

RHEON

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M.A. Thesis project

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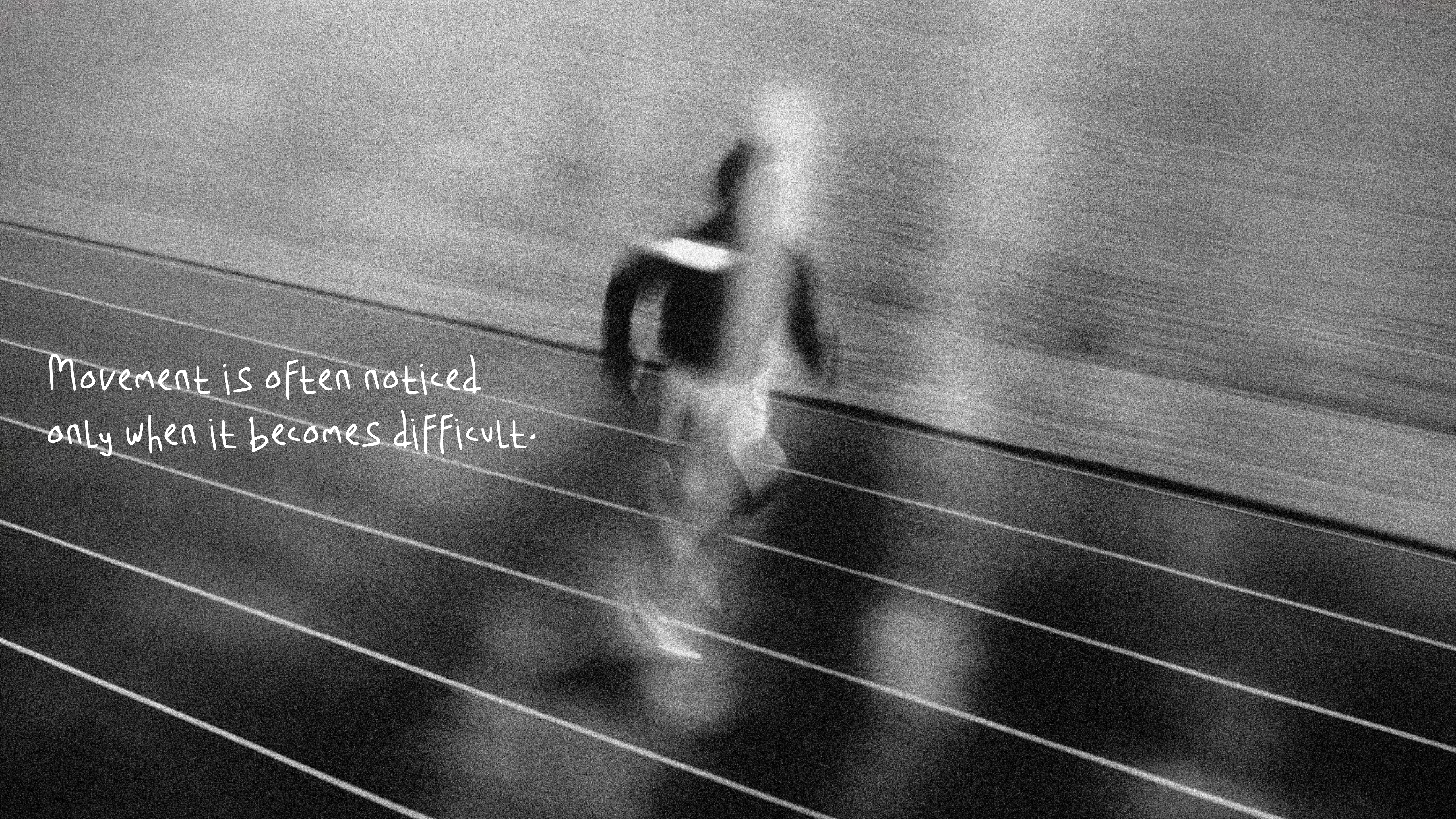
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Movement is often noticed
only when it becomes difficult.



Movement is not only motion.
It is the possibility to take part.

REACH.
CHOOSE.
WORK.
CARE.
RETURN.
BELONG.



NOTHING.
RETURN.
CARE.
FROM
HOOD.
REACH.

Movement as a common good

**BEFORE BEING A FUNCTION,
MOVEMENT IS ACCESS.**

Access to move is access to participate.

WHEN MOVEMENT BECOMES FRAGILE

Access starts to depend on support

Movement vulnerability does not always mean immobility.

Sometimes the body can still move, but every movement becomes negotiated: with **fatigue, instability, hesitation, asymmetry, compensation** or **fear of losing control**.

In this condition, support is not about replacing the body.
It is about preserving the possibility to keep acting.



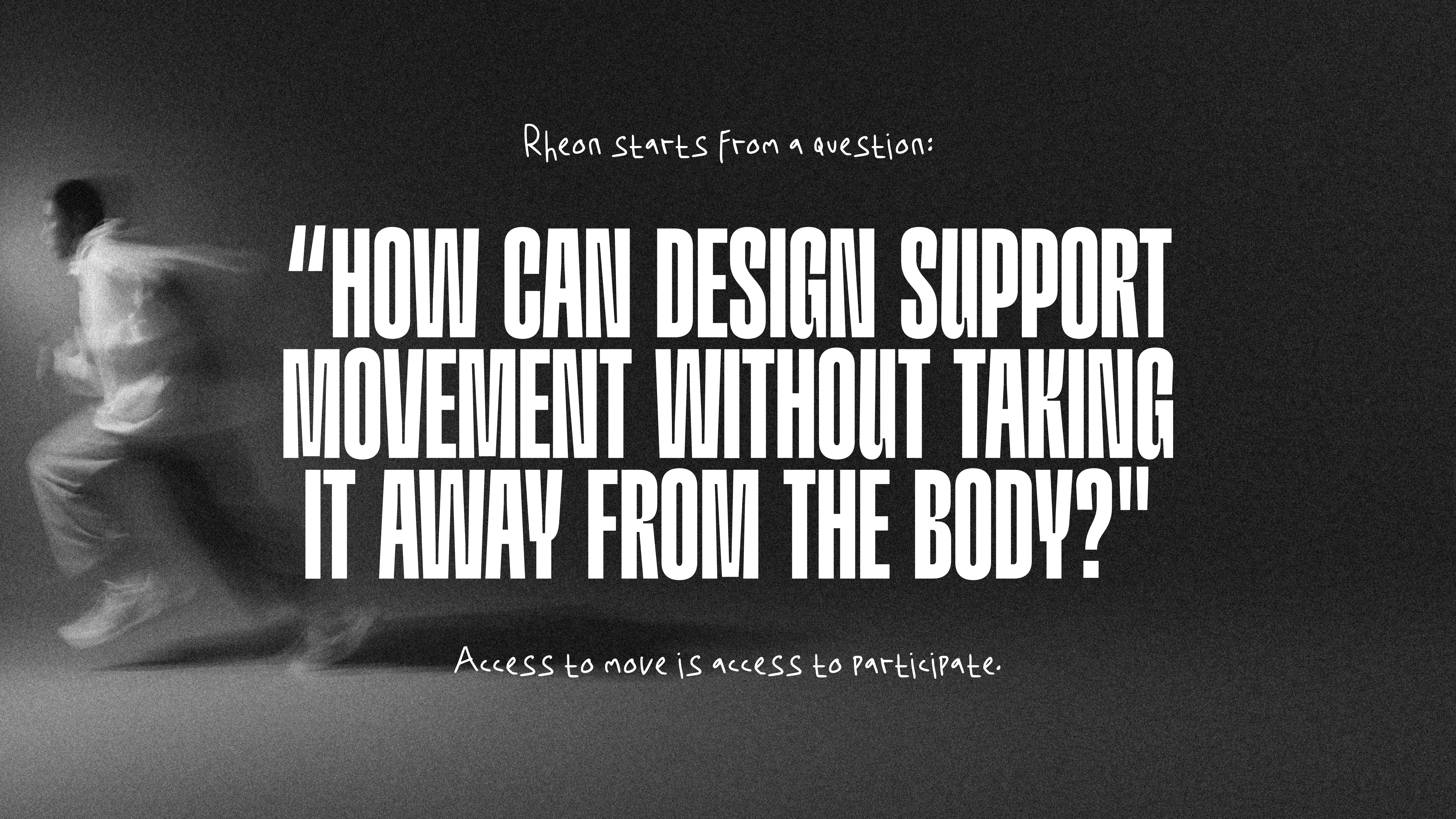
RHEON BEGINS HERE

Preserving movement as autonomy and participation

RHEON begins from the need to preserve movement not as a performance metric, but as a shared condition of autonomy and participation.

