FABRICADEMY

IBERO PUEBLA IDIT

asimMETRI

by Mar

PROBLEM

Life with insoles

The sacrum and pelvis can tilt or rotate, leading to postural imbalance, joint wear, and lower back or sacroiliac pain.

In my daily life, I need to wear orthopedic insoles, which are essential for preventing complications caused by the difference in length between my legs.

This condition is hereditary, as my mother also has it, meaning it is not acquired but rather part of my genetics.

However, I was not diagnosed until I was 31, as I had always assumed my discomfort was due to poor posture.

My leg length difference is approximately 1 cm.

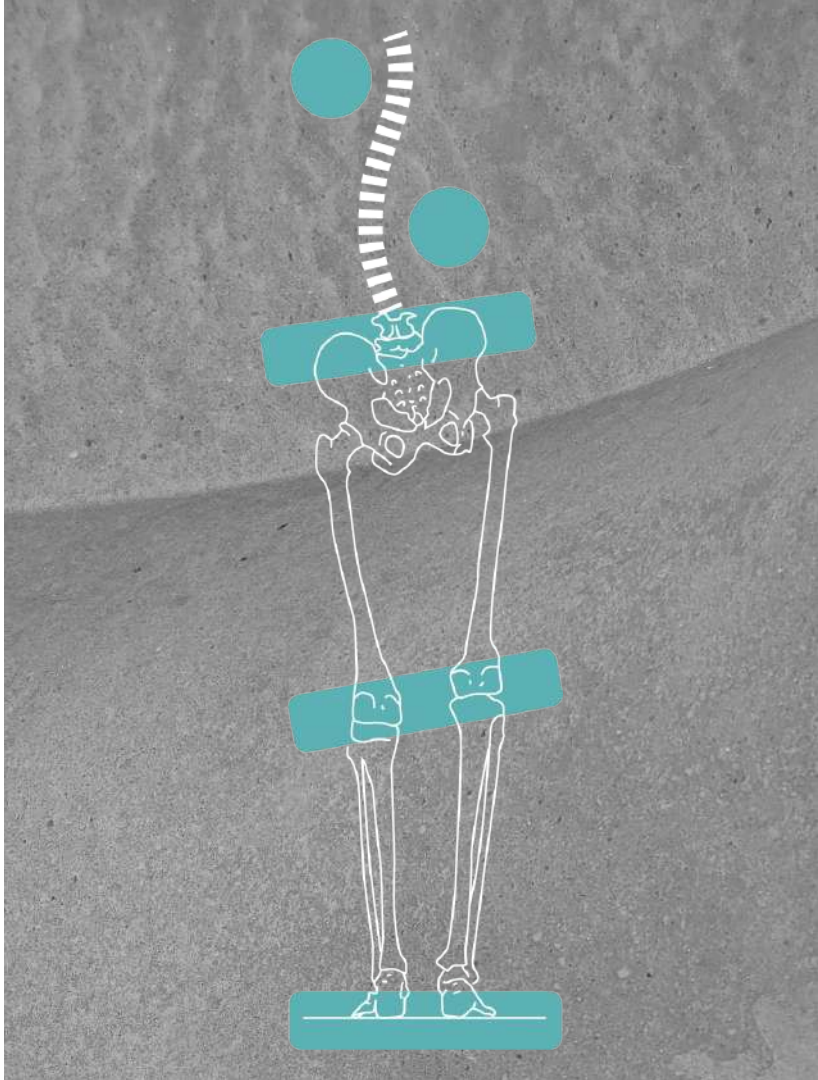
Typically, for discrepancies between 1 and 3 cm, custom insoles are recommended. However, since I did not address the issue in time, I had to wear a brace for six months and start using custom-made insoles.

This was possible thanks to several tests conducted by my orthopedist, which were crucial for accurately diagnosing my condition.

Orthopedic brace for spinal correction due to bone asymmetry

Lower limb discrepancy

It is a condition in which there is a difference in the length of the leg bones, which can affect posture, gait, and weight distribution in the body.



What is an Orthosis?

An orthosis is an external device designed to modify structural or functional aspects of the musculoskeletal system. It is used to:

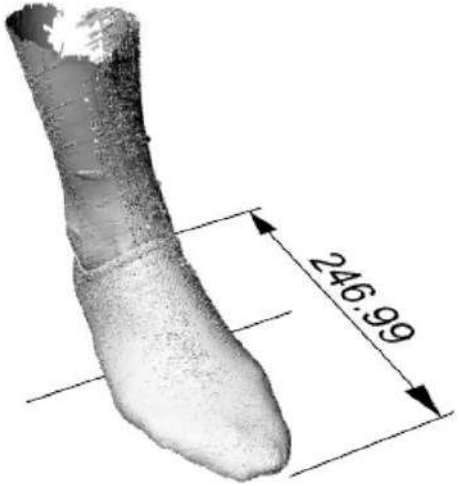
Insoles

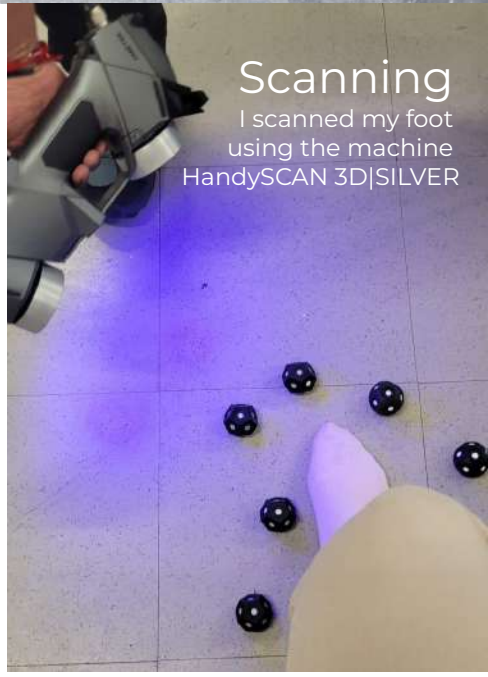
ANALYSIS

Scanning my feet

I scanned my foot using the machine Handy SCAN 3D SILVER.

