

# Virtual Prototyping in Development Cycle of 3D Printed Cranial Orthoses

Foreword

# Invent Medical

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Technology-Medical startup

Direct Digital Manufacturing in custom orthotics and prosthetics

Focused on product innovation using digital technologies





Standard process

# Cranial orthoses - Treatment

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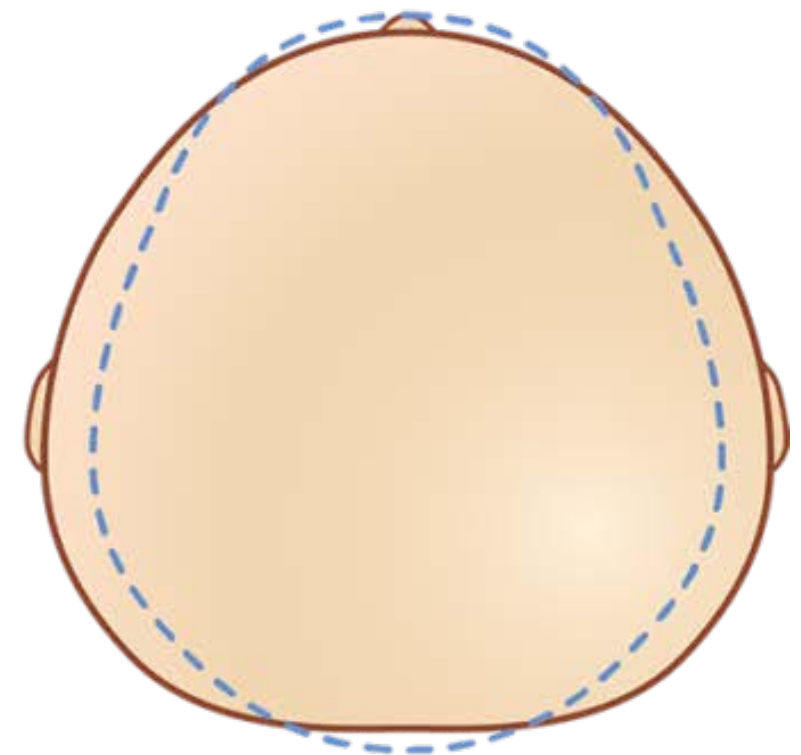
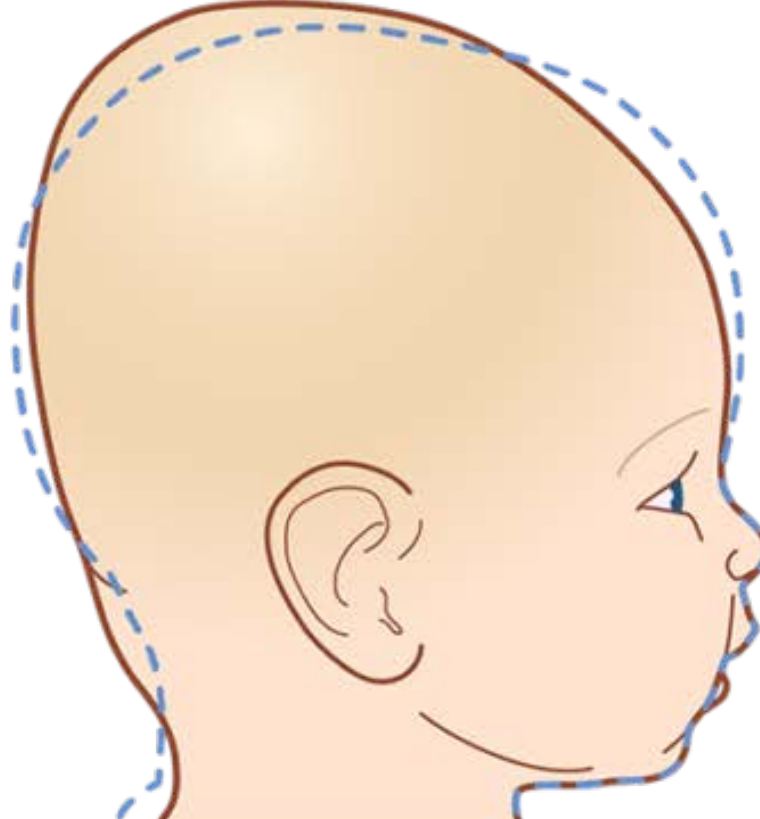
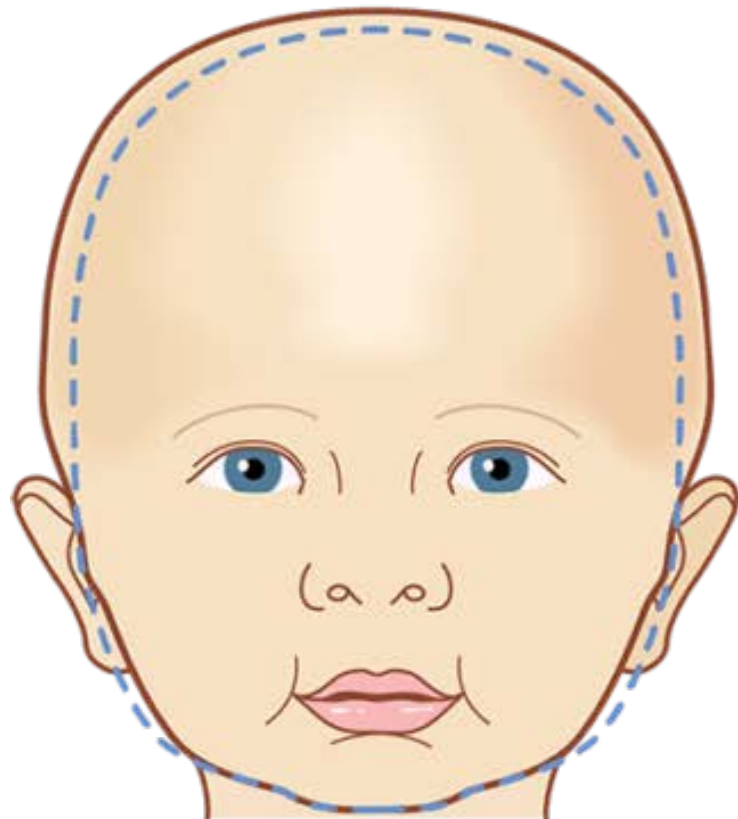