Rather than correcting the body or pushing it toward higher output, the project explores **how structural support can help active bodies** continue to move through instability, fatigue, asymmetry and reduced confidence.

The objective is not to act instead of the body, but to remain in dialogue with it.



Rheon starts from a question:

**"HOW CAN DESIGN SUPPORT
MOVEMENT WITHOUT TAKING
IT AWAY FROM THE BODY?"**

Access to move is access to participate.

THE UNSUPPORTED MIDDLE GROUND

Between clinical correction and performance optimization

Existing support systems are generally designed around two opposite conditions. Clinical devices protect, stabilise or correct the body when movement is compromised. Performance systems enhance efficiency, output and physical capability when performance is already the goal.

Clinical
Correction

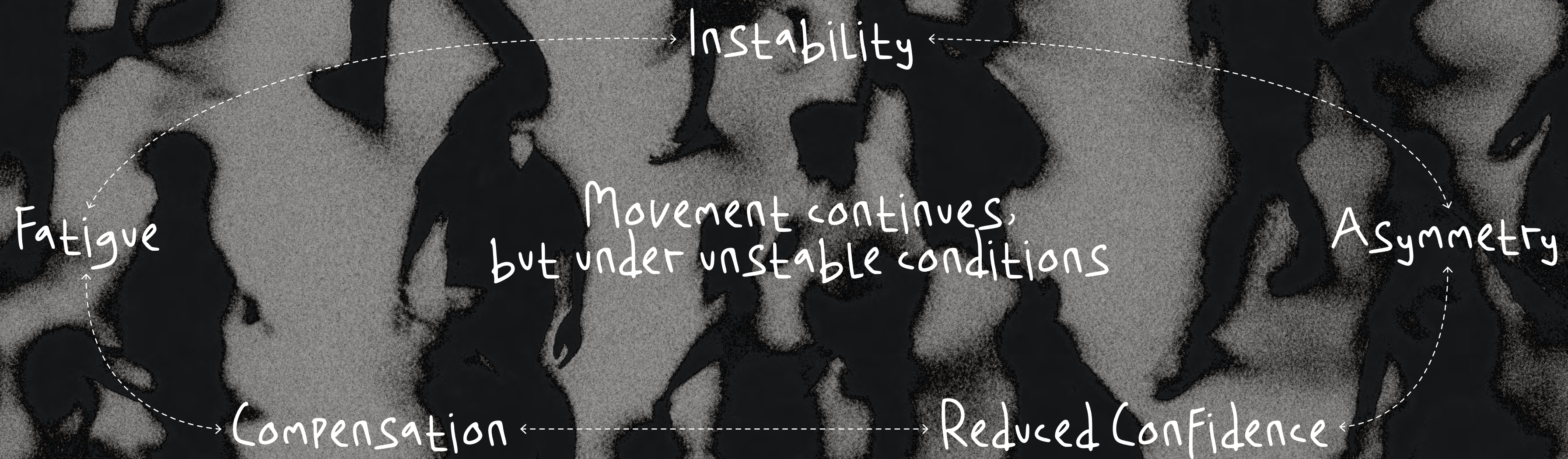
Persistent
Movement Vulnerability

Performance
Optimization

Movement is possible, but no longer fully supported.

PERSISTENT MOVEMENT VULNERABILITY

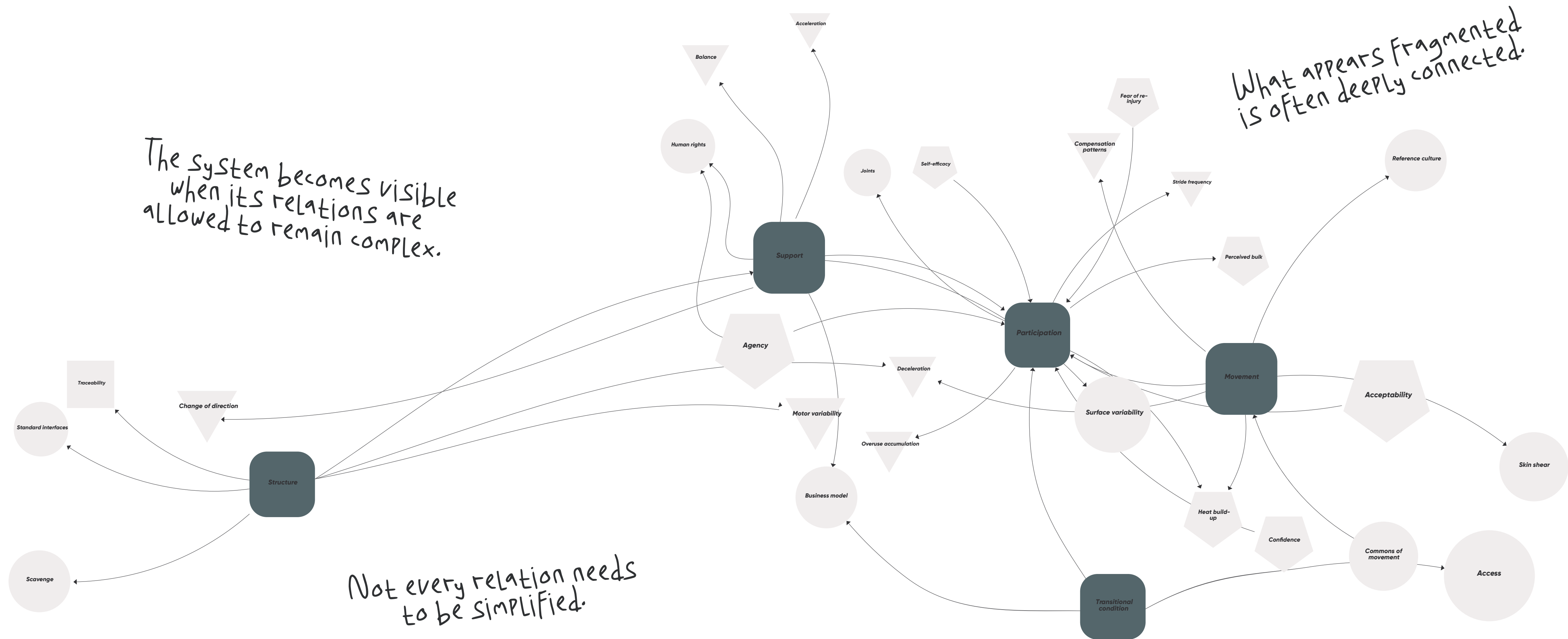
When movement is possible, but not fully supported



Persistent Movement Vulnerability describes **active bodies** that continue to move through recurring **instability**, **asymmetry**, **fatigue**, **compensation** or **reduced confidence**. It is not a temporary recovery phase alone, but a condition in which support remains meaningful over time.

RELATIONAL MAPPING

Making complexity visible



RESEARCH POSITION

From assistance to structural mediation



Assistance

Replaces function.
Compensates limitation.
Acts instead of the body.



Structural Mediation

Redistributes forces.
Stabilizes interaction.
Preserves bodily agency.

RHEON does not act instead of the body, it structures the conditions through which the body can continue to act



NO STANDARD BODY

Different anatomies, different structural responses

Bodies do not move, carry load or experience vulnerability in the same way.

Proportions, alignment, muscular volume, movement patterns and **local force conditions** continuously alter the relationship between anatomy and support.

