INTRODUCTION TO RESEARCH
Finger Prosthesis Modeling for Rehabilitation.

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As part of my fourth year in engineering school, I conducted an introduction to research during my four-month internship at the Faculty of Engineering in Rijeka, under the supervision of Professor Ervin Kamenar. My project focused on the modeling and manufacturing of a rehabilitation finger prosthesis in soft robotics.
I carried out several studies on materials and manufacturing methods, using 3D printing and molding techniques. I also studied the impact of geometry on finger bending and the compatibility of materials for dual extrusion 3D printing. The results of these studies aim to improve the efficiency and comfort of finger prostheses for patients requiring rehabilitation.

Key words: Hyperelastic materials, 3D Printing, SoftRobotics

ISSUE

How can we develop a soft robotic device to assist finger rehabilitation, offering flexibility, comfort and efficiency?

1 NEEDS ANALYSIS

Objectives :

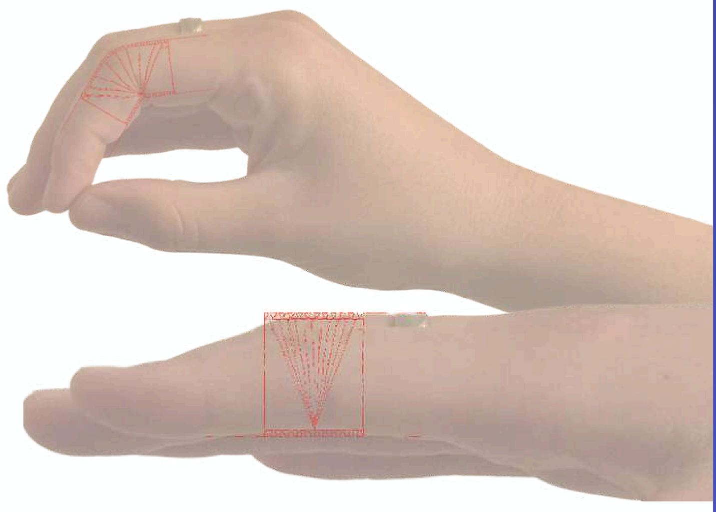
- Design of a functional rehabilitation device
- Use of appropriate materials
- Compatibility with additive manufacturing techniques

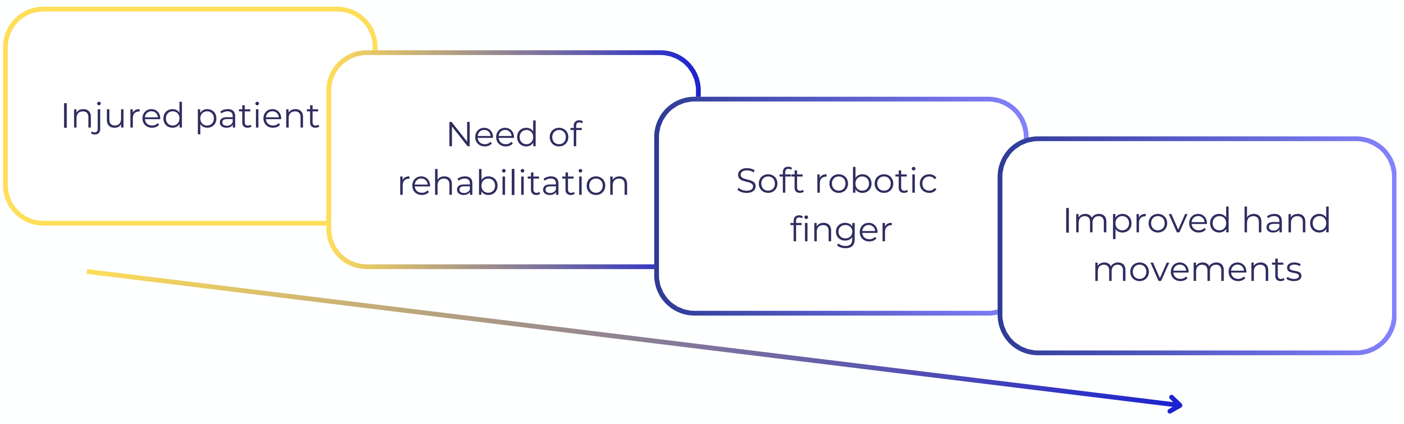
Constraints :

- Dimensions and bulk
- Reliability of components
- Manufacturing method
- Pressurised air system

Functional requirements :