Standard process

## Treatment

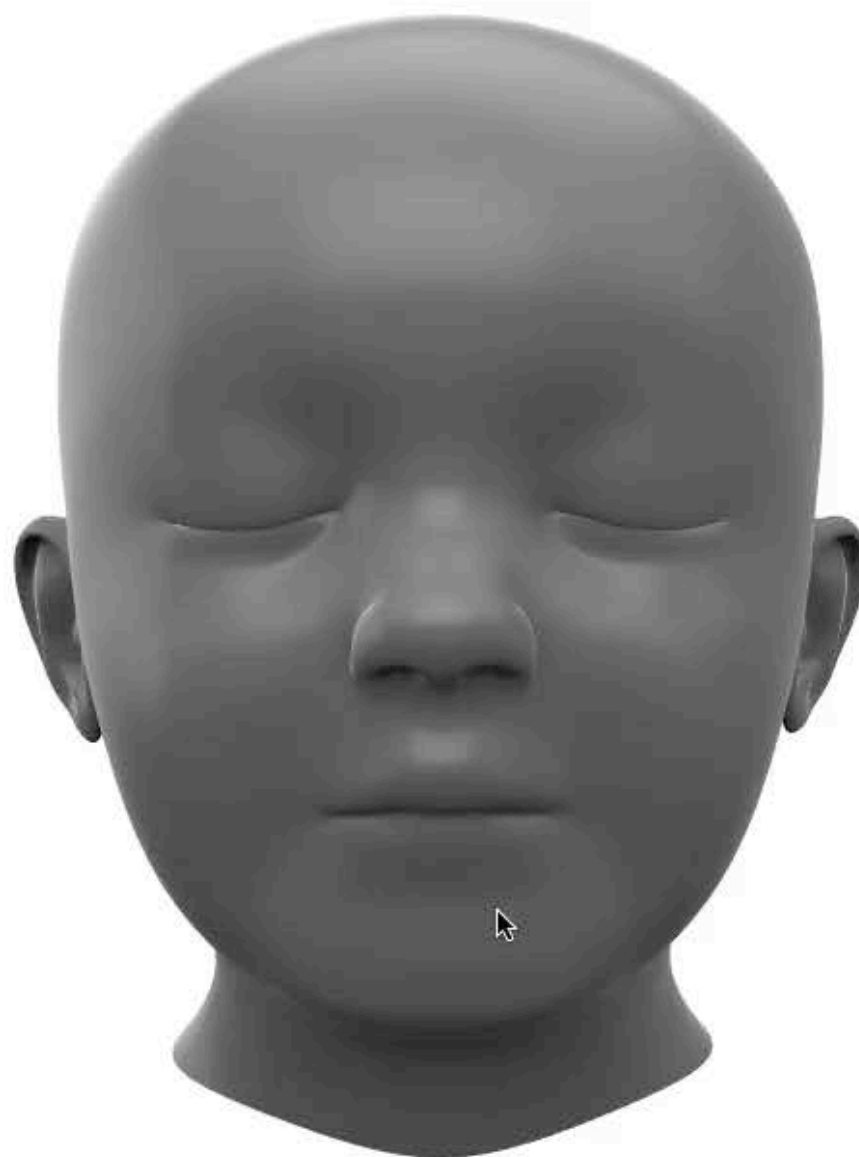
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Standard process

# Treatment

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1 Diagnóza

- ☐ Plagiocefalie
- ☐ Brachycefalie
- ☐ Dolichocefalie
  
- ☐ Pravostranná
- ☐ Levostranná
- ☐ Symetrická

POKRAČOVAT

Standard process

## **Standard cranial orthotics**

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Standard process

## Standard cranial orthotics

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Manual process

Time consuming manufacture

Contactless in target areas

Low stability

Non breathable

Direct digital manufacturing

# 3D printed cranial orthosis

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Direct digital manufacturing

## Lightweight design

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Direct digital manufacturing

