



# LiftTiles

Constructive Building Blocks for Prototyping Room-scale Shape-changing Interfaces

Ryo Suzuki, Ryosuke Nakayama, Dan Liu, Yasuaki Kakehi, Mark Gross, Daniel Leithinger



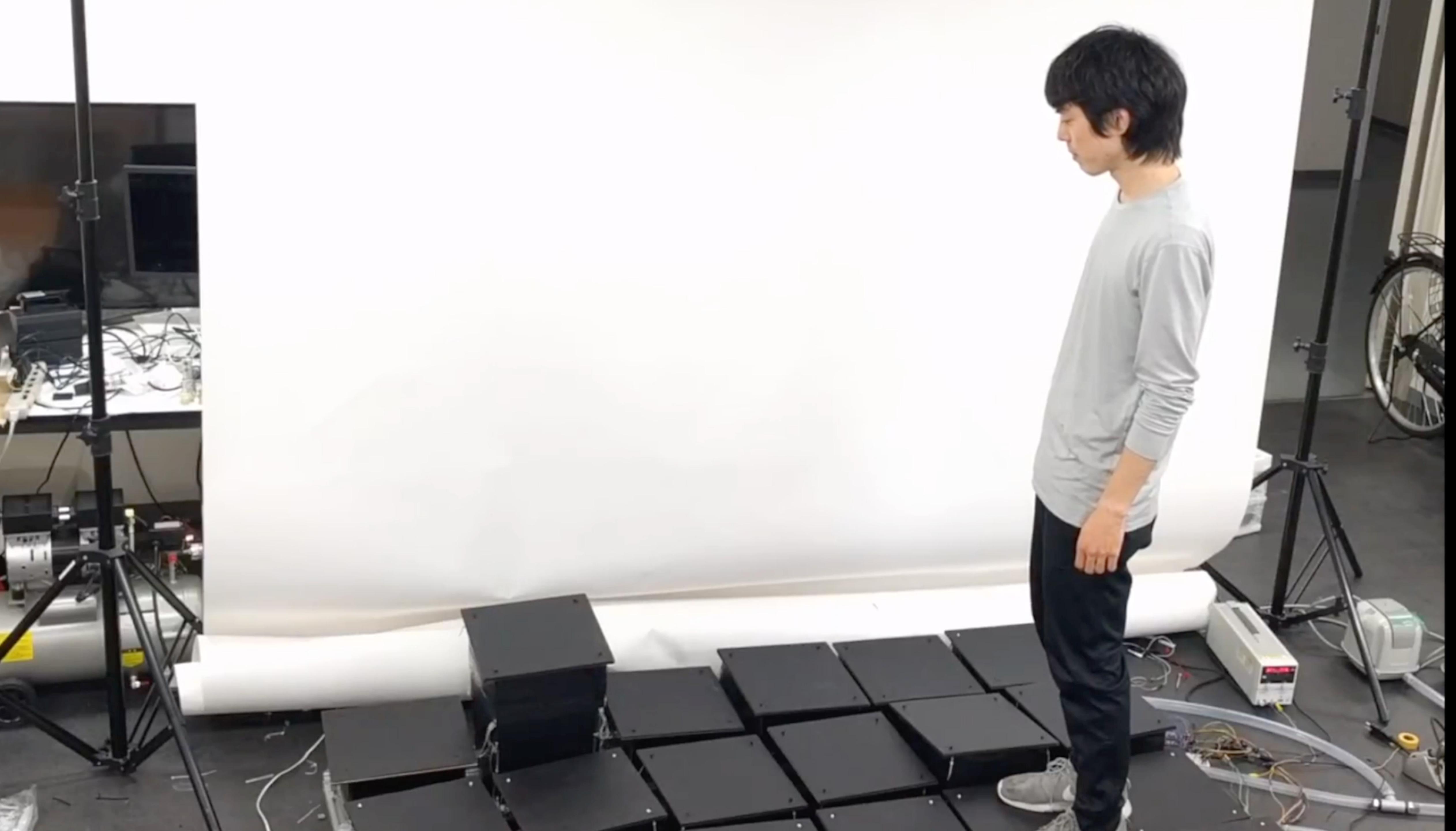
University of Colorado  
Boulder



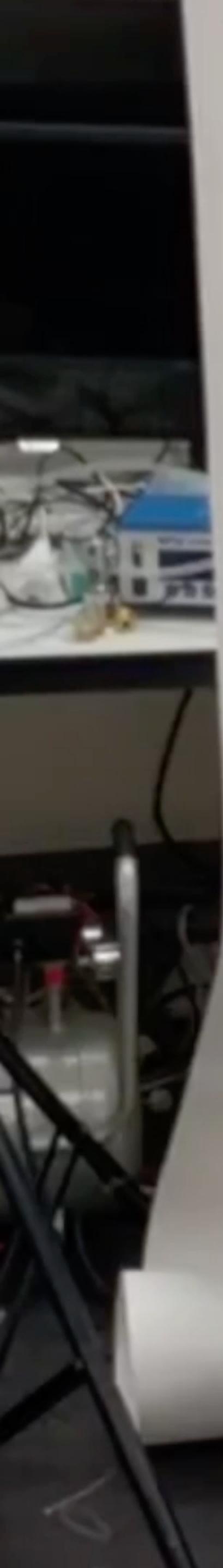
Keio University



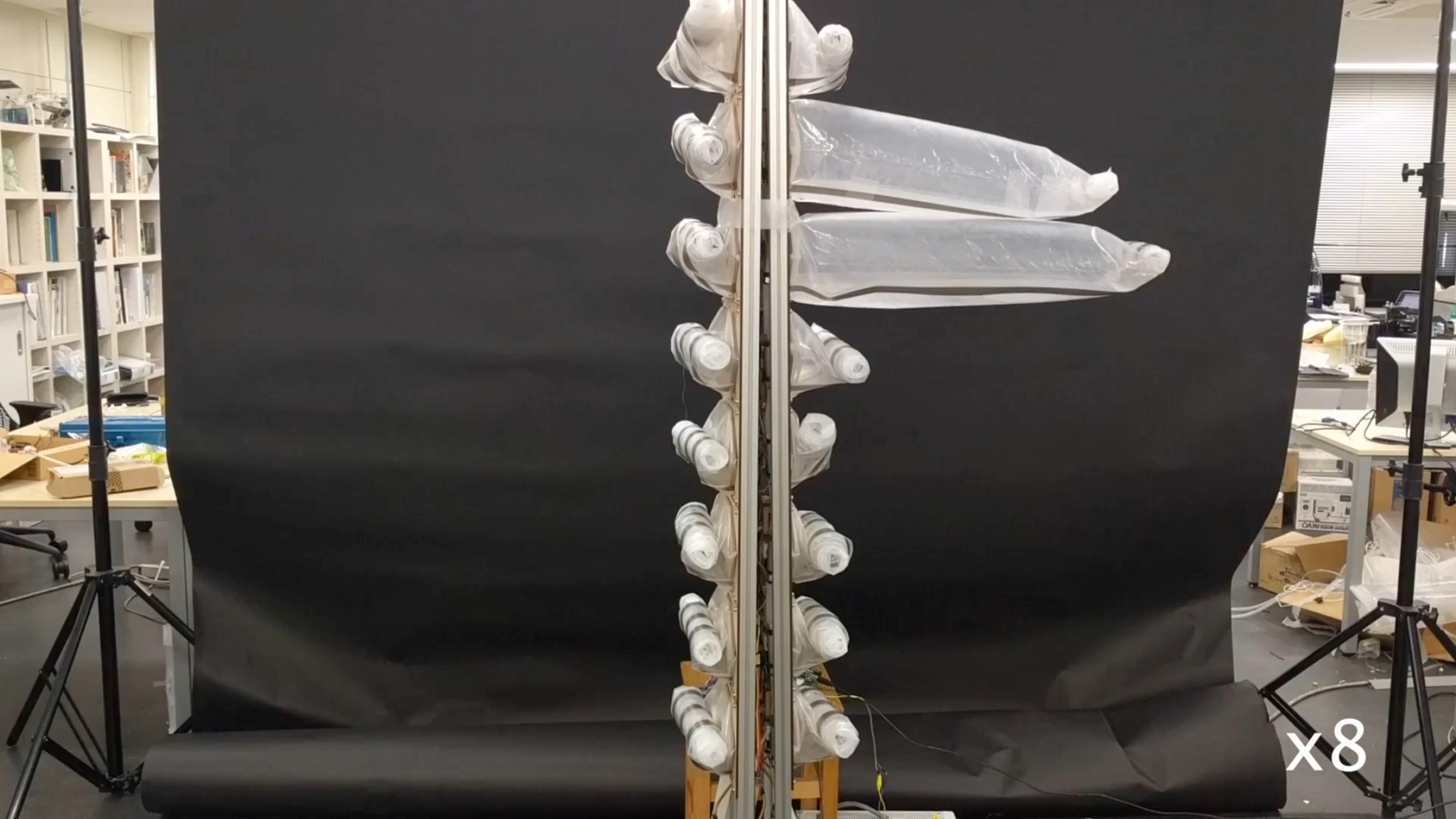
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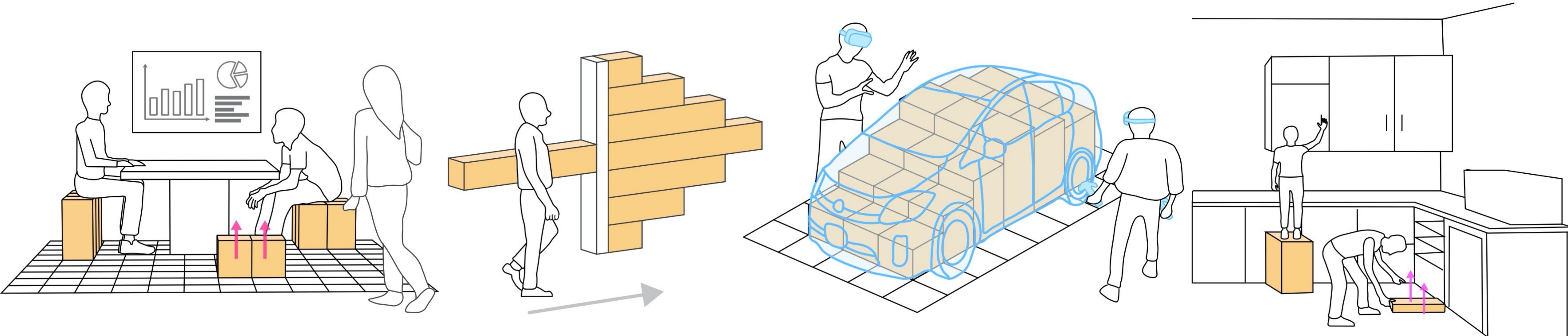




