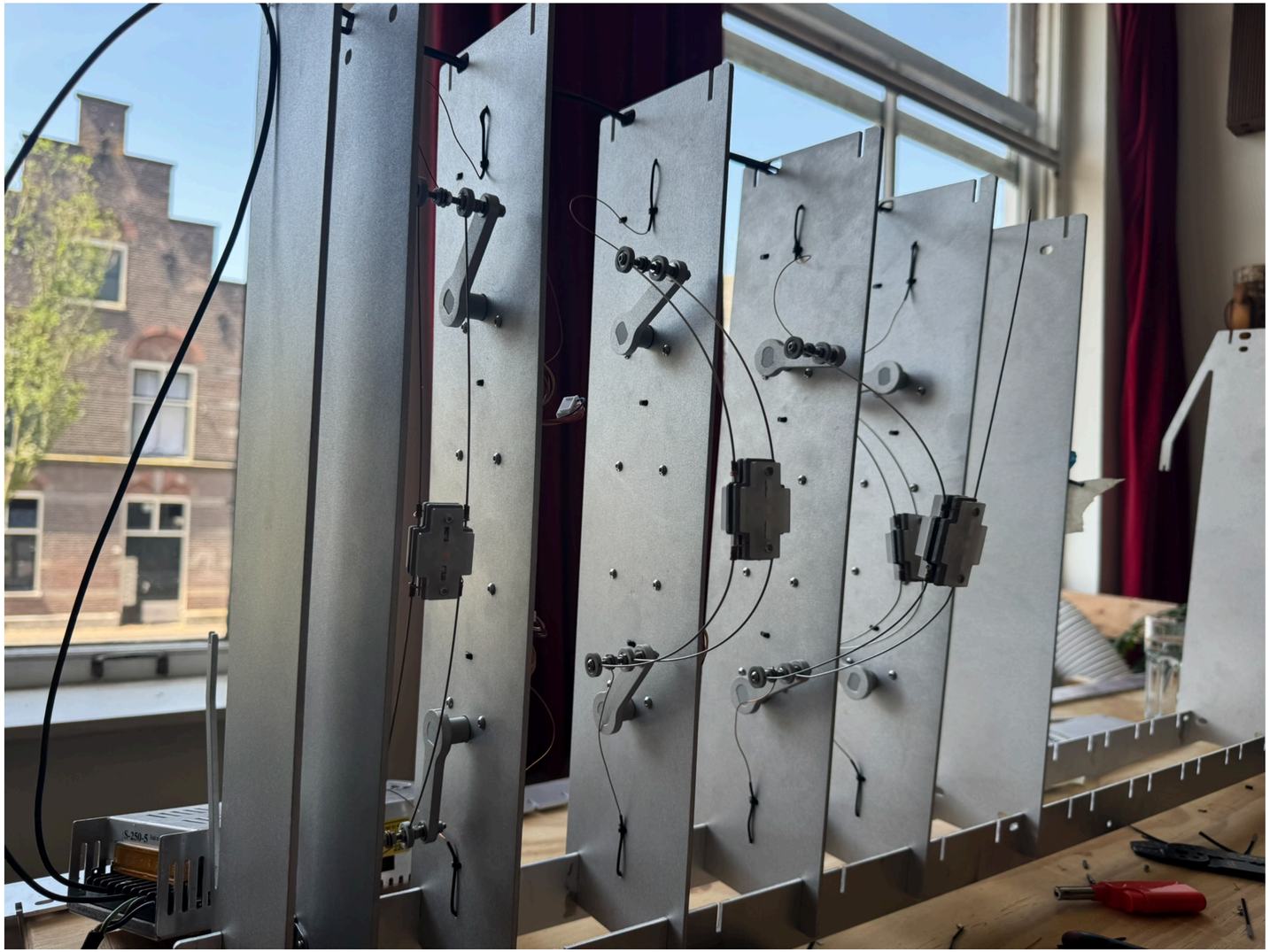










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GENCE
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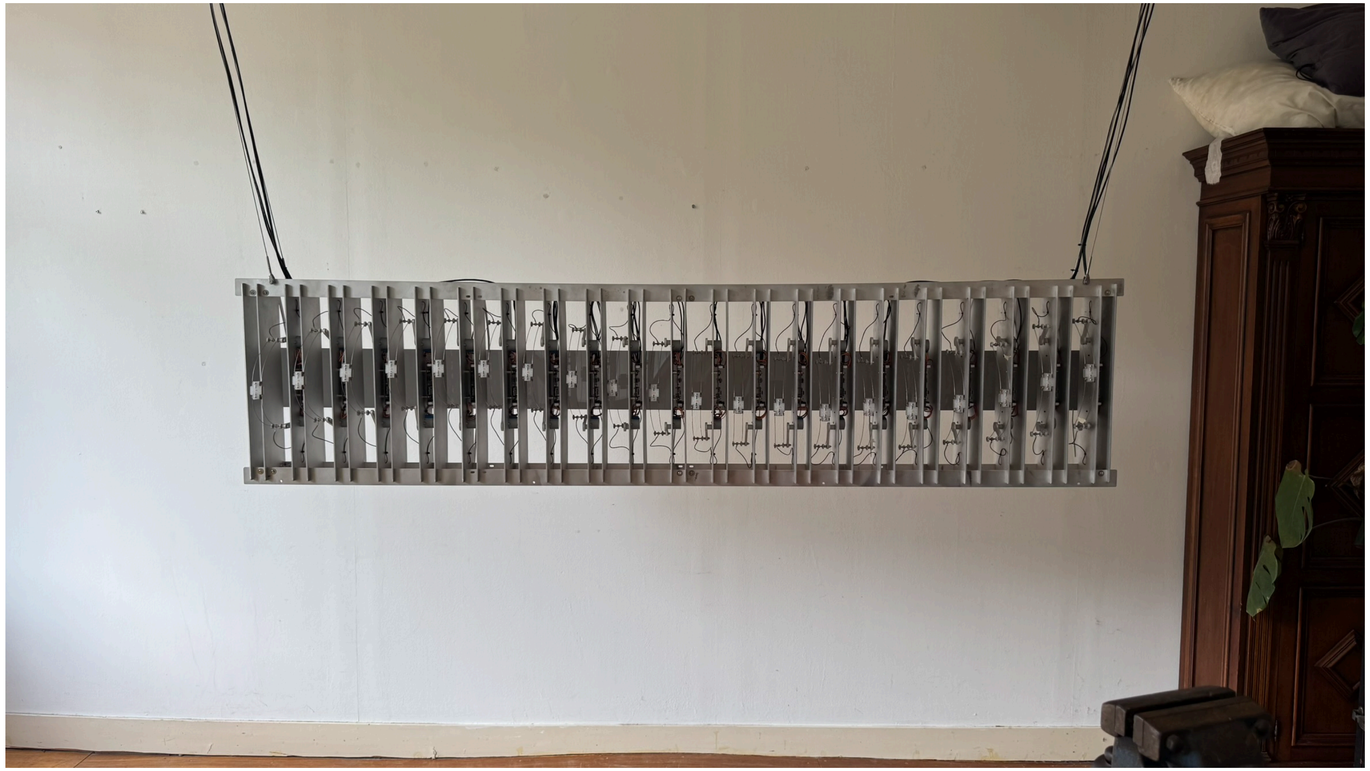




Conteratium 2026 [1]



Contrarium is a series of audiovisual live shows. The seated concerts will take place under a custom installation by Lumus Instruments at Lofi Amsterdam, which acts as a canvas for improvisation and experimentation.

During the event series, Lumus Instruments collaborates with various sound artists to explore the visual manifestation of sound. Electronic sounds and gritty sound design, generated live, are translated to light that travels through space in the form of a three-dimensional light installation.

