HASU

IED

EcoDesign
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CONTEXT

& Problem

Many semi-enclosed or **poorly ventilated spaces** suffer from **stagnant air**, **odors**, and **poor indoor air quality.** Traditional mechanical filters require fans, energy, maintenance, and often generate noise.

WOOL-BASED

Passive Scaled Air Mediating System

A modular architectural skin that filters, diffuses, and mediates indoor air through the natural properties of wool and a biomimetic geometry inspired by fiber scales.

OUR GOAL IS TO DESIGN A

PASSIVE MODULAR

MATERIAL DRIVEN SYSTEM

THAT IMPROVES AIR QUALITY WITHOUT DEPENDING ON MECHANICAL VENTILATION

APPLICATION CONTEXT

Where our product operates

Our product is designed for indoor spaces where air circulation is present but poorly distributed, such as **offices**, **libraries** and **educational or semi-public interiors.** Instead of replacing mechanical ventilation, the system works within the occupied zone, slowing and diffusing low-velocity airflow to increase interaction with material surfaces. Its suspended and modular nature allows our product to integrate into existing spaces without modifying building infrastructure.

GANDINO

A material and territorial context

Gandino is historically rooted in wool production, where material knowledge and manufacturing culture have shaped the territory over time. Today, however, much of the local wool is considered economically marginal, as its coarse fibres generate little return within contemporary textile markets. As a result, wool is often treated as a by-product rather than a resource, despite its strong technical potential for non-textile applications.

MATERIAL REALITY

Why local wool is currently underused

From the outset, we chose to be base our project on **Bergamasca wool**, recognising its strong territorial identity and technical potential. However, the limited economic return of this material has led to the fragmentation of its supply chain, making collection, processing and transformation structurally unviable within the current local context. This condition does not reflect a lack of material quality, but rather the absence of an industrial framework capable of supporting its contemporary technical use.

FUTURE SCENARIOS

From local origin to extended production

Given the current structure of the Gandino supply chain, the production process proposed by us cannot be applied locally at present. However, through potential collaborations with external or third-party manufacturers, local wool could enter an extended production network, enabling controlled treatments and technical processing. In this scenario, Gandino remains the material origin, while production evolves through a hybrid model that reconnects territorial resources with contemporary manufacturing systems.

WHY WOOL?

Material’s Properties

Wool naturally performs many of the functions required by air filtration. The **chemical structure of keratin** allows wool fibres to bind volatile organic compounds, formaldehyde and nitrogen oxides directly from the air. The presence of **lanolin**, a natural fat, gives the material an affinity with oily aerosols, enabling their capture through a slightly sticky surface behaviour. At the same time, the intrinsic **porosity** and **crimp** of wool slow down airflow, increasing contact time between air and material. Wool is also **hygroscopic**, meaning it can absorb and release moisture to regulate humidity fluctuations in the environment. Its naturally **acidic pH** helps inhibit bacterial proliferation, while its thermal responsiveness supports passive convection and micro-air movements.

FROM MATERIAL

To System

Instead of using wool as a simple panel, the project reinterprets its **microscopic structure**, specifically the overlapping cuticle plates that define each wool fiber, at an architectural scale. This micro-to-macro translation generates a **biomimetic skin** whose geometry increases surface area and creates controlled turbulence, forcing air to slow down and interact more deeply with the material. By extending the logic of the fiber to the scale of architecture, the system enhances contact between air and wool, amplifying its filtering potential without relying on mechanical acceleration or additional energy input.

CASE STUDIES

Where our inspiration comes from

Understanding existing modular and textile-based systems was essential to define our design direction. We analysed a series of architectural and product case studies that explore **porosity**, **modularity**, **geometry**, and **airflow mediation**. Although none of these were conceived as air filters, each of them revealed a specific principle that can be translated into the logic of our wool-based scaled system. Together, they illustrate how surfaces can behave not as barriers, but as air-mediating skins, where geometry, material and assembly shape how air moves, slows down, and interacts with space.

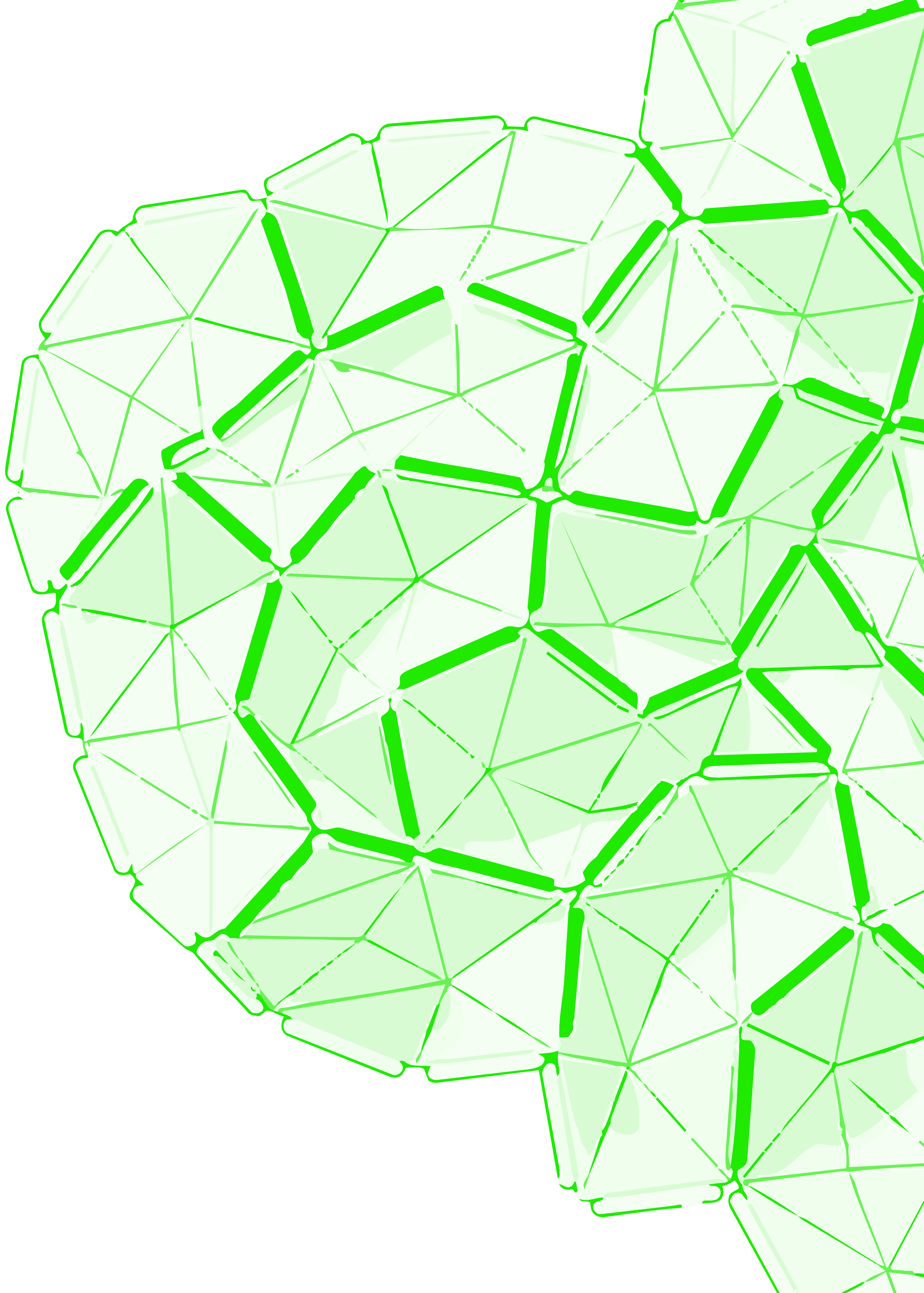
CLOUDS

Bouroullec × Kvadrat

Key Insights

Corrugated, porous, reversible surface

Clouds shows how a textile surface can behave as a porous architectural skin rather than a flat barrier. Its corrugated and overlapping geometry diffuses air, slowing it down and redirecting it in multiple directions. The elastic connectors introduce a lightweight, reversible assembly logic, an approach that inspires
our own modular system with replaceable wool cartridges.



ALGUE

Bouroullec × Vitra

Key Insights

Distributed porosity through modular repetition

Algue demonstrates that filtration and mediation can happen through a field of elements, not a continuous surface. Its modular “net” produces distributed porosity, breaking airflow into smaller streams.This suggests a design logic where spaces between units become active components, fundamental for shaping the porosity of our scaled wool surface.

