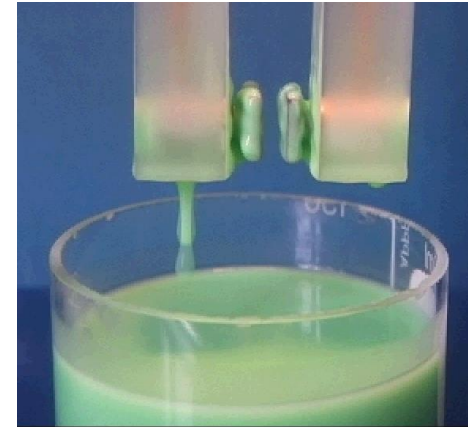
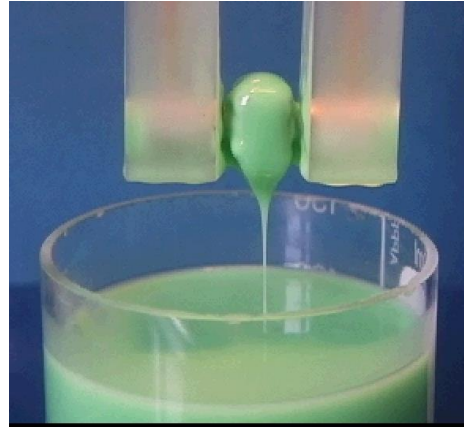


Session: Medicine in AM

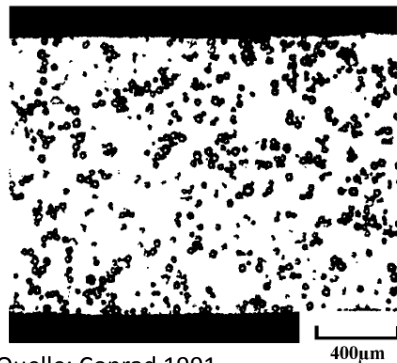
- 3D-printed elastomeric bellow actuator for linear motion

M. Eng. Holger Freyer

Introduction - *electrorheological fluid* -



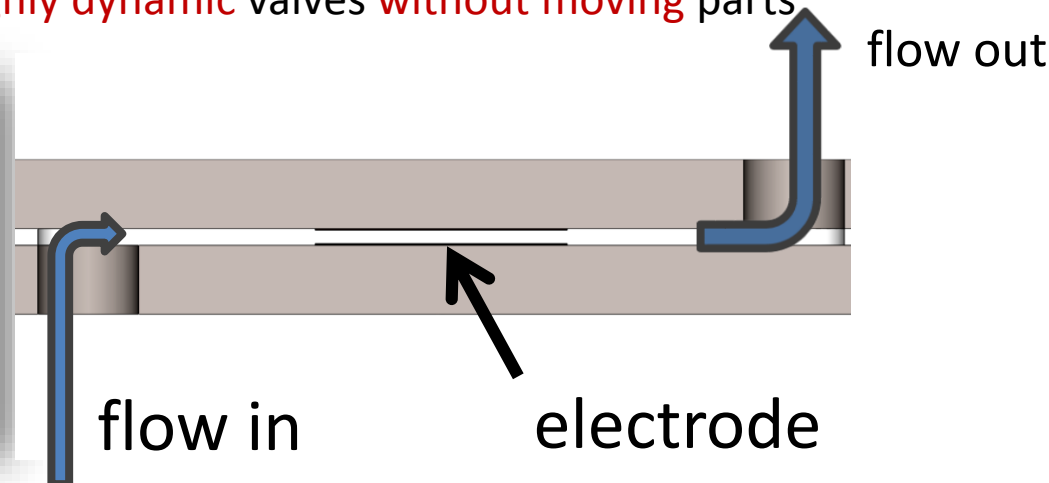
- **Rapid** and **reversible** changes of the viscosity
- Realisation of **highly dynamic** valves **without moving** parts



Quelle: Conrad 1991

400µm

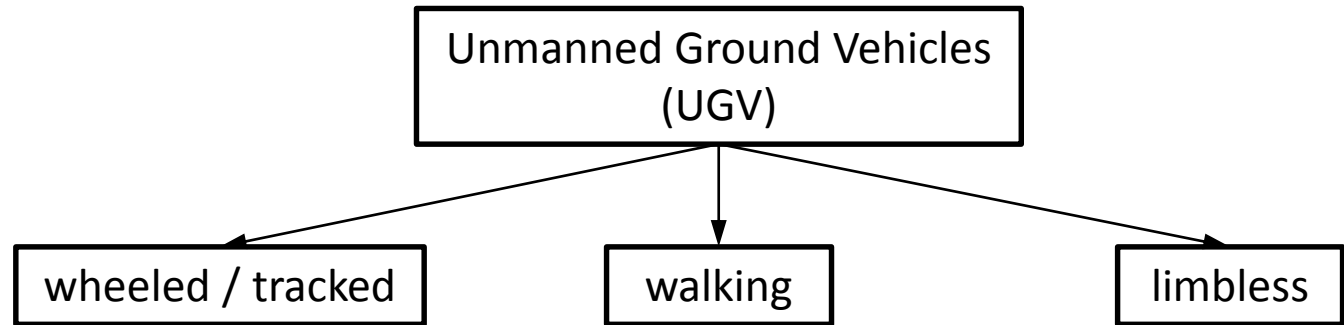
400µm



Outline

- 1. Motion strategies of Unmanned Ground Vehicle (UGV)**
 - a. Overview
 - b. Limbless locomotion
 - c. Peristaltic locomotion
- 2. Printed Elastomeric bellow**
 - a. Overview
 - b. Development step 1
 - c. Development step 2
- 3. Moulding elastomeric bellow**
- 4. Outlook**

1. Motion strategies of UGV - overview -



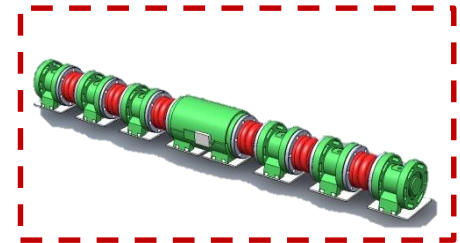
(iRobot, 2014)