Conteratium 2026 [2]



Dynamic Spatial Composition

Light moves through the installation as an active spatial element, continuously reshaping the composition of the environment.

Improvisational Scenography

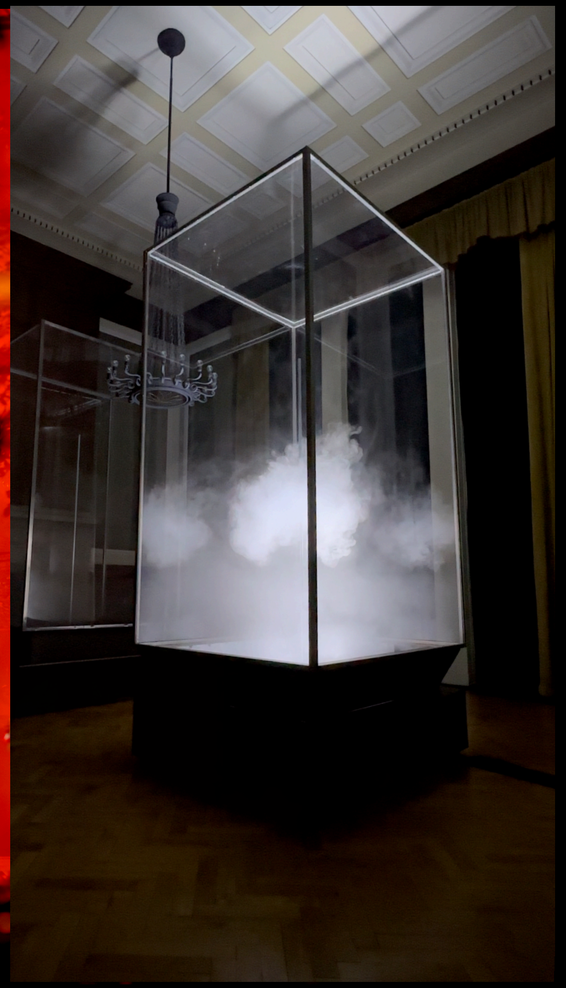
The system functions as a performative instrument, enabling live experimentation and improvisation in the choreography of light.

Expressive Materialisation of Sound

Abstract electronic and textural sound design is given physical presence through its visual manifestation in light.

Entropy 2024 [1]





“In an isolated system, entropy can only increase”.

The second law of thermodynamics finds its significance both in physics and in philosophy. It confronts us with the fact that everything in the universe tends towards chaos. It appears that disorder is the default, a given that is in conflict with our longing for order and predictability.

ENTROPY is an analogue particle simulator that explores the transition of elements and their movement in space. The 4 meter tall transparent structures are inhabited by a system that converts liquid into gas, and displays its transition and growth, visually drawing analogues to clouds and climate systems. With Entropy, Lumus Instruments invites us to meditate on the act of entropy, and the aesthetic of disorder and unpredictability.

Volumetric space through matter
Space is defined not by lines or surfaces, but by volumes of diffuse material. Density and distribution become the primary spatial language.

Diffuse spatial obstruction
Visibility is continuously shaped by semi-transparent matter that obscures and reveals parts of the installation, creating layered perception.

Entropy 2024 [2]



From Entropy, a key insight is that obstruction and diffusion of vision can be just as powerful as illumination itself. Rather than using light only to reveal and define space, the installation shows how partial visibility and atmospheric interference can actively shape perception. What is hidden or obscured becomes just as important as what is visible.

This idea relates to the compositional capabilities of my own project, where the LEDs are intentionally not always fully exposed; as they move across the structure, they can be partially hidden behind elements of the installation. In this way, attention is continuously drawn towards the light source, while at the same time it disappears and reappears within the structure. The tension between revealing and concealing contributes to the experience, light movement does not only produce light effects, but also modulates absence and presence within the visual field.