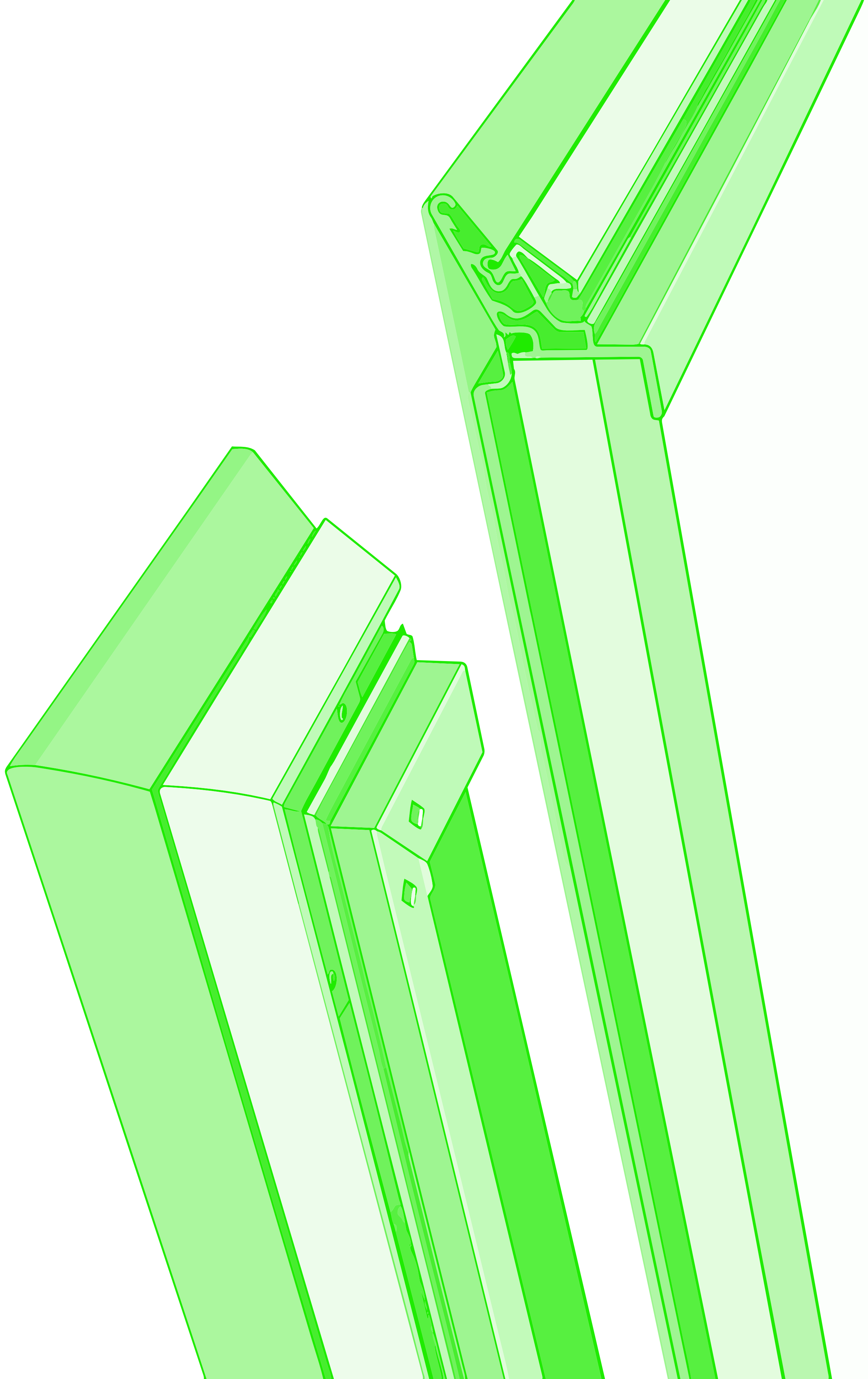
SOFT CELLS

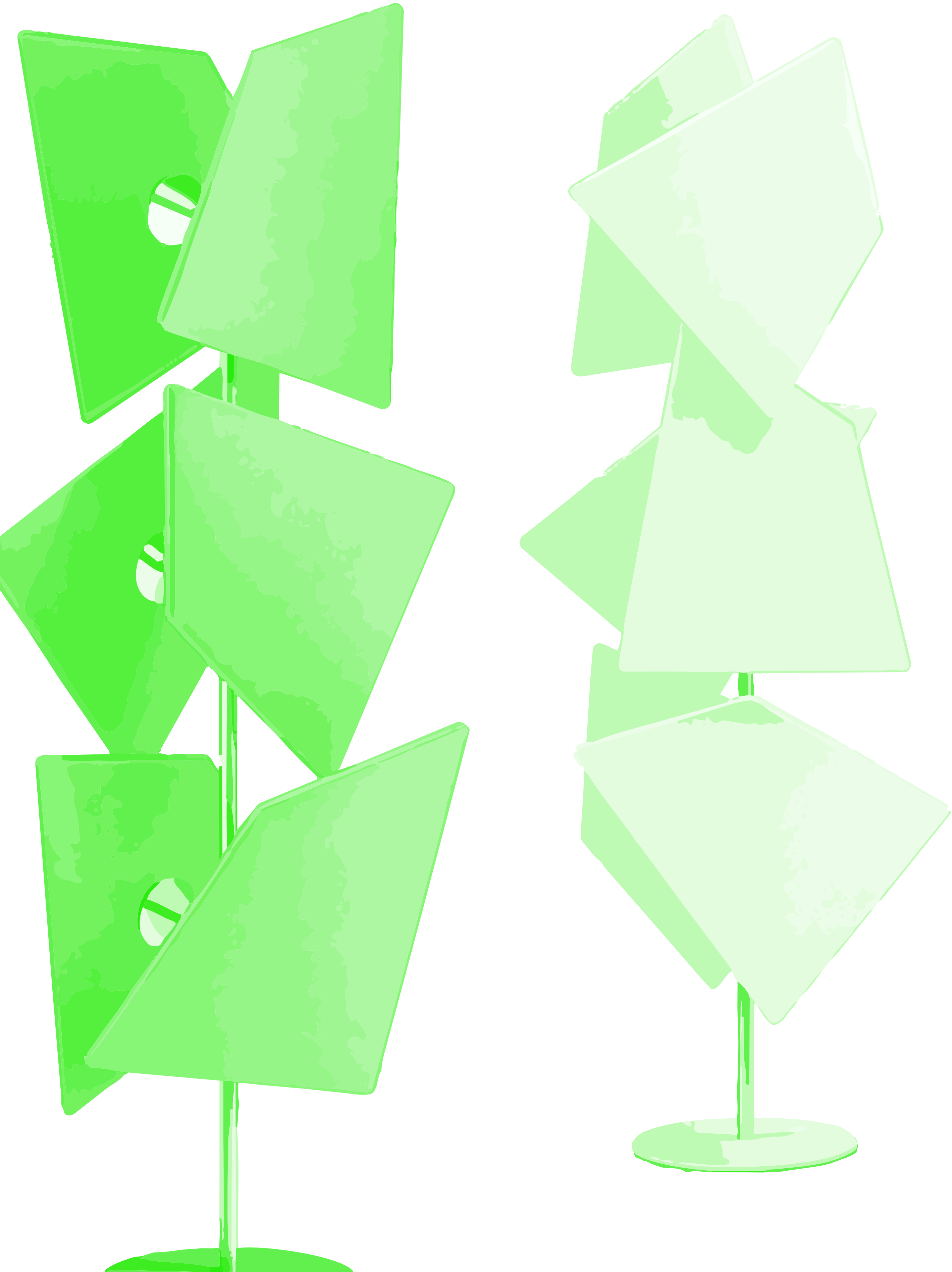
Kvadrat

Key Insights

Architectural integration & hidden assembly

Soft Cells exemplifies how textile panels can be integrated into architectural spaces with clean lines and concealed fixings. Their structural strategy, frames, rails, and reversible attachment, shows how a soft system can become maintenance-friendly and building-ready. This informs our approach to hidden rails and modular scale replacement.