- developed / in use
- electric drive
- widely used
- limited all-terrain



(BostonDynamics, 2014)

- in development
- hydraulic drive
- all-terrain ability
- complex control



- in development
- hydraulic drive
- robust, low profile
- low speed

Outline

1. Motion strategies

- Overview
- Limbless locomotion
- Peristaltic locomotion

2. Printed Elastomeric bellow

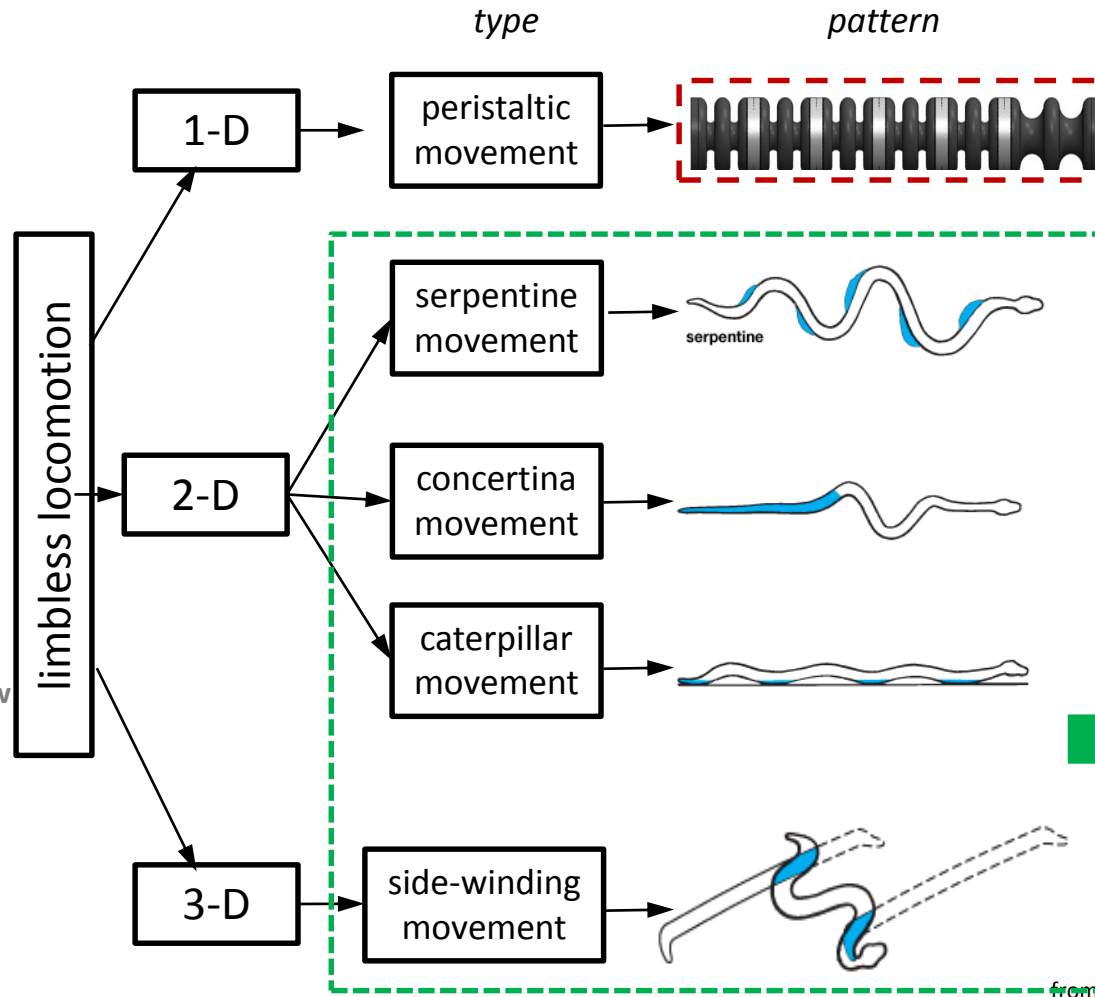
- Overview
- Development step 1
- Development step 2