Rather than adapting a standard device through sizing or local adjustments, **RHEON explores how support can be generated from the specific conditions of the body it is designed to mediate.**

A Fixed structure asks the body to adapt, RHEON reverses this relationship

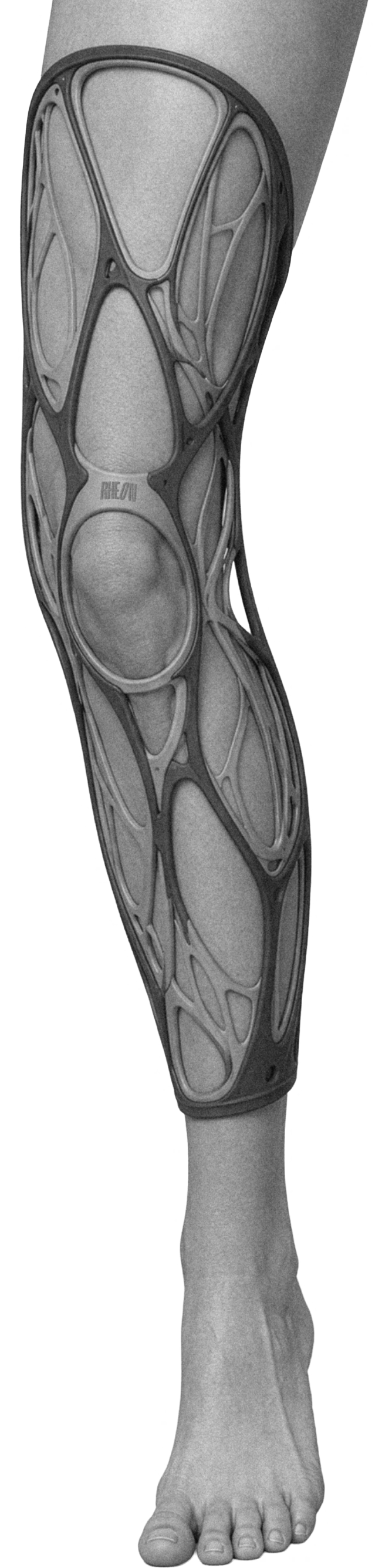
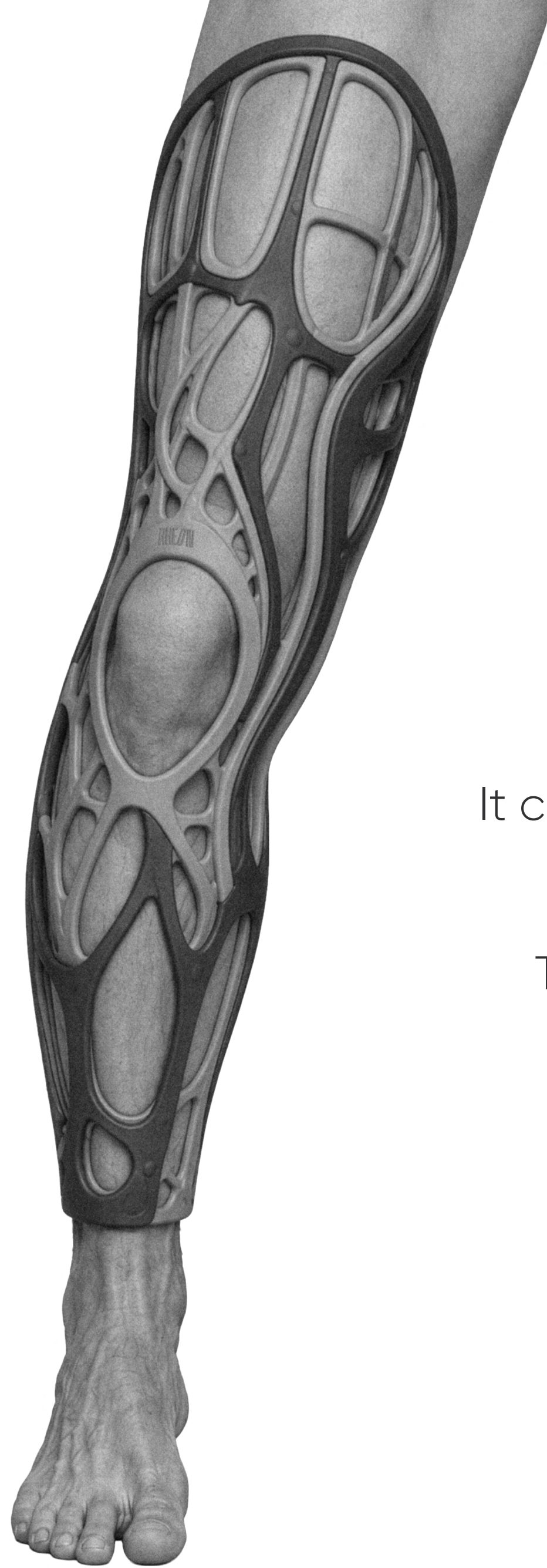
REGENERATED

Same Logic, new Structure

A change in anatomy, alignment or local force condition does not simply alter the size of RHEON.

It changes the rules through which the system is generated: branch direction, density, clearance, material distribution and structural continuity.

The **outcome is not a resized version** of the same object, but a **different response** produced by the **same computational framework**.



RHEON FITTING LAB

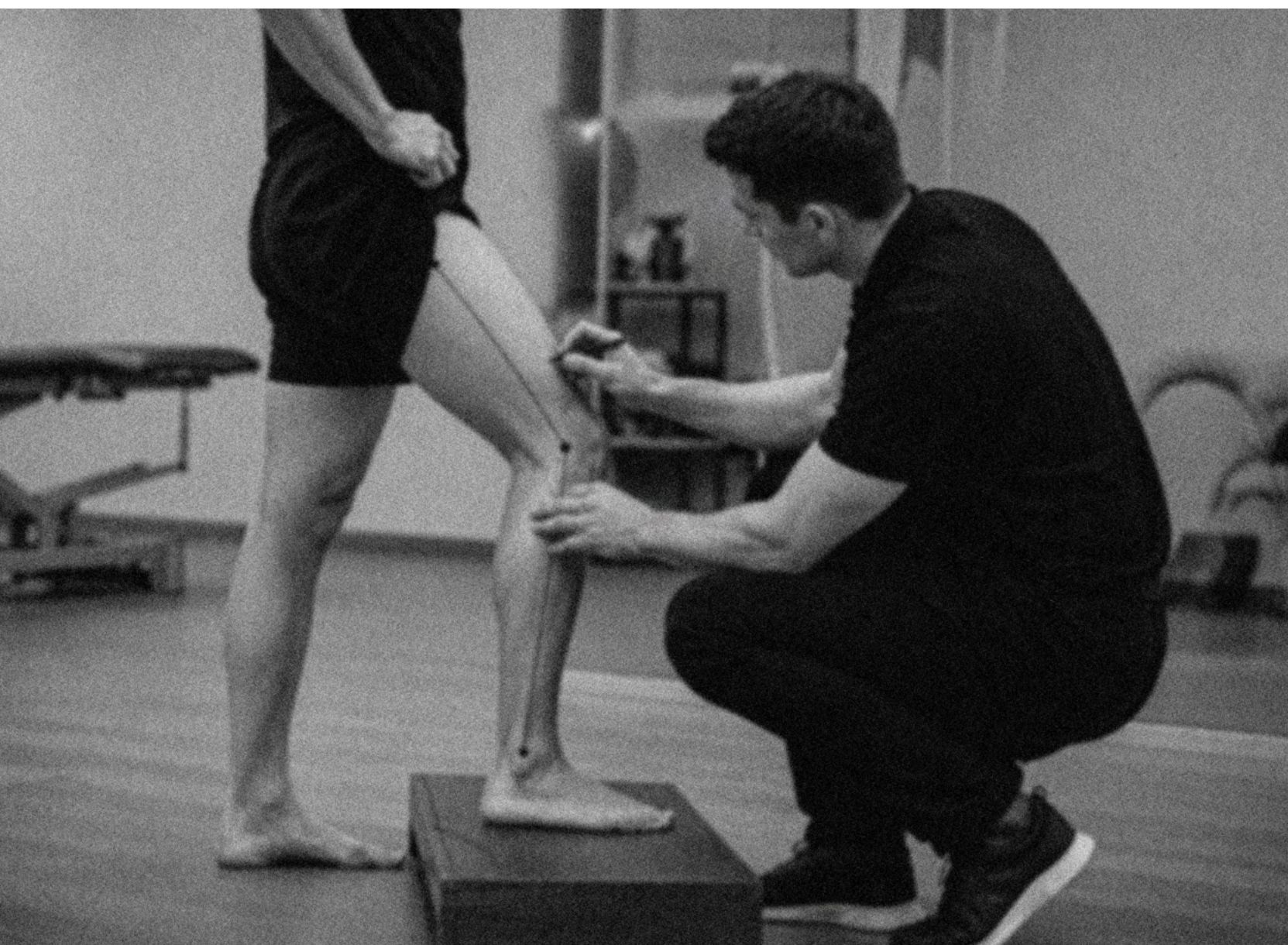
A physical-first, digitally extended service

RHEON is not selected from a catalogue.

It is developed through a **body-specific fitting process** that combines anatomical reading, movement observation, force conditions and material requirements.

The Fitting Lab translates an individual movement condition into a set of computational parameters capable of generating a specific structural response.