FLAP

Caimi Brevetti

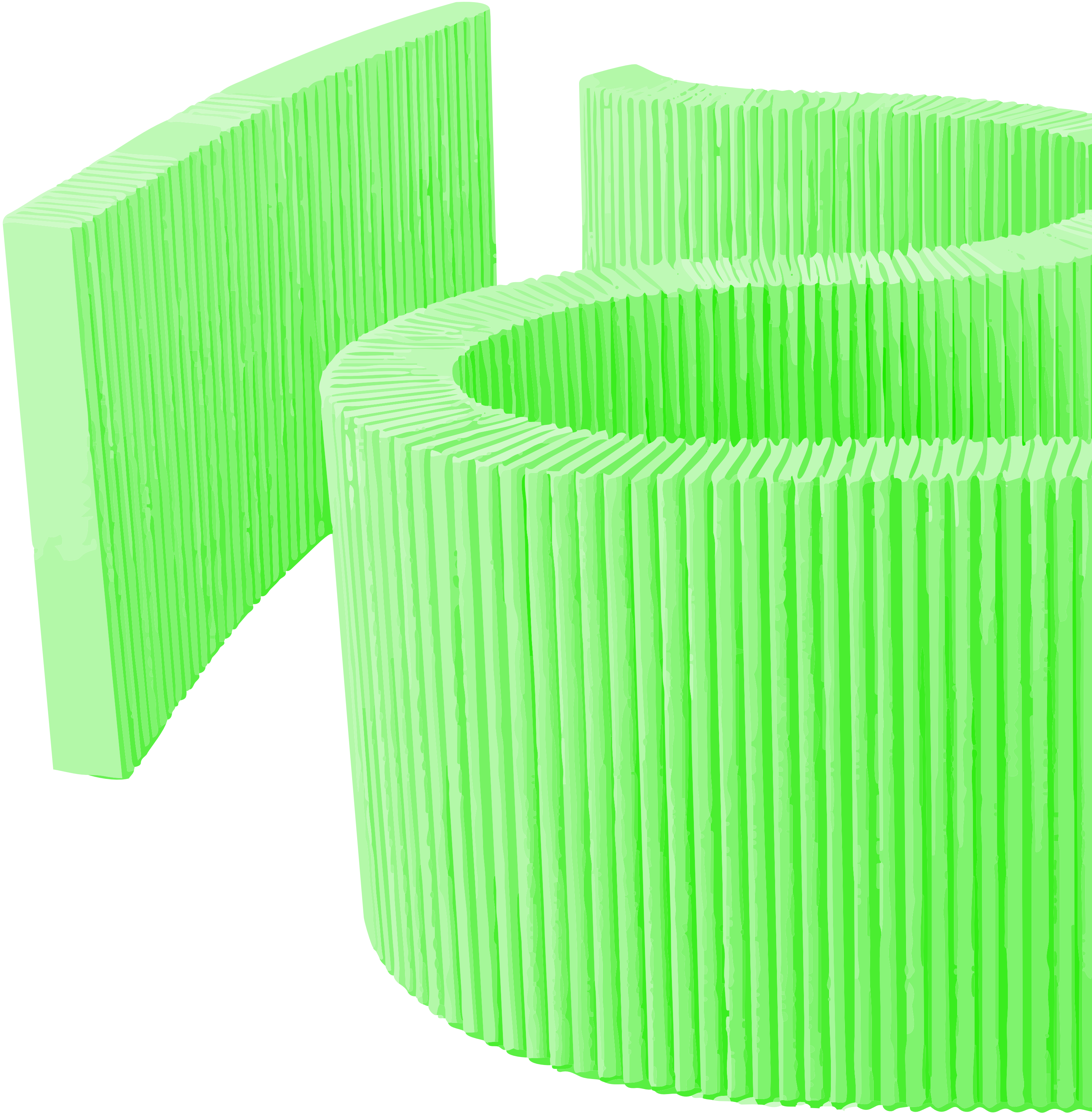
Key Insights

Air deflection through depth and orientation

Flap panels project outward into space, acting as air deflectors. Their adjustable orientation shows how panel tilt can break, redirect, and diffuse airflow. This closely aligns with our concept of scales behaving like small aerodynamic vanes, guiding passive air movement.

SOFTWALL

Molo



Key Insights

Micro-cavities and active thickness

Softwall uses a honeycomb structure to create internal cavities that slow down air and let it pass through the volume rather than around it. It teaches us that thickness can be a functional zone, not just aesthetic or structural. This principle informs the internal logic of our wool modules and their layered filtration properties.

BUZZIFALLS

BuzziSpace

Key Insights

Graded porosity and patterned apertures

It uses perforated felt screens to create controlled openness, allowing air and light to pass while reducing acoustic reflections. The patterned voids offer a model for designing porosity gradients within a textile surface. This inspires how we modulate openness across our system using EMPTY modules and spacing variation.

DESIGN PRINCIPLES

The rules we can define from our case studies

The case studies collectively show **how a surface can actively mediate airflow through geometry** and **porosity.** Corrugated and overlapping forms reveal how a skin can slow and diffuse air, while modular open systems demonstrate that filtration can happen between elements through distributed porosity.

DESIGN PRINCIPLES

The rules we can define from our case studies

Hidden and **reversible assemblies** inform a clean architectural integration, and tilted or protruding components illustrate how small geometric shifts can passively deflect and break the flow. Internal cavities highlight the **role of thickness** in retaining and conditioning air, and graded openness teaches how to calibrate how air enters, travels through, and exits the surface.

HASU

PROJECT EVOLUTION

From material process to functional system

Initial Hypothesis

The project initially started from a material curiosity rather than a defined object. Wool was approached primarily as a biological substance, with attention focused on its chemical composition, washing processes, and potential for purification.

At this stage, the core question was not what to design, but how wool could be treated, cleaned or activated to express new behaviours.

1

Key Focus

- Wool as a chemical and biological material
- Washing, cleansing and transformation processes
- Interest in bio-based purification
- Object and scale still undefined

Process-Driven Exploration

The research progressively concentrated on washing as the central act: washing wool, washing air, washing pollutants. The idea of designing a process rather than an object became dominant, with attention shifting toward chemical reactions, treatments and activation through liquids, UV, additives However, this phase revealed a critical tension: the project was moving toward biochemical control, a field that required expertise beyond design.

2

Emerging doubts

- Where does design end and chemistry begin?
- Can a designer realistically control chemical purification processes?
- Is the project becoming dependent on external scientific validation?

Critical Repositioning

The project initially started from a material curiosity rather than a defined object. Wool was approached primarily as a biological substance, with attention focused on its chemical composition, washing processes, and potential for purification.

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3

Key Realisation

"We are not bio-chemists, but we can design how materials, air and space interact". This moment represents the true turning point of the project.

Material Behaviour

Following this repositioning, wool was no longer treated as a substance to be chemically transformed, but as a material with inherent behaviours with porosity, fibre structure, lanolin adhesion, hygroscopic response

The project moved from washing air to mediating air, shifting the logic from purification to contact, slowness and repetition.

4

Key Shift

- No more active chemical dominance
- Emphasis on passive interaction
- Performance distributed across time and surface, not reactions

Systematisation

The project consolidated into a modular system, where different wool treatments perform specific roles without altering the overall structure.

The focus moved definitively from process to system design. At this stage modules were defined, their thicknesses and densities calibrated and the functions distributed across the field

5

The New Path

The project is now a design system rather than a material experiment.

Hasu

The final outcome is Hasu: a distributed, modular, passive system where performance emerges from the relationship between wool as a technical material, geometry as airflow mediator and repetition as a performance strategy

Rather than claiming chemical control, the project operates within a realistic, designer-driven framework, where architecture becomes an interface between air and matter.

6

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Emerging doubts

- Where does design end and chemistry begin?
- Can a designer realistically control chemical purification processes?
- Is the project becoming dependent on external scientific validation?

Critical Repositioning

At this point, a conscious decision was made: the project could not, and should not, become a biochemical system.

Rather than seeing this as a limitation, it became a clarifying moment. The focus shifted from changing the chemistry of air to designing the conditions under which air interacts with matter.

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Hasu is a passive, modular wool-based surface designed to mediate indoor air through geometry and material chemistry. The name Hasu comes from the Japanese word for water lily, referencing a layered, radial form that floats, overlaps, and interacts continuously with its environment. In the project, this concept translates into a scaled, porous skin where petal-like modules slow, diffuse, and redirect airflow, allowing it to interact with wool over time. Instead of forcing air through a dense filter, Hasu works as a breathable architectural field that conditions air naturally and passively.

HASU MODULES

System Overview

Hasu works as a distributed field of thin modules. Performance is achieved through repeated contact: the scaled geometry **slows**, **deflects**, and **diffuses airflow** so that air interacts multiple times with different materials across the surface. Each Hasu unit keeps the same outer shell for visual coherence, while the internal cartridge changes according to function. By distributing modules strategically, Hasu creates a **graded filtering landscape**, more open where air needs to pass, more reactive where pollutants need to be treated, remaining compatible with passive airflow and low-pressure conditions.

MODULE A

Activated Carbon (High-density module)

This module targets **odours** and **residual VOCs** through activated carbon, working as a polishing layer within the Hasu field.
Due to its thin vertical configuration, loose carbon granules are avoided in favour of a **carbon-loaded wool-based media**, where particles are chemically fixed to a technically stabilised fibrous structure. Rather than concentrating adsorption capacity in a single element, the module contributes through distributed repetition, ensuring stability, controlled airflow and consistent performance across the system.