3. Moulding

4. Outlook

1.b Limbless locomotion

actuator



from Encyclopedia Britannica, 2012

Outline

1. Motion strategies

- a. Overview
- b. **Limbless locomotion**
- c. Peristaltic locomotion

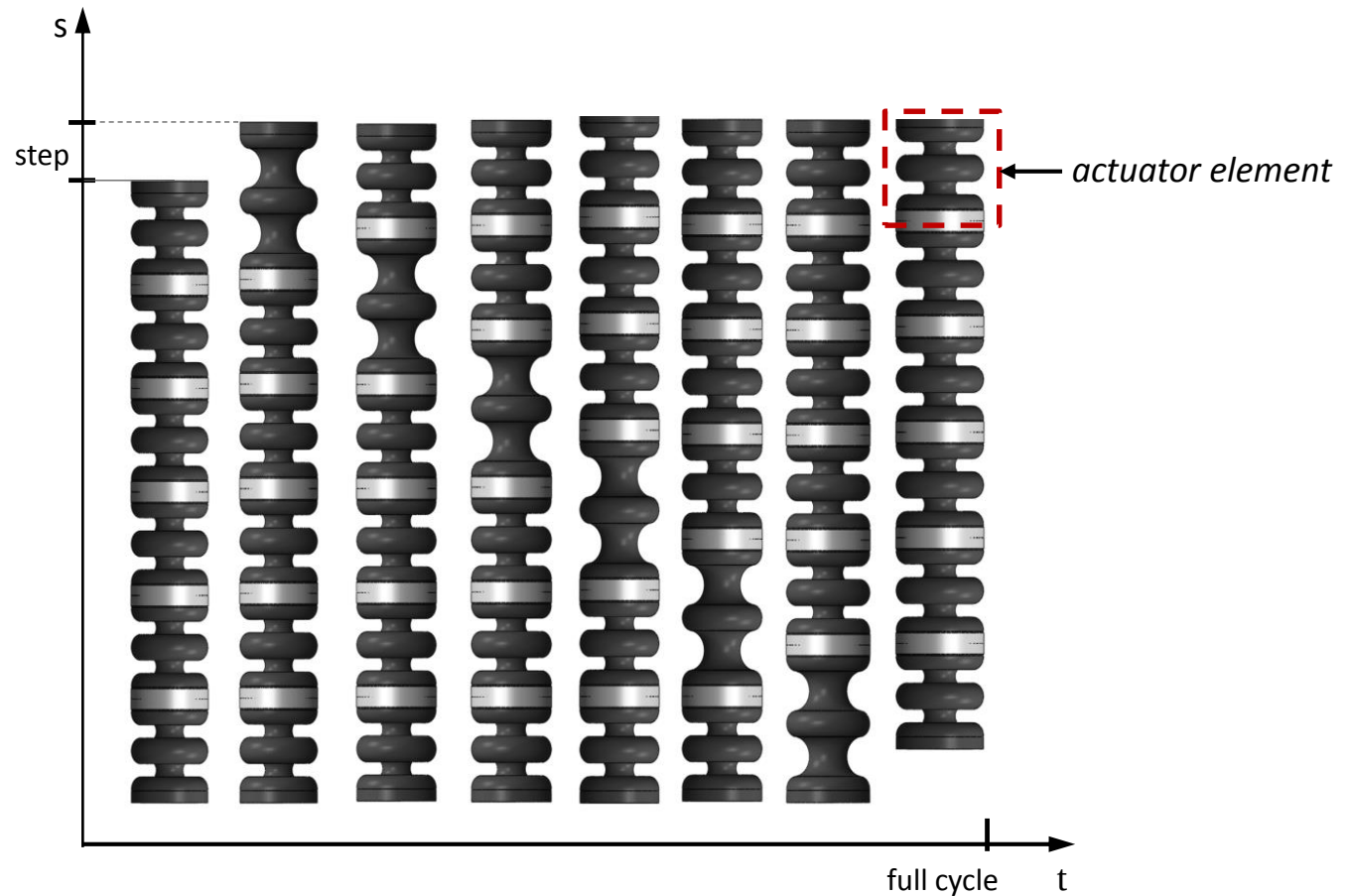
2. Printed Elastomeric bellow

- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

4. Outlook

1.c Peristaltic locomotion



Outline

1. Motion strategies

- a. Overview
- b. Limbless locomotion
- c. **Peristaltic locomotion**

2. Printed Elastomeric bellow

- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

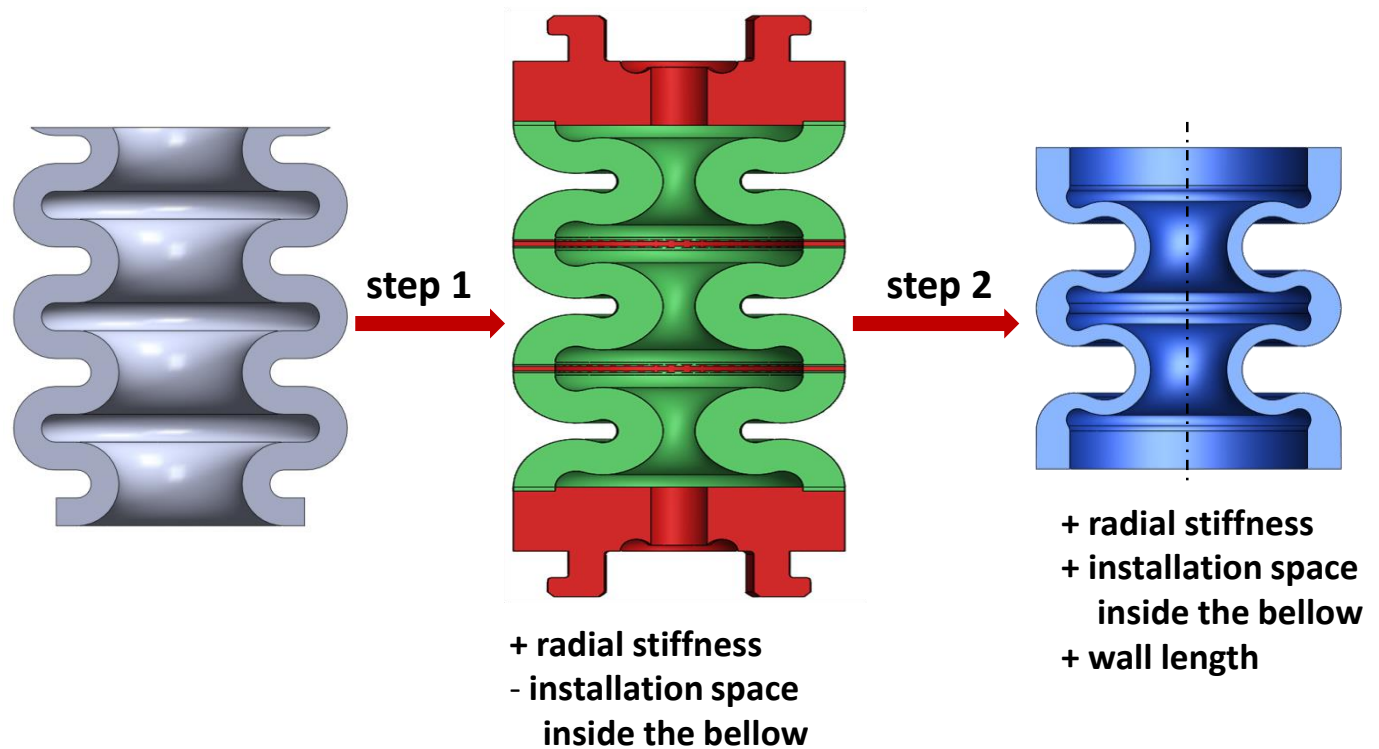
4. Outlook

2.a Elastomeric bellow

- Development -

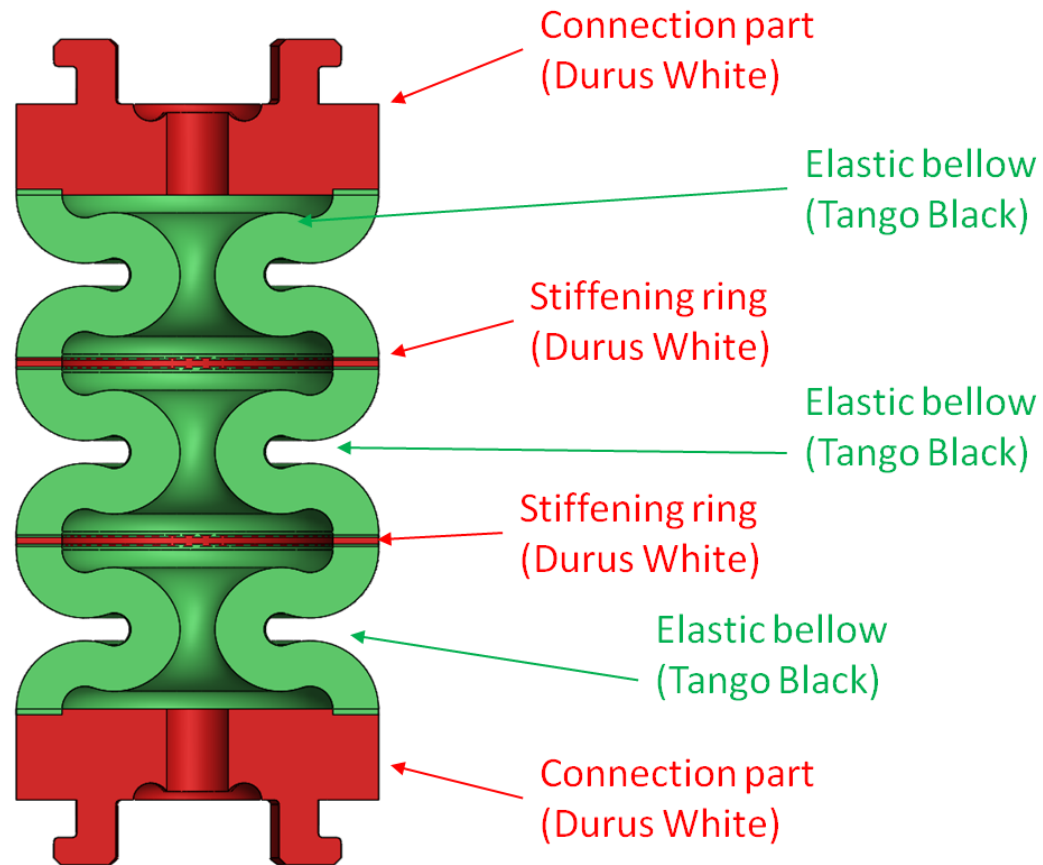
Outline

1. Motion strategies
 - a. Overview
 - b. Limbless locomotion
 - c. Peristaltic locomotion
2. Printed Elastomeric bellow
 - a. Overview
 - b. Development step 1
 - c. Development step 2
3. Moulding
4. Outlook



2.b Elastomeric bellow

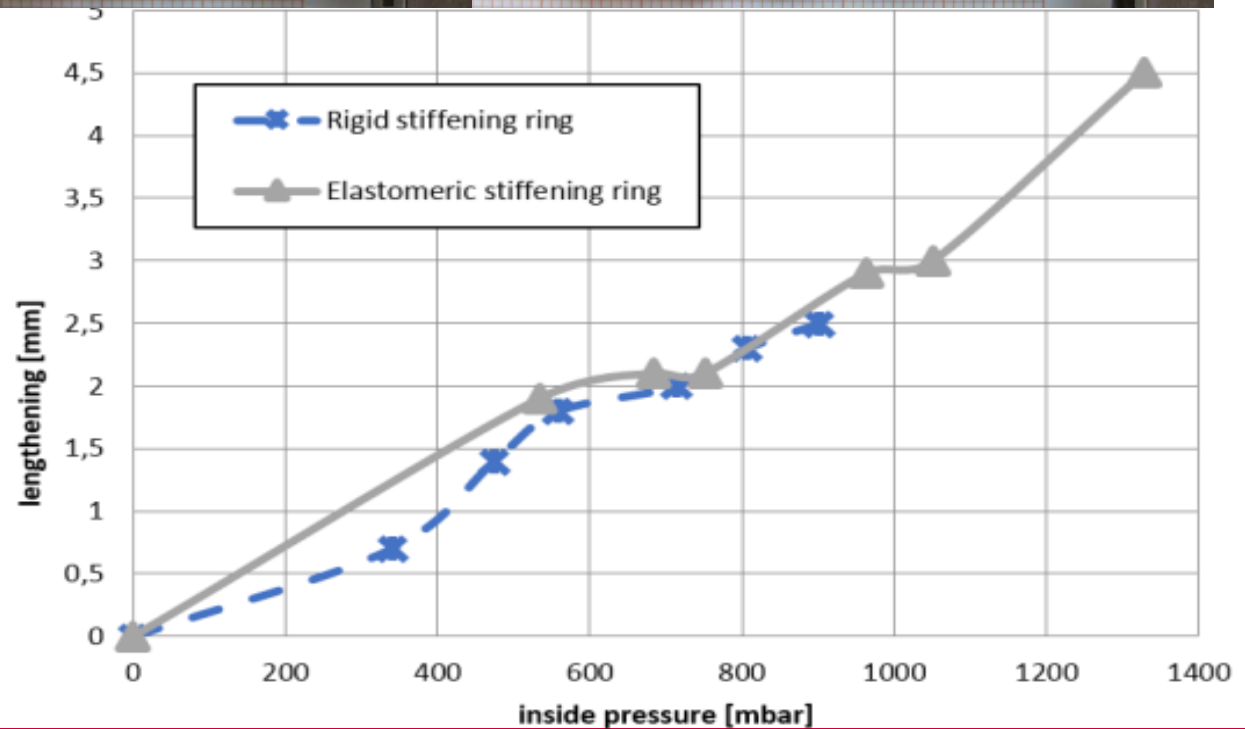
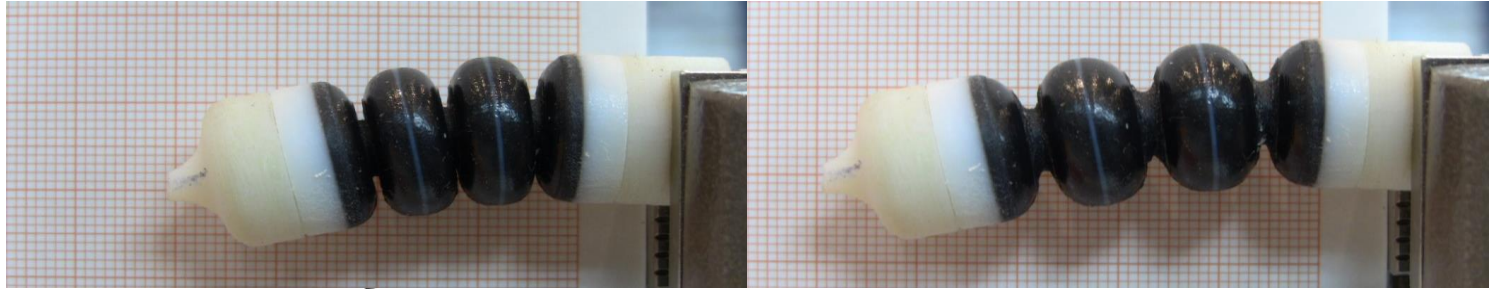
- development step 1-