## Benefits of 3DP cranial orthoses

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Design Freedom

Integrated functions

Customizable design

Breathable

Lightweight

Full contact

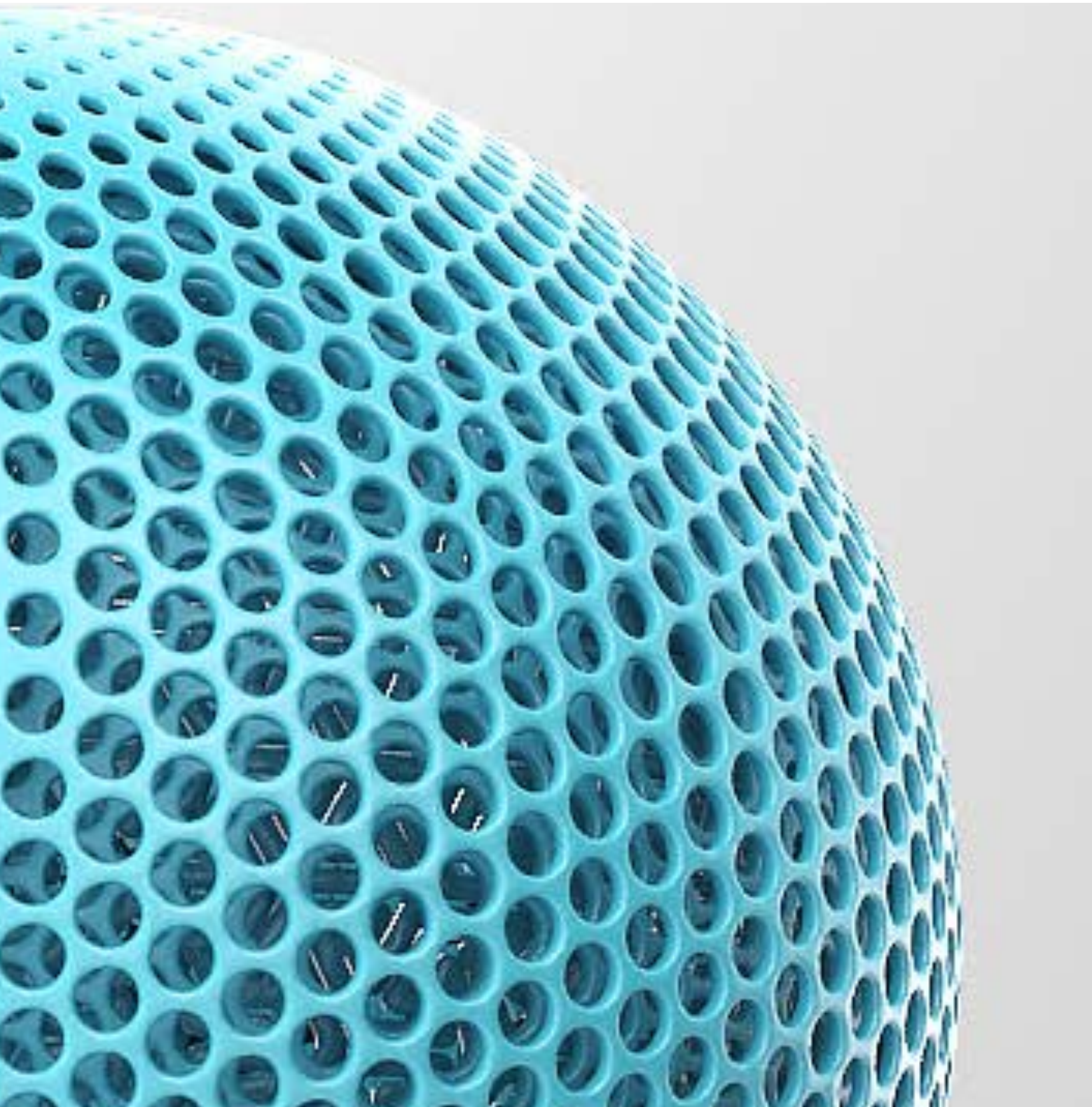




# Direct digital manufacturing

## **3D printed cranial orthoses**

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40% weight reduction using  
static structures



# Direct digital manufacturing

## 3D printed cranial orthoses

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Full contact design allowed  
using dynamic structures