x8



# LiftTiles: Constructive Building Blocks for Prototyping Room-scale Shape-changing Interfaces



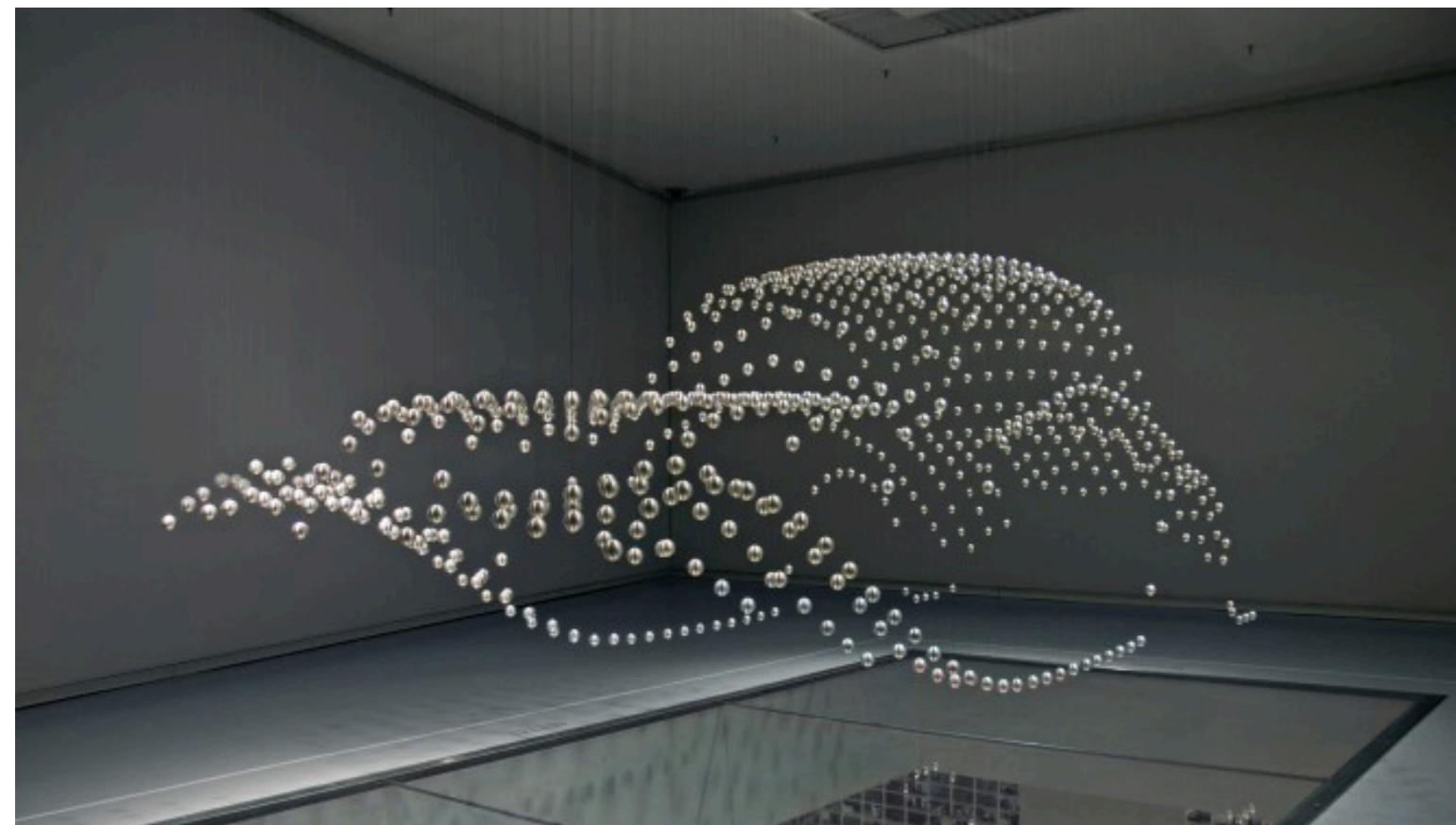
1. Summary

## 2. Background

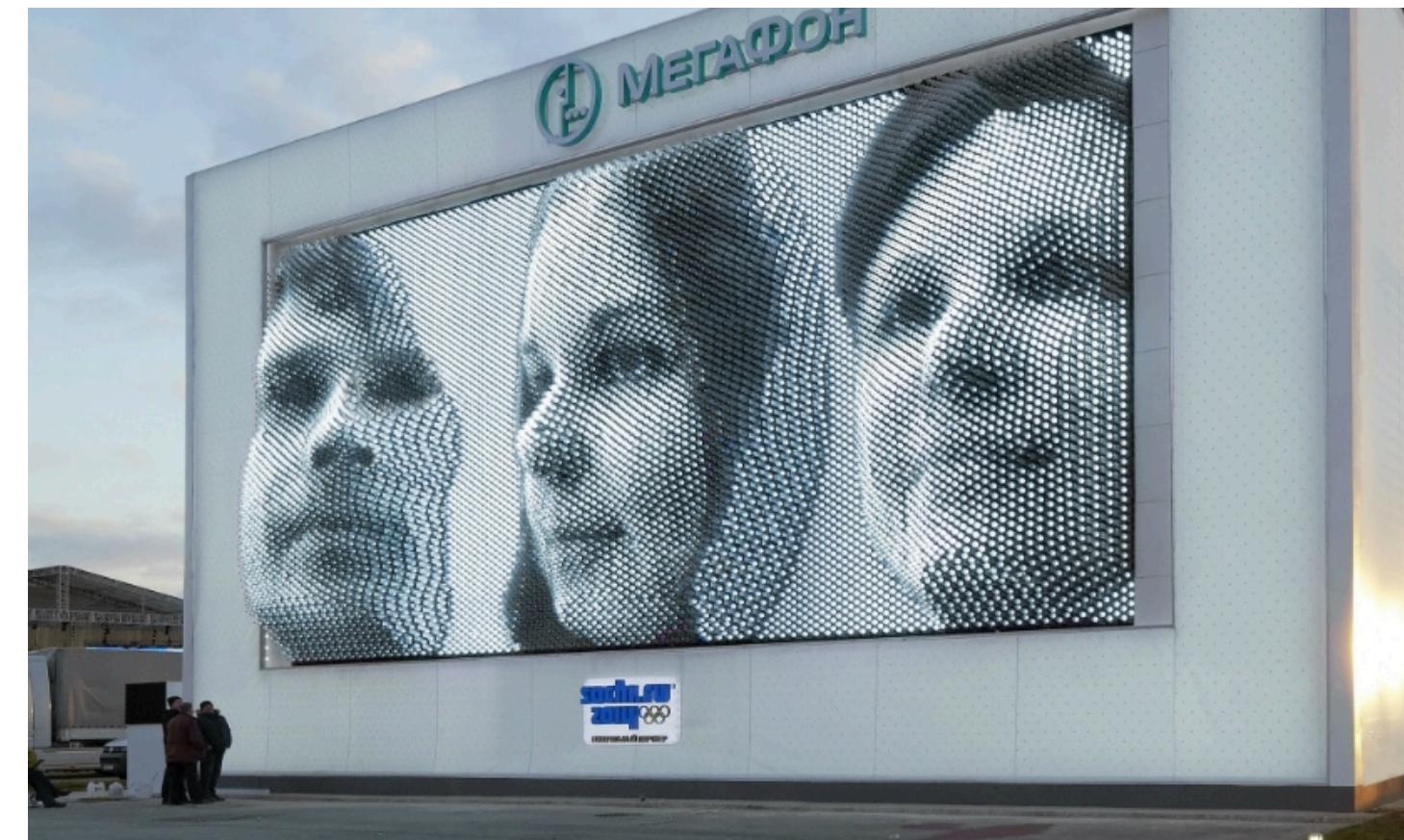
3. LiftTiles: System and Implementation

4. Conclusion

# Large-scale Shape-changing Interfaces have great potential



**Kinetic Sculpture of BMW Museum**  
Art+Com 2007

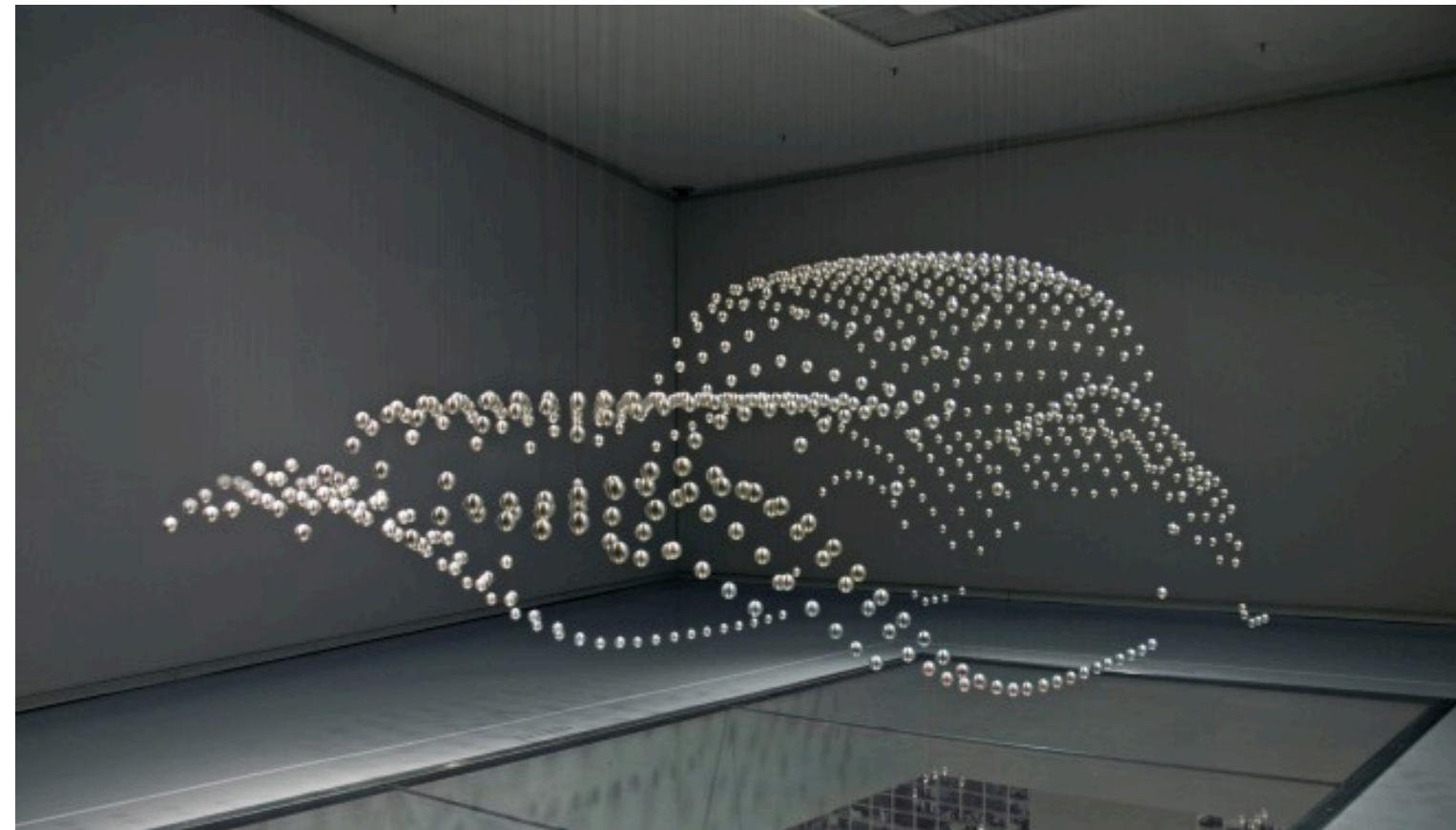


**MegaFaces**  
Asif Kahn 2014

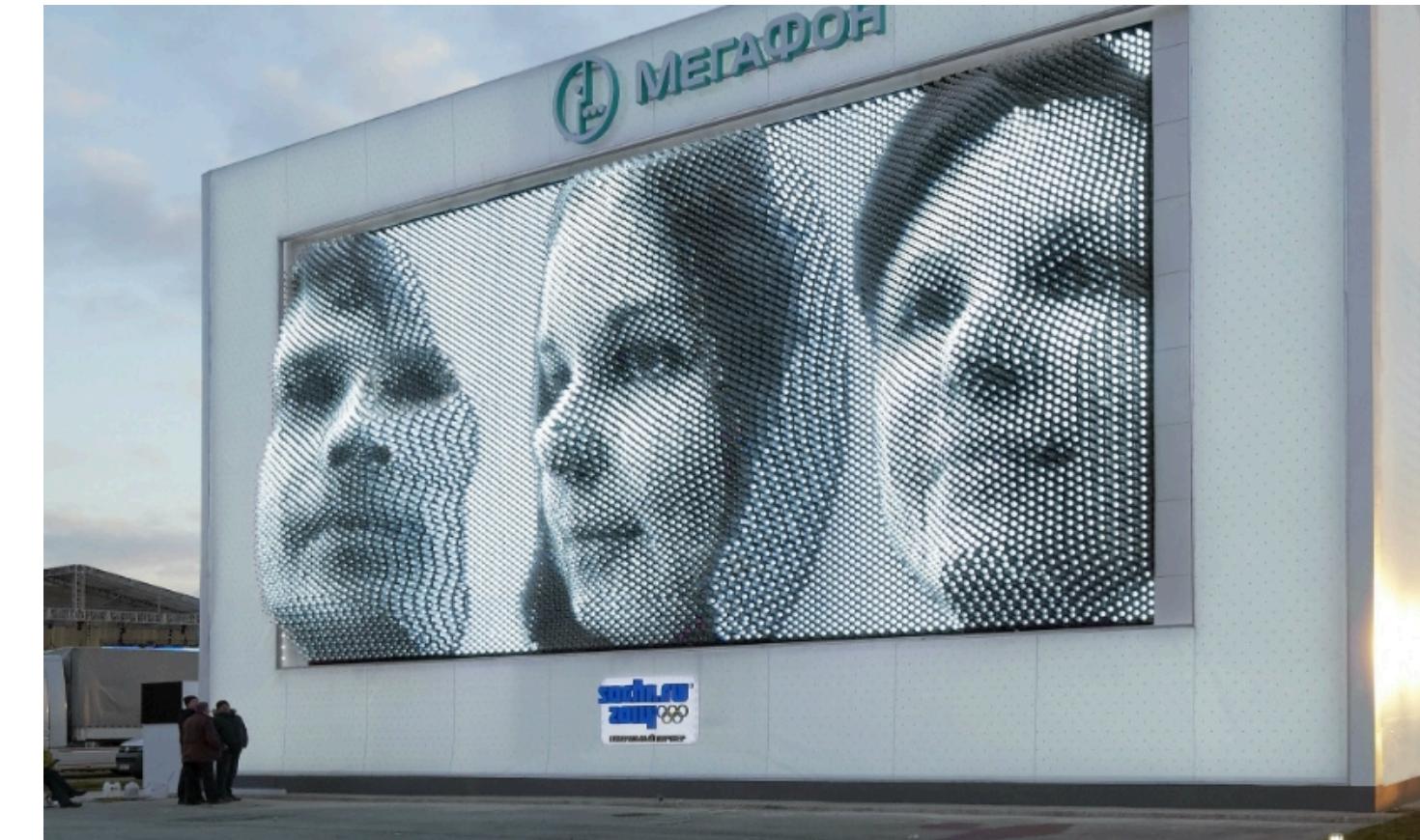


**HypoSurfaces**  
Mark Goulthorpe et al. 2001

# Large-scale Shape-changing Interfaces have great potential



**Kinetic Sculpture of BMW Museum**  
Art+Com 2007



**MegaFaces**  
Asif Kahn 2014



**HypoSurfaces**  
Mark Goulthorpe et al. 2001

**but require substantial time, cost, space, and efforts**

**Goal: Enable more accessible prototyping  
for room-scale shape-changing interfaces**

# Mechanical Actuation

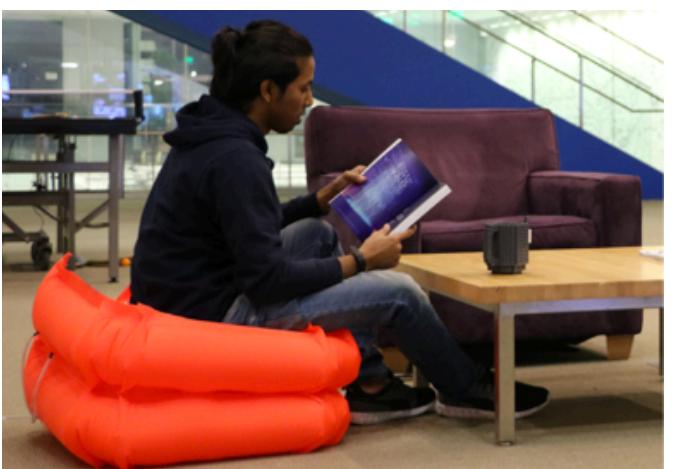


Lift-Bit  
Morillo et al 2013

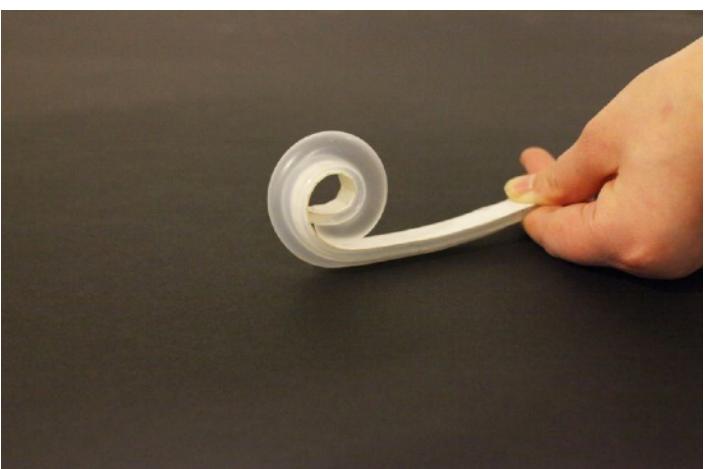
Tangible Pixels  