1

Pre-Map

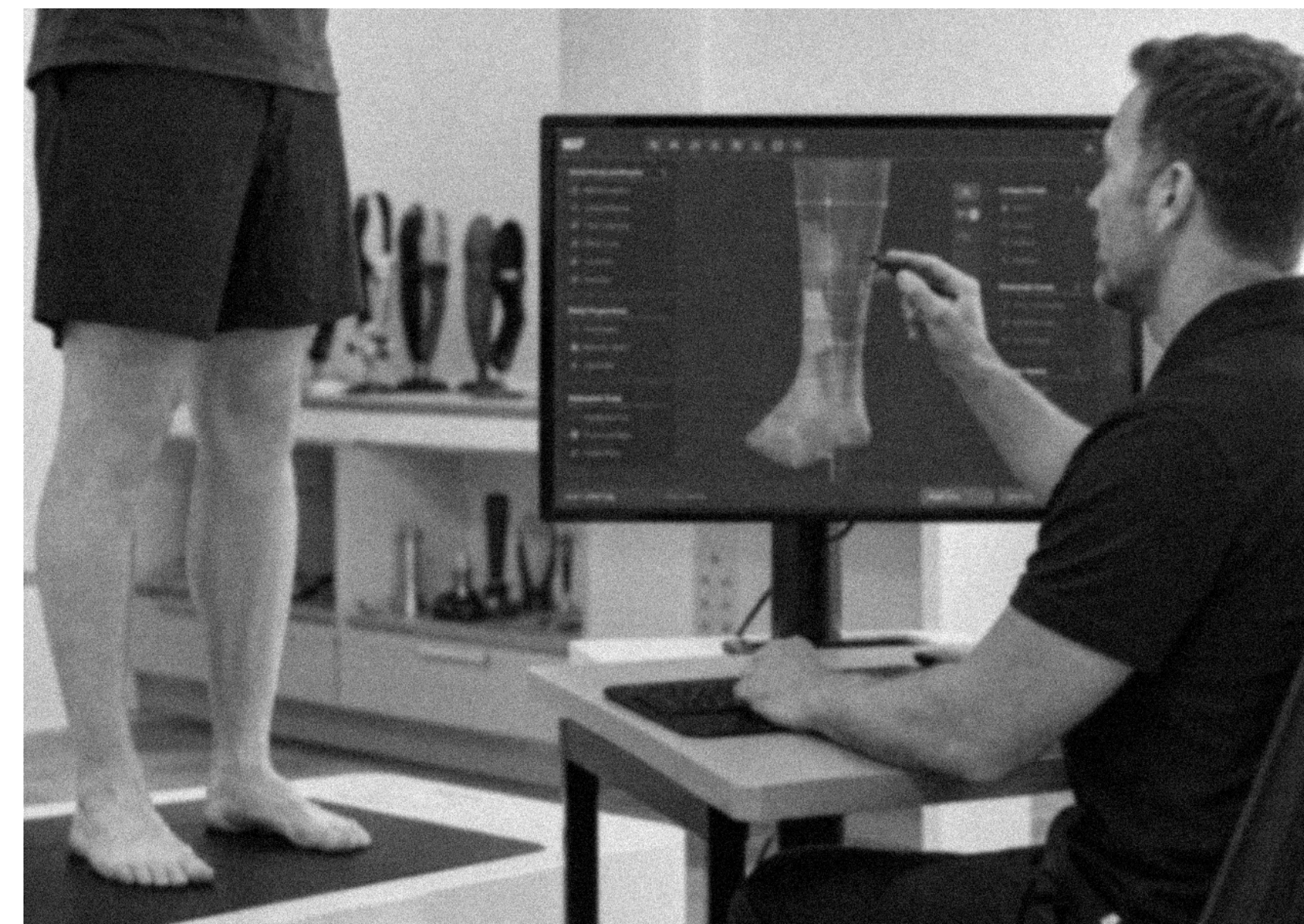
Identifying anatomical landmarks and proportions