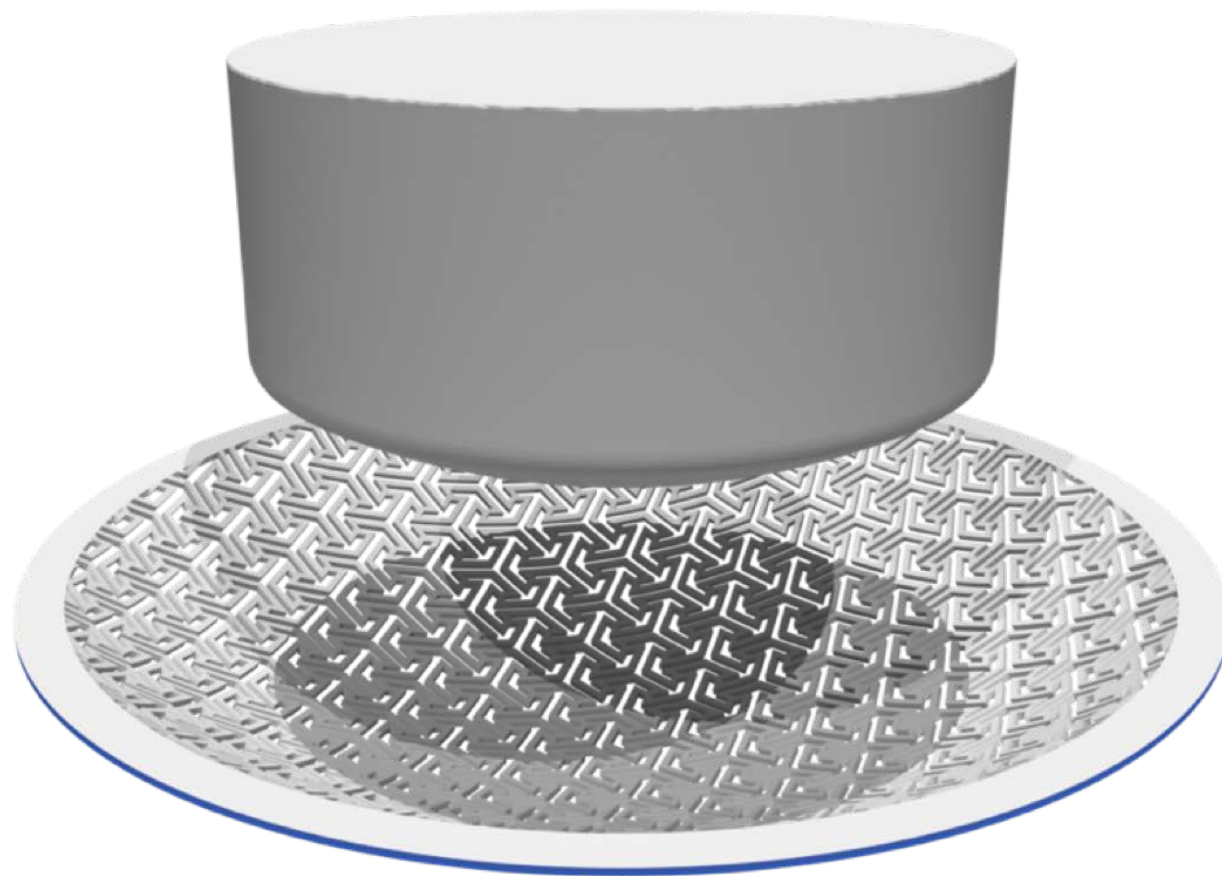
Providing stability and  
flexible adaptation



# Virtual Prototyping

## Physical Testing





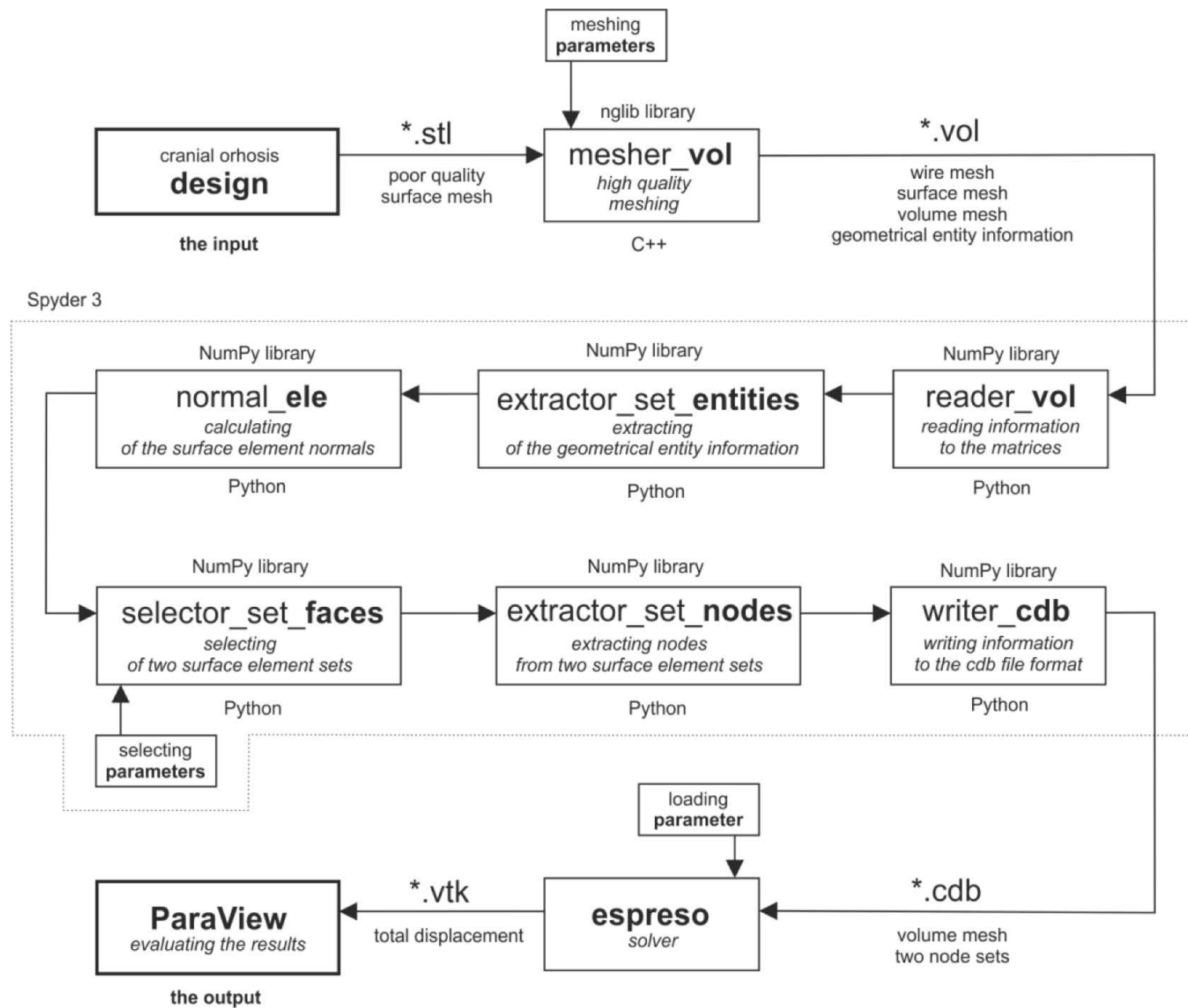
Mechanical property	Value
Young modulus	1 500 MPa
Poisson ratio	0.39