- Flexible and adaptable system
- Support the movement of a human finger
- Durability and repeatability





2 RESEARCH OF MATERIALS AND STUDY OF MANUFACTURING METHODS

1st method presented: MOLDING / INJECTION

	Advantages	Disadvantages
Molding	• **Precise & complex production** • **Good mechanical properties**	• **Difficulty of execution**
Silicone	• Biocompatibility • Flexibility & softness	• Curing time
Rubber	• Abrasion resistance • Low cost	• Poor biocompatibility

2nd manufacturing method: 3D PRINTING

Method / Thermoplastic	Advantages	Disadvantages
3D printing	• **More possibilities** • **Precise geometry**	• **High cost of equipment**
TPU : Polyurethane	• High flexibility	• Slow print speed
TPE : Elastomers	• Extensible	• Harder to print
TPA : Polyamide	• High thermal and mechanical resistance	• Poor flexibility

3 DESIGN PHASES

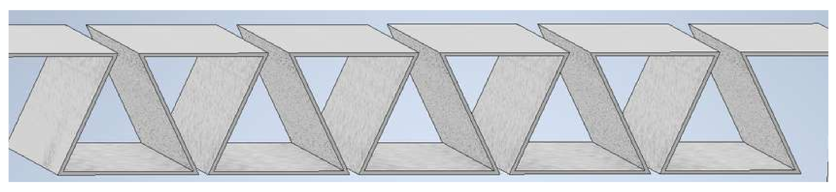
Modelling tools

Inventor, Modelling software

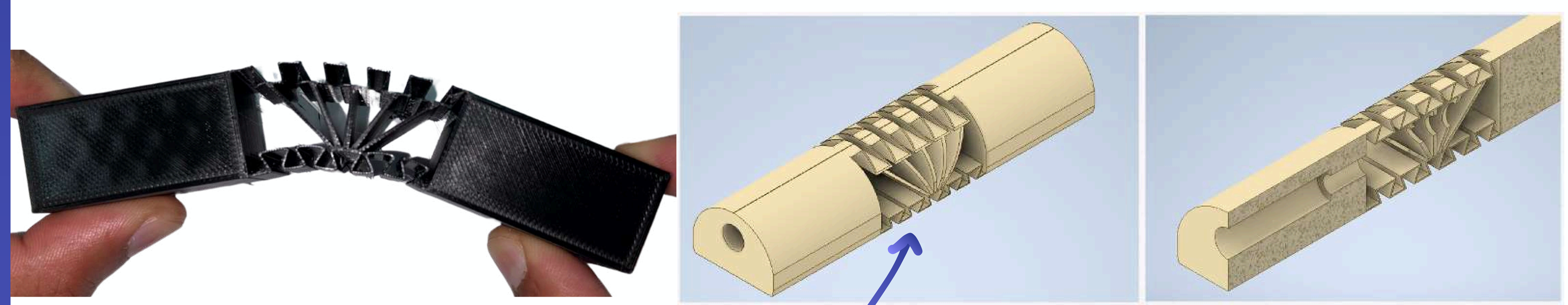
FlashPrint 5, Slicing software

Impact of geometry

Initial shape, series of triangles allowing flexibility in a single direction

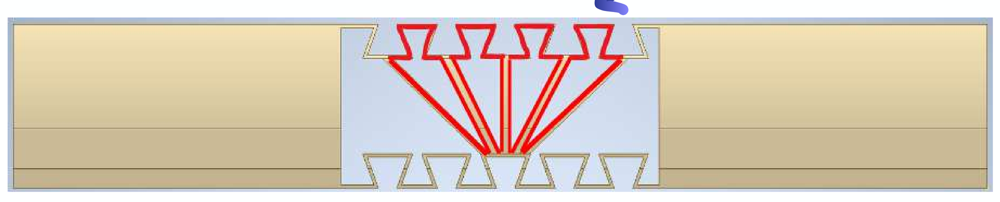


After several tests, this is the first model :