Technical Data

Material: Carbon-loaded non-woven (wool based)
Thickness: 15 mm (3 × 5 mm layers)
Density: 170–180 kg/m³
Function: Odour & VOC polishing
Notes: Stable vertical behaviour, no particle migration

MODULE B

Raw Wool with Lanolin (Prefilter module)

This module exploits the natural **adhesive properties of lanolin** to capture coarse dust and oily aerosols. Its effectiveness depends on a **very open fibre structure**, allowing air to weave through the greasy fibres without forming a clogging surface layer. Positioned where air first encounters the system, it acts as a **front-line prefilter**, reducing the load on downstream modules while remaining breathable.

Technical Data

Material: Raw wool with natural lanolin
Thickness: 15 mm
Density: ≈ 50 kg/m³
Function: Coarse dust & oily aerosol capture
Notes: Open, low-clogging fibre structure

MODULE C

Wool with TiO_2 (Photocatalytic module)

This module introduces a **photocatalytic function** through wool treated with titanium dioxide. Activated by integrated UV lighting, it enables the **chemical degradation of VOCs** and **organic pollutants**, rather than simple adsorption. Designed as a thin, permeable element, the module prioritises uniform activation and airflow compatibility, operating efficiently within Hasu's passive logic.

Technical Data

Material: Wool treated with titanium dioxide
Thickness: 15 mm
Density: ≈ 90 kg/m³
Function: Photocatalytic VOC degradation
Notes: UV-activated, reactive rather than volumetric

MODULE D

Pure Wool (Standard filtering module)

This module provides the system's **baseline interaction with air**, supporting particulate capture and humidity regulation. Its performance relies on a **soft, non-compressed wool structure**, ensuring low airflow resistance and continuous contact across the field. Rather than acting as a deep filter, it contributes through repetition and distribution, forming the breathable backbone of the system.

Technical Data

Material: Carded pure wool
Thickness: 15 mm
Density: 20–25 kg/m³
Function: Particulate capture & humidity buffering
Notes: High permeability, non-compressed structure

MODULE OVERVIEW

Technical Summary

Module	Material	Thickness	Density	Weight	Main Function
Activated Carbon	Carbon-loaded non-woven	15 mm	180 kg/m³	345 g	Odour & VOC polishing
Raw Wool + Lanolin	Lanolin-rich wool	15 mm	~50 kg/m³	95.8 g	Coarse dust & oily aerosols
Wool + TiO_2	TiO_2-treated wool	15 mm	~90 kg/m³	172 g	Photocatalytic VOC degradation
Pure Wool	Carded wool	15 mm	25 kg/m³	47.9 g	Particulate & humidity buffering

MODULE LIFETIME

Duration and Maintenance

Wool-based modules are designed as **consumable but replaceable elements**. Over time, exposure to dust, pollutants and humidity progressively reduces their effectiveness. Rather than aiming for permanence, Hasu embraces **planned replacement**, allowing individual modules to be removed, regenerated or substituted without dismantling the system. This approach aligns material ageing with maintenance logic, ensuring long-term performance through renewal rather than durability alone.

MODULE DISTRIBUTION

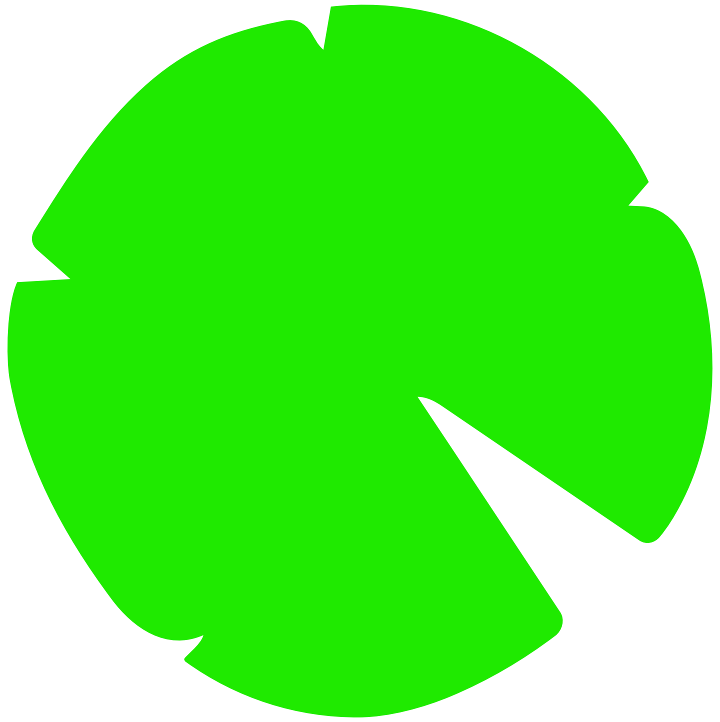
How functions are arranged

Hasu does not apply a single filtering
function uniformly across its surface.

Instead, different modules are distributed across the field to create
zones with varying levels of openness, absorption and reactivity.

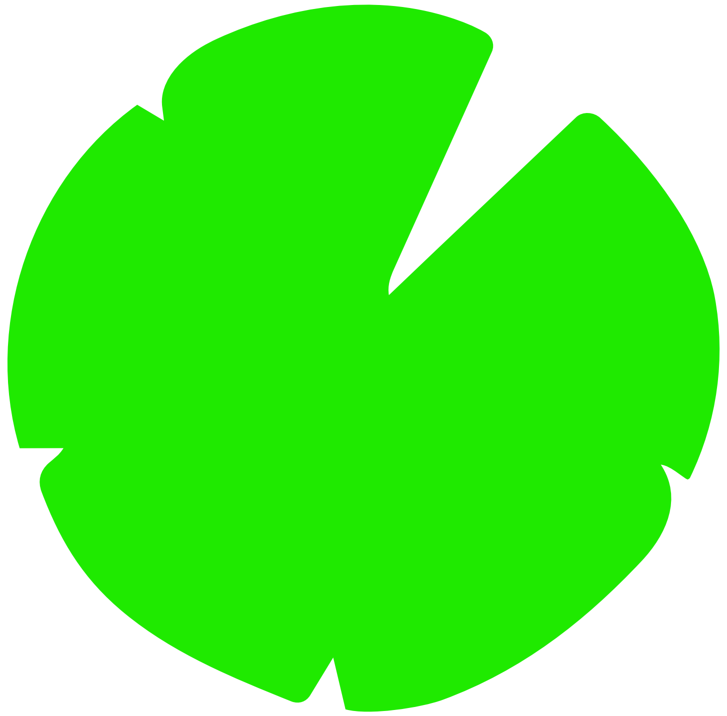
MODULE DISTRIBUTION

How functions are arranged



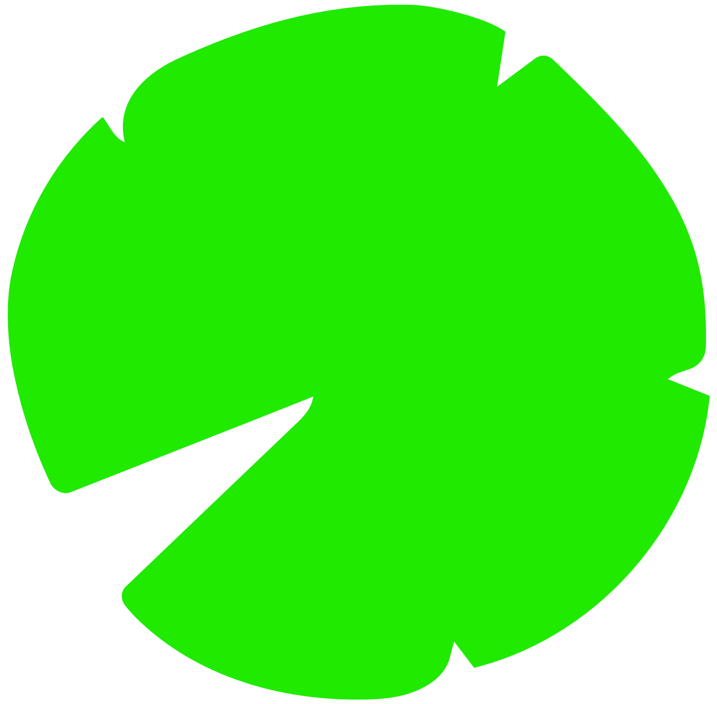
Lanolin Wool

Modules in raw wool with lanolin are placed where air first encounters the system, acting as a pre-filter for coarse particles and oily aerosols.