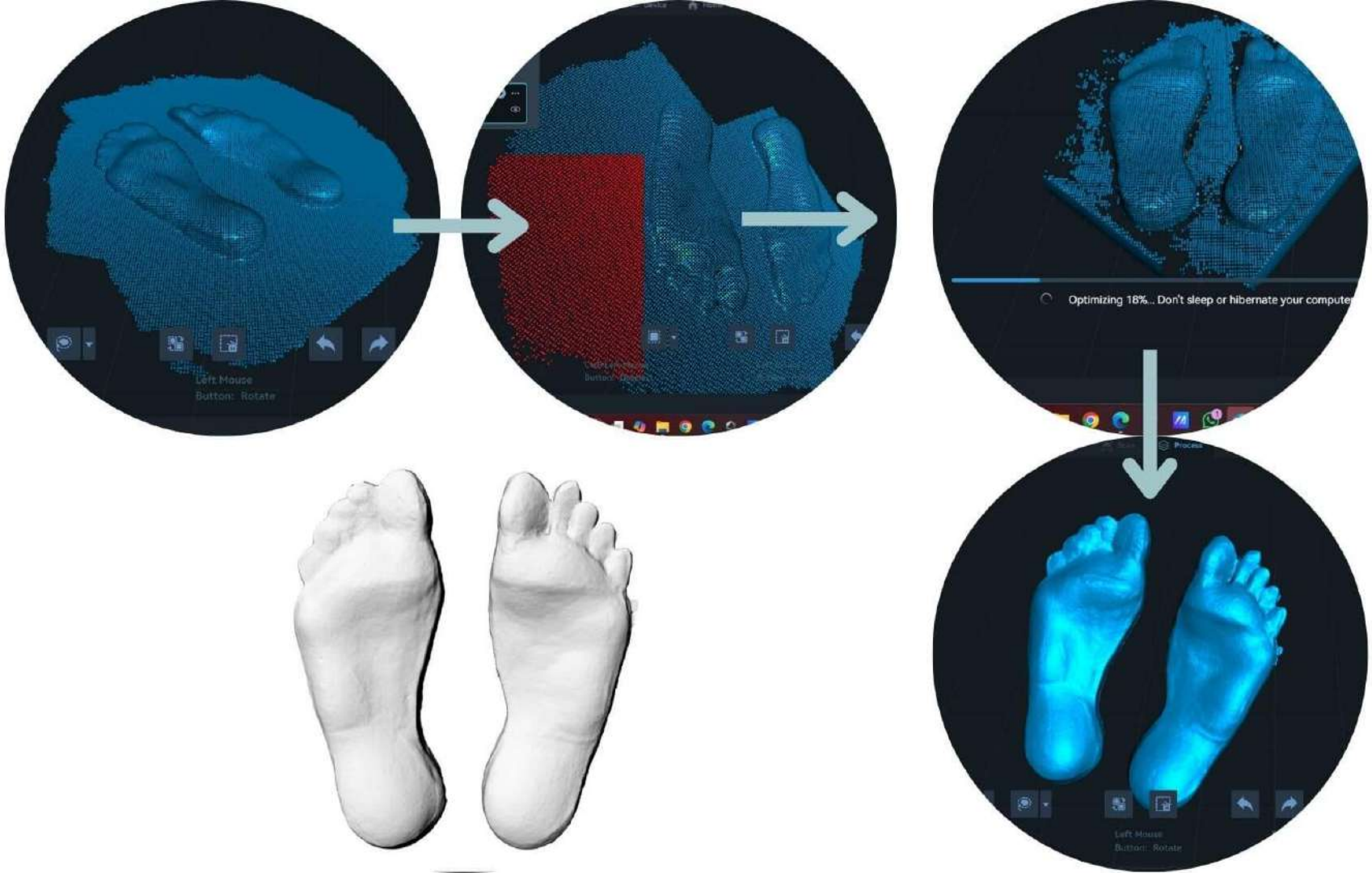
This technology is not yet available in our FabLab, but a team came to give us a demonstration, and I asked them to help me with the scan, as it is rare to have the opportunity to use such a specialized product.





