Chest Tube Securing Device

Pre-manufacturing line

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Objectives

Main objective

Main Goal

The goal of this project is to finalize the prototype for chest tube securing device which can be used to secure the chest tube to the patient's chest wall without the need of sutures.

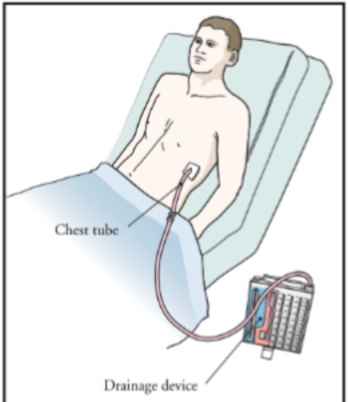

Figure 1: Chest tube placement [1].

Specific Objectives

- Evaluation of the clinical benefits of the prototype.

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- Three material combinations per CTSD part (retainer, base, and receptacle) will be produced.

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- Evaluation of the clinical benefits of the prototype.
- Definition and testing of the Good Manufacturing Practices (GMP).
- Three material combinations per CTSD part (retainer, base, and receptacle) will be produced.
- 100 pre-production prototypes.

Engineering targets

Top part

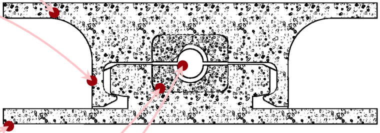
- Flexibility for opening the snaps.
- Not exceed the maximum elastic zone.

Bottom part

- The adherence with the tape.

Flexible part

- Adherence.
- Maximum friction.



Whole part

- The adherence with the rubber part.
- The product life (fatigue).
- The proper snap-fit.

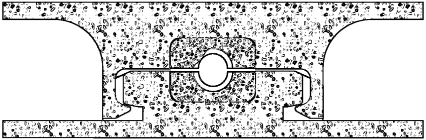


Figure 1: Half-section view complete CTSD

According to the design requirements, perform the comparison between 3D printing and plastic injection, in terms of mechanical strength, manufacturing viability, price.

Research Plan

- Evaluation of the 3D printing process.

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Research Plan

- Evaluation of the 3D printing process.
- Evaluation of the Plastic injection process.
- Numerical analysis process.
- Testing protocol.

3D printing process

Design of experiments (Part I)

		Top part					
		ABS	PC/ABS	Nylon	PC	PLA	SLA
Bottom part	ABS	✓	✓	✓	✓	✓	✓
	PC/ABS	✓	✓	✓	✓	✓	✓
	Nylon	✓	✓	✓	✓	✓	✓
	PC	✓	✓	✓	✓	✓	✓
	PLA	✓	✓	✓	✓	✓	✓
	SLA	✓	✓	✓	✓	✓	✓

Table 1: Design of Experiments for 3D printing.

Design of experiments (Part I)

		Top part					
		ABS	PC/ABS	Nylon	PC	PLA	SLA
Bottom part	ABS	✓	✓	✓	✓	✓	✓
	PC/ABS	✓	✓	✓	✓	✓	✓
	Nylon	✓	✓	✓	✓	✓	✓
	PC	✓	✓	✓	✓	✓	✓
	PLA	✓	✓	✓	✓	✓	✓
	SLA	✓	✓	✓	✓	✓	✓

Table 2: Full factorial DOE for 3D printing.

		Top part					
		ABS	PC/ABS	Nylon	PC	PLA	SLA
Bottom part	ABS	✓	✓	✓	✓	✓	
	PC/ABS		✓	✓	✓	✓	
	Nylon			✓	✓	✓	
	PC				✓	✓	
	PLA					✓	
	SLA						✓

Table 3: Total number of combinations.

Flexible part

Flexible materials	Printing Method
TPE	FDM
TPU	FDM
Flexible	SLA

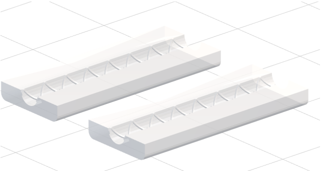


Figure 2: Receptacle CAD

Total number of experiments

ID	No.
Top - Base	16
Flexible	3
Total	48

Table 4: Total Number of experiments

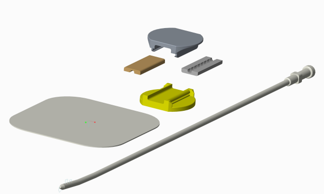


Figure 3: Render of the CTSD

What do we want to figure out?

Manufacturability

- Printing quality.
- Time.
- Printing complexity.

Mechanical properties

- Bonding force.
- Sliding force.
- Snapping.