Tang et al. 2011

## Large-scale Shape-changing Interfaces

## Inflatable Shape-changing Interfaces



Printflatables  
Sareen et al. 2017



PneUI  
Yao et al. 2013

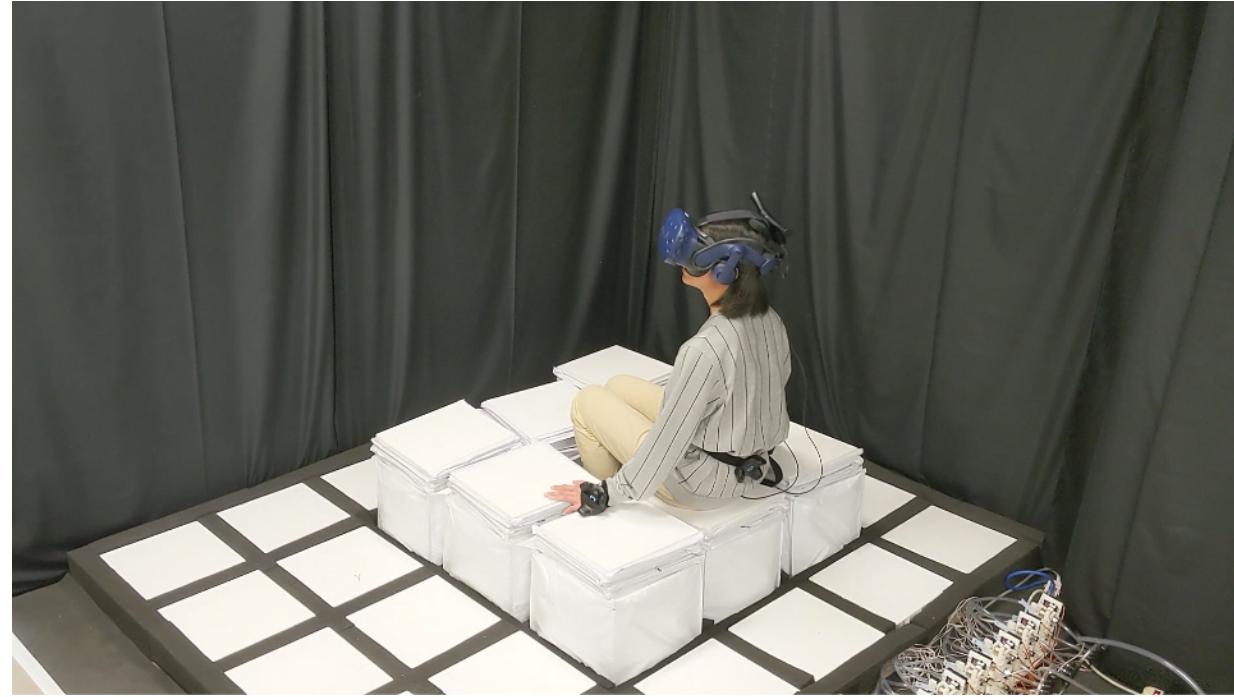
## Modular Prototyping Toolkits



ShapeClip  
Hardy et al. 2015



Topobo  
Raffle et al. 2004



**TilePoP**

Teng et al. UIST 2019

## Large-scale Shape-changing Interfaces

## Mechanical Actuation

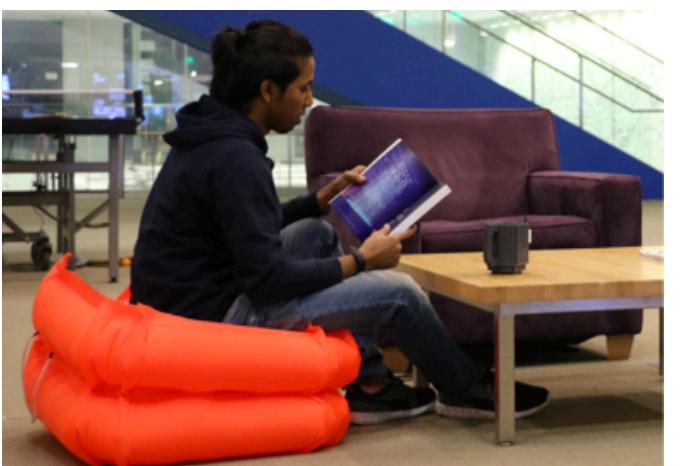


**Lift-Bit**  
Morillo et al 2013

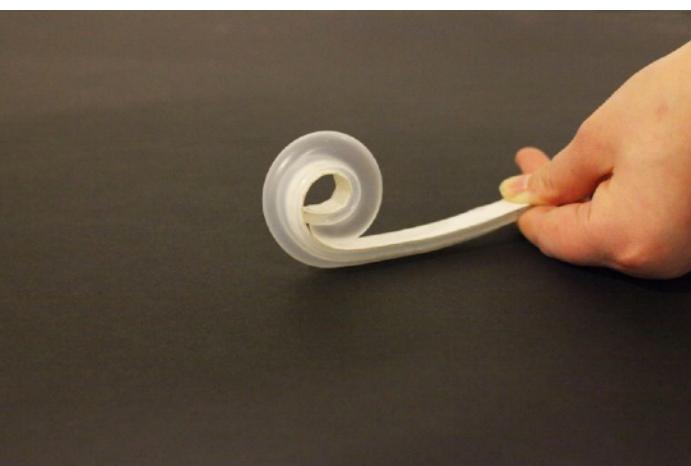


**Tangible Pixels**  
Tang et al. 2011

## Inflatable Shape-changing Interfaces



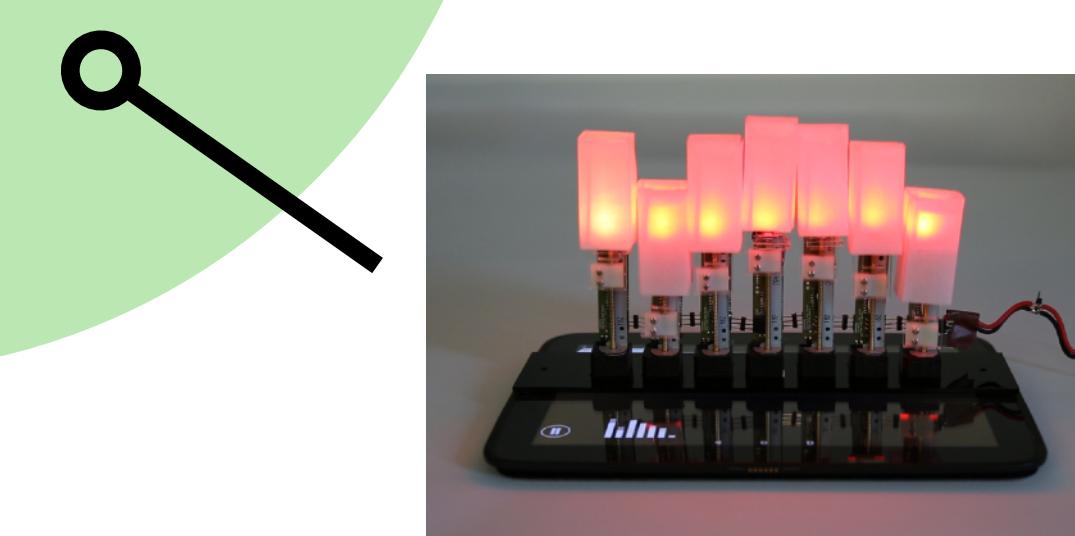
**Printflatables**  
Sareen et al. 2017



**PneUI**  
Yao et al. 2013

**Pneumatic Reel Actuator**  
Hammond et al. ICRA 2017

## Modular Prototyping Toolkits



**ShapeClip**  
Hardy et al. 2015



**Topobo**  
Raffle et al. 2004



## Modular large-scale inflatable actuators

that are light (10 kg), low-cost (8 USD), large footprints (30cm x 30cm), and compact (15ccm) yet highly extendable (x10).

