“Injection System for Soft Pneumatic Actuator Fabrication”

Reconfigurable Robotics Laboratory

http://rrl.epfl.ch

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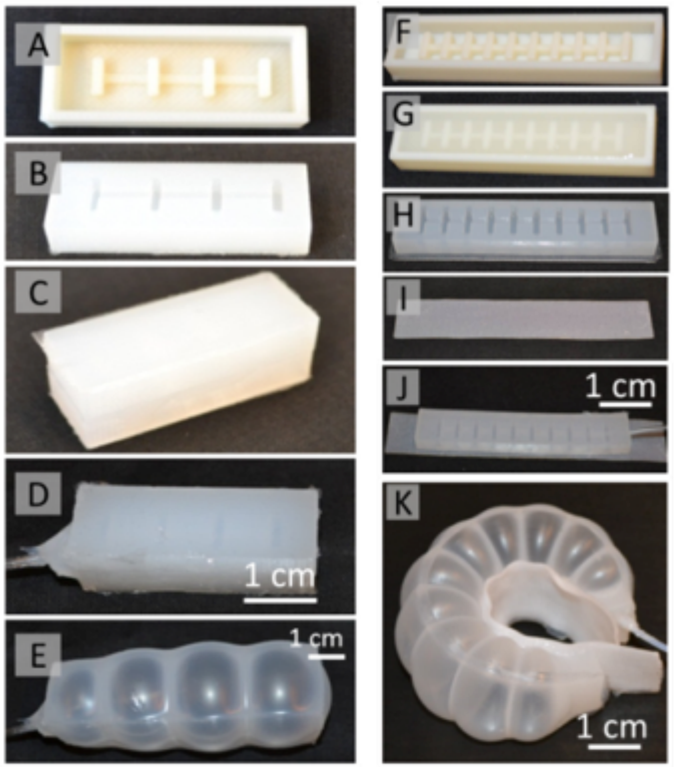
Swiss National Science Foundation