Hypothesis 1 — Hypnotic, meditative atmosphere and a sense of timelessness
Initial reactions: "Oh, bright! Wow." The participant noted that a single light appears less bright on its own, and described the experience as somewhat meditative. They also observed a reflection in the back panel.

How would you describe the atmosphere?
The light is very warm, and the overall feeling is calming, meditative, comfortable, and quiet.

Did your sense of time change while watching?
The movement is very slow. At a quick glance the lights appear not to be moving, but they are in fact moving continuously. The speed does not feel entirely realistic.
Did the installation have a beginning, middle, or end, or did it feel ongoing?
It felt like one single, continuous thing, without a clear beginning or end.



What is more dominant, the individual light points or the larger patterns?
The participant perceived the larger patterns rather than the individual points.

How would you describe the patterns you saw?
They described the pattern as a wave.

Were you able to predict what would happen next?
The behaviour was predictable. The movement is structured and even, because the spacing between the lights is consistent.

How would you describe the way the lights moved — random, structured, or in between?
The movement was perceived as structured and regular.

Did the installation feel simple or complex, and did that change over time?
It felt very complex, but at the same time it had something simple and uncomplicated about it, owing to its rhythm.

Semantic-differential scales (1–7):

- Hypnotic - Not hypnotic: 3
- Calming - Stressful: 2
- Meditative - Stimulating: 2
- Monotonous - Constantly evolving: 5

How did your attention behave while watching?
The participant's thoughts stayed with the installation; their attention remained held by it.

Did it become more, less, or equally interesting over time?
It remained equally interesting. The installation takes on many different positions while the underlying movement stays the same. It did not become less interesting; the diversity among the individual lights is what makes it interesting to keep watching.

Could you imagine it in a room you spend time in?
They could imagine it in a space where experience and light play a central role and where visitors can walk around it — a public space.

Did it demand your attention or compete with its surroundings?
It did not strongly demand attention; it has a subtle quality and is not overly dominant. In the current setting it did stand out, but with other things around it this would likely be less so. That said, the movement does draw the eye noticeably, even in peripheral vision.

How would you describe the noise level?
The participant could not hear it well at first and moved closer to listen. The noise is minimal, rhythmic, and aligns with the movement. It was not perceived as disturbing, because it feels integral to how the work operates.

Hypothesis 1 — Hypnotic, meditative atmosphere and a sense of timelessness
How would you describe the atmosphere?
I find it calming, hypnotic, and radiant.

Did your sense of time change while watching?
A moment ago I caught myself gazing at the installation and lost track of the questions you were asking — so that says something about its enchanting, captivating power.

Did it have a beginning, middle, or end, or feel like an ongoing state?
It felt like an ongoing state, except that all the elements stood upright when it began. Otherwise it seems as though it could simply continue forever.

Semantic-differential scales (1–7):
- Hypnotic - Not hypnotic: 1
- Calming - Stressful: 2
- Meditative - Stimulating: 3
- Constant - Evolving: 1



Hypothesis 2 — Simple repeated movements generate complex, emergent patterns

What is more dominant, the individual light points or the larger patterns?
The larger patterns, because I notice I look more at how they move as a whole — though the individual light is also interesting to watch.
Did the way the lights moved seem related to each other, or independent?

Related, because the movements are coordinated with one another. They are obviously not random.
Were you able to predict what would happen next?

I find it unpredictable what happens to the whole, but predictable what an individual light does relative to the lights next to it.
How would you describe the way the lights moved — random, structured, or in between?

Structured, if you look at the relationship between one light and the next — but it also seems as though the whole could form any kind of movement.

Did the installation feel simple or complex, and did that change over time?
Complex in its simplicity.

Hypothesis 3 — Engaging without demanding constant attention

How did your attention behave while watching?
Hard to answer.