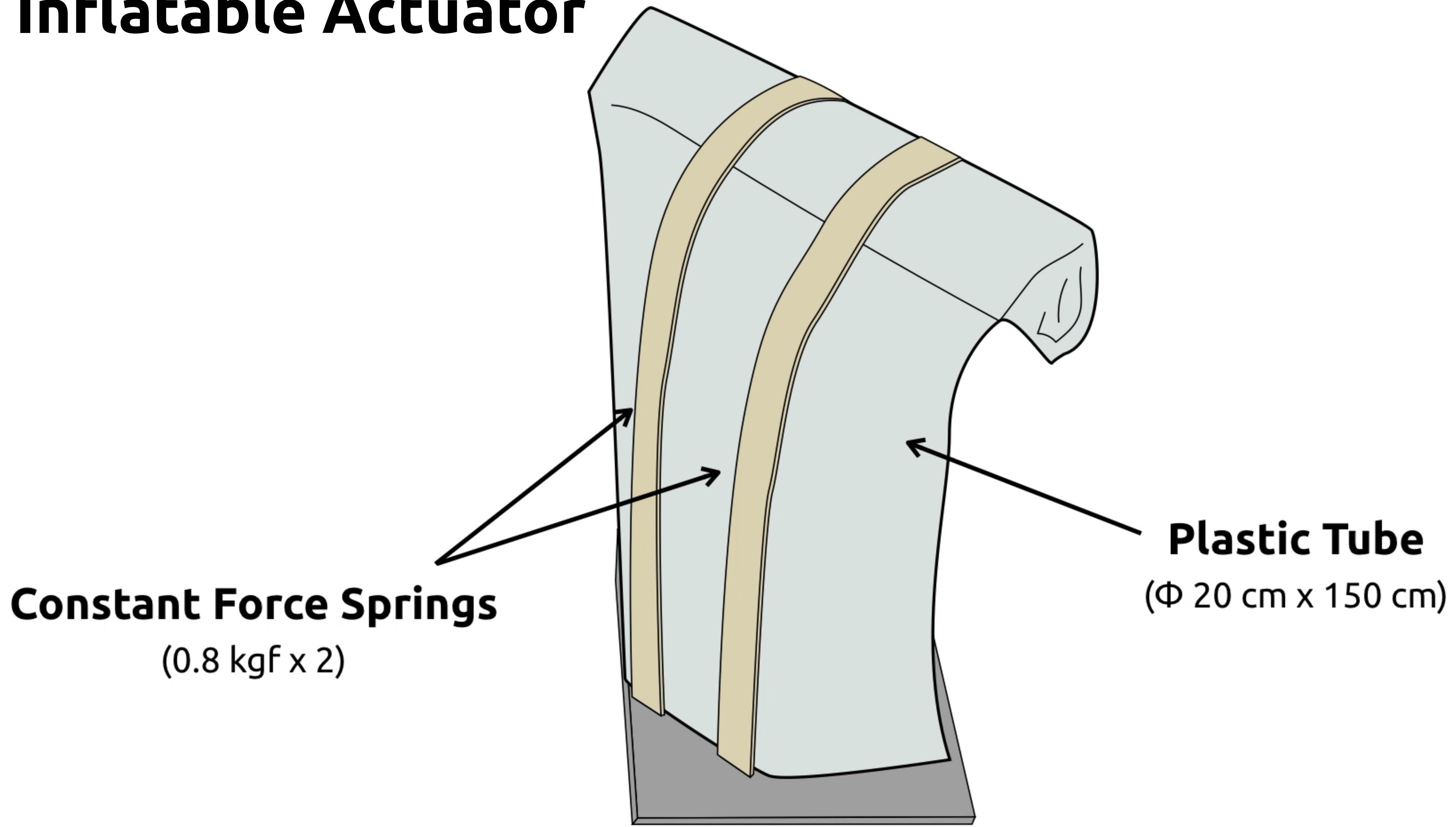
1. Summary
2. Related Work

## 3. LiftTiles

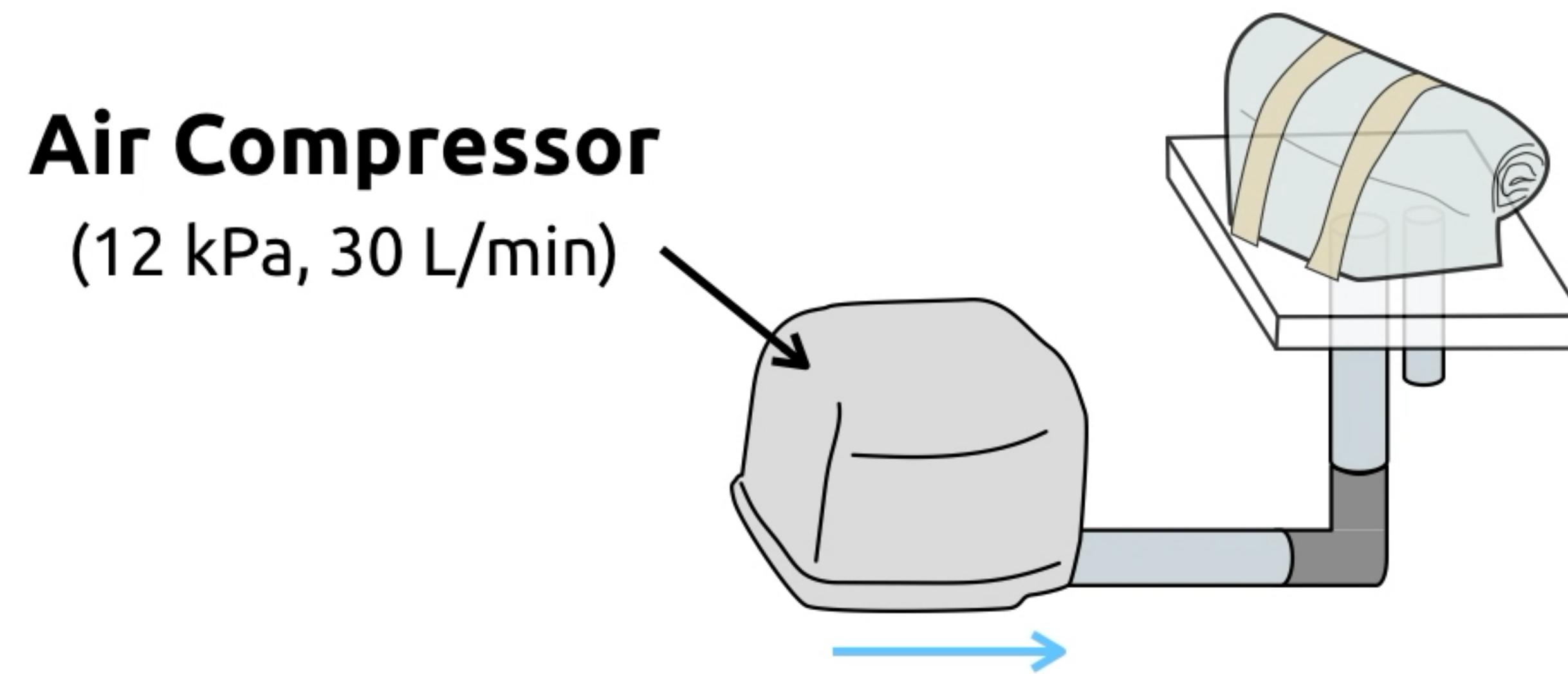
4. Conclusion

# Inflatable Actuator

# Inflatable Actuator



# Inflatable Actuator



# Inflatable Actuator

150cm

Air Compressor  
(12 kPa, 30 L/min)