Swiss National Centre of Competence in Research

Soft Pneumatic Actuators



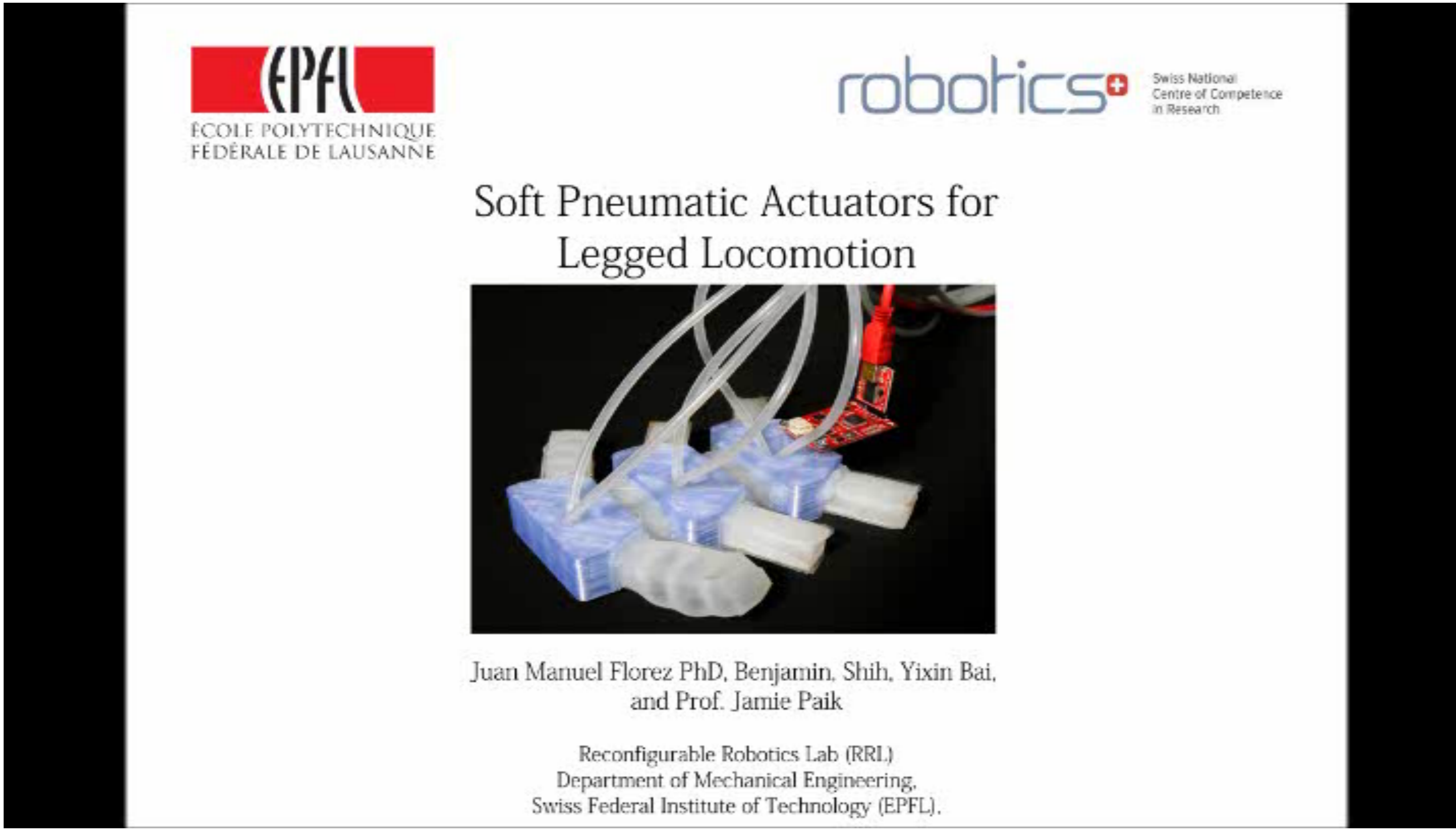
Fabrication process of SPAs. The left column corresponds to the fabrication of linear SPAs while the right column illustrates the process for bending SPAs. (A) 3-D printed mold. (B) the molded silicone-rubber structure. (C) Two identical bodies shown in (B) are bonded together. (D) The fabricated linear SPA with an air tube. (E) Inflated linear SPA. (F) 3-D printed mold. (G) liquid silicone-rubber is poured into the mold and cured. (H) The molded silicone-rubber structure. (I) the strain-constraining layer, which is a thin fabric coated with silicone-rubber. (J) The final bending SPA produced by bonding (H) and (I). (K) The actuated bending SPA.

Advantages:

-compliance in human robot interface (inherently safe)

-"embedded intelligence" automatic adaptable to the environment

Crawler robot



Soft Wearable Exoskeleton

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Postdoc: Juan Manuel Florez (former postdoc: Yun Seong Song)
PhDs: Edurado Martin Moreau, Sophie Wurtz

Injured rat

Soft Exoskeleton

Rehabilitation Strategy
Test Setup

Motivation

Providing Appropriate Sensory Inputs

Two main goals:

- Automatic assistance to training with controlled force.
- Transparent and reversible structure to respect gait intention of the subject