Nodes	1 257 000
Elements	5 012 000

	Test sample
Laboratory testing	6.30 mm
ANSYS	5.22 mm



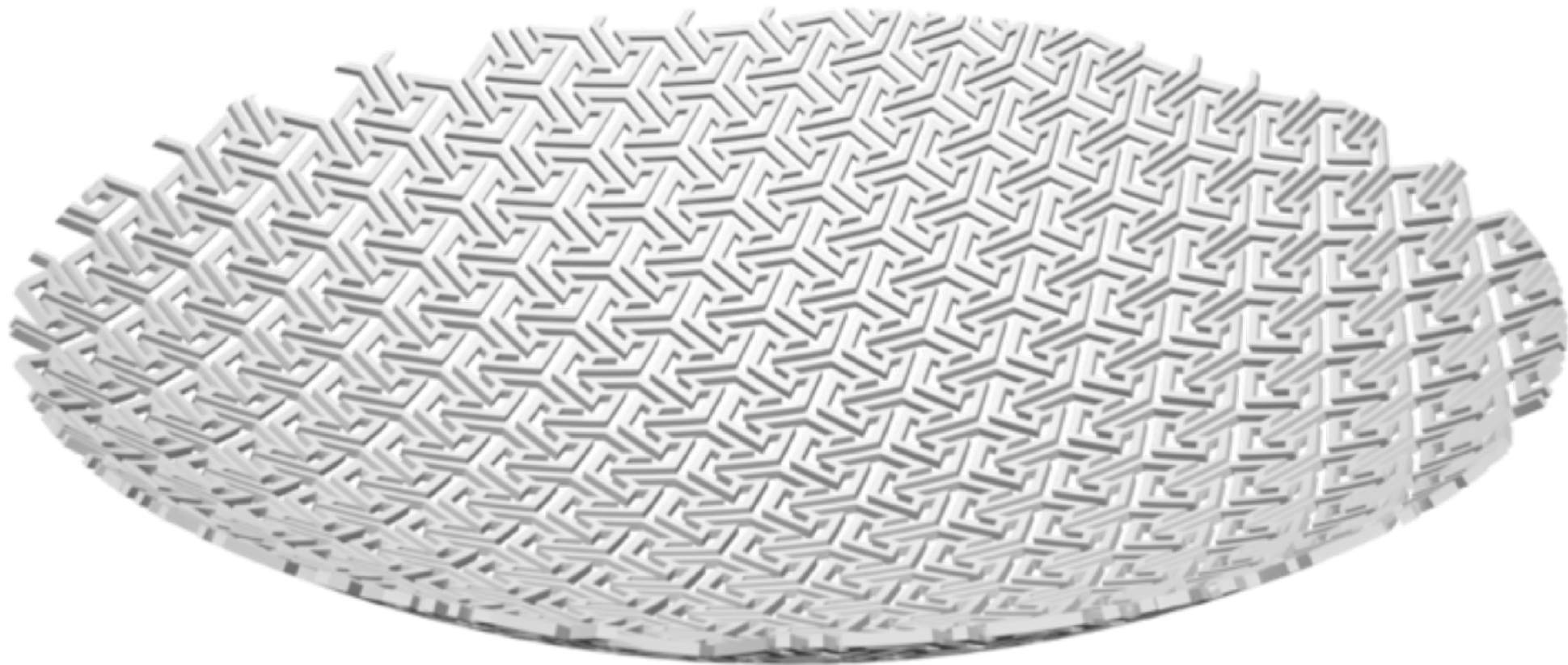
# Virtual Prototyping Workflow



# Virtual Prototyping

## Simplified Model

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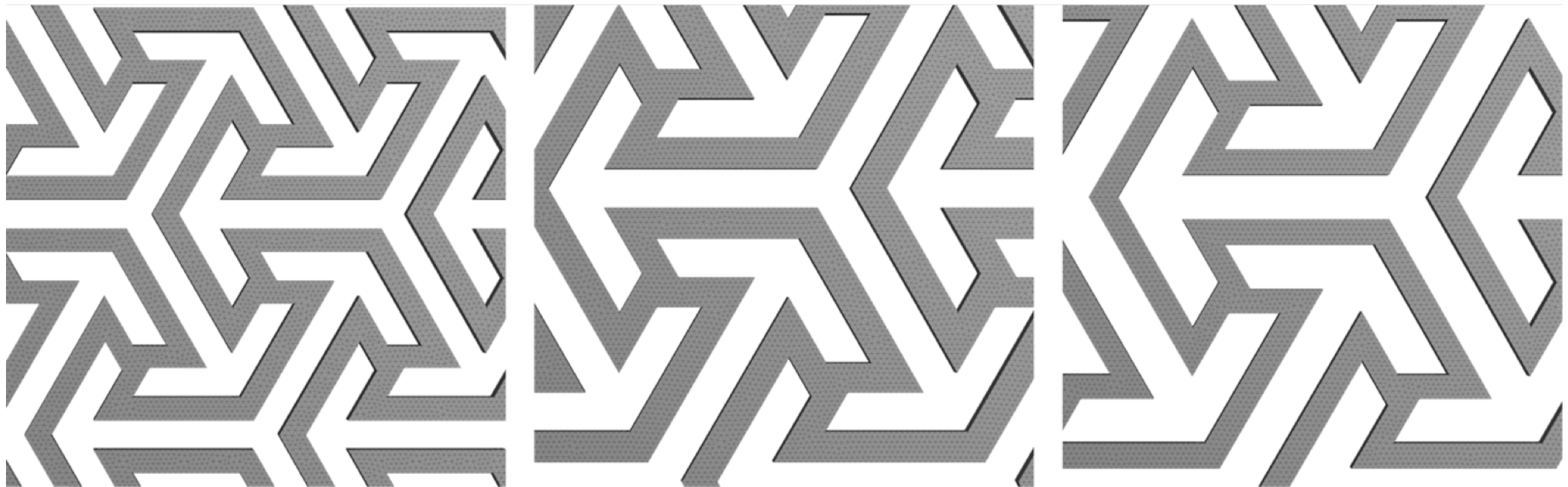