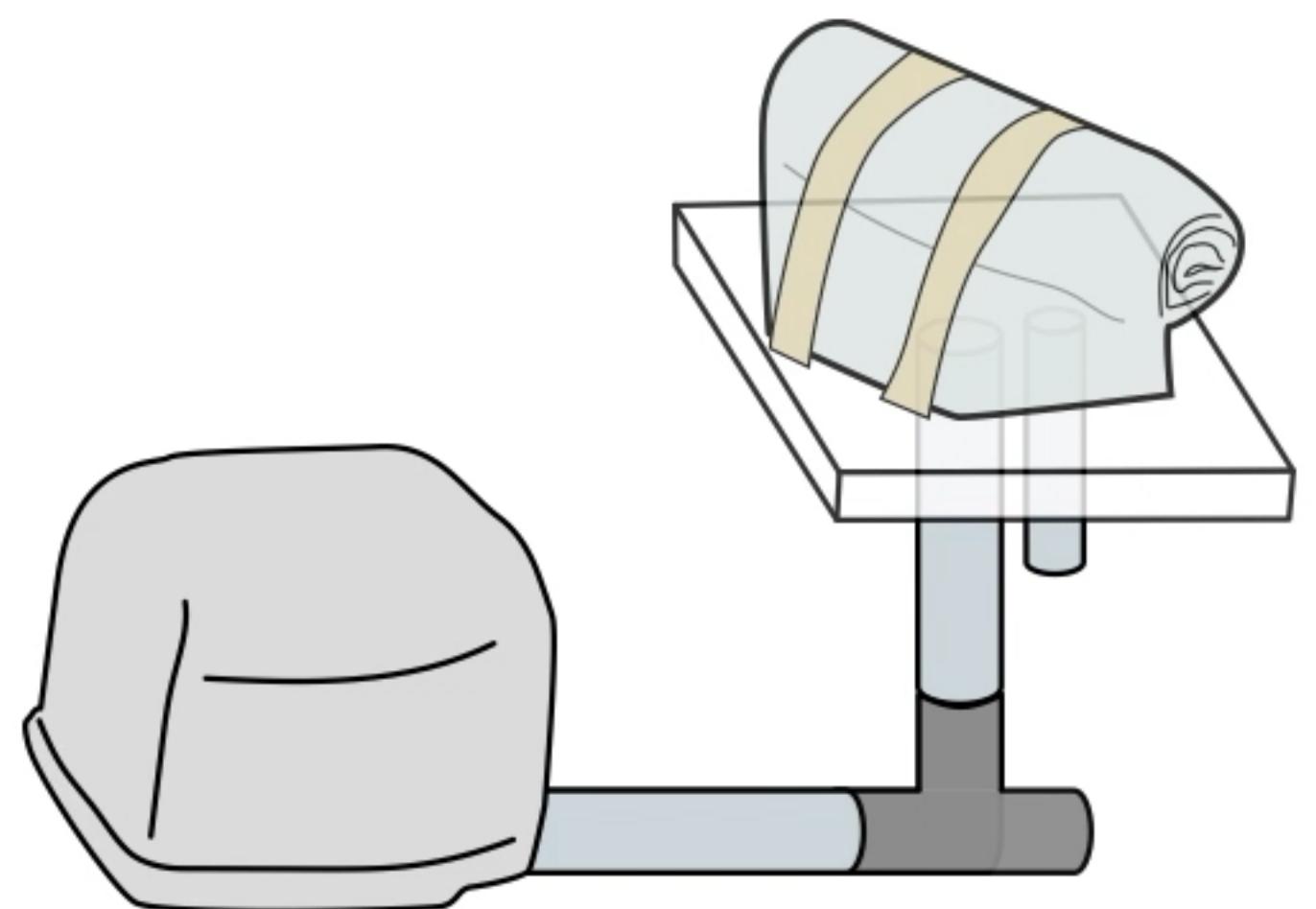
15cm ↑↓

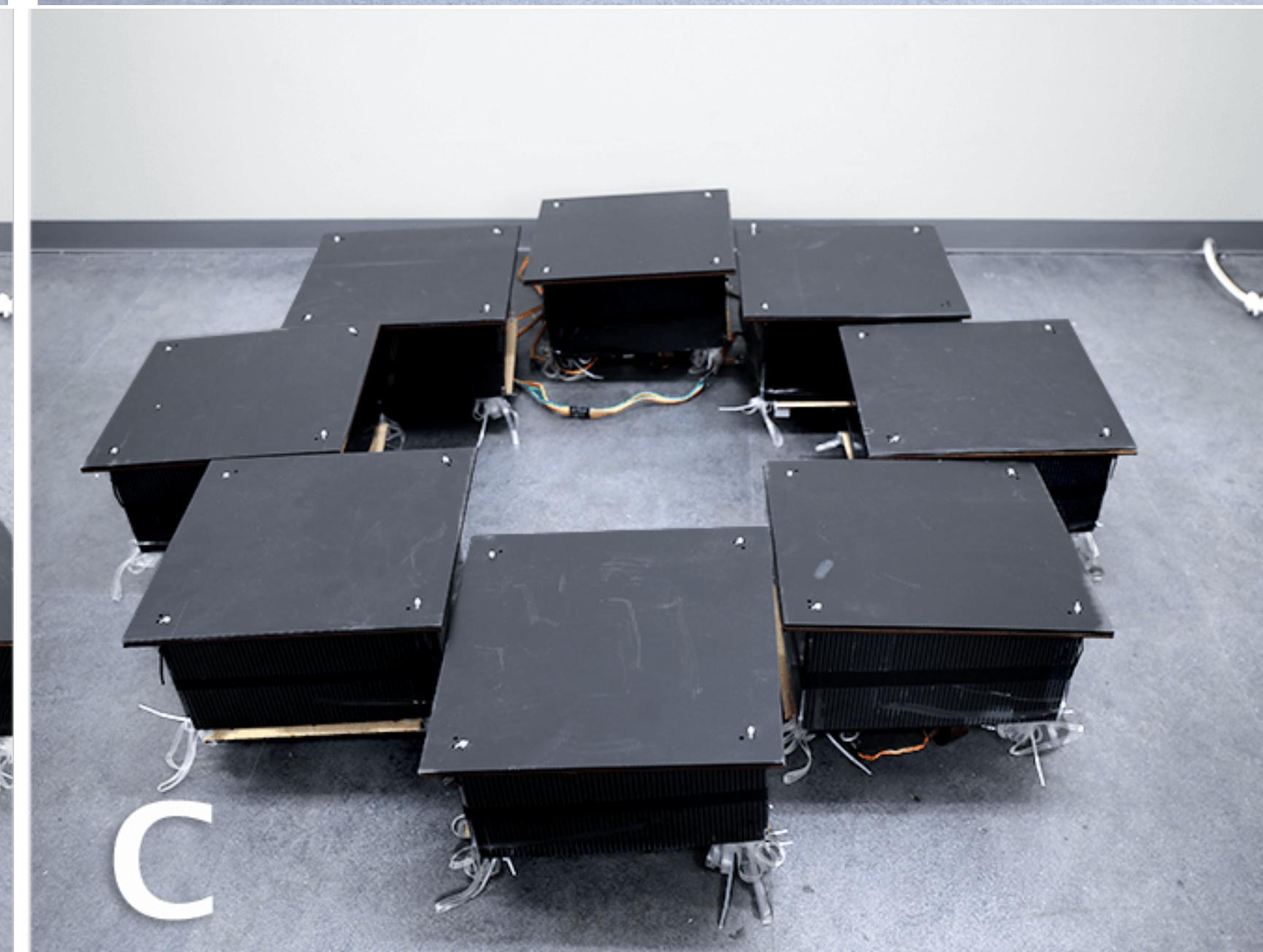
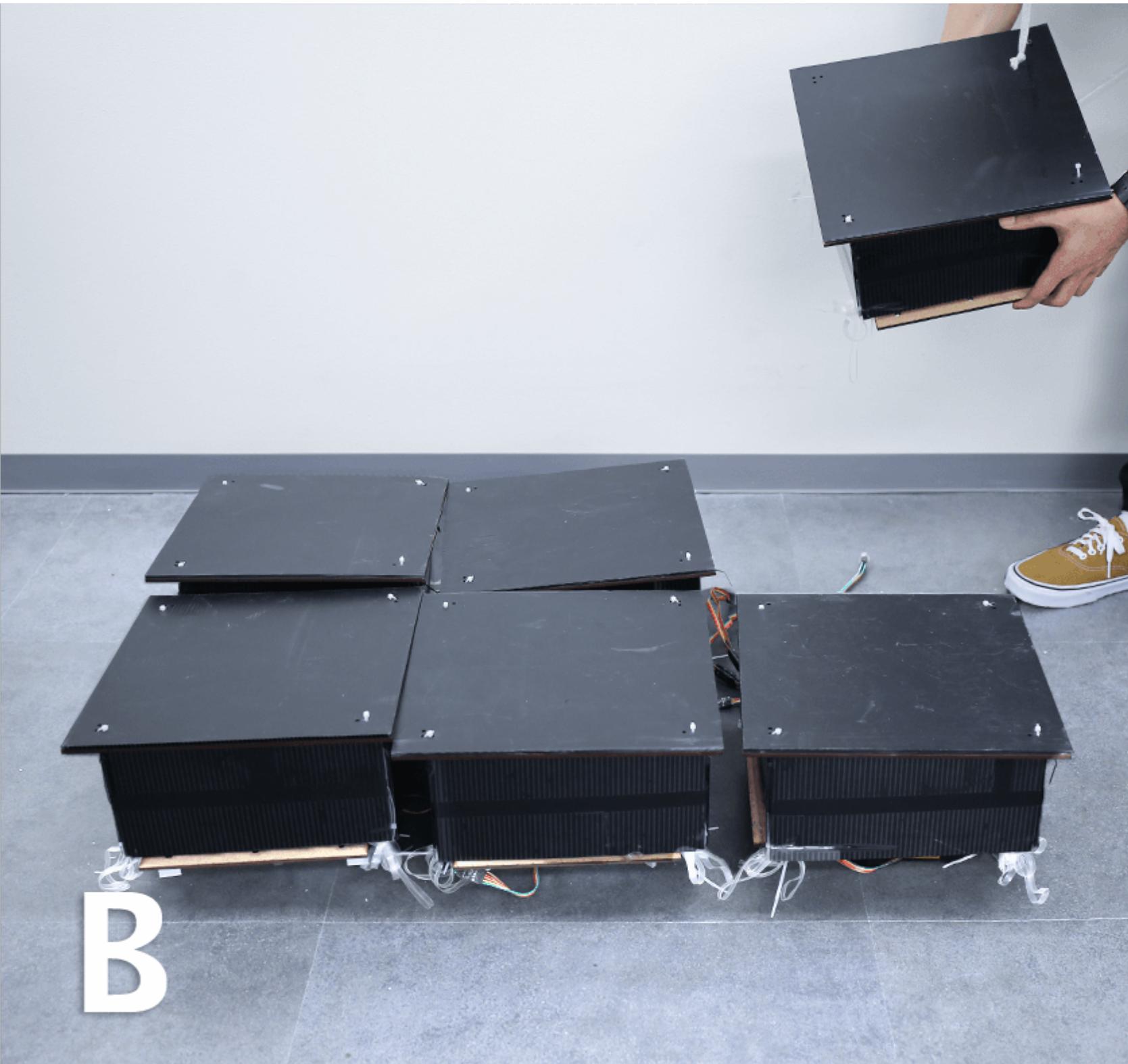