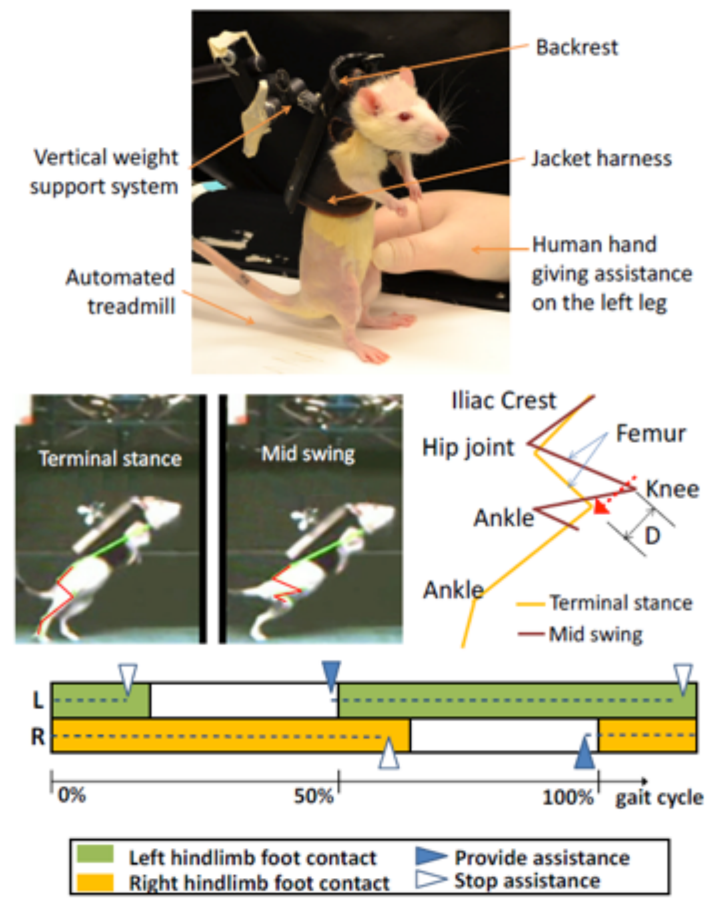
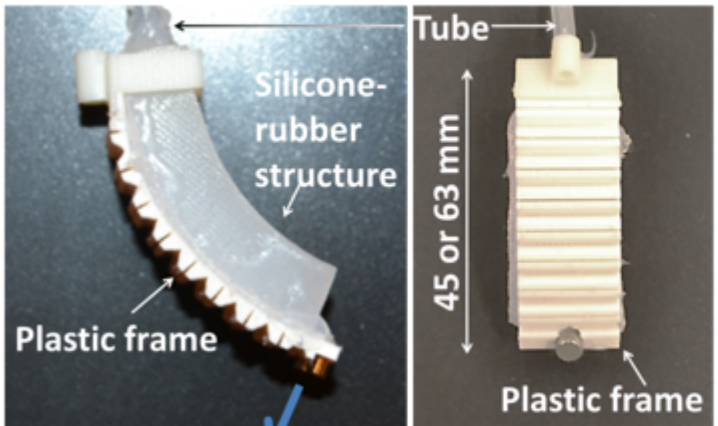


Figure 1. Top: Spinalized rat on a treadmill shown with assistance from human researcher. Middle: Joints and their range of motion during a typical overground gait. The travel of the knee joint position, D, is less than 15 mm. Bottom: Gait cycle and the timings of assistance given by human researchers.