# Virtual Prototyping

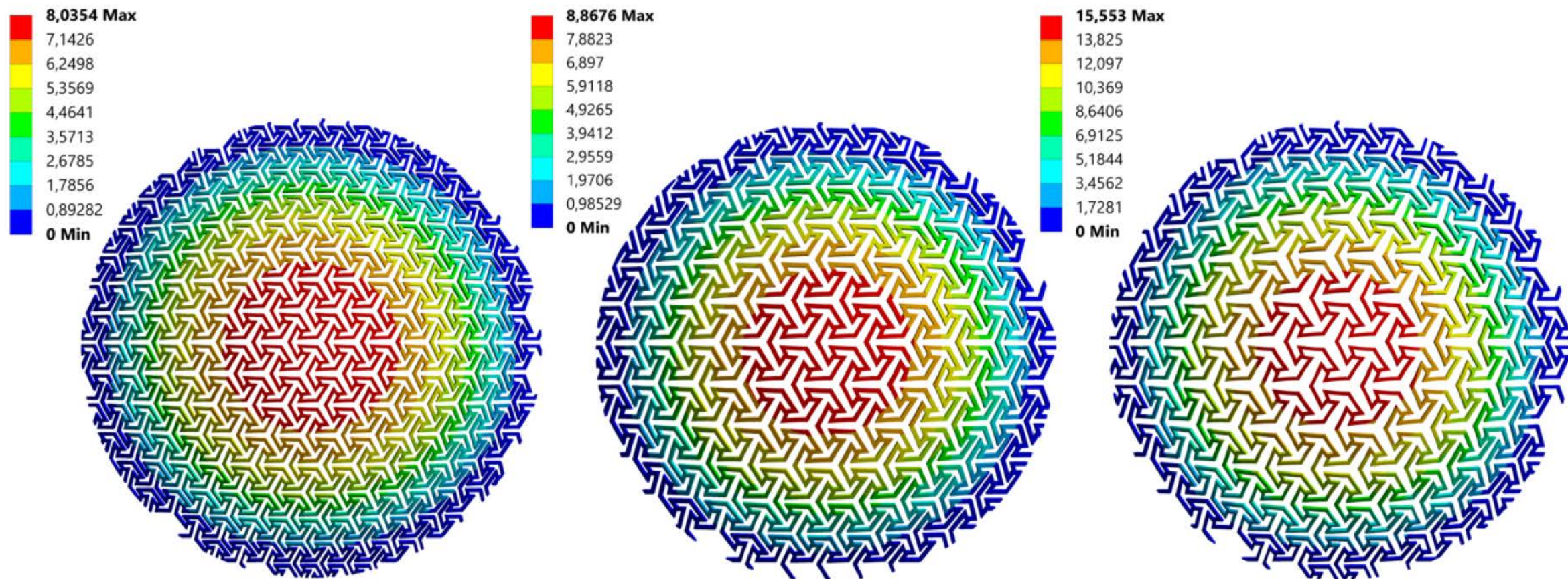
## Design Testing

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# Virtual Prototyping

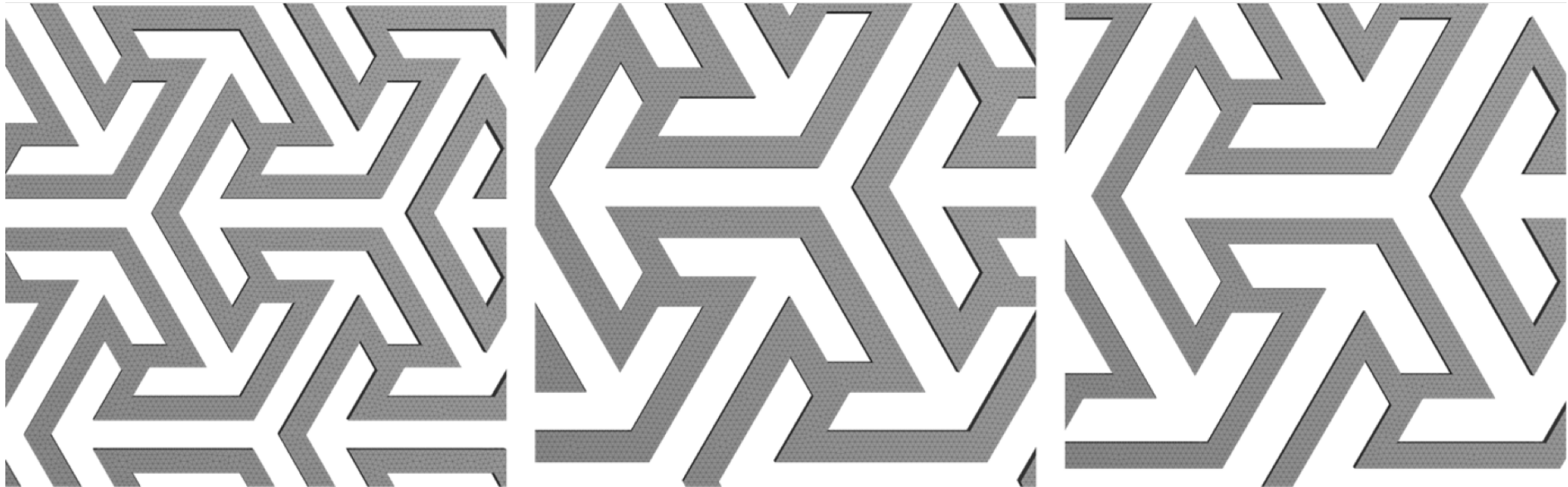
## Numerical Results





# Virtual Prototyping

## Benchmarking

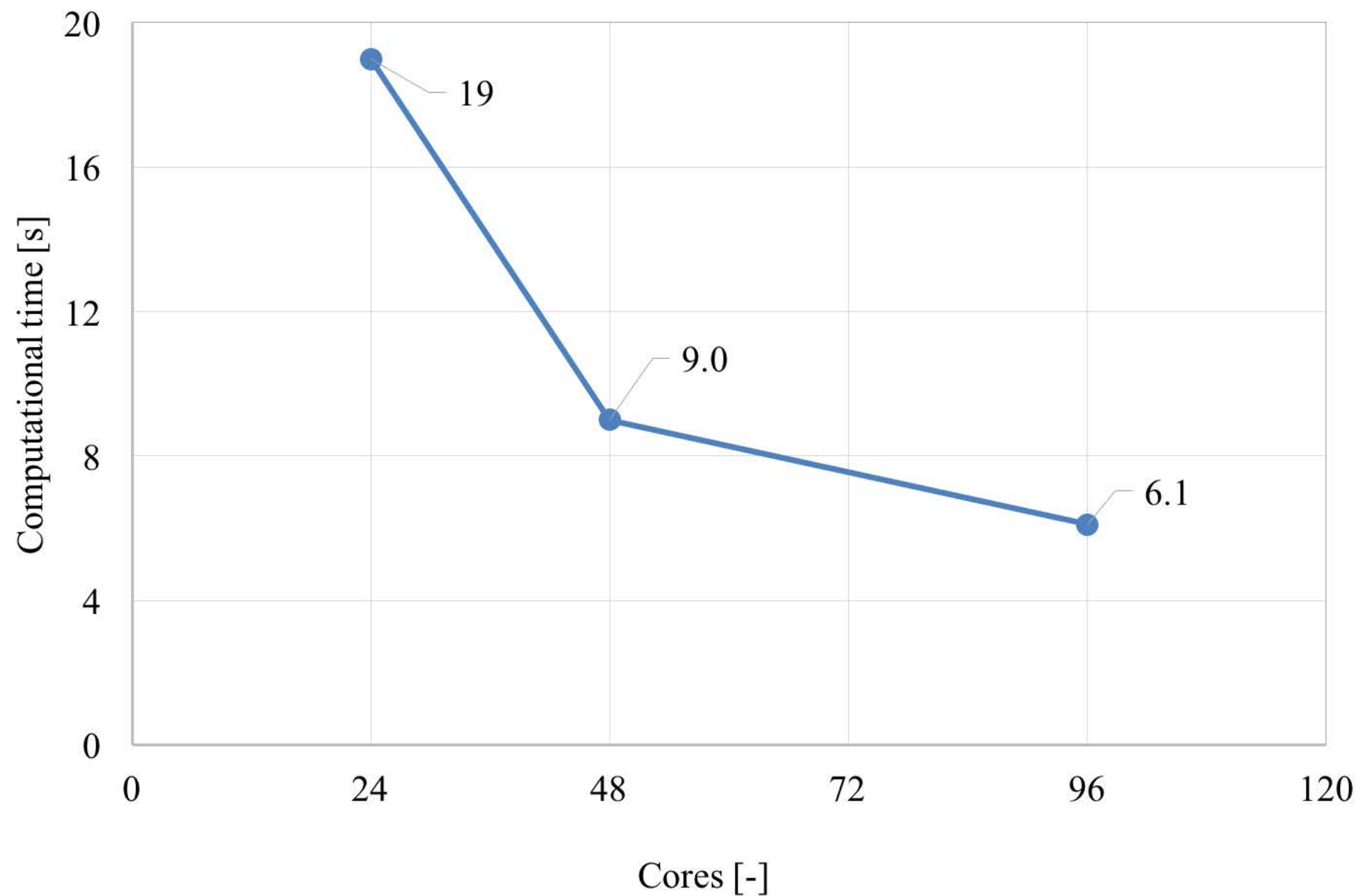


	Geometry 1	Geometry 2	Geometry 3