Outline

1. Motion strategies
 - a. Overview
 - b. Limbless locomotion
 - c. Peristaltic locomotion
2. Printed Elastomeric bellow
 - a. Overview
 - b. Development step 1
 - c. Development step 2
3. Moulding
4. Outlook

2.b Printed elastomeric bellows - development step 1-



Outline

1. Motion strategies

- a. Overview
- b. Limbless locomotion
- c. Peristaltic locomotion

2. Printed Elastomeric bellows

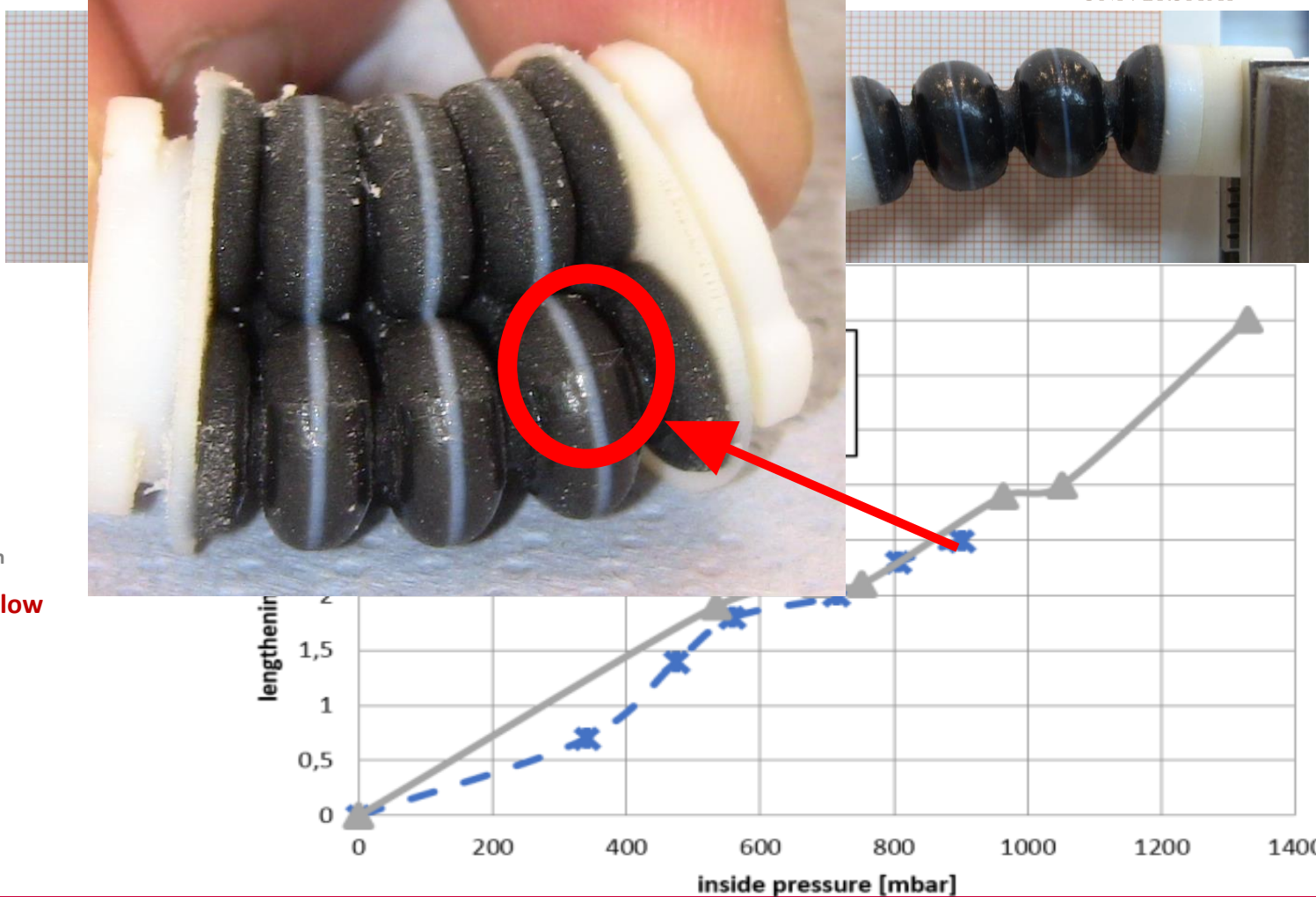
- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