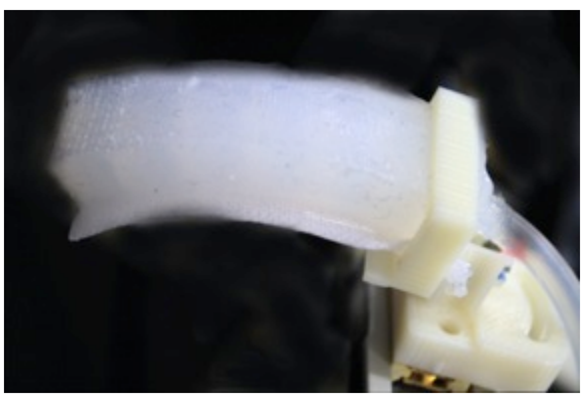
Fabrication and Characterization

Current Design of the actuator

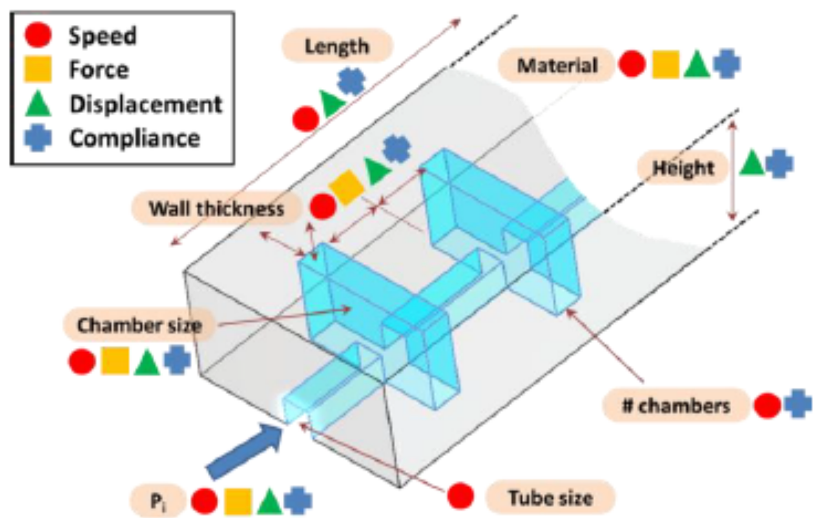


Direction of actuation

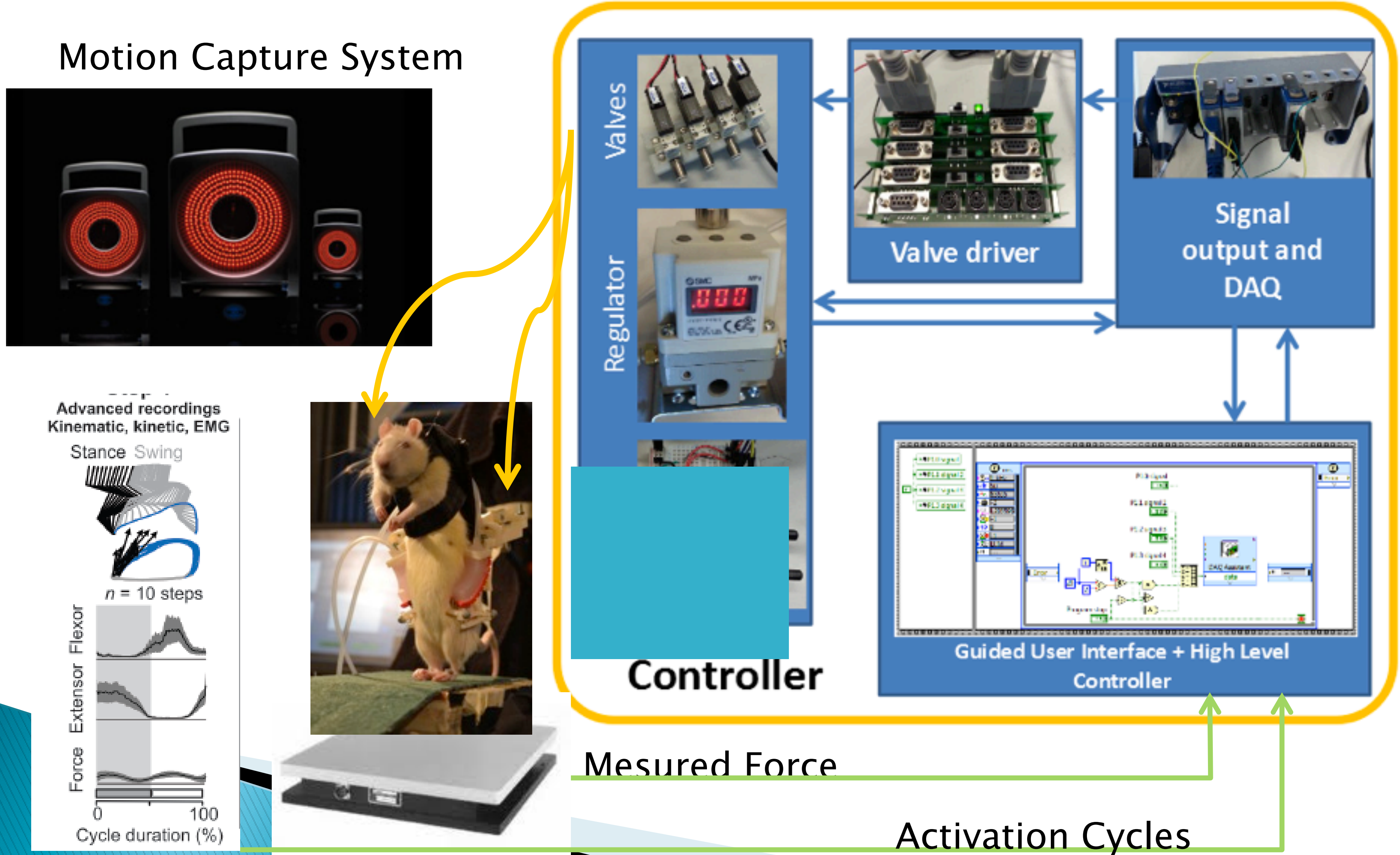
Parameter	Performance	
	L= 45 mm	L= 63 mm
Blocked Force	> 2.1 N	> 0.8 N
Passive stiffness	22 N/m	9 N/m
Range of motion	20 mm	35 mm
Speed of actuation	> 5Hz	> 5Hz