2

Scan

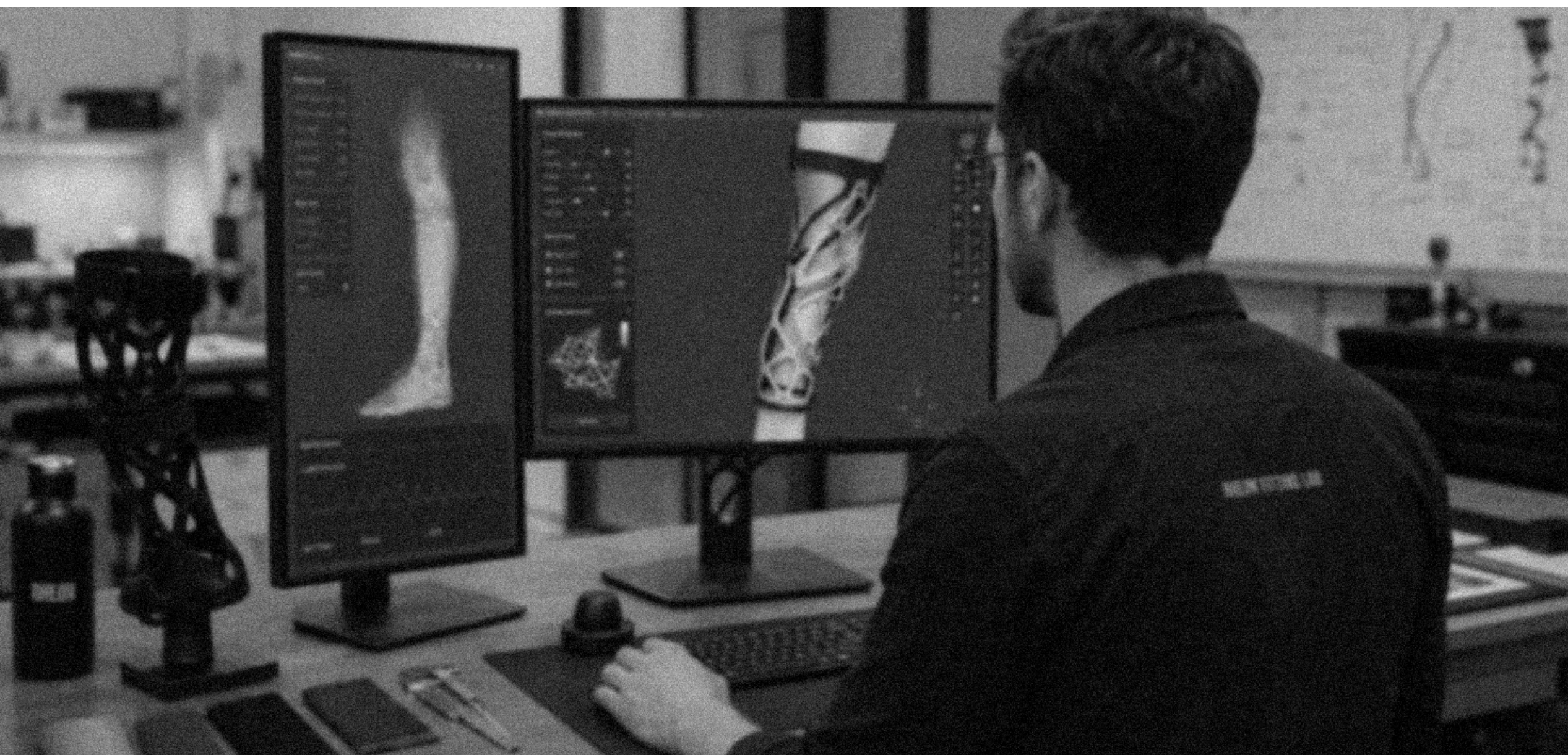
Capturing the body condition



3

Map

Translating body data into design constraints



4

Generate

Translating forces into
material structure



5

Fit

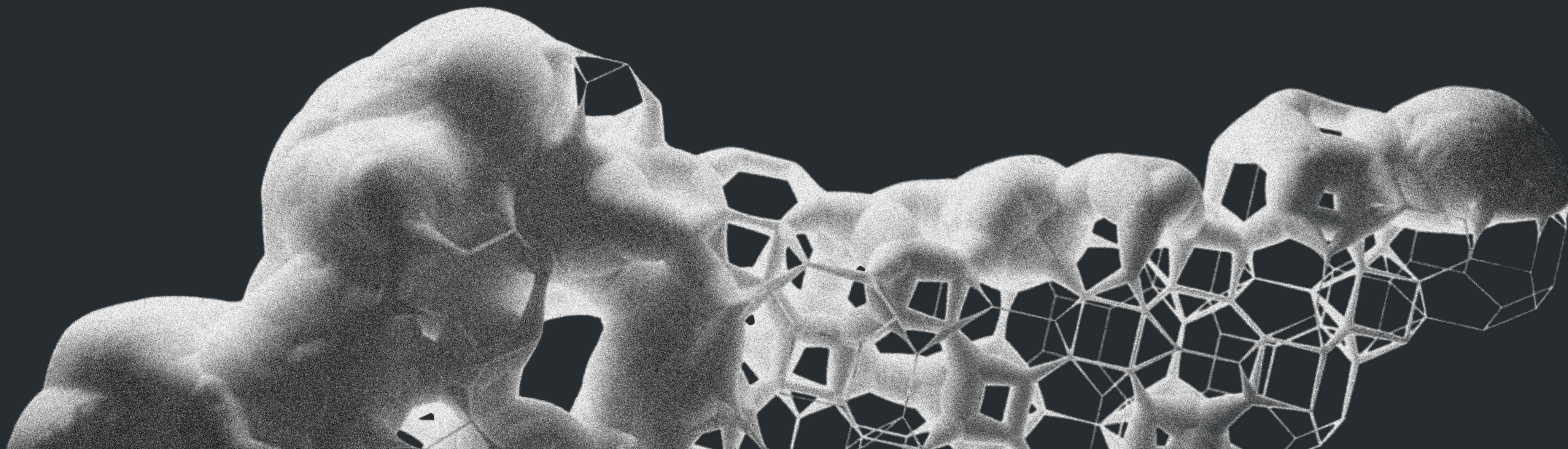
Positioning, contact
and adjustment

THE SHAPE IS NOT DRAWN

From Conditions to Form

RHEON is **not developed by modelling** a fixed structure around the leg. The process begins from the body as a moving system: its proportions, anatomical boundaries, movement states and local force conditions.

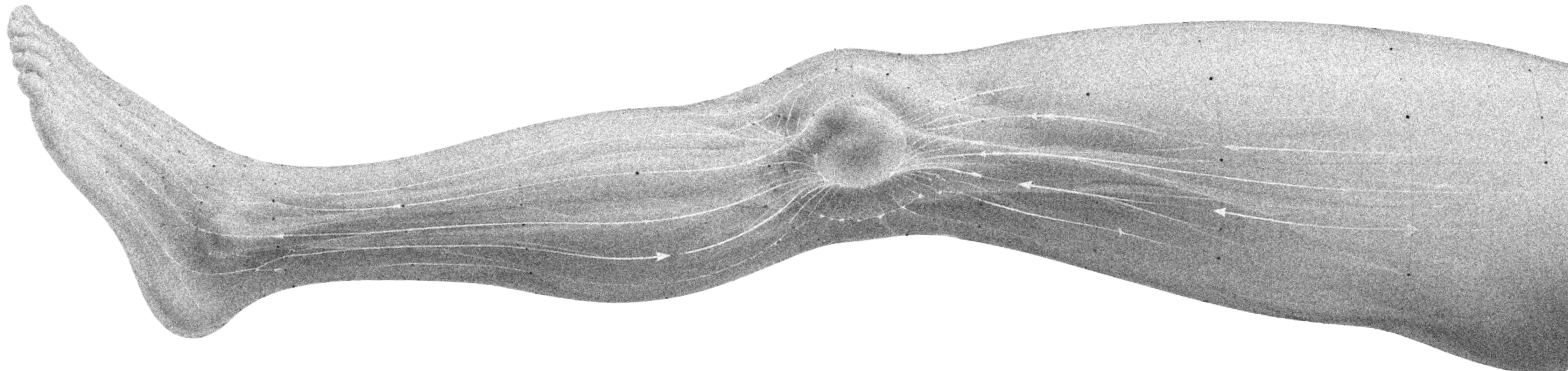
These inputs are translated into **computational rules** that define where the structure can exist, where it needs to remain compliant and where material must remain absent.



FROM BODY TO STRUCTURE

A body-specific computational workflow

RHEON translates **anatomical, movement** and **force-related inputs** into an individual structural response. The system does not begin from a predefined geometry. It begins from the body in motion.



THE BODY IS CAPTURED IN MOVEMENT

Extension and Flexion define the first design conditions

RHEON does not begin from a static body scan.
The lower limb is read through at least two states:
extension and **flexion**. These reveal how proportions, soft tissues,
joint space and movement-sensitive areas change during motion.

The aim is not only to record shape,
but to understand how the body behaves while moving.

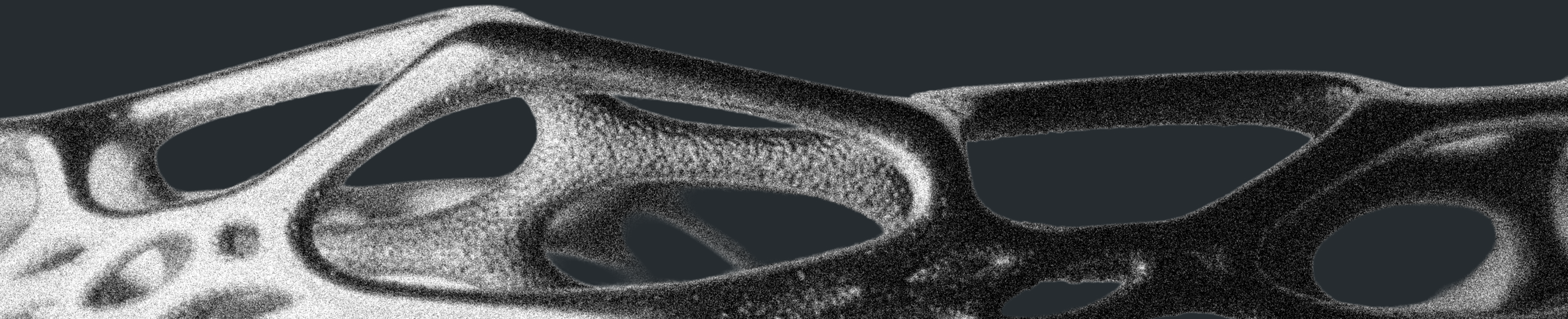


DESIGNING FOR MOTION

The structure can only exist where movement allows it

By comparing the extended and flexed states, RHEON generates a **movement-informed anatomical envelope**.

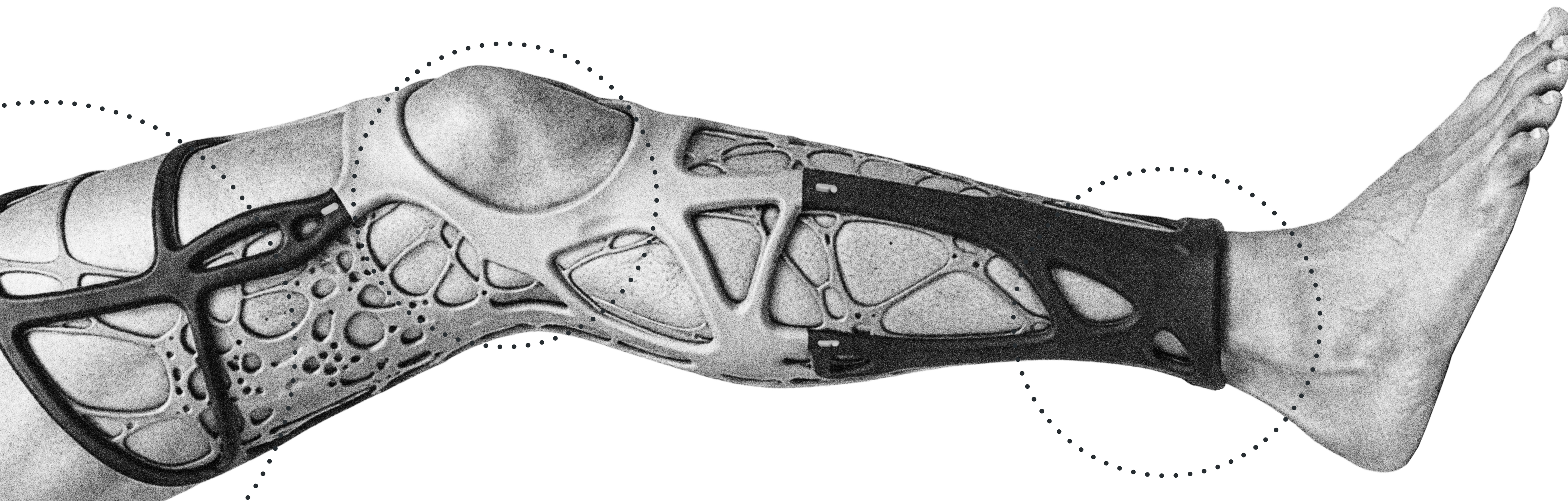
This envelope identifies where the structure can remain close to the body, where it needs clearance, where compliant contact is required and where material must remain absent.