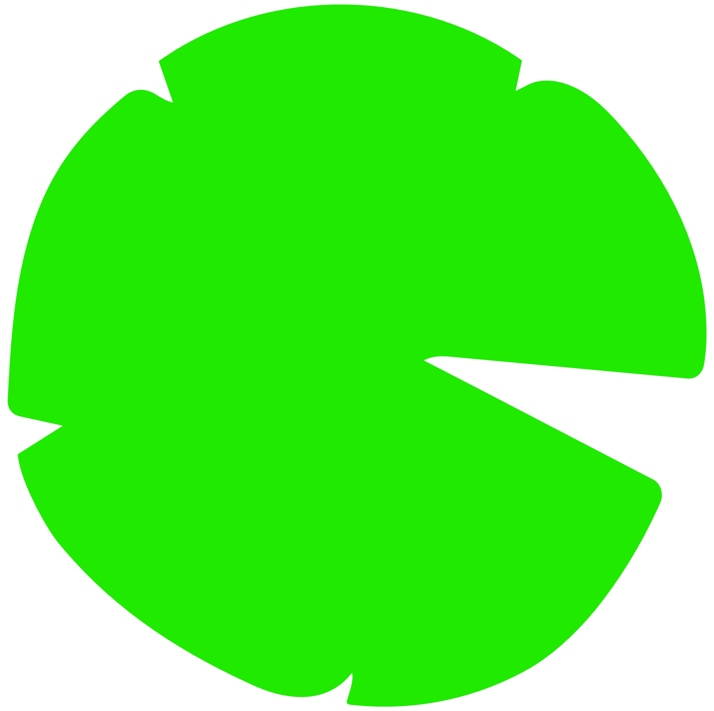
Carbon Wool

Pure wool modules are spread throughout the surface to support particulate capture and humidity buffering while maintaining breathability.



Base Wool

Activated carbon modules are positioned in more enclosed or stagnant areas, where odours and residual VOCs tend to accumulate.



TiO_2 Wool

TiO_2 modules with integrated UV activation introduce localized reactive zones without defining the behaviour of the entire system.

AIRFLOW PATH

How air moves through Hasu

Air does not pass through Hasu in a single direction or through a single filter layer. Instead, the scaled geometry of the surface **captures airflow**, **breaks its linear path**, and **slows it down** through continuous deflection and overlap. As air moves across the surface, it repeatedly encounters thin wool-based modules, increasing contact time without creating pressure buildup. Filtration and conditioning occur progressively, through multiple interactions distributed across the field rather than concentrated in one point. The result is a **passive**, **low-resistance system** where air is guided, diffused, and treated as it flows through the architectural skin.

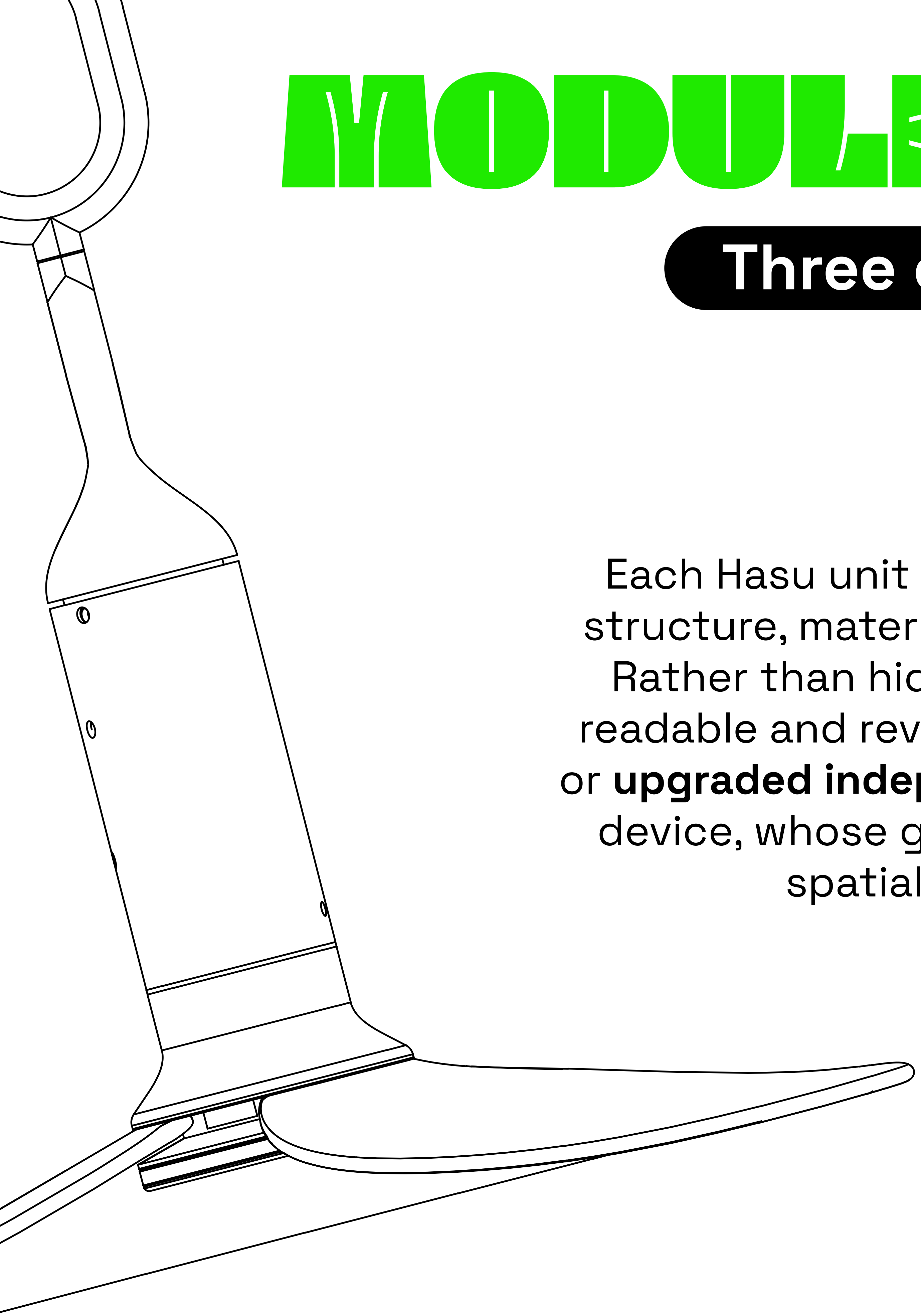
SUSPENDED SYSTEM

Composable and reconfigurable structure

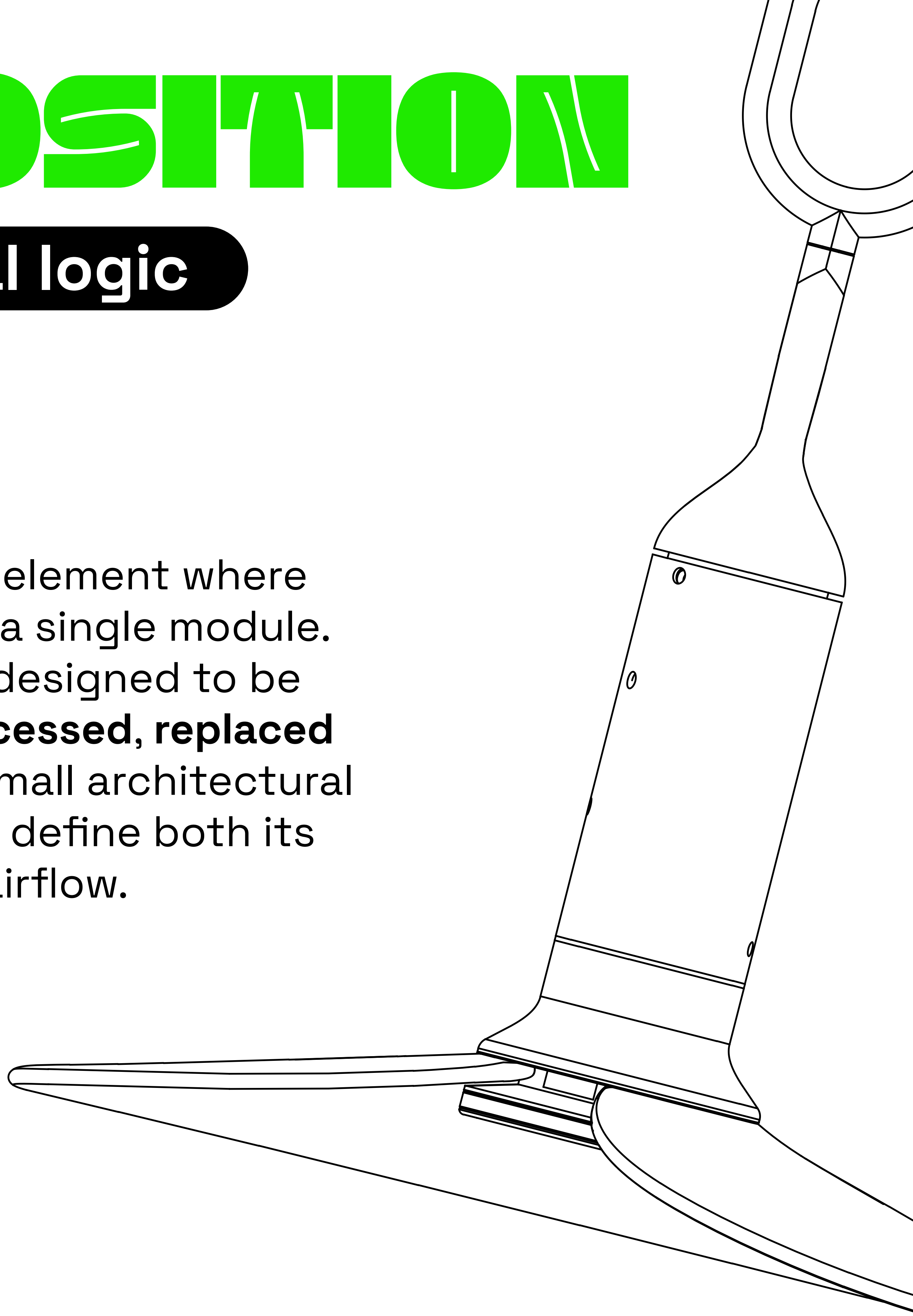
Hasu is conceived as a **fully composable system**, adaptable to the specific dimensions and constraints of each space. The number of modules is not fixed, but defined by the available surface, allowing the system to scale freely from small installations to fully saturated ceilings. At the base of the system, a series of **tensioned cables** act as linear attachment rails. Multiple cables are arranged in parallel to progressively populate the ceiling, creating a suspended field. This configuration allows the modules to be repositioned both **horizontally**, by changing their spacing along the cables, and **vertically**, by adjusting their hanging height. The result is a floating landscape of water-lily-like elements, where density and depth can be tuned according to spatial and environmental needs.