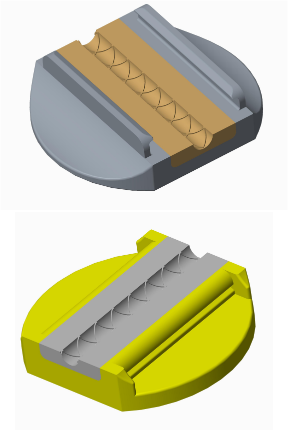


Figure 4: Dual material parts render.

Plastic Injection Molding

Design mold process

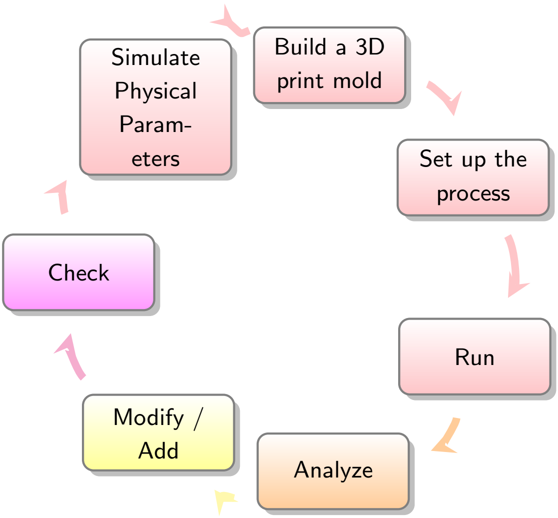
Develop the final mold

Develop the dual injecting process

Make molds in 3D printing

Choose the material according to the 3D print experiment

Methodology



Numerical Analysis process

Purpose I

- To determine max stresses.
- To determine the product life (fatigue).
- To make structural optimization.

Purpose II

- CTSD experiments.
- To avoid mold trials.

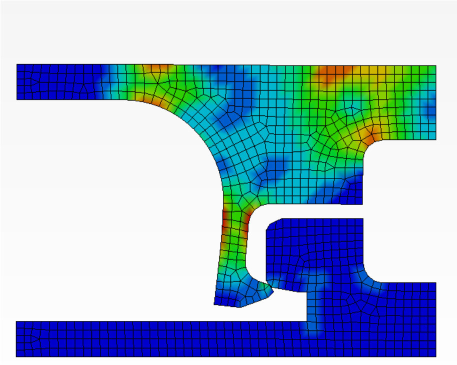


Figure 5: Explicit Simulation CTSD

Testing process

Sliding force

Figure 6: Sliding force testing.

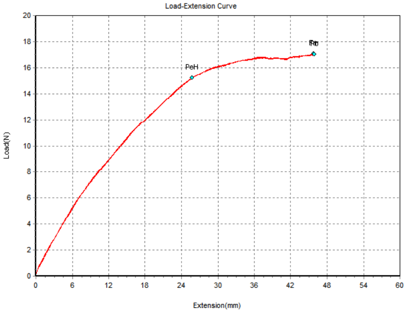
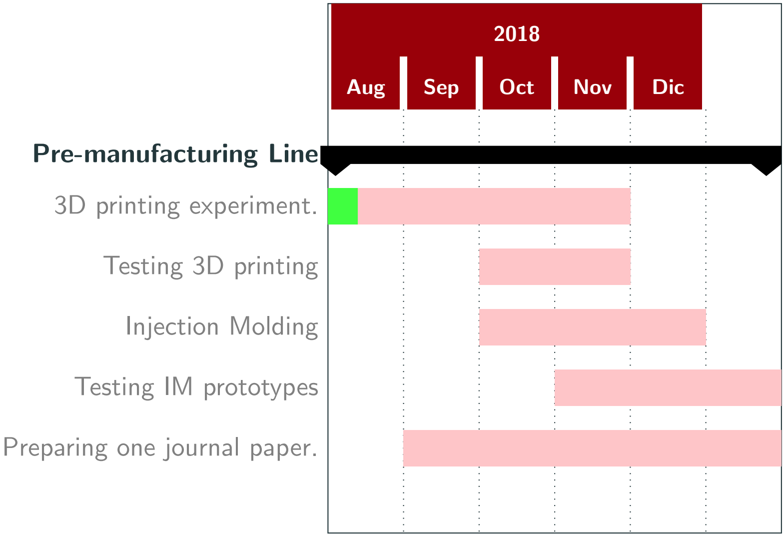


Figure 7: Force Displacement curvature

Schedule

Schedule


2018
Aug
Sep
Oct
Nov
Dic
Pre-manufacturing Line
3D printing experiment.
Testing 3D printing
Injection Molding
Testing IM prototypes
Preparing one journal paper.

Questions?