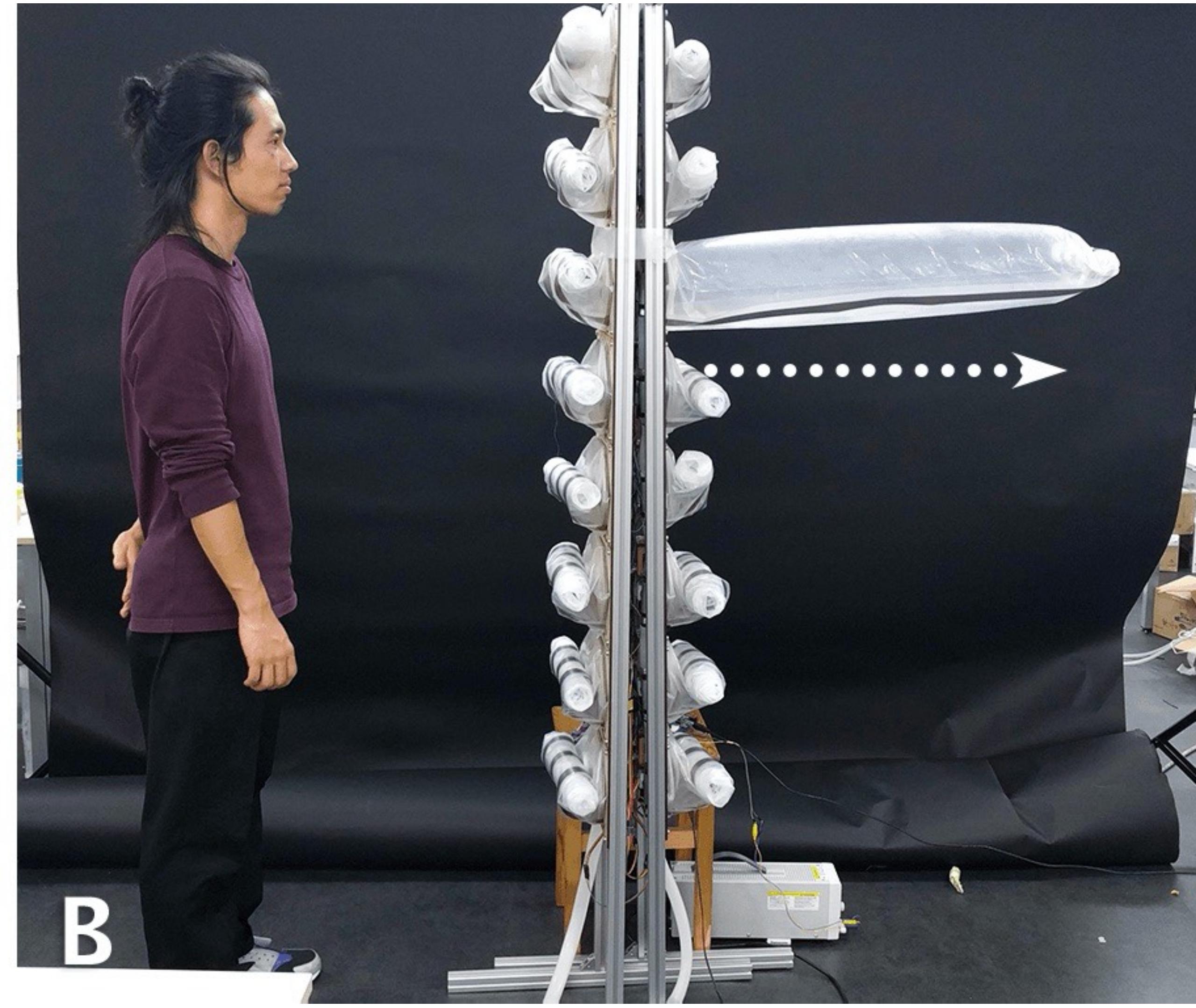
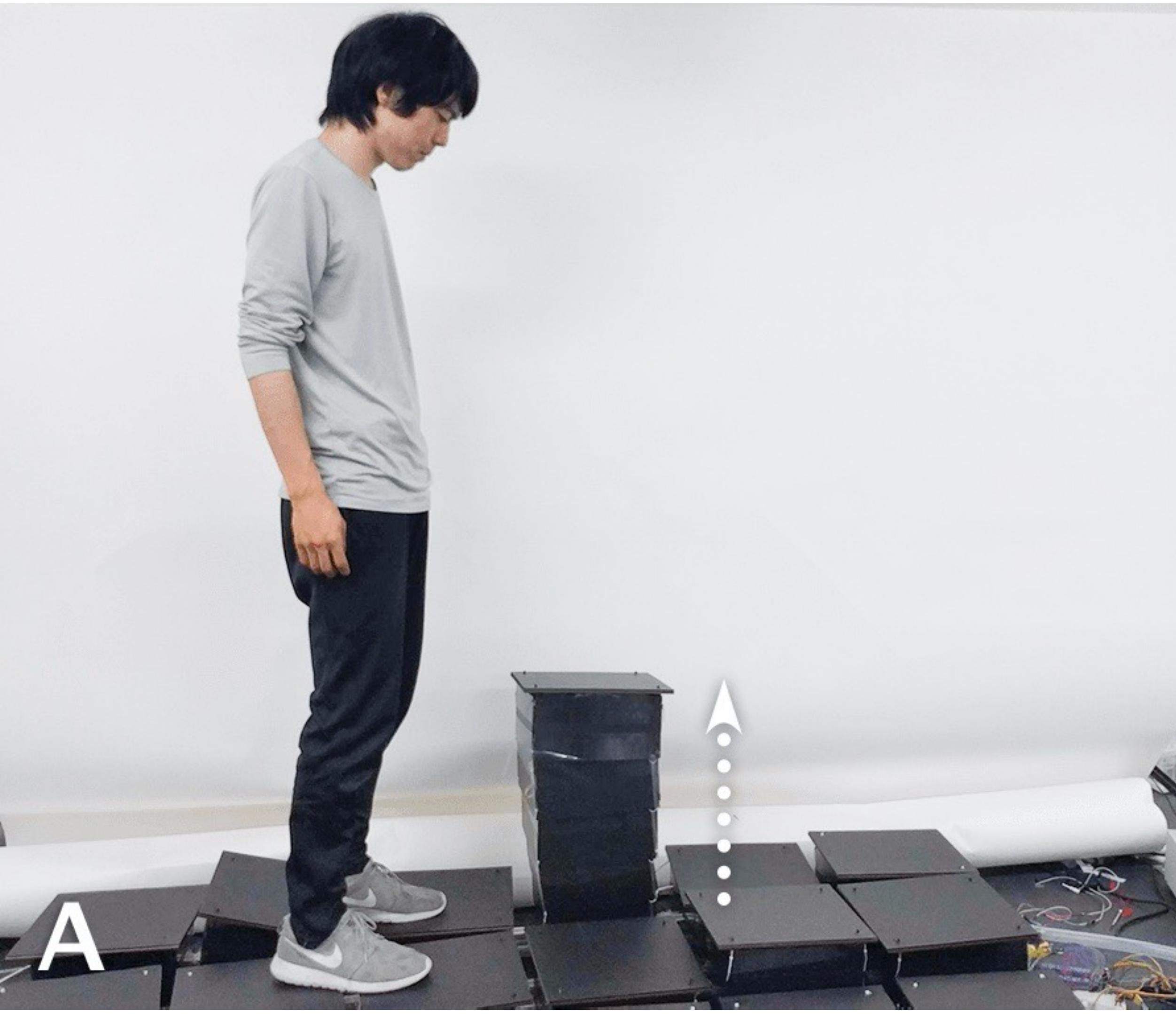
Extend: 16 sec  
Retract: 4 sec

x1

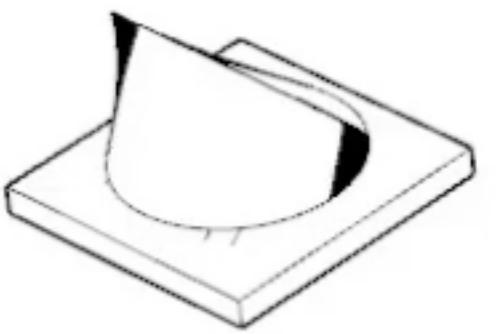
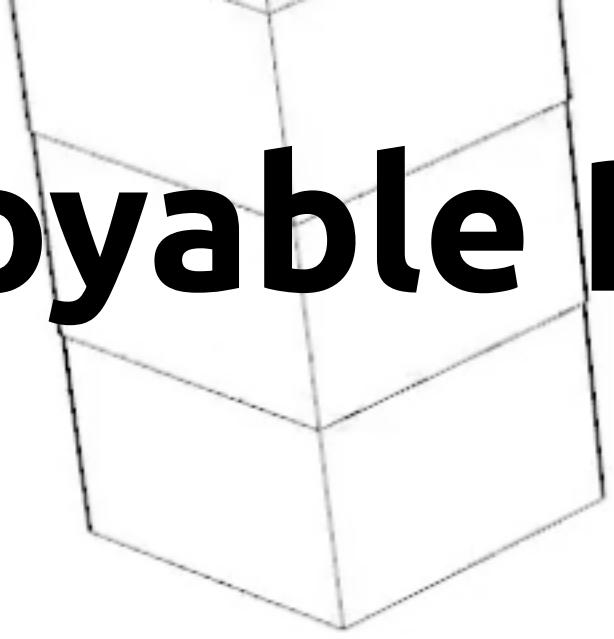
# Inflatable Actuator



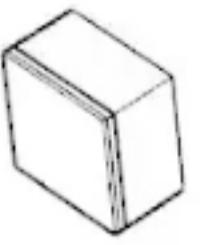




# Deployable Room-scale Shape Display



# Shape-changing Walls



1. Summary
2. Related Work
3. LiftTiles: System and Implementation

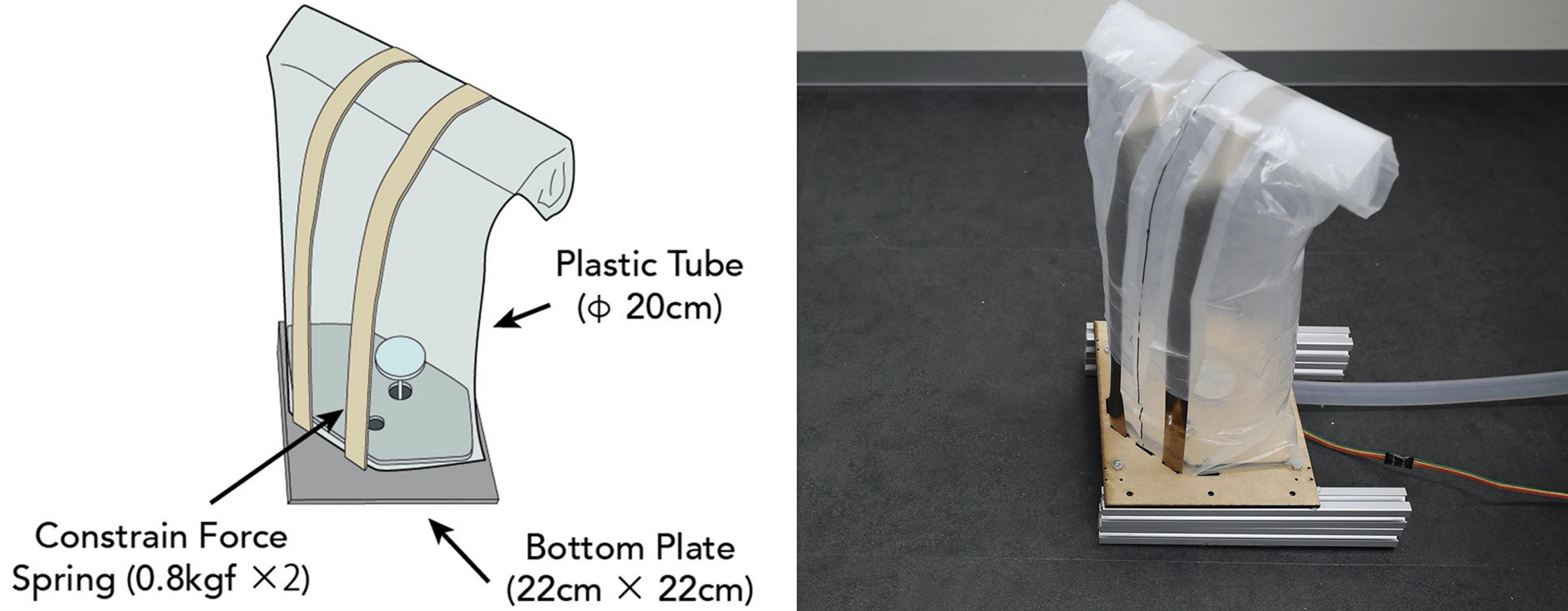
## 4. Conclusion

# Contribution



A concept of **modular constructive building blocks** as more **accessible prototyping tools** for room-scale shape-changing interfaces

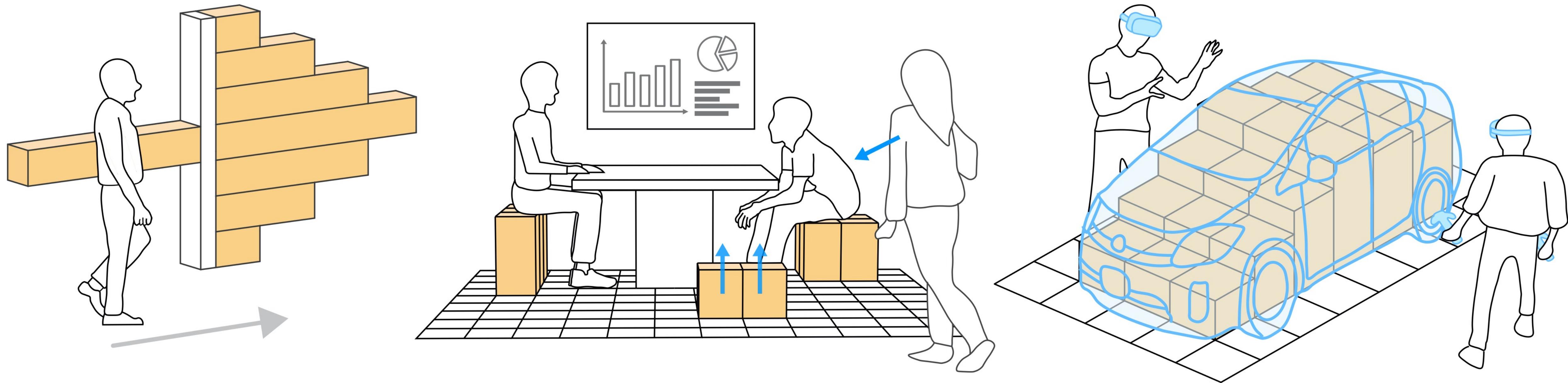
# Contribution



## Novel large-scale inflatable actuators

that are light (10 kg), low-cost (8 USD), large footprints (30cm x 30cm), and compact (15ccm) yet highly extendable (x10).