MODULE COMPOSITION

Three elements, one structural logic



Each Hasu unit is conceived as a compact, layered element where structure, material and function are integrated into a single module. Rather than hiding its components, the system is designed to be readable and reversible, **allowing each part to be accessed**, **replaced** or **upgraded independently.** The module works as a small architectural device, whose geometry and internal configuration define both its spatial presence and its interaction with airflow.

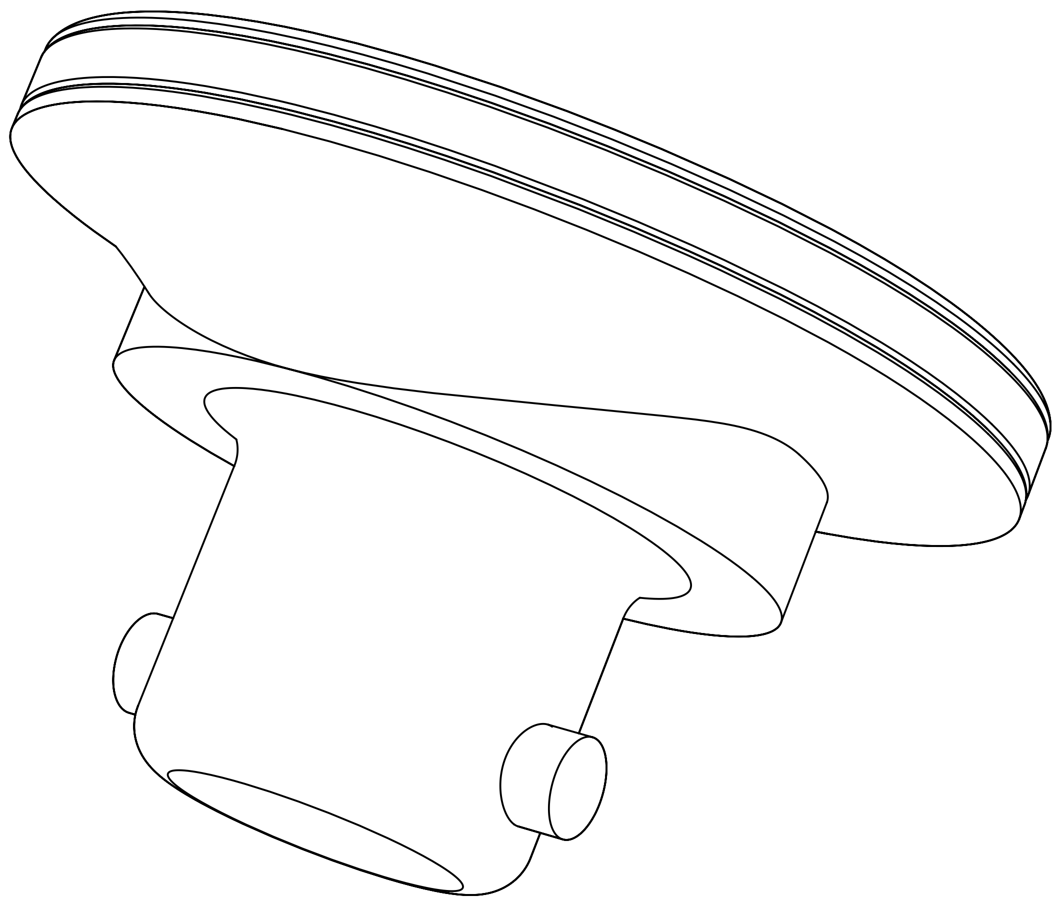


HASU - Overview

CLOSING HEAD

Locking and shaping element

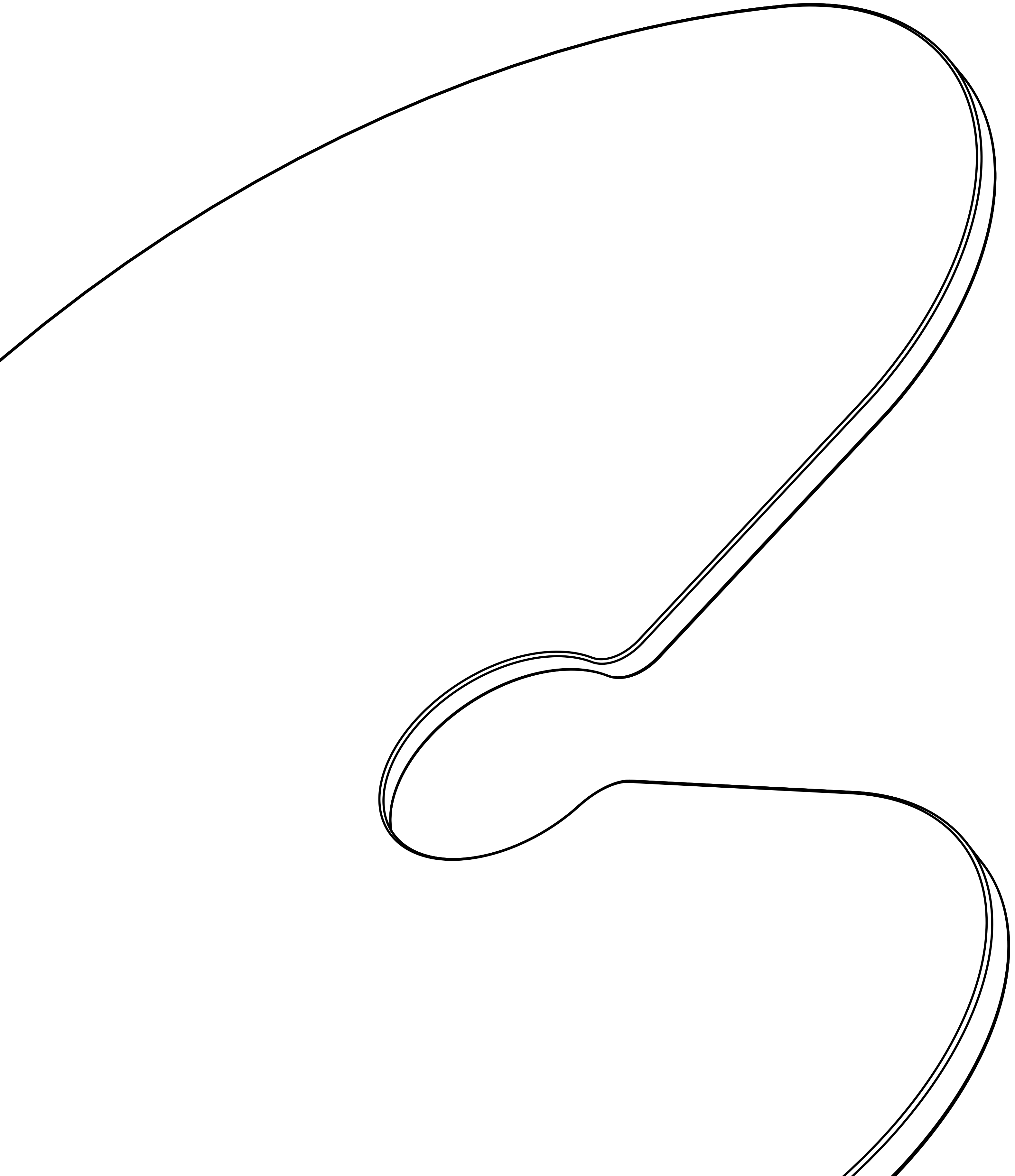
The closing head acts as the **structural core** of the module.
It locks all components together and defines the final tension of the wool surface. Its countersunk geometry slightly bends the wool sheet when tightened, introducing a controlled **three-dimensional curvature** that enhances both airflow deflection and spatial depth.
In the TiO_2 version, this element also integrates the **UV lamp**, making the reactive function fully contained within the module.