4. Outlook

2.b Printed elastomeric bellow

- development step 1-



Outline

1. Motion strategies

- a. Overview
- b. Limbless locomotion
- c. Peristaltic locomotion

2. Printed Elastomeric bellow

- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

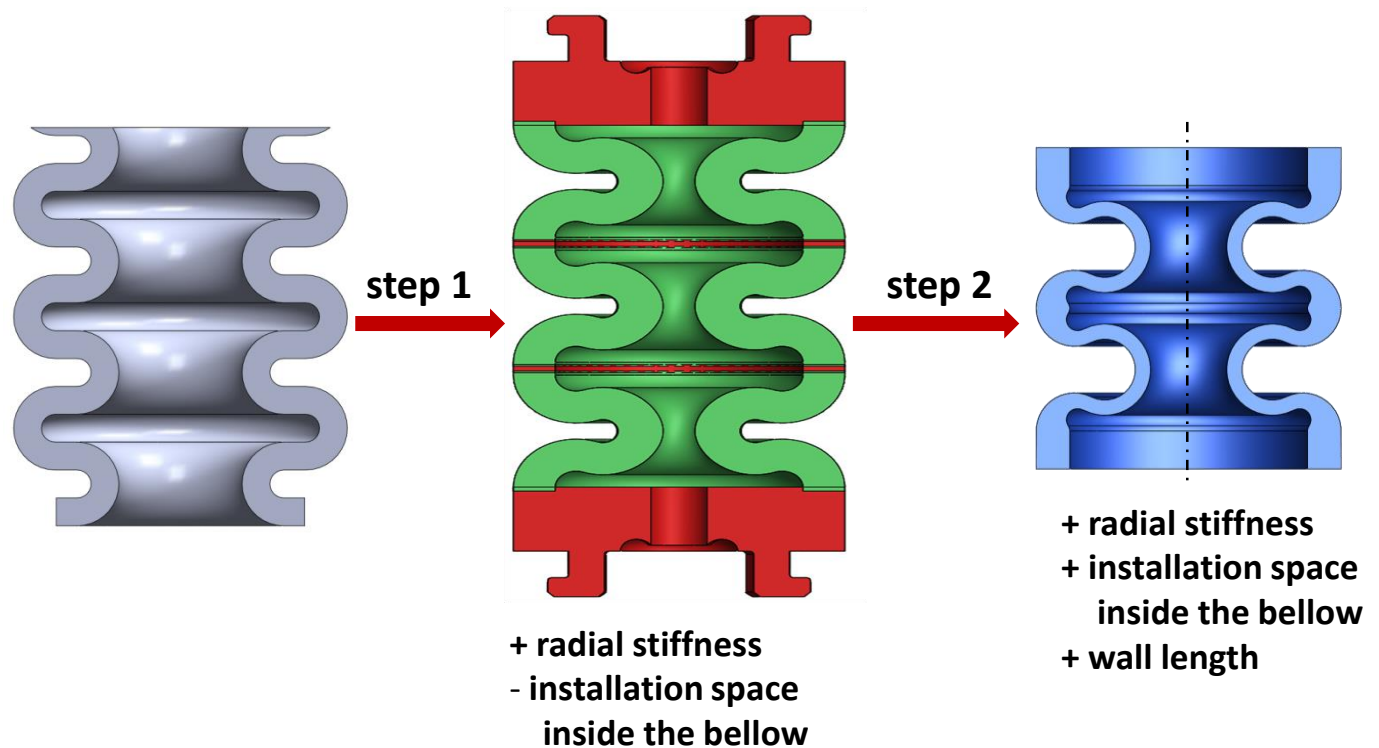
4. Outlook

2.a Elastomeric bellow

- Development -

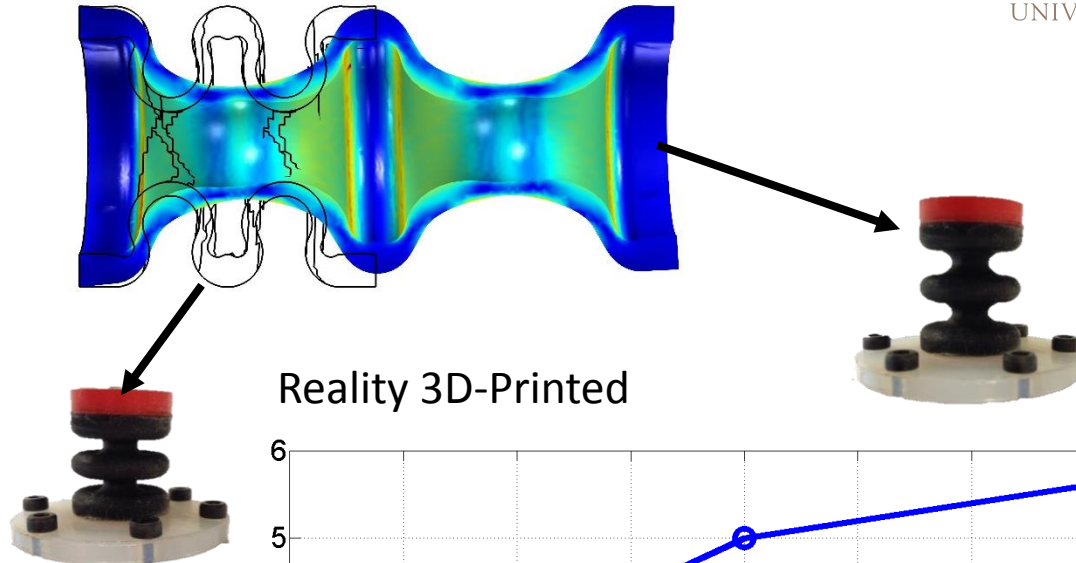
Outline

1. Motion strategies
 - a. Overview
 - b. Limbless locomotion
 - c. Peristaltic locomotion
2. Printed Elastomeric bellow
 - a. Overview
 - b. Development step 1
 - c. Development step 2
3. Moulding
4. Outlook