Scanning

I scanned my foot using the machine Creality scan (Oliver lab)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Button: Rotate
Optimizing 18%.. Don't sleep or hibernate your compute
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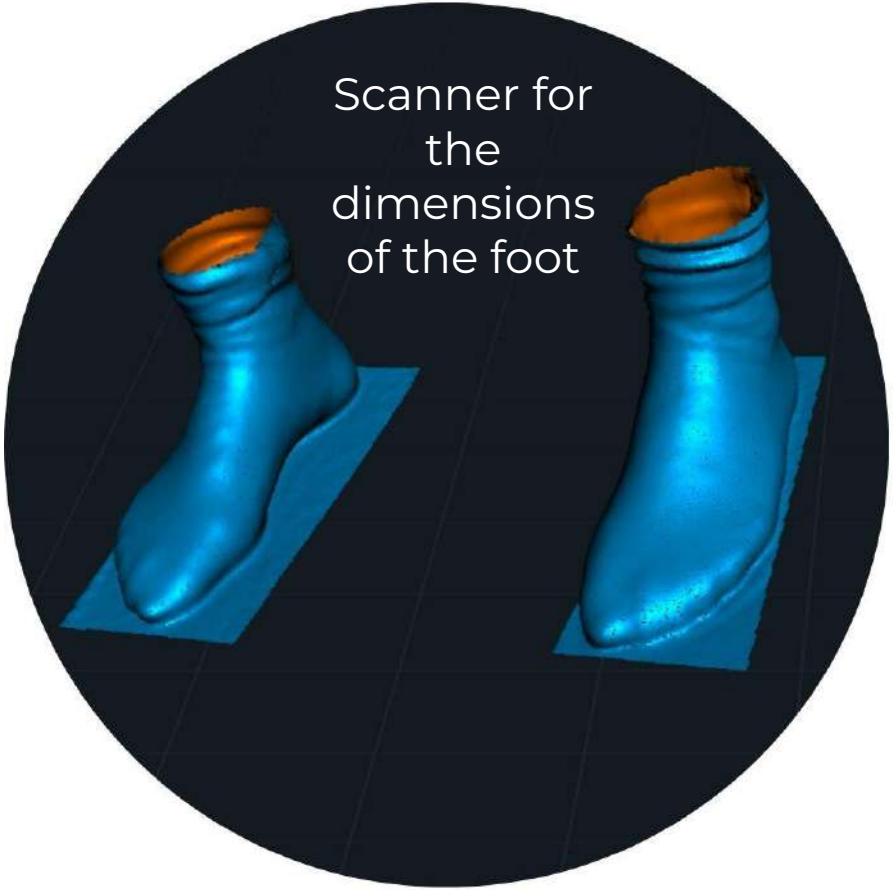
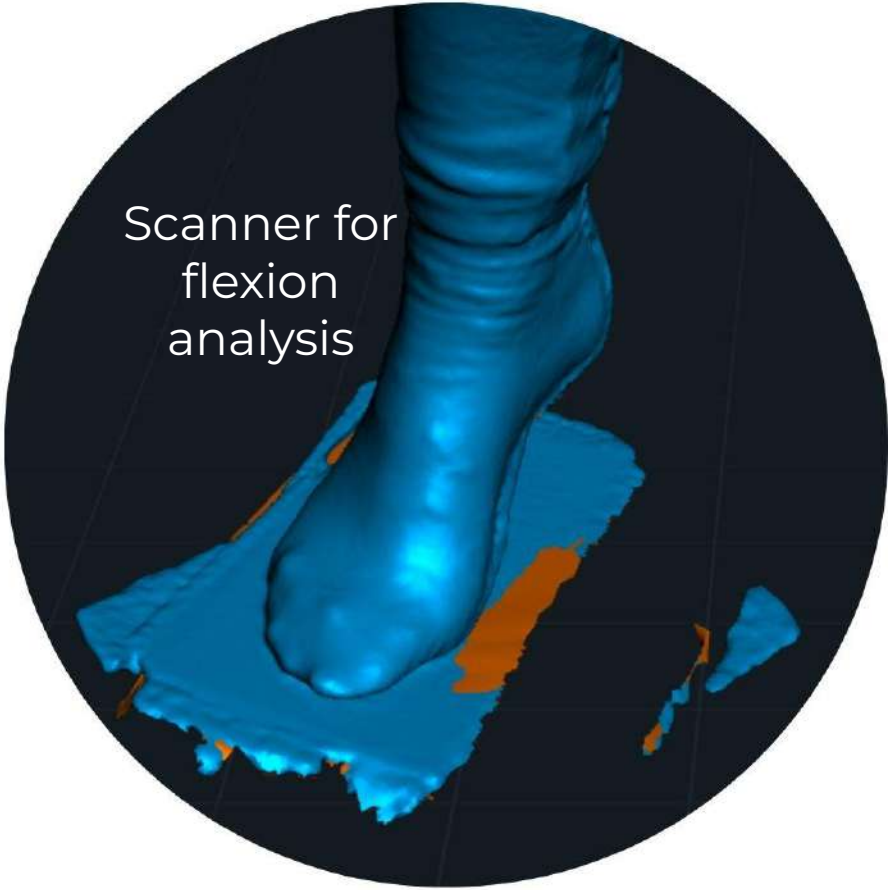
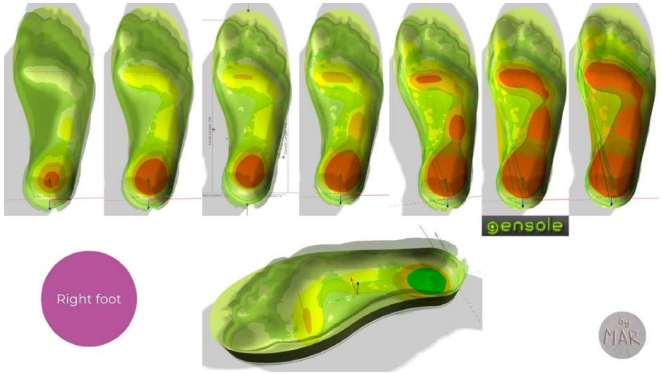
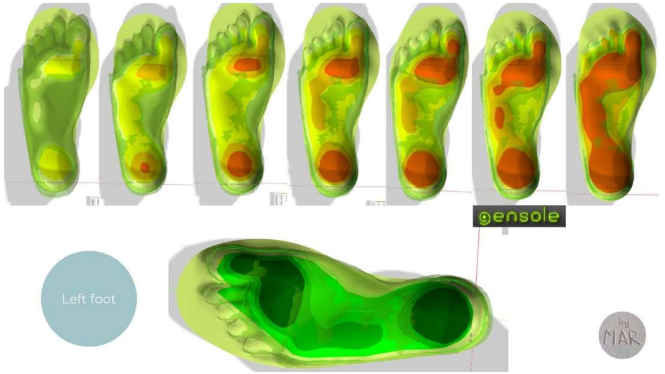

Scanner for
the
dimensions
of the foot


Scanner for
flexion
analysis

DIAGNOST



This test allowed me to observe the difference in pressure between my left and right foot. While I had some initial assumptions, I decided that the best course of action was to consult the orthopedic specialist who had previously treated me.



Using the 3D design of my foot soles, captured while applying pressure with my own body.

Doctor's notes:
"His notes indicate a pair of full insoles in Pelíre: 12 mm longitudinal arch, 2 mm external wedge, and a 5 mm heel lift for the right foot, size 26."