Triangle sequence, for greater flexibility

Bridges to guide the bending

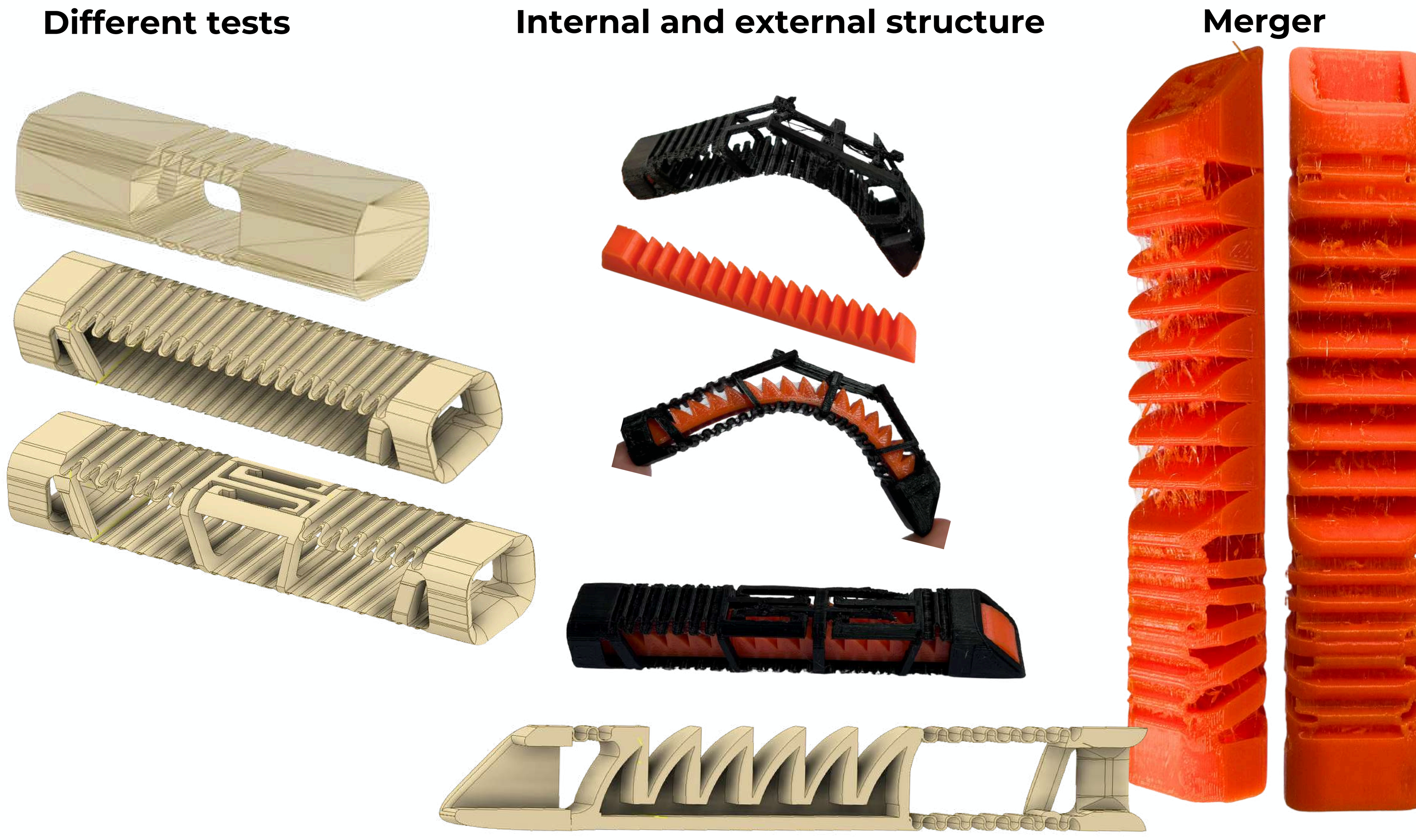


The next objective is to fill in the gaps between each bridge to make air chambers.

Different tests

Internal and external structure

Merger



4 FUNCTIONAL TESTS

Tests carried out:

- Between 3 and 4 bar
- On 2 different models

Results :

- Air does not accumulate in the chambers as expected

5 CONCLUSION & PROSPECTS

This project highlighted the benefits of double extrusion in 3D printing, combining TPU and PLA filaments to optimise the flexibility and durability of the prototype.
Although technical constraints prevented this experimentation, this approach deserves to be developed further to maximise performance. Further research into materials and printing methods would offer interesting prospects for improving the prototype and extending its applications.

REFERENCES

Horne, Richard • Hausman, Kalani Kirk, 2017, 3D Printing For Dummies
Diplomski rad KONSTRUKCIJA MEKOG ROBOTA ZA REHABILITACIJU ŠAKE, Graduation diploma for Karlo Juric, a student at the Faculty of Engineering in Rijeka
TPU Filament Guide (2023). Understanding TPU for 3D Printing. All3DP.com