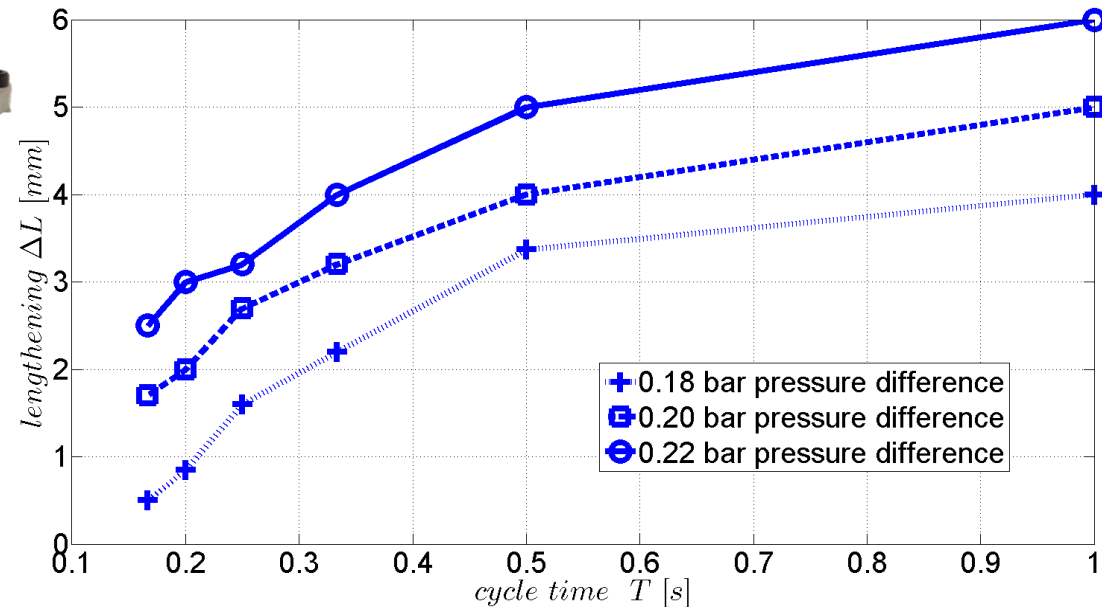


2.c Printed elastomeric bellows - development step 2-

Simulation



Reality 3D-Printed



Outline

1. Motion strategies

- a. Overview
- b. Limbless locomotion
- c. Peristaltic locomotion

2. Printed Elastomeric bellows

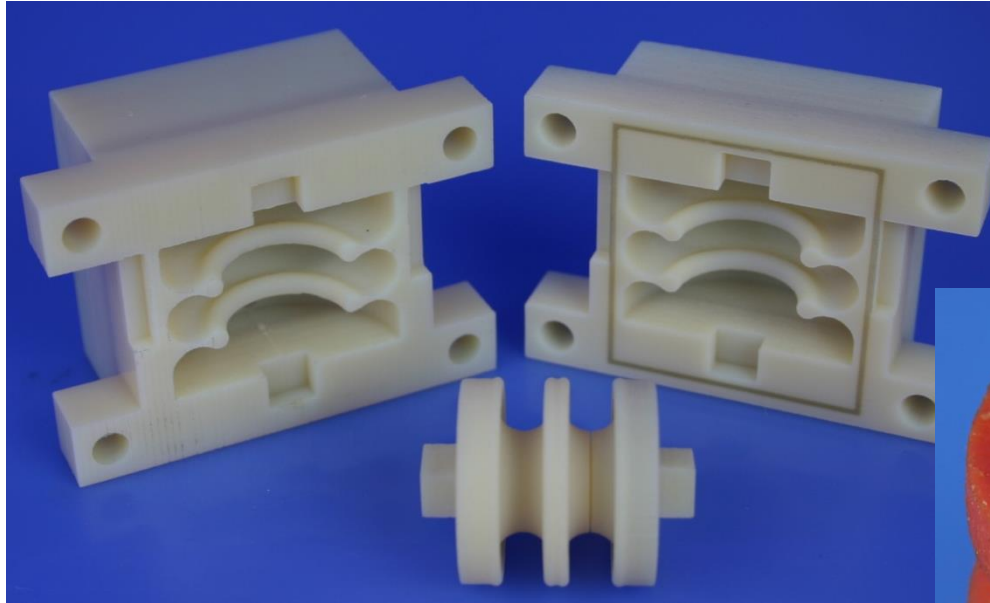
- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