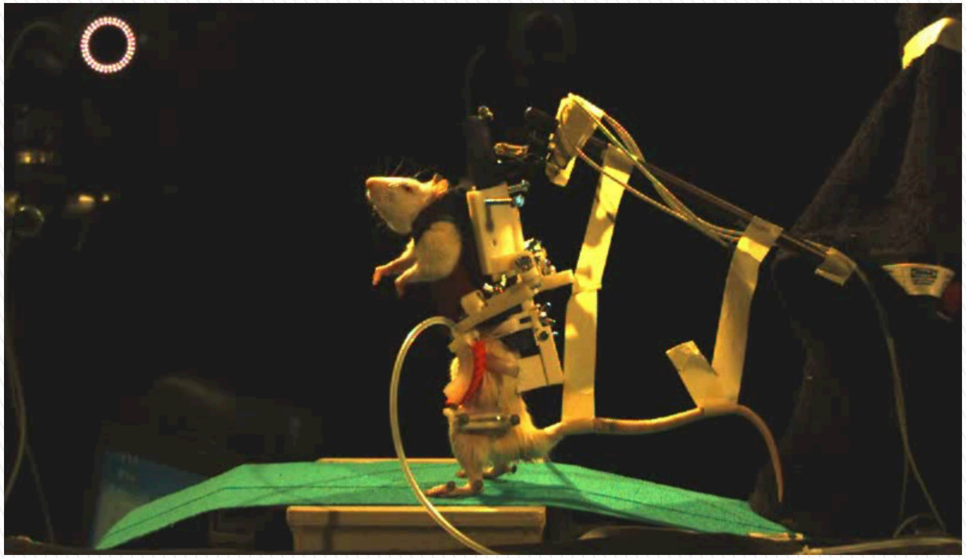
Convex actuator (option)



Overall System



Experimental Videos



Pressure=35kPa,
Freq=1Hz

Pressure=32kPa, Freq= 4Hz

King's College London Stifflop surgical robot

https://www.youtube.com/watch?v=iw5FTrqN2Ro

https://www.youtube.com/watch?v=e7NsBwl9LYI&feature=youtu.be&a

Research project (part 1/3)

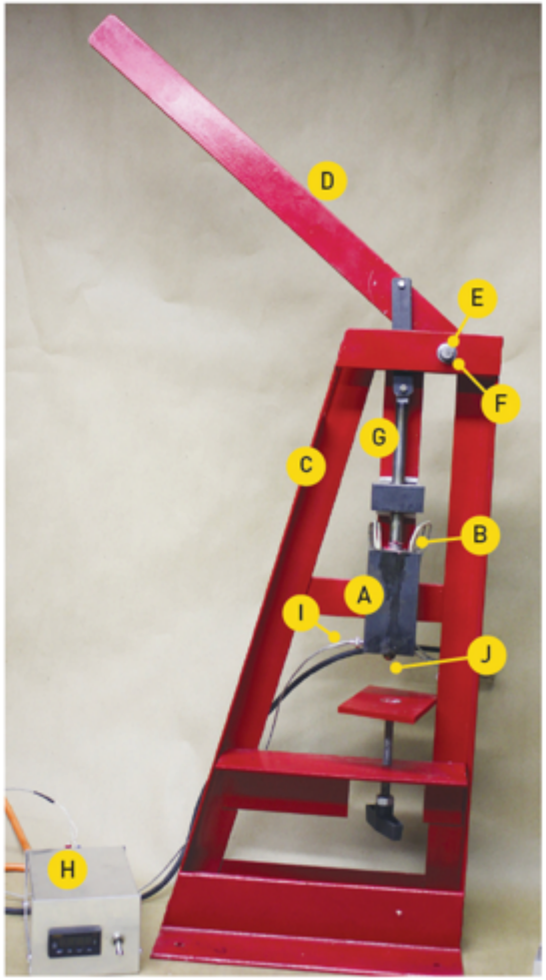
Evaluate and design solutions for an **injection system** for SPA