ANATOMICAL BOUNDARIES

Freedom is designed into the structure

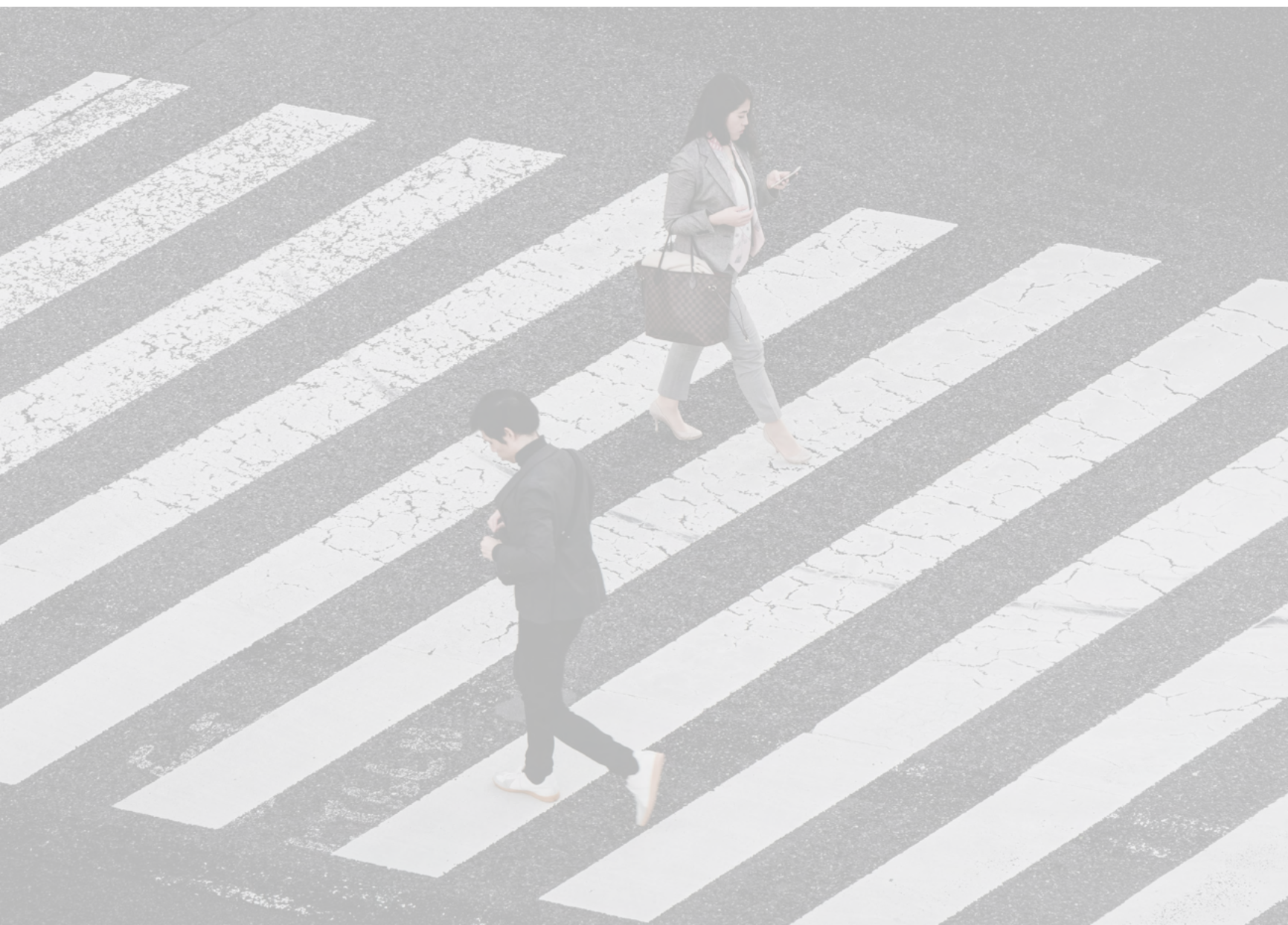
RHEON is defined not only by where it acts, but also by where material must withdraw. Sensitive anatomical regions become non-negotiable exclusion zones. The **patella**, **popliteal fossa**, **medial thigh corridor** and **malleoli** remain free from direct structural occupation. In RHEON, absence is not a missing part of the system. It is a design rule.



FORCE CONDITIONS

Support responds to movement, not to shape alone

RHEON does not respond to a single load condition.
The project organizes biomechanical references into three design scenarios:



Baseline

Walking, standing and low-intensity daily movement.



Elevated

Stairs, controlled squatting, light training and repeated movement under fatigue.



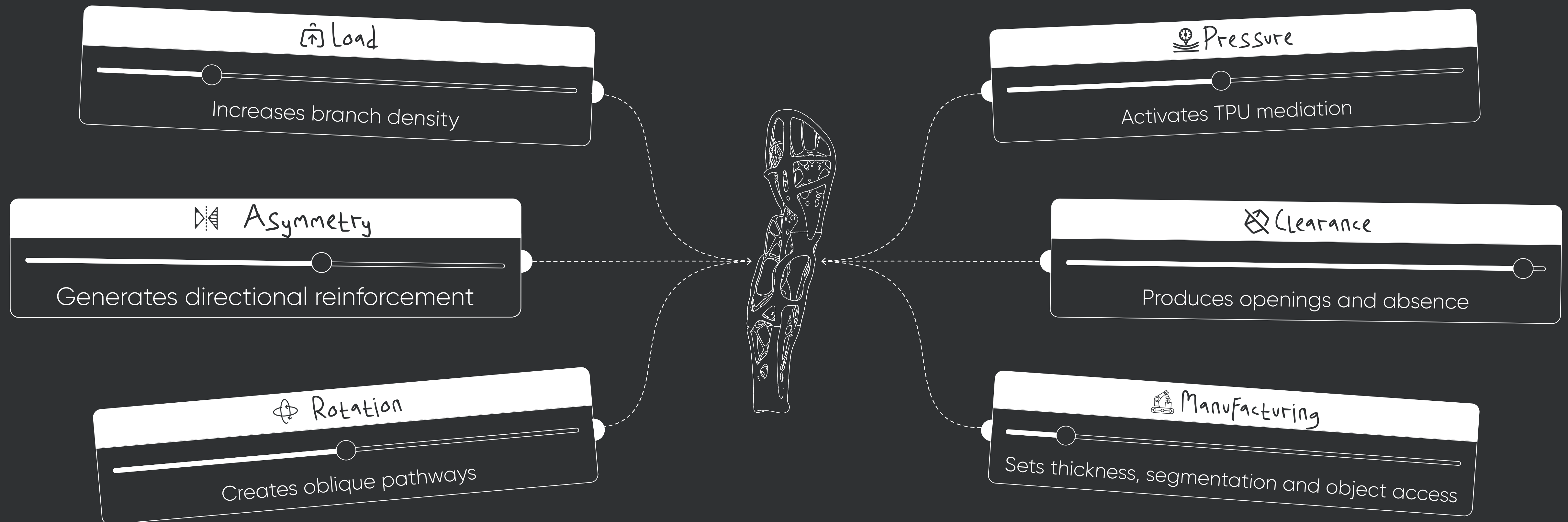
Maximum

Extreme biomechanical references used to define the upper boundary of the system.

BIOMECHANICAL INPUTS

Forces as design coefficients

Biomechanical data are not used to claim final clinical validation. They are used as **design coefficients** that help define where the structure should become denser, where it should open, where it should soften and where it should remain free.





FROM FORCE TO RULE

Forces become design instructions

Force conditions do not directly generate material. They are first interpreted through **anatomical boundaries**, **movement requirements** and **local contact conditions**.