# Contribution



**Prototyping application scenarios**, such as adaptive floor, shape-changing wall displays, and haptic environments for VR



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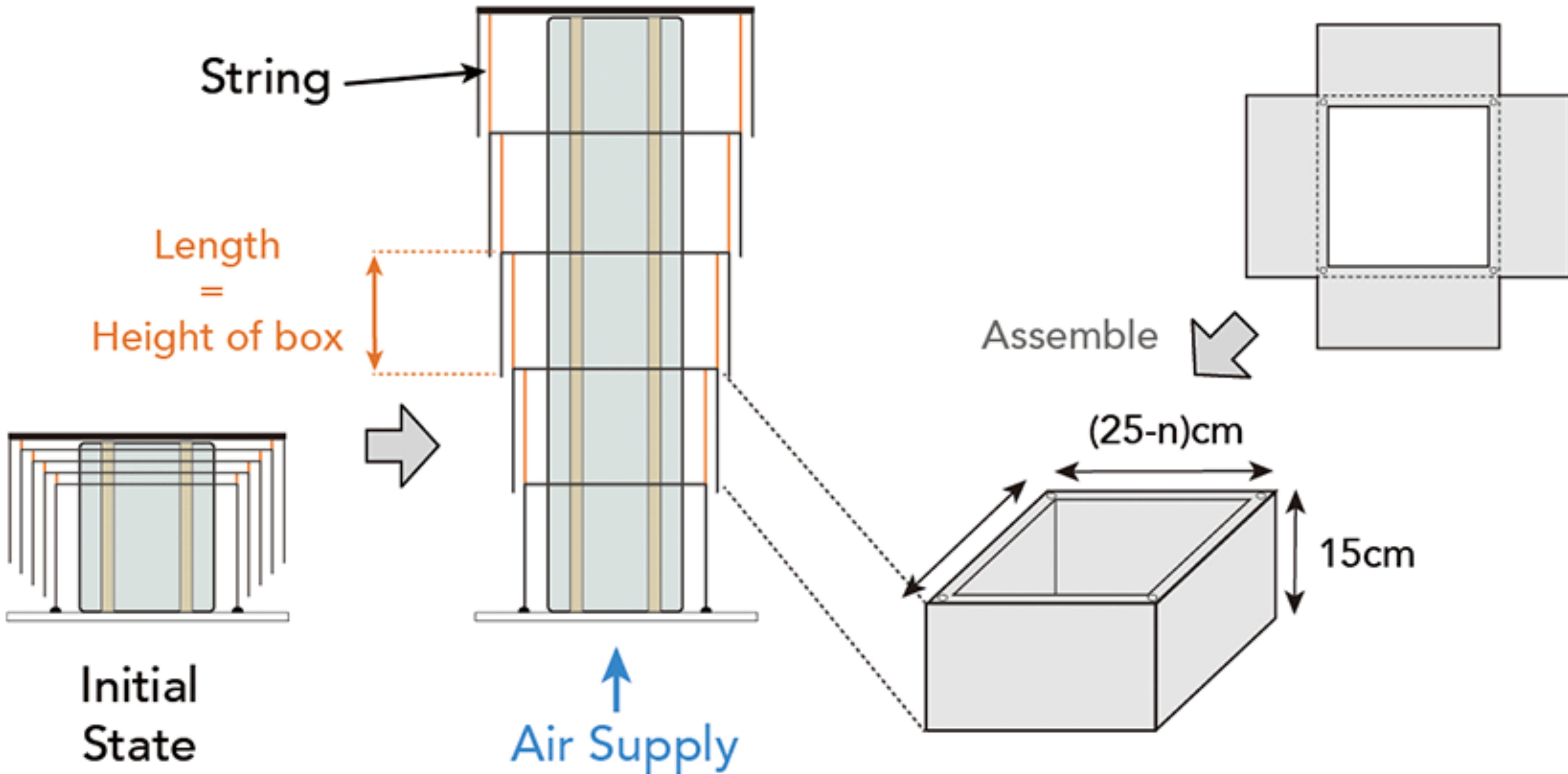
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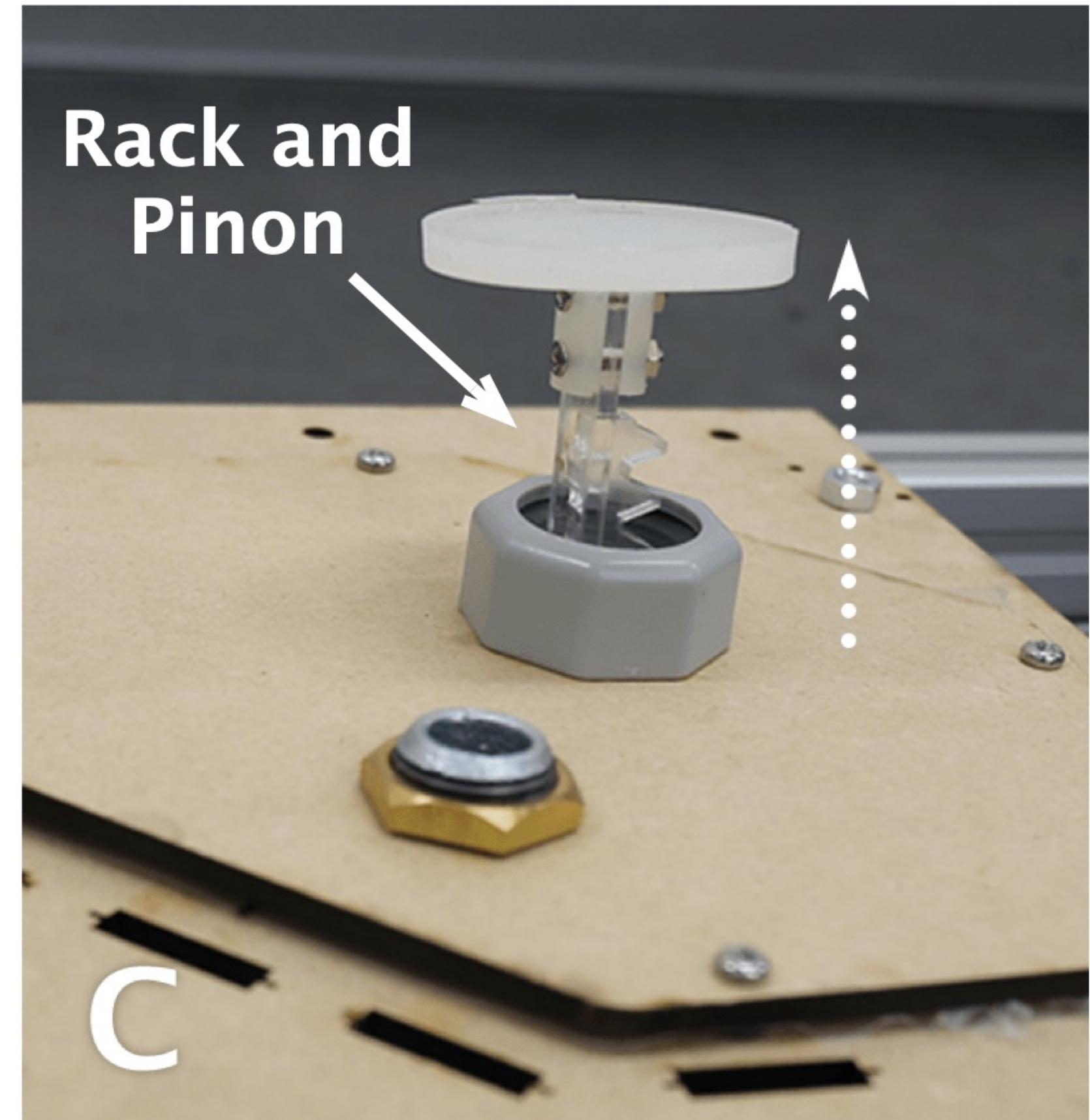
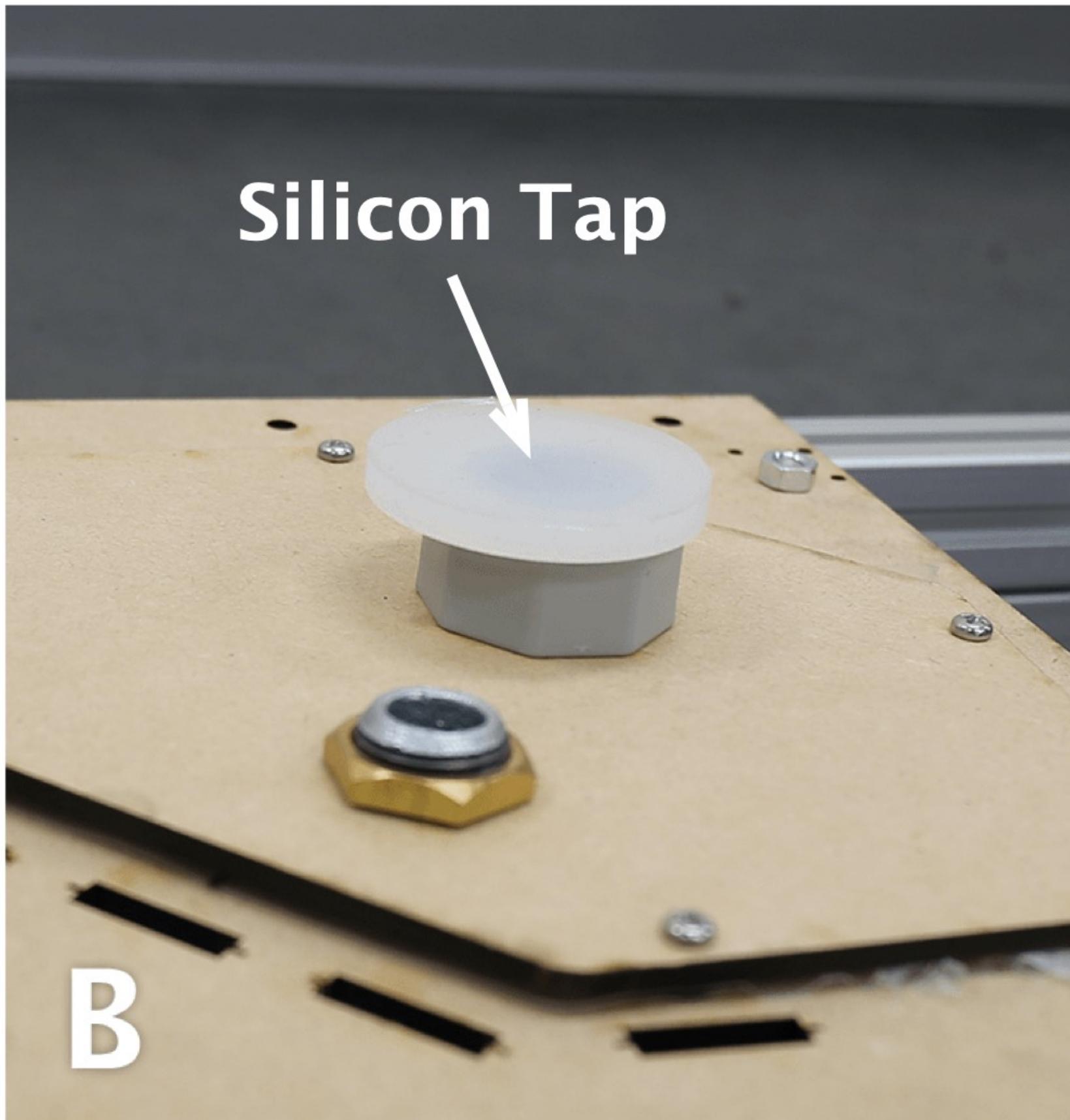
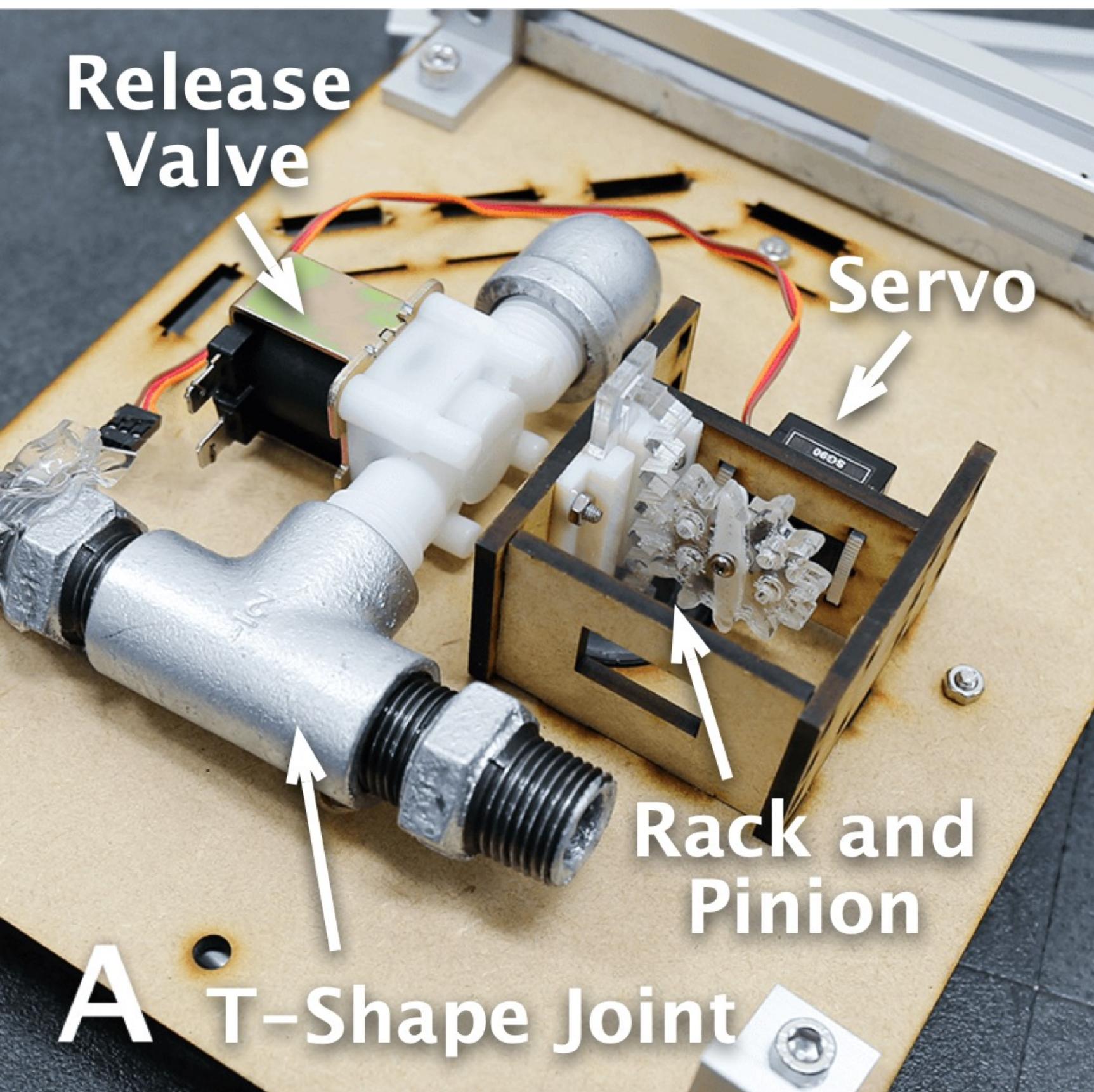
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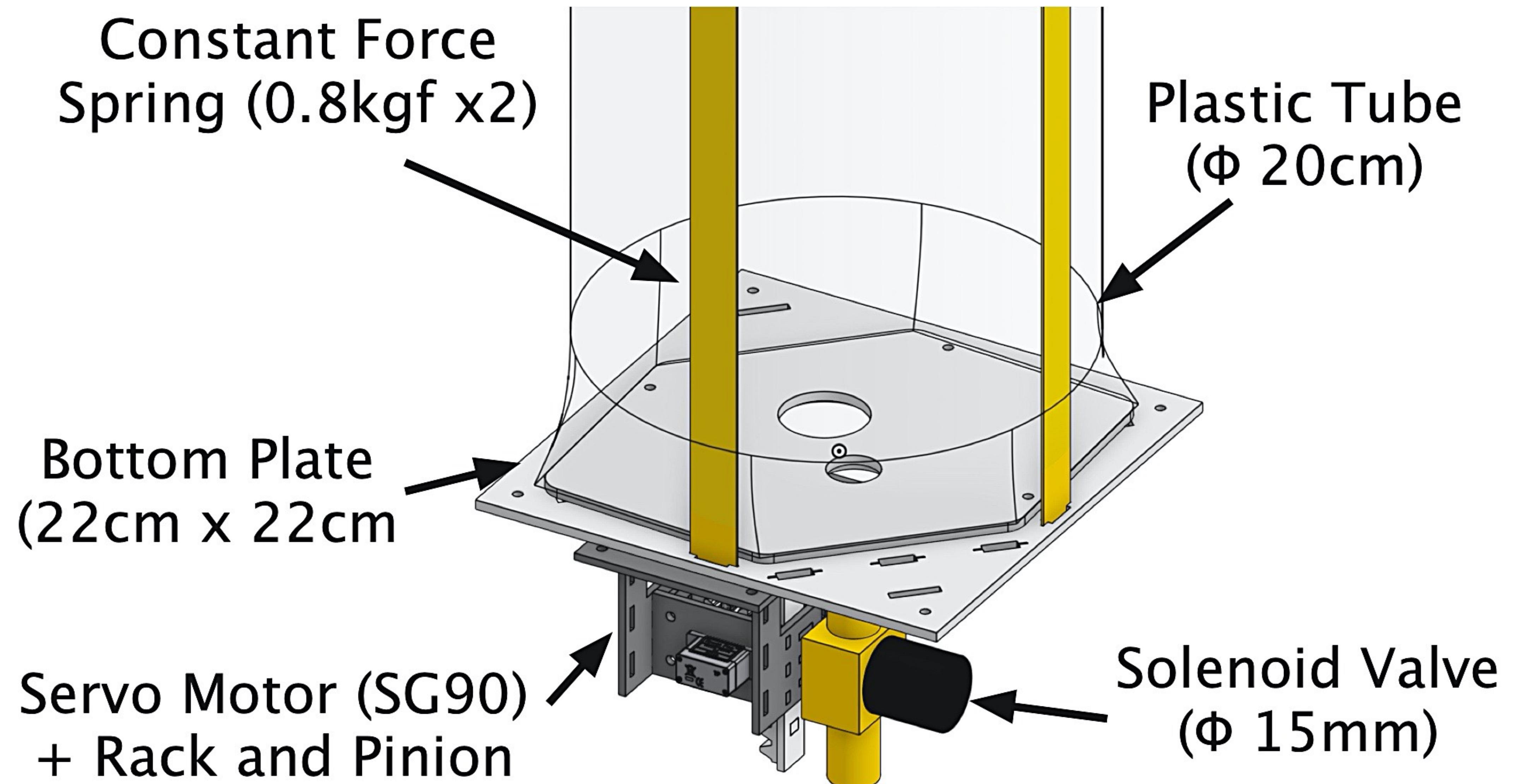