This is the analysis I requested: Full-body densitometry, with a cost of 584.25 MXN.

Monto total	$ 584.25
Ahorro digital	$ 194.75
Forma de pago	Pagado en linea
Fecha del pedido	28-02-2021
Hora del pedido	10:06:50

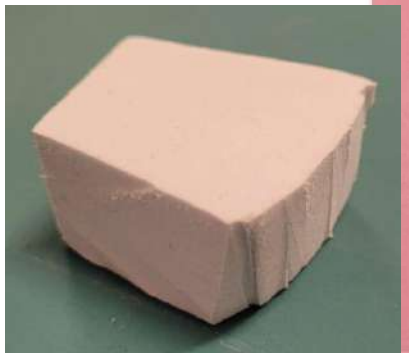
Descargar Cotización

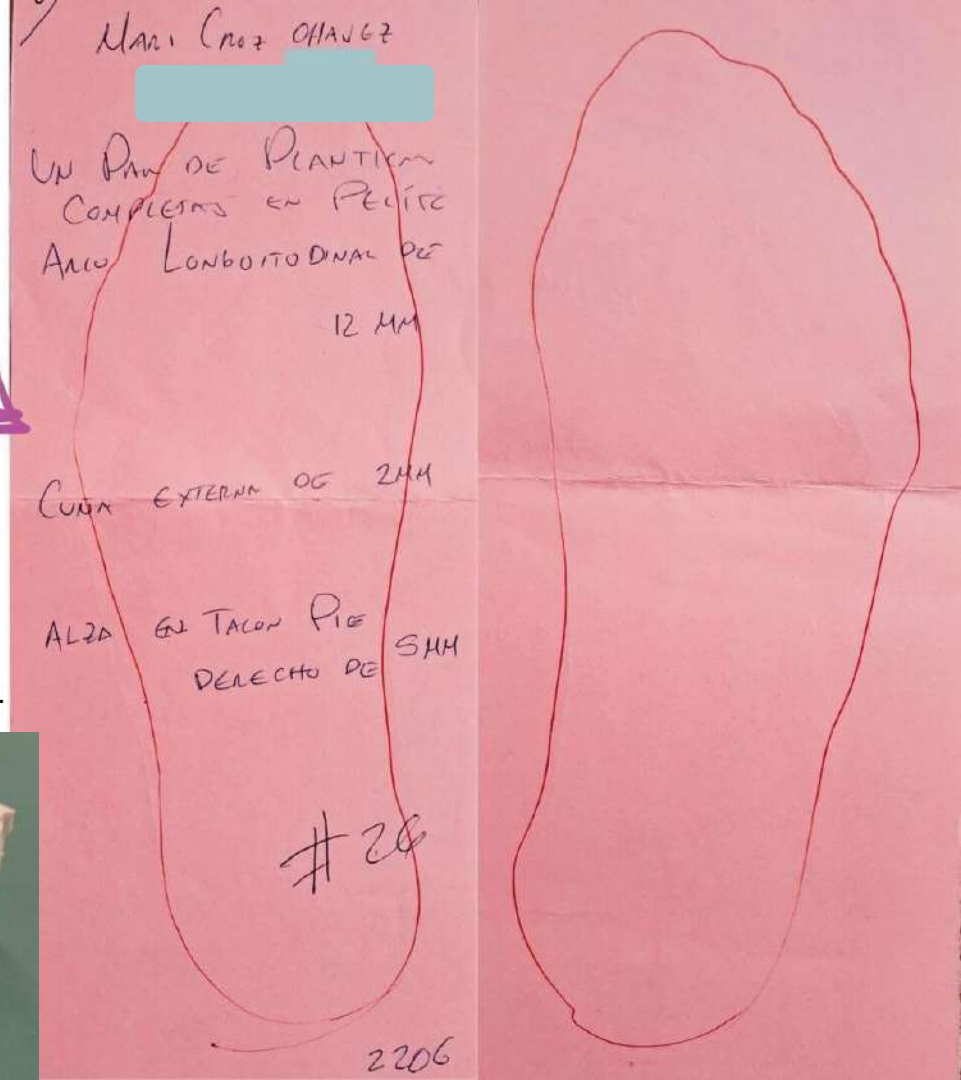
El resumen de tus estudios

DENSITOMETRIA DE CUERPO ENTERO

Precio $ 584.25

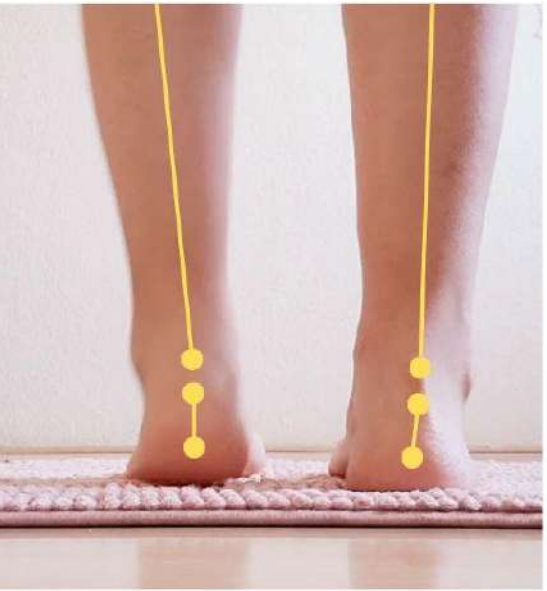
Sample of the foam used in the insoles, it is the desired density.