Did it become more, less, or equally interesting over time?
It becomes more and more interesting, because the movements keep changing. I could not watch it for hours — perhaps the wall behind it, but not the lights themselves. If it were hanging in a gallery, it would be very appealing for people to watch what is happening.

Where could you imagine encountering a work like this, and for how long?
In a gallery or museum, for a few minutes.

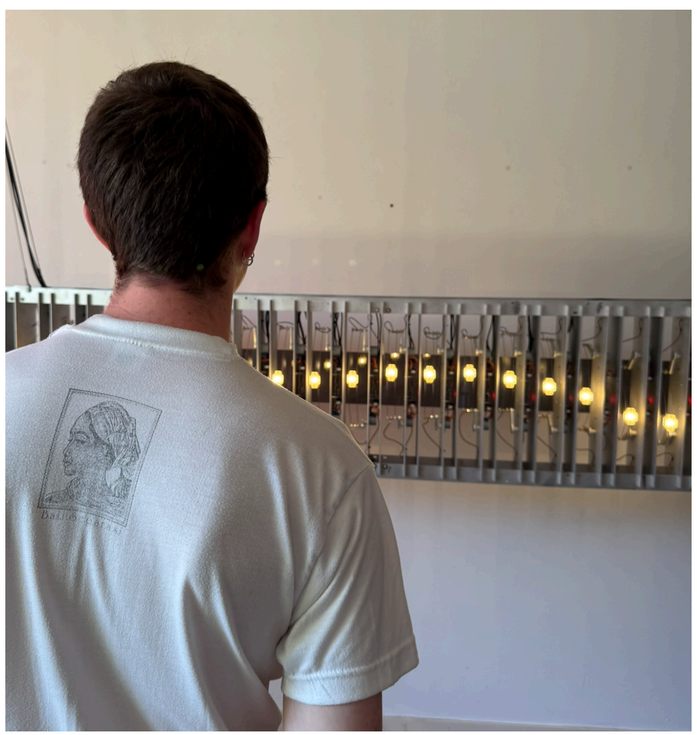
Did it demand your attention or compete with its surroundings?
That depends heavily on the other things in the space, but here in this room, not particularly.

How would you describe the noise level?
Vibrating, but not disturbing.

Hypothesis 1 — Hypnotic, meditative atmosphere and a sense of timelessness
Initial reaction: It is bright, but the sound is much less than expected.
How would you describe the atmosphere?

It has a very technical atmosphere, in the sense that everything is so open and exposed. At the same time it is quite calming, because there is a rhythm to it that repeats. In a way it is minimalistic.

Did your sense of time change while watching, and did it have a beginning, middle, or end?
There is no beginning, middle, or end; it seems to continue endlessly. What is interesting is that you only realise it is forming different patterns after it has already happened, without noticing the change as it occurs.



Semantic-differential scales (1–7):

- Hypnotic - Not hypnotic: 2
- Calming - Stressful: 2 — "it is very fluid"
- Meditative - Stimulating: 4 — slightly more towards stimulating, because you become curious about what is coming next, even though the movement itself is very meditative
- Monotonous - Constantly evolving: 7

Hypothesis 2 — Simple repeated movements generate complex, emergent patterns

What is more dominant, the individual light points or the larger patterns?
You mainly see the larger patterns, but you also find yourself zooming in on a single light, because it is interesting how it is put together. The lights each move slightly differently, which makes you want to look at all of them.

Were you able to predict what would happen next?
It does not feel predictable; you only notice that something has changed once it has already happened.

How would you describe the way the lights moved — random, structured, or in between?
The movement is structured. It is not random, because there are clearly patterns, and the whole is very structured: you can see waves forming, or the lights gradually aligning into a line.

Hypothesis 3 — Engaging without demanding constant attention

How did your attention behave while watching?
The participant's thoughts stayed with the installation. Whenever a new pattern emerges, attention is sparked again, and because you see the reflections on both the back and the front, these also draw the eye.