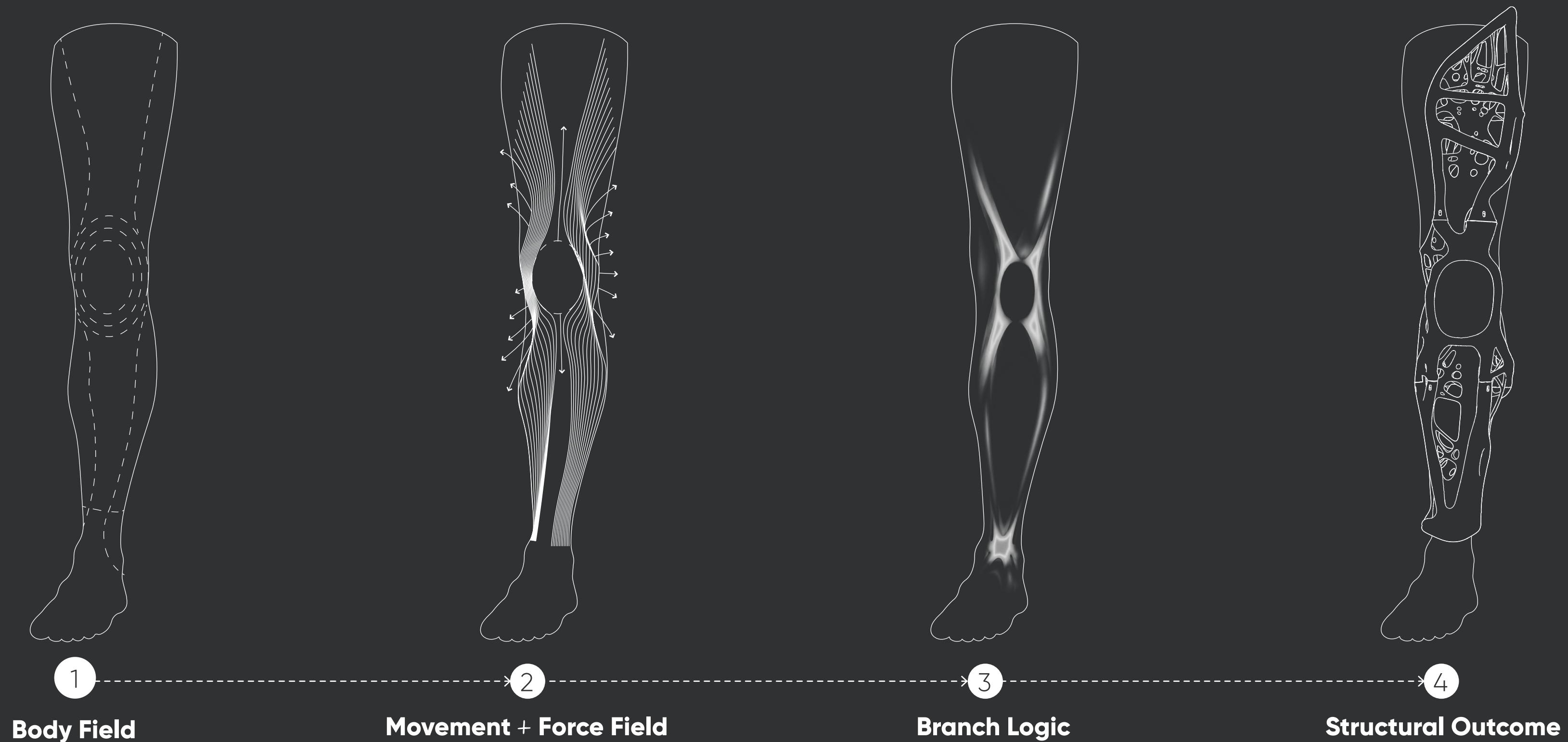
These inputs become computational rules that define how the structure behaves across the lower limb.



GENERATIVE LOGIC

Rules become structure

Anatomical boundaries, movement envelopes, force paths and material requirements are **translated into interacting computational fields**.



nTOP WORKFLOW

From body constraints to material geometry

1

Body Geometry

Scan mesh, anatomical landmarks, alignment axes

2

Exclusion Fields

Patella, popliteal fossa, malleoli, inguinal fold, donning corridor

3

Preserve Regions

Upper anchoring nodes, knee mediation section, strap interfaces

4

Load Conditions

Maximum reference scenarios

5

Material Setting

PA11 structural field, TPU compliant field, tendon layer interface

6

Optimization Controls

Volume fraction, member size, smoothing, thickening, segmentation

SYSTEM OVERVIEW

Technical Views of one possible iteration



KNEE MEDIATION

The joint is mediated, not enclosed

The knee is not treated as a hinge to lock or cover.

It becomes a **movement-sensitive node** where structural continuity, local clearance and directional force redistribution must coexist.

The patella remains free, while the structure redirects around the joint through asymmetric and diagonal trajectories.



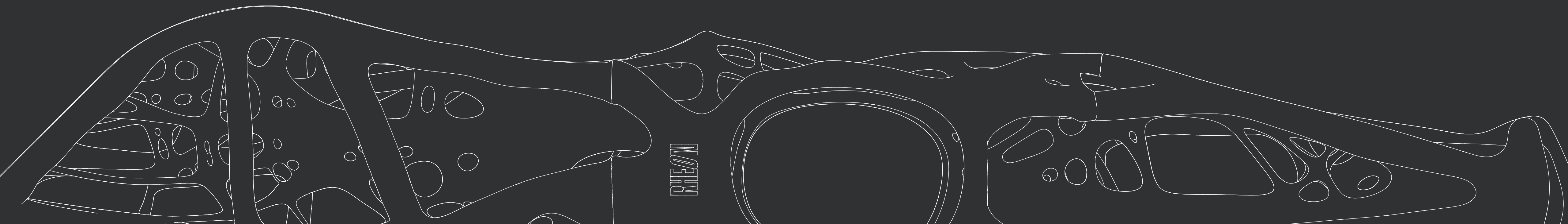
ONE SYSTEM, TWO BEHAVIOURS

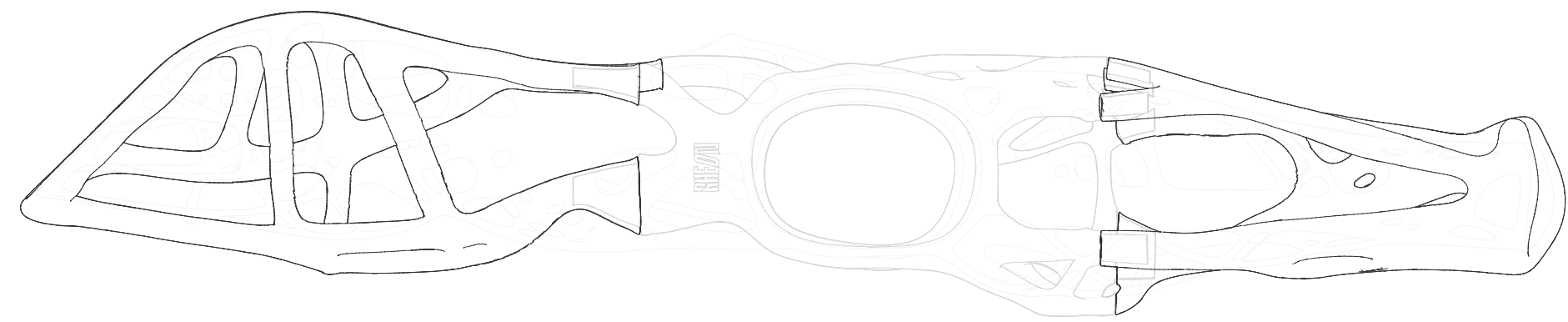
Support that knows when to yield

RHEON combines two complementary material behaviours within one continuous structural system.

The **rigid network** redistributes load and maintains directional continuity across the limb.

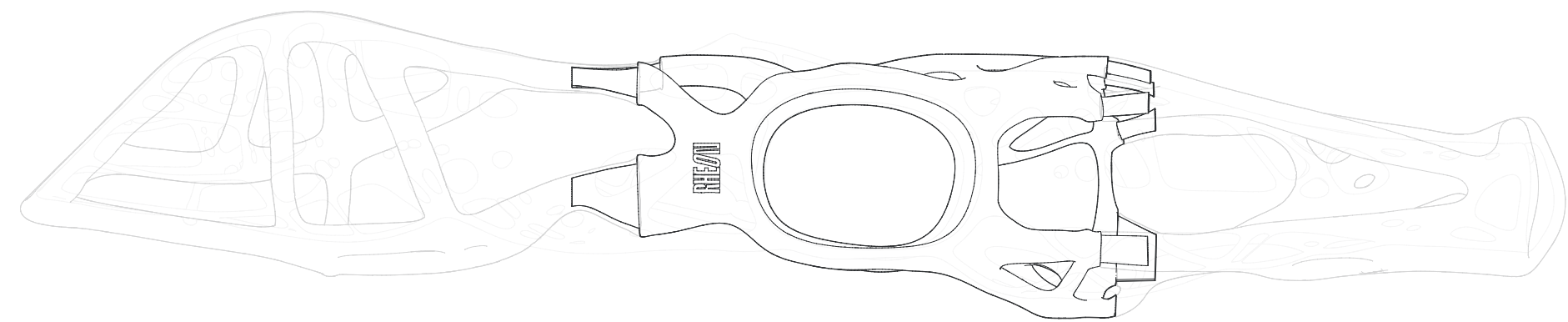
The **compliant layer** mediates local pressure, contact and movement-sensitive areas without turning the system into a rigid brace.