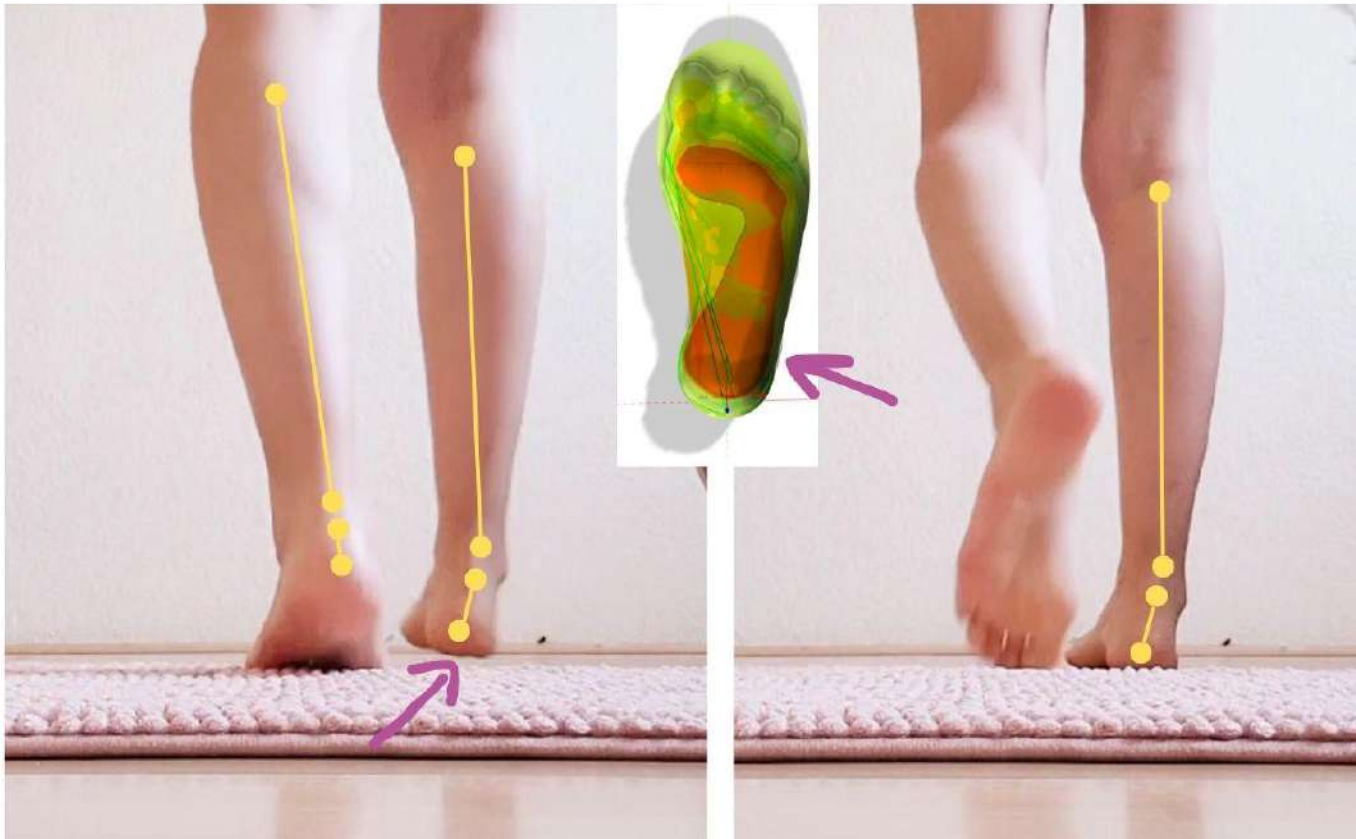




Over-supination

Over-supination (or excessive supination) in the gait occurs when the body's weight shifts too much to the outer edge of the foot while walking or running.

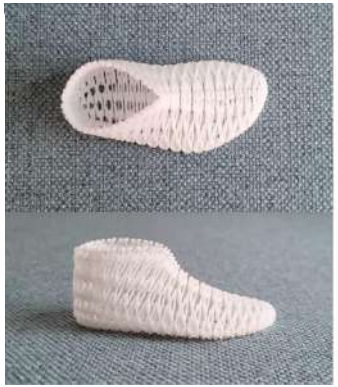




DESIGN

I wanted to create some proposals to experiment with how a parametric design would look on the shoes.





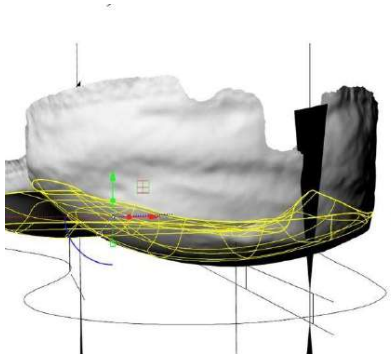

As a starting point, I began designing the insoles by considering the organic shape of my right foot and the following key aspects:

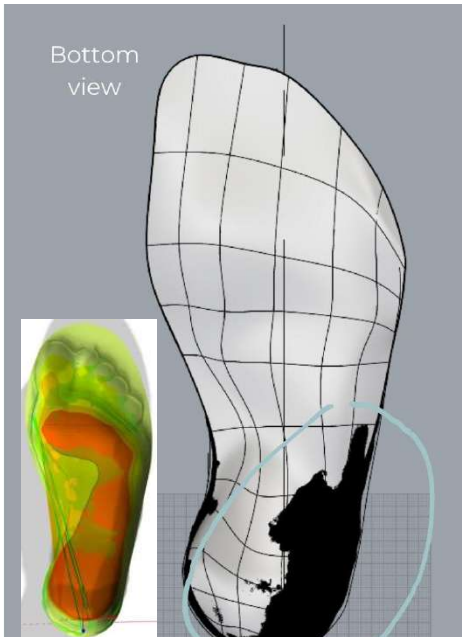
- Correction for Over-Supination: The insole should maintain the natural shape of the foot while incorporating a 2 mm elevation in the specified area, as recommended by the orthopedist, to correct over-supination.
- Compensation for Bone Asymmetry: A 5 mm heel elevation and a 12 mm arch will be added to improve alignment and weight distribution.