4. Outlook

3. Moulded elastomeric bellow

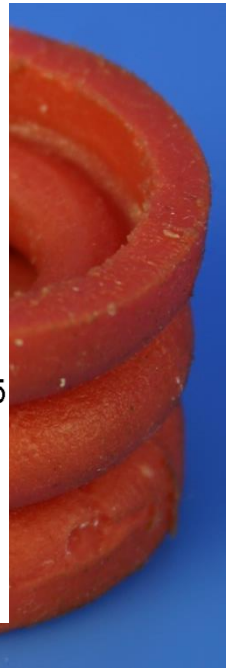
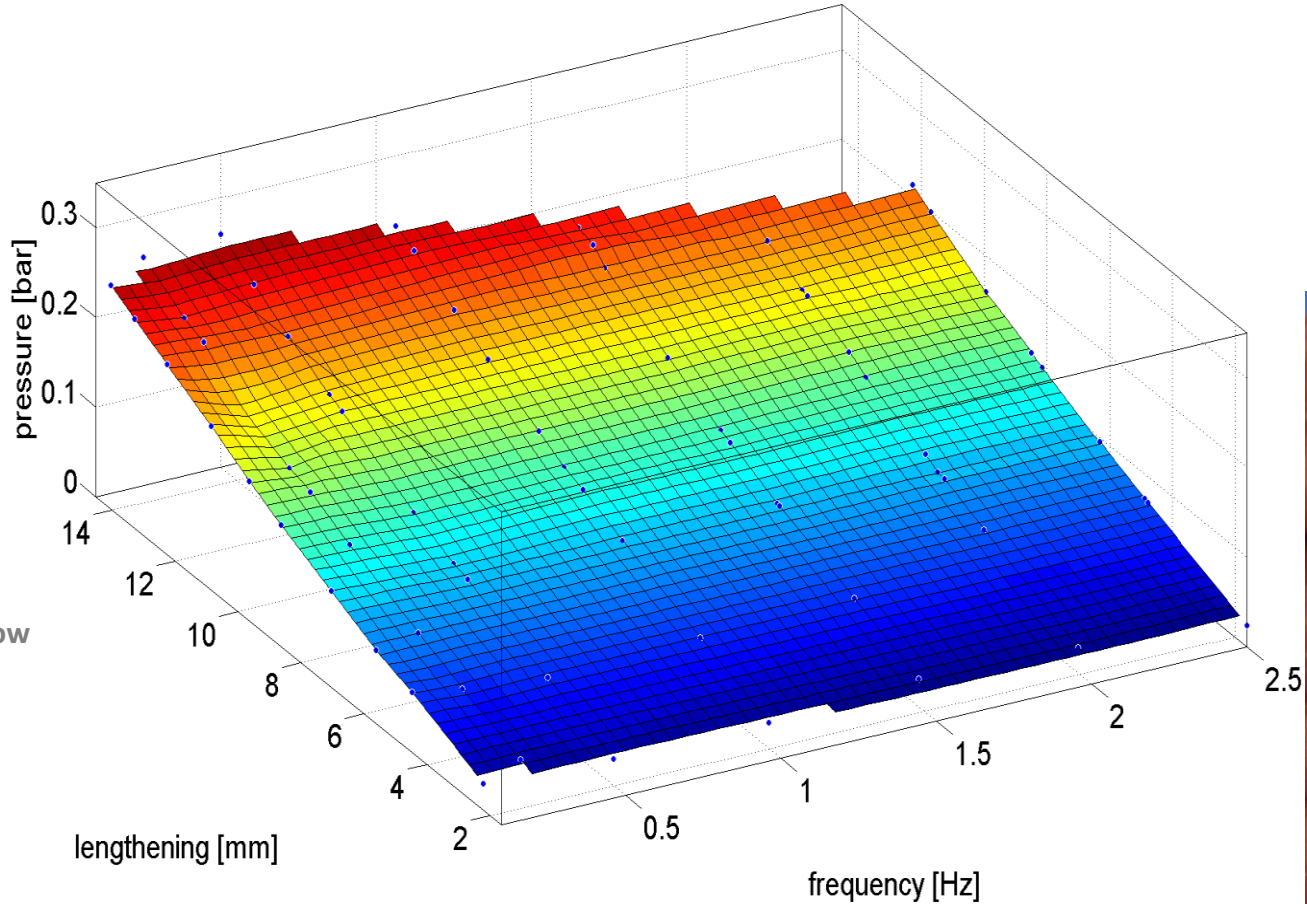
- moulding form and bellow -



Outline

1. Motion strategies
 - a. Overview
 - b. Limbless locomotion
 - c. Peristaltic locomotion
2. Printed Elastomeric bellow
 - a. Overview
 - b. Development step 1
 - c. Development step 2
3. Moulding
4. Outlook

3. Moulded elastomeric bellow - performance chart -



Outline

1. Motion strategies

- a. Overview
- b. Limbless locomotion
- c. Peristaltic locomotion

2. Printed Elastomeric bellow

- a. Overview
- b. Development step 1
- c. Development step 2

3. Moulding

4. Outlook

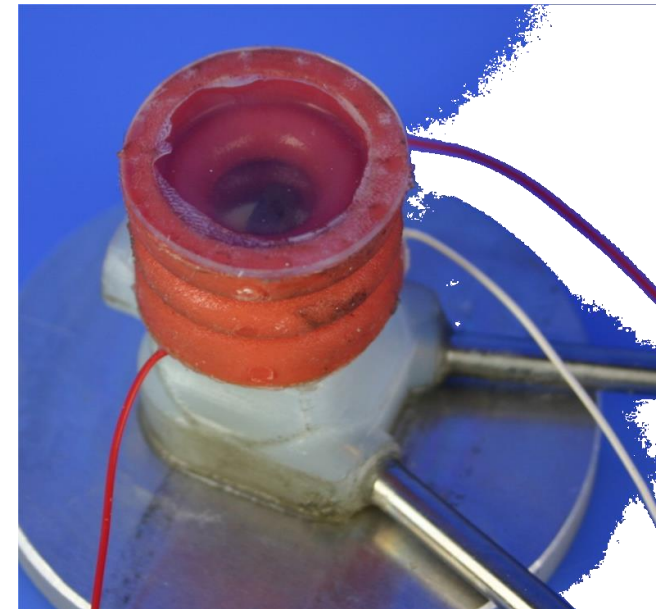
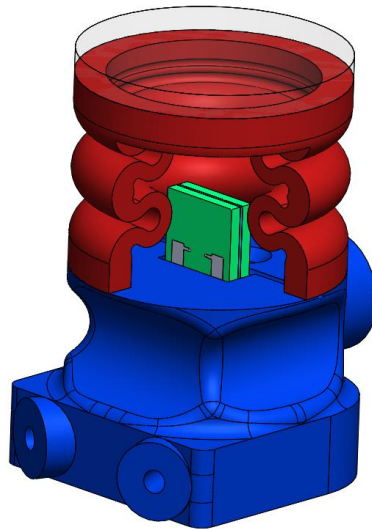
4. Summary & Outlook

- + Very good for fabrication moulding forms
- + Perfect for small material stretching development

- Not useful for
long elongation

Outline

1. Motion strategies
 - a. Overview
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 - a. Overview
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3. Moulding
4. Outlook



Thank you for your attention!



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