TiO2 Closing Head with light

WOOL MODULE

Functional filtering surface



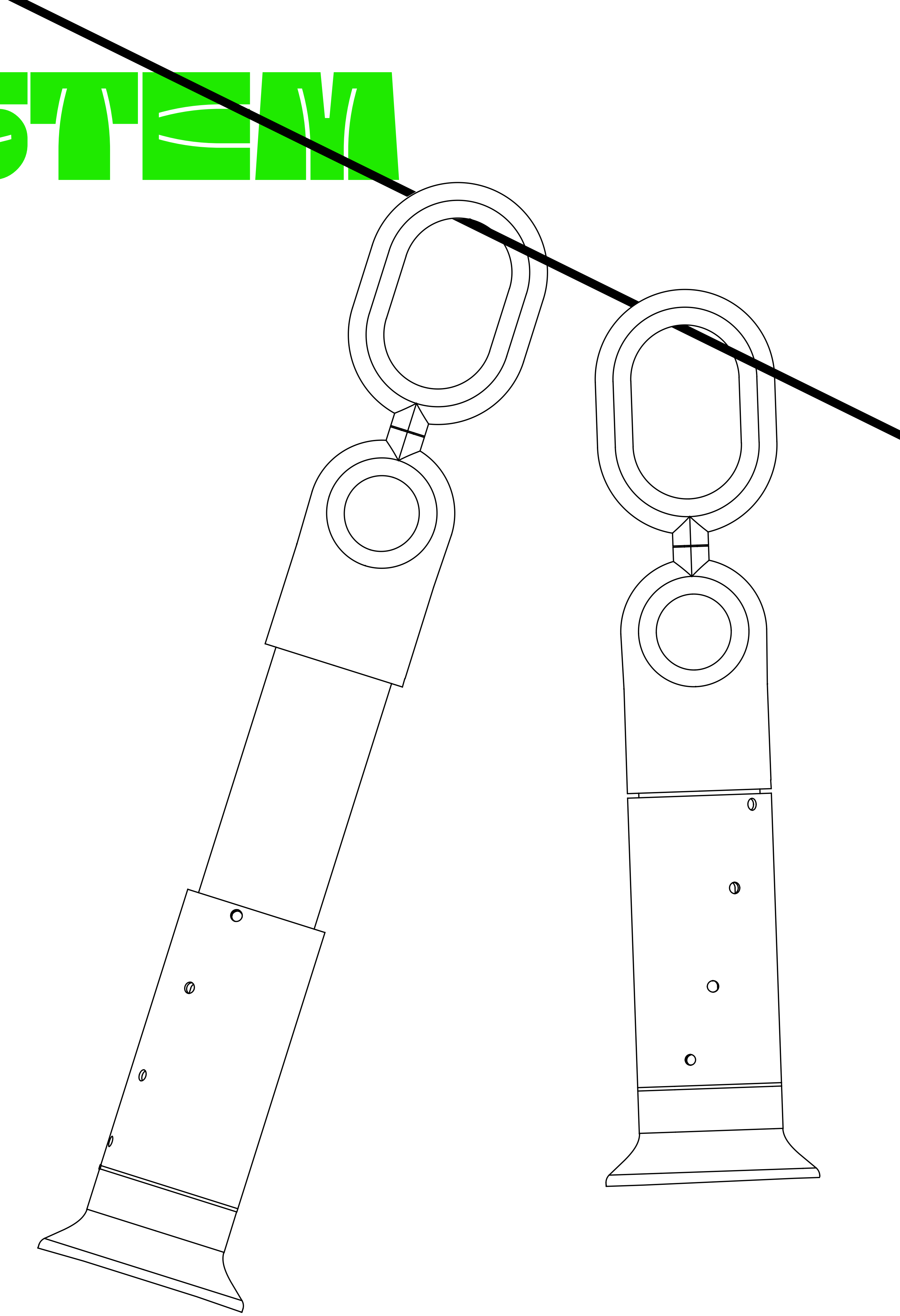
The wool element represents the **active surface** of the Hasu module. Depending on the cartridge type, this layer is composed of pure wool, lanolin-rich wool, carbon-loaded media or TiO_2-treated wool. Its thin profile of 15mm is designed to remain breathable while maximizing contact through repeated exposure across the field. Rather than relying on thickness, performance is achieved through **material chemistry**, **surface interaction** and **repetition**.

Wool Module

ATTACHMENT SYSTEM

Suspension and maintenance

The attachment system connects each module to the tensioned cable structure. A tubular element with receives the closing head, while the opposite end terminates in a carabiner, allowing **quick attachment** and **removal.** This solution enables easy maintenance, replacement and reconfiguration, reinforcing Hasu's logic as a reversible and adaptable system rather than a fixed installation.