Heel Anatomy and Its Importance in Walking

The primary bone of the heel is the calcaneus, one of the seven tarsal bones located in the back of the foot. It plays a crucial role in stability and locomotion by:

- Forming the base of the heel and absorbing impact while walking or running.
- Providing a large surface for muscle and ligament attachment.
- Acting as the first point of support for the foot during gait.
- Working with the talus to form the subtalar joint, which enables side-to-side movement of the rearfoot.





Foot Arch Structure

The foot arch consists of several tarsal and metatarsal bones that work together to distribute weight and provide stability.

Tarsal Bones That Form the Foot Arch:

Calcaneus: The largest bone in the foot, forming the base of the heel.

Talus: Sits above the calcaneus, connecting the foot to the leg.

Navicular: Located in front of the talus, contributing to arch stability.

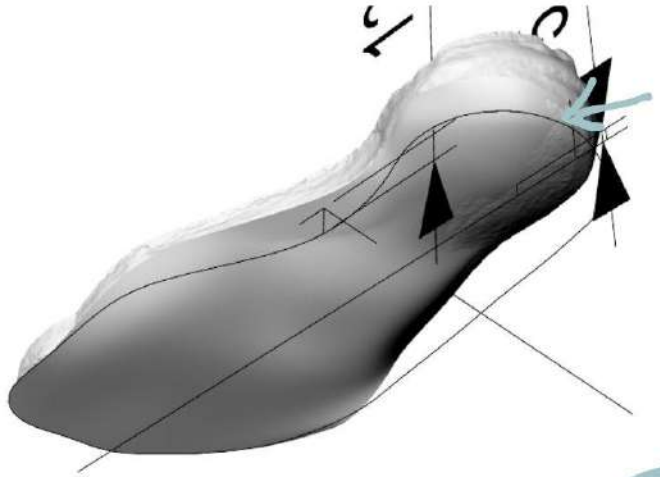
Cuboid: Positioned on the lateral side of the foot, in front of the calcaneus.

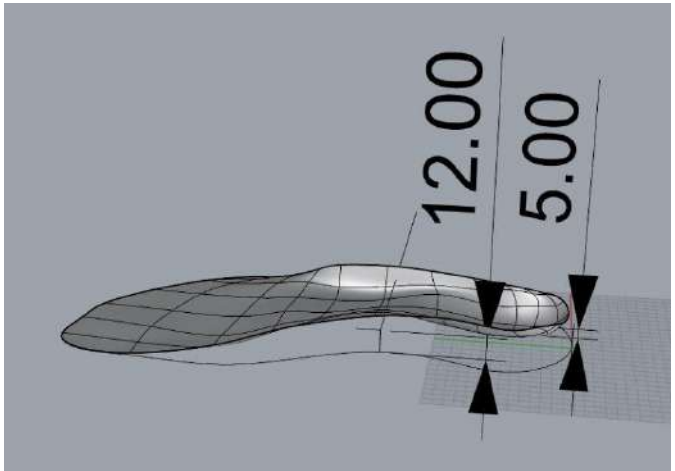
Cuneiforms: Three aligned bones located in front of the navicular.

Metatarsal Bones That Form the Foot Arch:

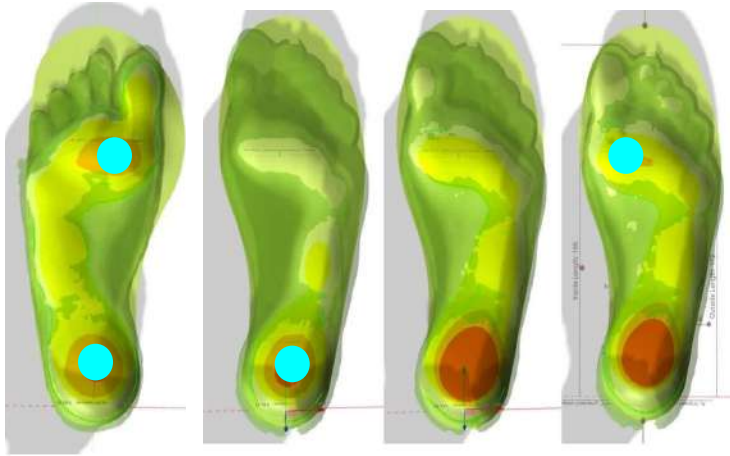
- First metatarsal
- Fourth metatarsal
- Fifth metatarsal
- Heel Medical Conditions
- The heel is a prominent bony structure that plays a vital role in body stability. However, it is susceptible to various medical conditions, including:
- Plantar fasciitis
- Heel spur
- Heel bursitis

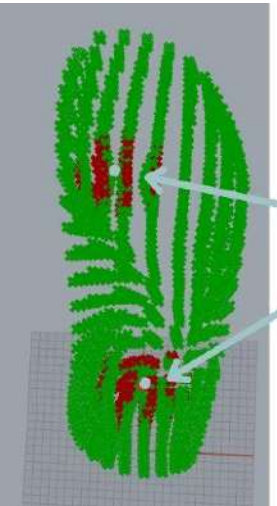
The toes and the arch of the foot can bend while walking due to various conditions. For this reason, the toe area is slightly wider, allowing them to naturally expand when flexing the foot to push off for the next step.