Did it become more, less, or equally interesting over time?
It becomes more interesting after watching a series of movements, because you gradually build up a sense of the range of movements the installation produces.

How would you describe the noise level?
The sound is not bothersome and takes nothing away from the meditative experience. If anything, it is a contribution: being able to both see and hear how the work moves adds something. The noise actually adds to the experience.

The technical, structural, acoustic, operational, and maintenance-related requirements are verified through demonstration, continuous-operation testing, and direct measurement of the prototype.

The aim is not to certify the installation to an industrial or commercial standard, but to establish whether the system performs reliably enough to function as intended in a gallery context. Each requirement is assessed against an explicit, observable criterion, resulting in a judgement of met, partially met or open.

Technical Requirements

- The system must be electronically controllable (microcontroller-based).

Each element is driven by an Arduino Nano controlling two stepper motors via the custom PCB; motion parameters are generated by the browser-based simulation and exported to the array.
Criterion: all elements respond to the shared control logic and execute the intended motion.

- The installation must operate reliably with repeated motion over long durations.

Verification: continuous-operation test, run uninterrupted for (10 hours), observed for cables becoming tangled or broken, loss of synchronisation, positional drift, connection failures, or component faults.

Note: the stepper motors have no position feedback, so elements are manually aligned at start-up. Accumulated step loss over very long runs would gradually shift alignment, some kind of homing sensor could improve this.

- The system must be structurally stable when suspended.

Verification: observation under suspension from four steel cables during operation.
The structure hangs stably, without sag, twist, or excessive oscillation, carrying the full load with margin.
Result: according to the SolidWorks simulation, the total weight is about 35 kg.

- The installation must operate with minimal mechanical and electrical noise.

When the installation was running, the noise measured around 45 decibels, close to the level of a quiet room or soft background murmur, well below normal conversation. It stays in the background rather than drawing attention to itself. This matched what came out of the viewer validation: the participant could hear it and then described the sound as soft, rhythmic, and in step with the movement, not disturbing, but rather something that felt like a natural part of how the work breathes. The noise level therefore fits the intended calm atmosphere well.

Studio Beersnielsen

To validate the project, I aimed to discuss the work both with people unfamiliar with lighting design and with professionals who have experience in designing with light and developing installation-based projects. One of these discussions took place with Beersnielsen, a studio specialised in architectural and experiential lighting design. Their work ranges from urban-scale and public lighting projects to interior spaces and artistic lighting installations, where light itself becomes an integral spatial and atmospheric element.

During the meeting, we discussed some of their projects, including the biophilic light chandeliers developed for Park Paviljoen De Hoge Veluwe. In this project, the lighting installation creates dynamic shadow projections onto the ceiling, inspired by the experience of light filtering through trees in a forest environment. An important insight from this discussion was how narrative and atmosphere can function as guiding principles within a lighting design process. As explained by Sjoerd Beer, both the technical solution and the conceptual narrative continuously develop together throughout the design process. In the case of the chandelier project, the intention was not simply to illuminate the space, but to translate qualities of the surrounding natural environment into an interior spatial experience, creating a calm and soothing atmosphere through light and shadow.

This discussion strongly resonated with how I should continue with my own project, particularly the importance of defining the intended experiential quality of the installation rather than focusing solely on technical possibilities. We discussed my prototypes and the conceptual direction of the project, exploring potential ways in which the installation could further develop. An important insight from this conversation was the distinction between two parallel trajectories within the design process: the development of technical possibilities and the development of narrative and atmosphere. Rather than existing separately, these two trajectories continuously influence one another. The technical system shapes the possible experience, while the intended atmosphere and narrative guide technical decisions and further experimentation. He recommended looking at other forms of creative expression, to develop the narrative of my project. This resulted in the earlier discussed conceptual comparison of my project to the Canto Ostinato



To be approved