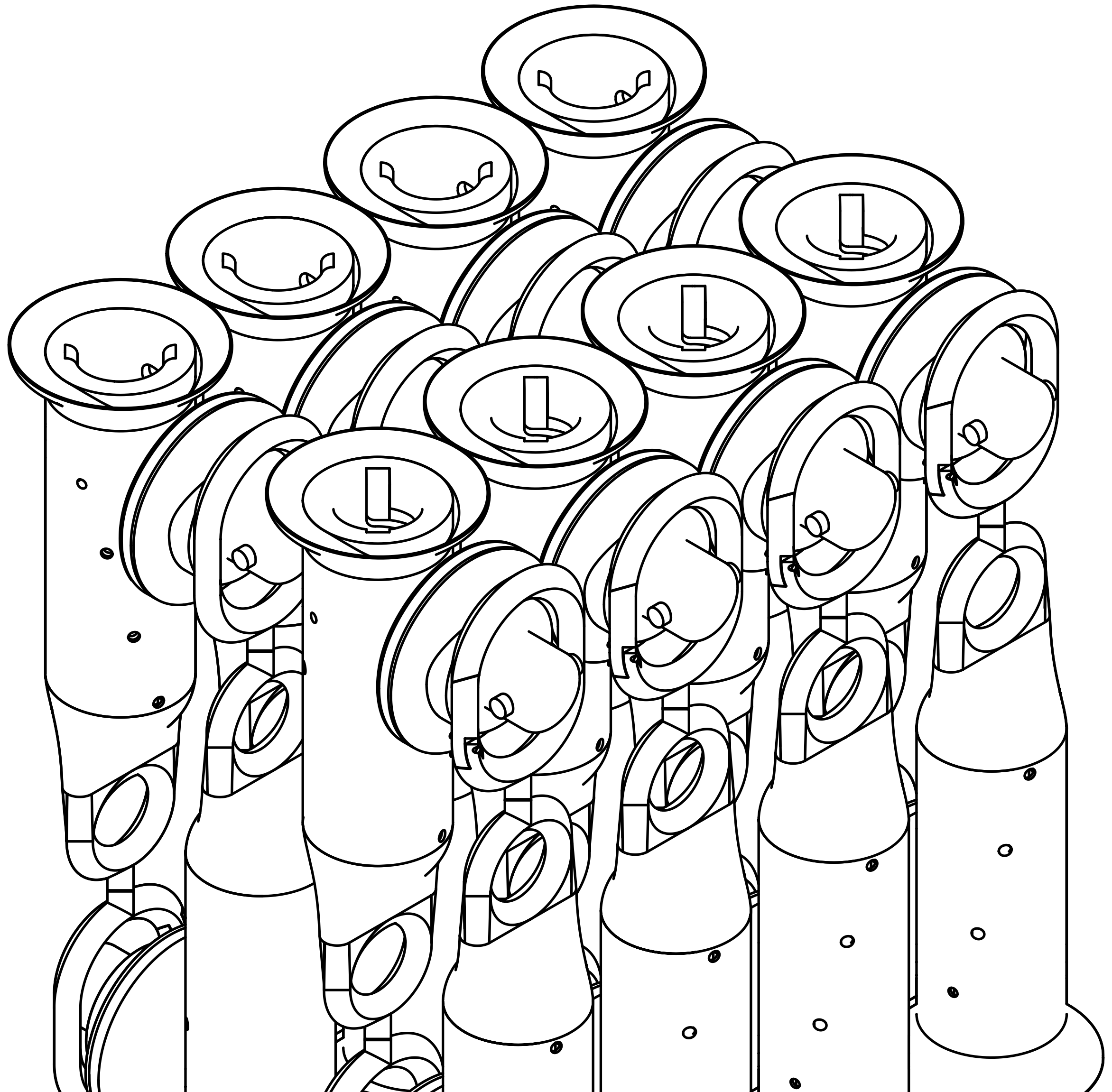


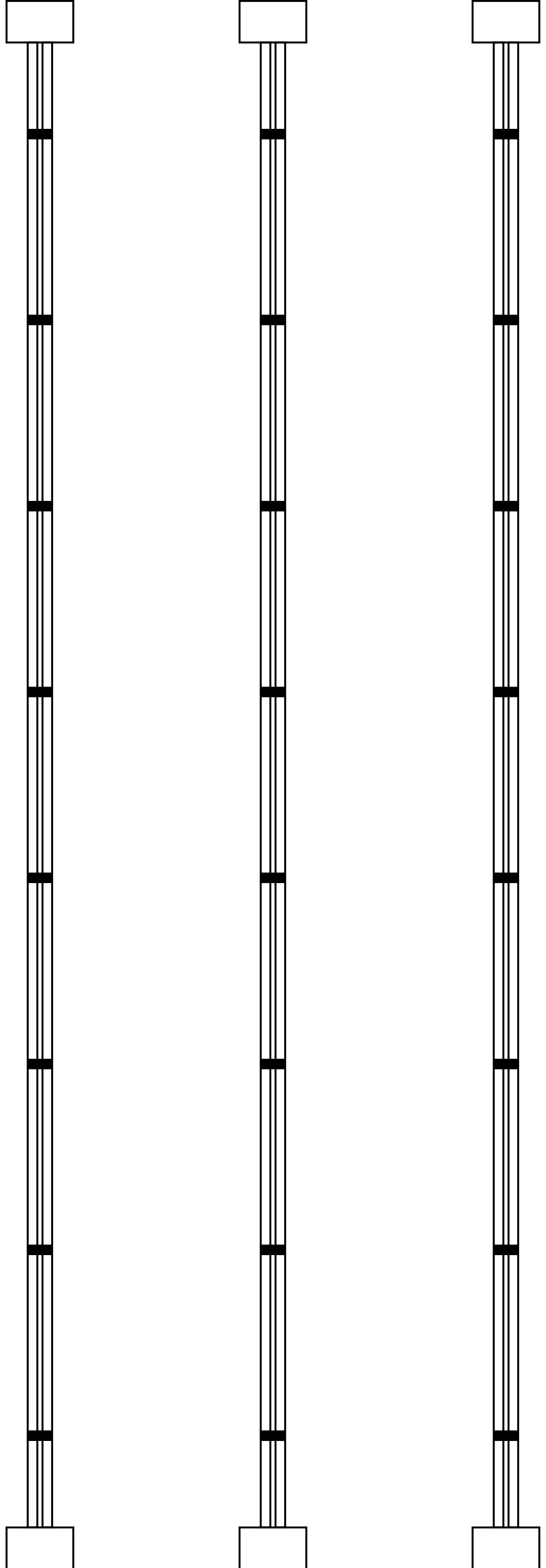
Opened and Closed Attachment System

MANUFACTURING METHOD

Attachment System and Head

The attachment system and head are manufactured through **aluminium powder bed fusion** on the **EOS M 400-4**, an industrial platform designed for high-speed and high-quality serial production. Through an optimized nesting strategy, multiple components are produced in a single print, enabling scalability, material efficiency and consistent quality.





CABLE SYSTEM

Structural support and energy distribution

The system is suspended through paired, tensioned lines that combine structural support and power distribution. Two parallel cables run in close proximity, acting as a single visual element while providing **low-voltage DC (+/–)** to the active modules.

By maintaining the lines under high tension and separating them through regular spacers and module bodies, the system ensures **dimensional stability**, **ease of installation** and **safe operation**. Power is accessed directly at the hook, allowing each TiO_2 module to draw energy locally while remaining fully repositionable within the field.

Modules Aggregated To The System

COLOUR STRATEGY

Material choice vs added value

Hasu allows two parallel approaches: using undyed wool to r**educe production steps** and costs, or **introducing mass-dyed fibres** to enhance the system's role as an architectural and interior element.

COLOUR STRATEGY

Option 1 - Material efficiency

Hasu can operate without any additional colouring process, relying on the natural tones of wool. By avoiding dyeing, **the system reduces production steps**, **energy consumption** and **costs** at an early stage of the supply chain. Natural shades reinforce the material-driven identity of the project, keeping the focus on performance, texture and biomimetic logic rather than surface appearance. In this configuration, Hasu is presented primarily as a passive air-mediating system, where colour is a direct consequence of the material itself.

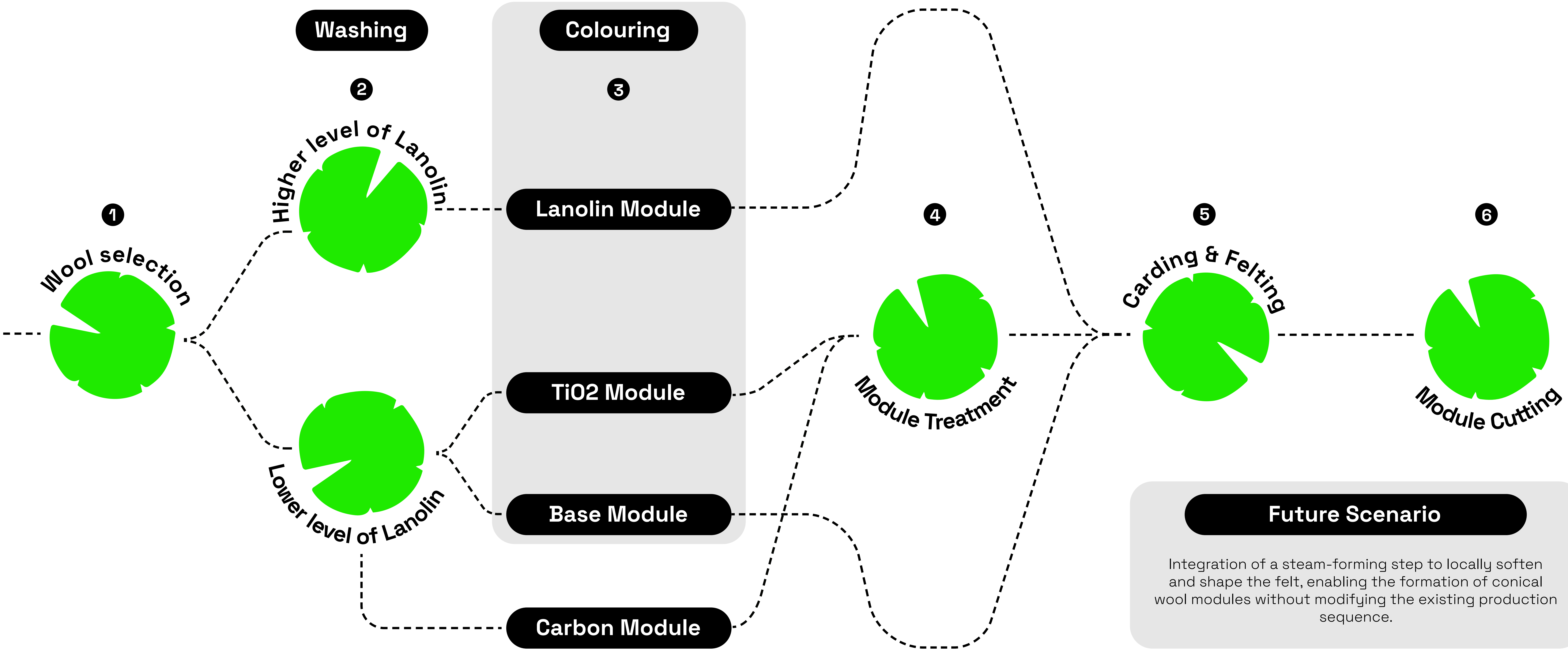
COLOUR STRATEGY

Option 2 - Product value

At the same time, Hasu is conceived not only as a filter, but also as a **suspended architectural element** that inhabits the space. Introducing colour through **mass-dyed wool fibres** allows the system to gain an additional layer of value, positioning it as both a functional device and a piece of interior design. Colour enhances spatial integration, legibility and identity, increasing the perceived value of the product without compromising permeability or performance. In this scenario, Hasu becomes an **air-mediating furniture-like system**, where function and aesthetics are intentionally aligned.

PRODUCTION PROCESS

From fibre to modular system



Future Scenario

Integration of a steam-forming step to locally soften and shape the felt, enabling the formation of conical wool modules without modifying the existing production sequence.

PRODUCT'S PALETTE

The colours of our system

Carbon Module

Lanolin Module

Base Module

TiO2 Module

Module’s Color Palettes

Mockup of our System in Action

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THANK YOU