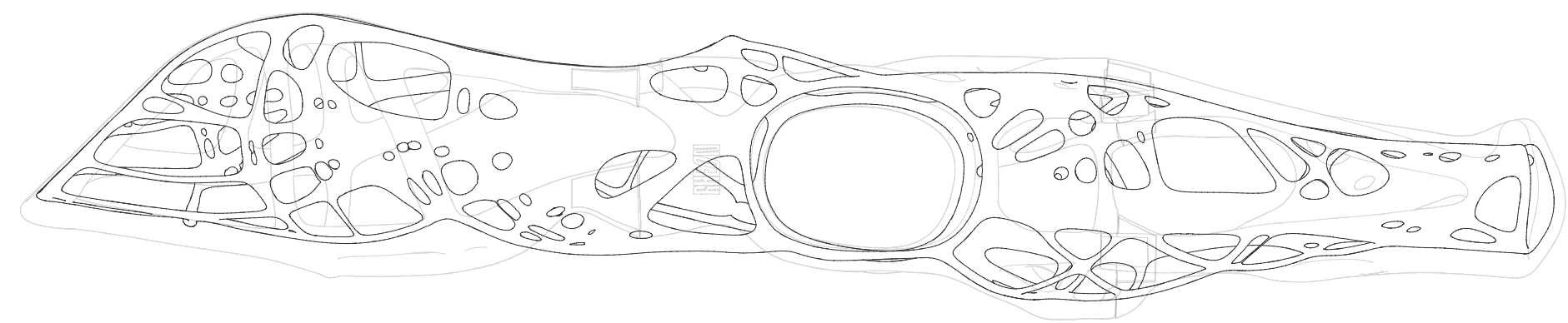
PA11 Primary Branches

Define the main load-bearing structure, guide force transfer and create the external generative skeleton.



TPU 88A Compliant Branches

Are generated through a secondary topology optimization, running alongside the PA11 network to translate structural paths into softer mediation zones.



TPU 88A Body-Facing Tendon Layer

Acts as the internal contact interface, reconnecting the branching system to the body while distributing pressure, damping and local contact.

PA11 – Primary Structural Network



Role in RHEON

Directional load transfer · Structural continuity · Branch reinforcement

Key Properties

Density: 1.03 g/cm³

Tensile modulus: 1,650 MPa

Tensile strength: 50 MPa

Elongation at break: 30%

High impact resistance · chemical resistance · lightweight

Why here

Used for the primary external branches, where RHEON needs to maintain geometry and redirect forces without becoming excessively heavy or brittle.

TPU 88A – Compliant Contact System



Role in RHEON

Pressure mediation · flexible connection · body-facing comfort

Key Properties

Tensile modulus: 75 MPa

Tensile strength: 7–8 MPa

Elongation at break: 130–270%

Flexural modulus: 70 MPa

Elastic recovery · abrasion resistance · local damping

Why here

Used for compliant branches and the body-facing tendon layer, where the system needs to follow local movement, distribute contact pressure and remain close to the body.

MANUFACTURING STRATEGY

Continuous system, separate production bodies

RHEON can remain continuous as a **morphological** and **functional system** without being produced as a single monolithic piece.

The PA11 primary branch network and the TPU 88A secondary compliant branch network can be **generated as separate production bodies**, then integrated through designed interfaces, nodal retention, open guided support and controlled emergence.

PA11 – Primary Structural Network

Produced through **MJF additive manufacturing** as the main structural body. The geometry is optimized for lightweight continuity, open cells and post-processing access.

TPU 88A – Compliant Contact System

Produced as separate flexible TPU components, including compliant branches and body-facing tendon layer. The TPU parts introduce local compliance, pressure mediation and controlled contact with the body.

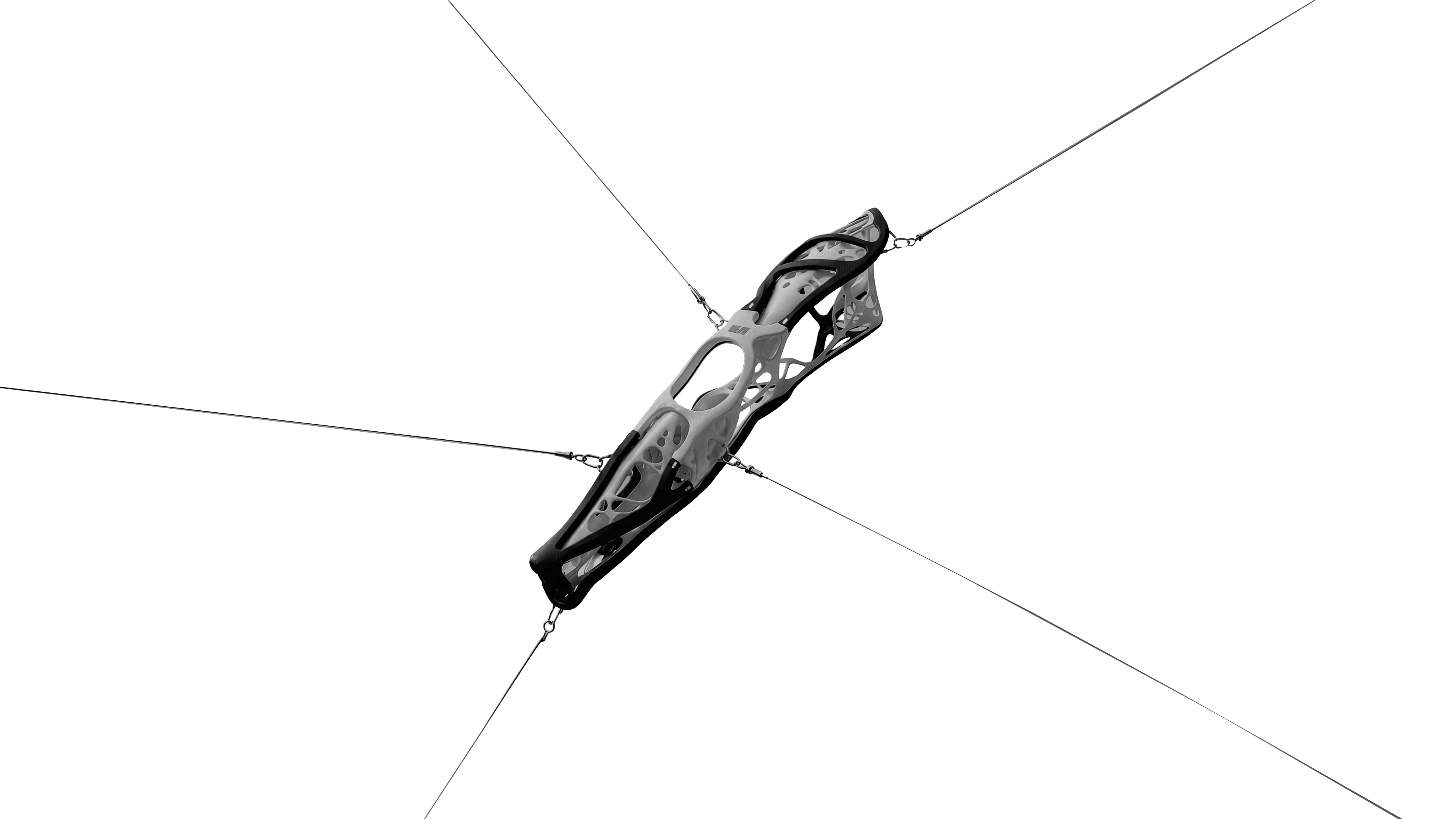
COMPLIANT INSERT

Controlled micro-travel for movement tolerance

The TPU inserts are designed to seat inside dedicated PA11 recesses, creating a soft mechanical interface between the structural frame and the body-facing system.

Each TPU insert integrates a **small guiding pin** that slides inside a narrow **PA11 rail**. This allows a controlled vertical micro-travel, helping the system **absorb minor over-movements, tension variations** and **fitting tolerances** without losing position.

AREON





"The body remembers every
wish one lives for or doesn't."
—Yusef Komunyakaa

"There is a vitality, a life
force, an energy, a quickening
that is translated through
you into action."
—Martha Graham





"We see in order to move;
we move in order to see."
—William Gibson

The object is one outcome,
THE WORKFLOW IS THE PROJECT



Thank You!