Nodes	724 000	682 000	580 000
Elements	2 205 000	2 237 000	1 808 000

Geometry	1	2	3
ESPRESO	8.035 mm	8.868 mm	15.55 mm
ANSYS	8.035 mm	8.868 mm	15.55 mm

# Virtual Prototyping

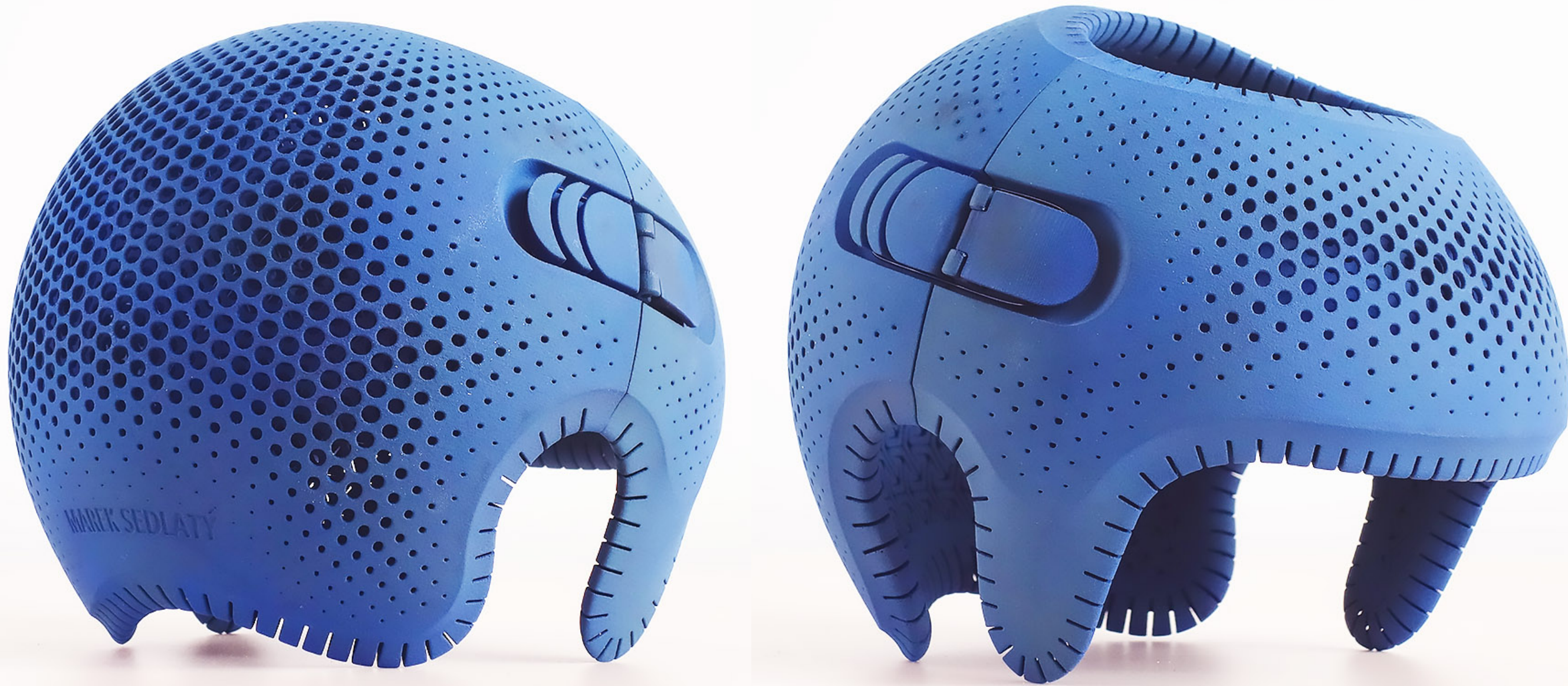
## Scalability test





Direct digital manufacturing  
**3DP final prototype**

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## Conclusions



- Replacement of physical testing by virtual prototyping
- Creation of semi-automated workflow
- Substitution of commercial codes by Open source
- Leveraging on HPC for design optimization



# HELPING THROUGH **INNOVATION**

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