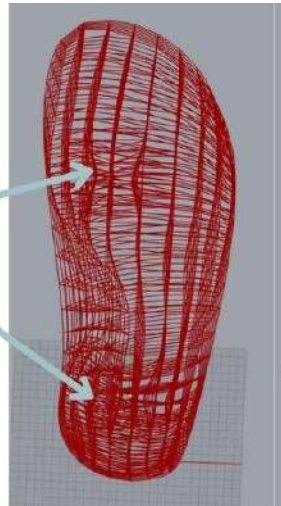


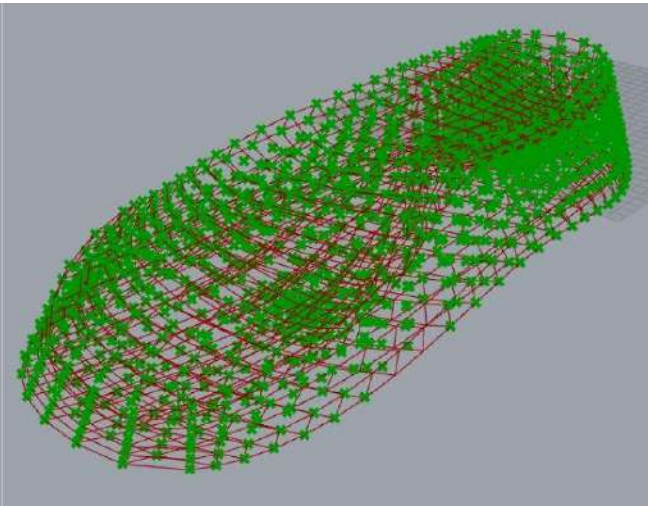
This is the 3D insole with openings for ventilation.





Plantar peak pressure points while walking.





INFILL INTERACTIONS

Twisted box consecutive surface

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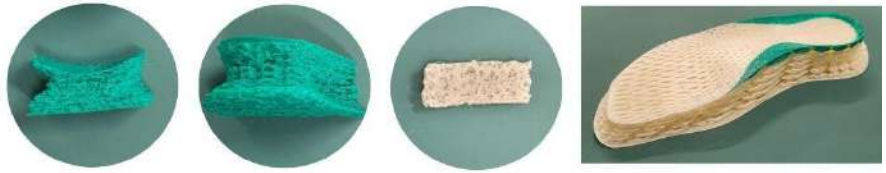
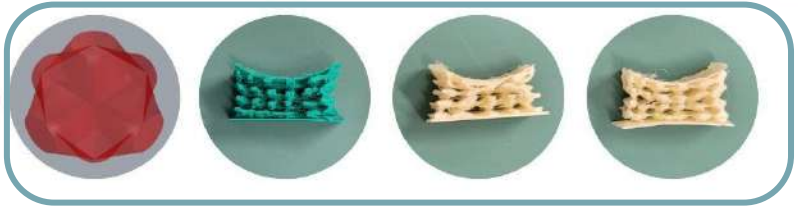
Platonic (mesh)

Nurbs





The strongest and most flexible structure was chosen to create the first full prototype.

PresetCell

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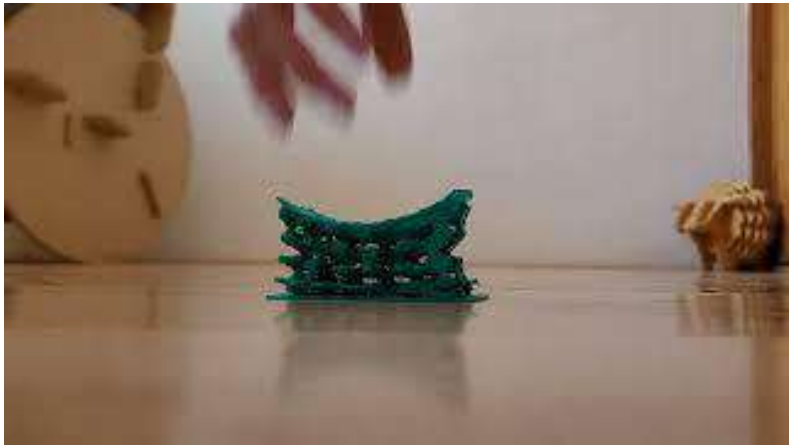
Grid, X, Star



Filament Selection and Printing Setup

At this stage, the standard (green) filament turned out to be too soft, so I had two options: design a stronger link or try a different material. Fortunately, my colleague Raúl helped by providing me with JAYO TPU Silk filament, which has silk-like properties, offering greater flexibility.

According to its specifications, this filament can be printed without heating the platform if adhesive is used (glue can be unheated). Without adhesive, the recommended bed temperature is 60-80°C. It also has a ±0.03 mm tolerance and a 1.75 mm diameter, compatible with the nozzle I used.

For both filaments, I set the following printing temperatures:

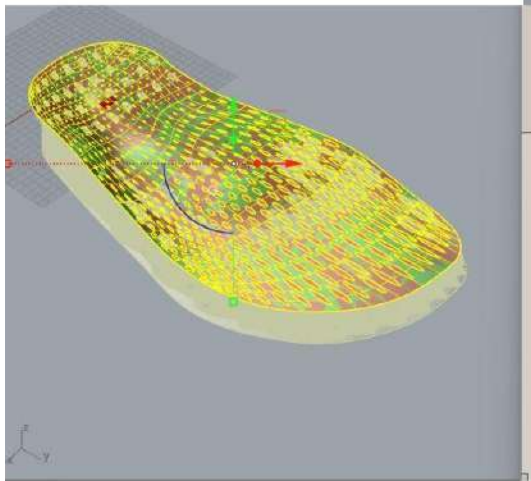
- Nozzle: 230°C
- Print bed: 70-80°C
- No retraction and low speed to prevent deformations in the part's geometry.
-

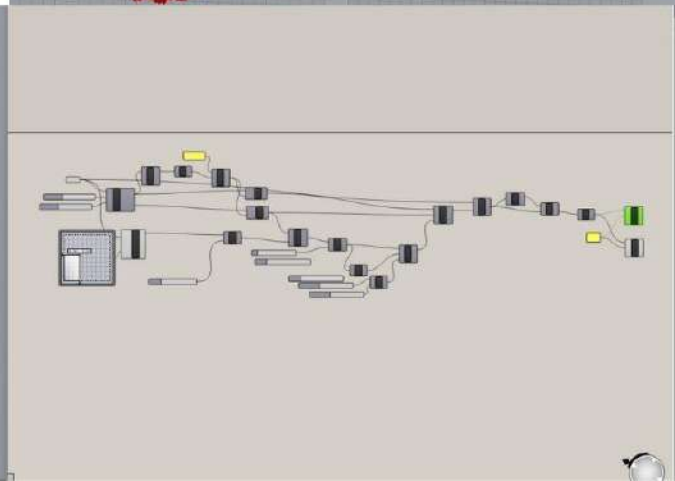
I used two 3D printers for this process:

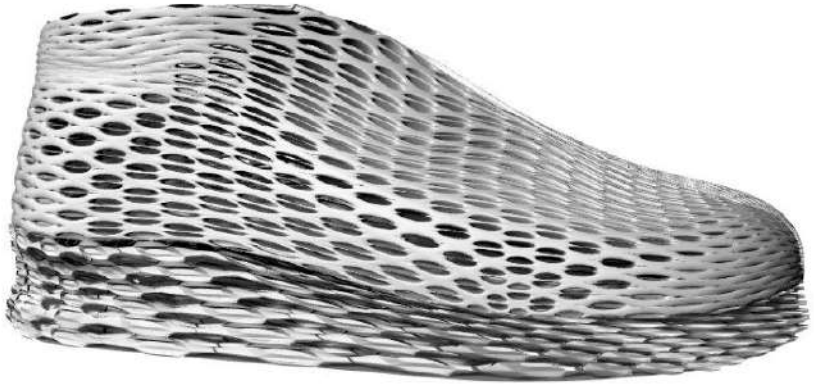
- Ultimaker S3 with Ultimaker Cura for small parts.
- Prusa XL with its default slicing software for larger parts.

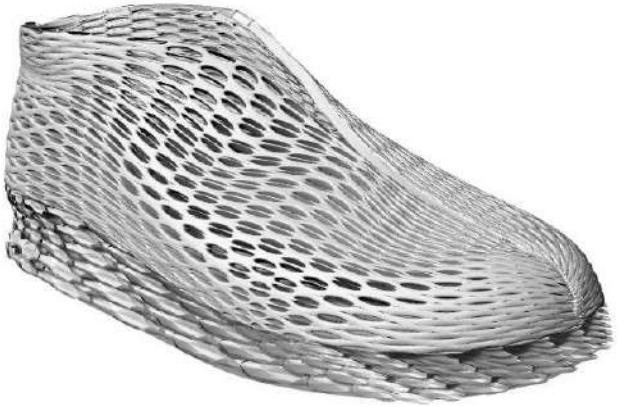
One important note: the Prusa XL does not allow printing open-curve geometries, so the model must be completely closed before printing.

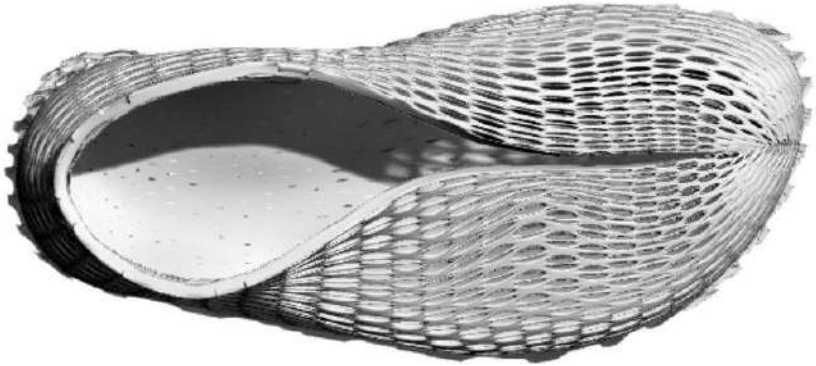
FINAL DESIGN

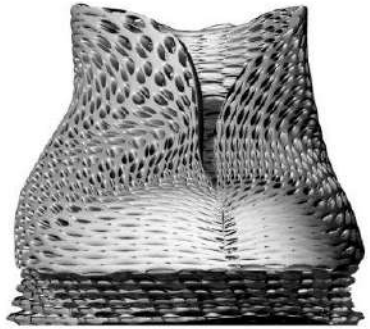






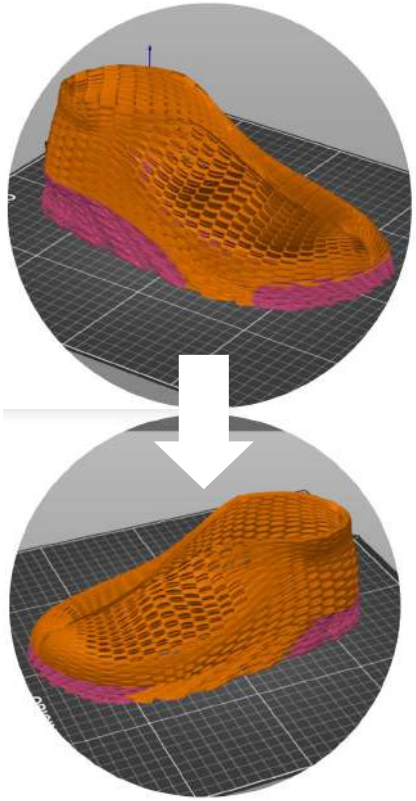






FIRST PROTOTYPE

In the first prototype, I identified that the Silk material was too rigid. As a result, I made a change for the final shoes, using Silk only for the tips. Adding unnecessary stiffness makes the shoe less flexible.



asimMETRI

by Mar

Since this project involves medical assistance, it is essential to establish a short- and medium-term testing period to evaluate the functionality of the footwear as an orthosis. This evaluation will be conducted through my own experimentation as well as under the supervision of a specialist. The next stages include:

March	April	June
20/03/25 First day 1 hrs 21/03/25 Second day: 3 hrs 30/03/25 Third day: 5 hrs	Visit with a specialist	Visit with a specialist X-ray study