Project steps:

- Conceptual ideas
- Design
- Producing drawings
- Manufacturing (workshop)

Advantages:

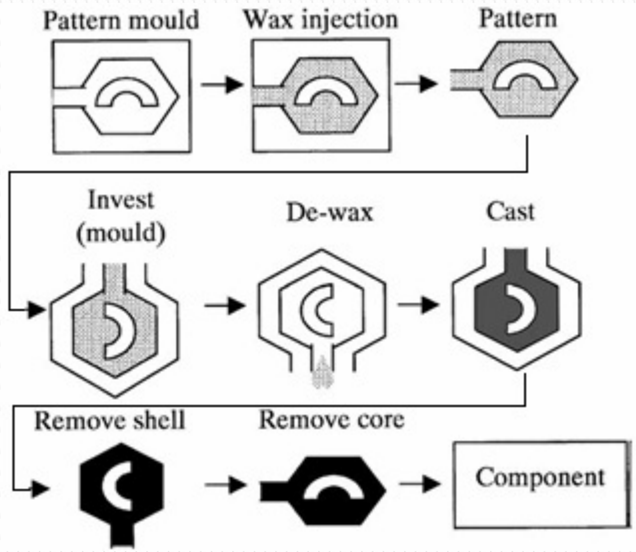
- decrease the air inclusion
- increase reliability
- increase repeatability
- decrease manufacturing time
- adaptable to different silicone viscosities



2-4 students

Research project (part 2/3)

Investigate
Lost-wax casting
(for chambers manufacturing)



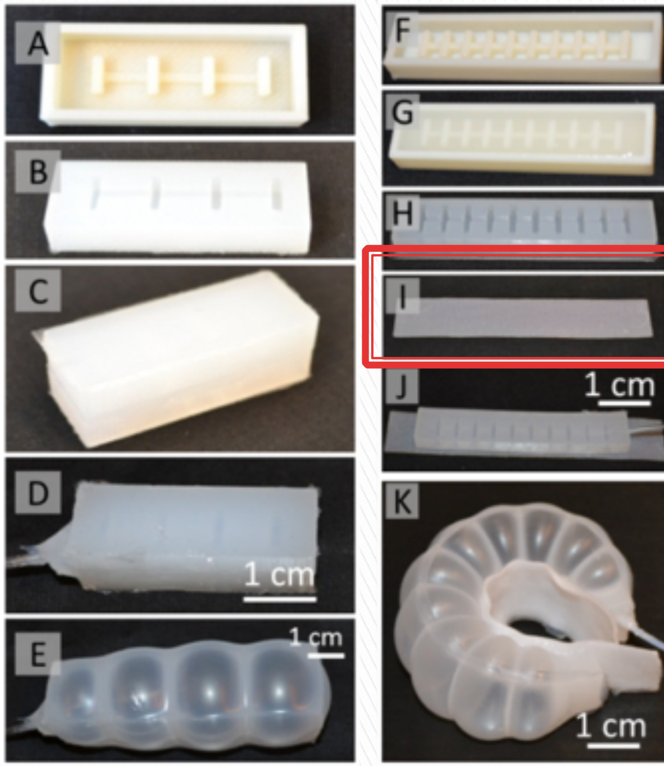
Methodology:

-by chemical or thermal removal of the lost wax mould

Advantages:

-obtaining an actuator made of a single part (no need of connecting different parts)

Research project (part 3/3)



Textiles integration

Advantages:

-directional actuation using non-isotropic textiles or weave/braids

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