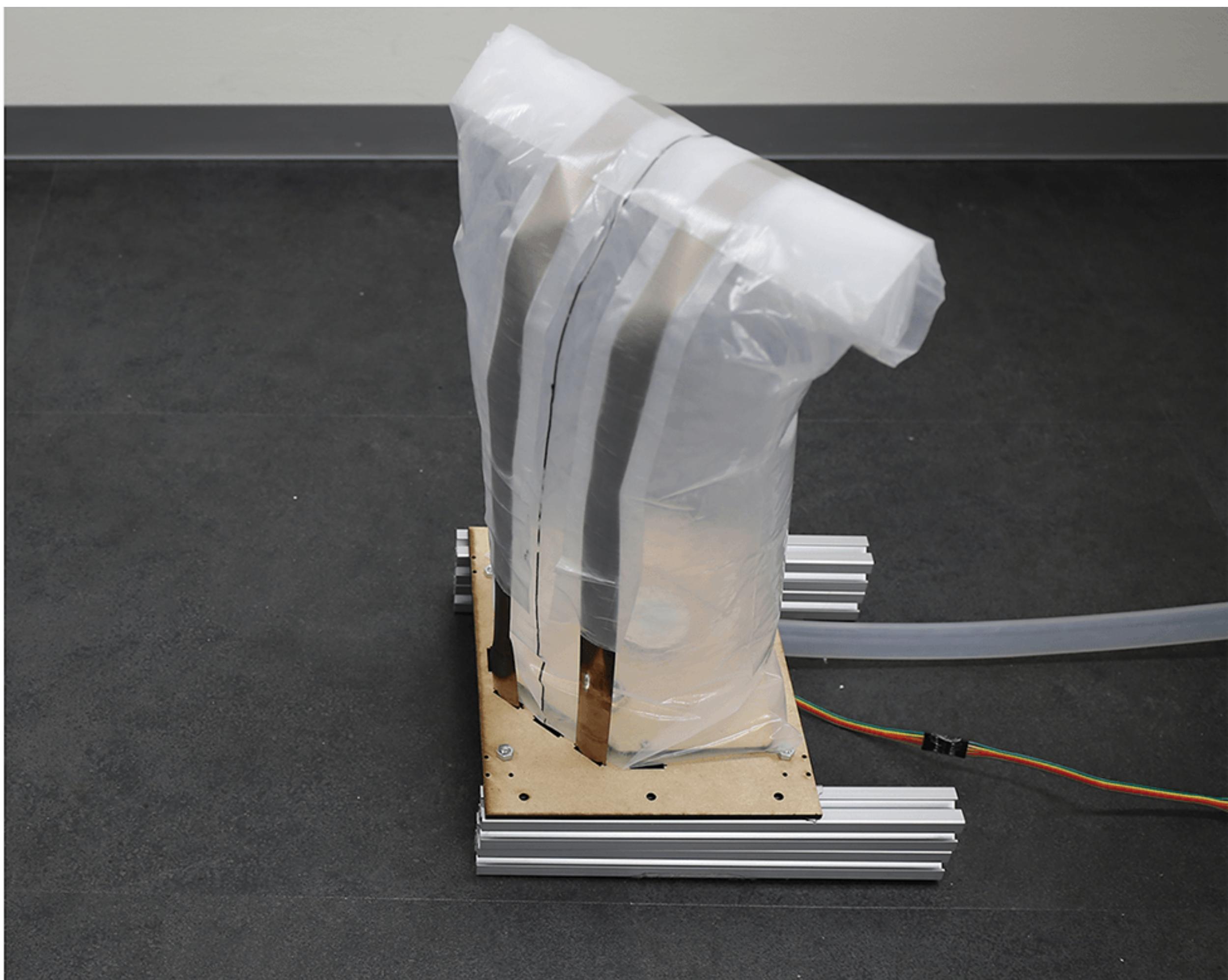
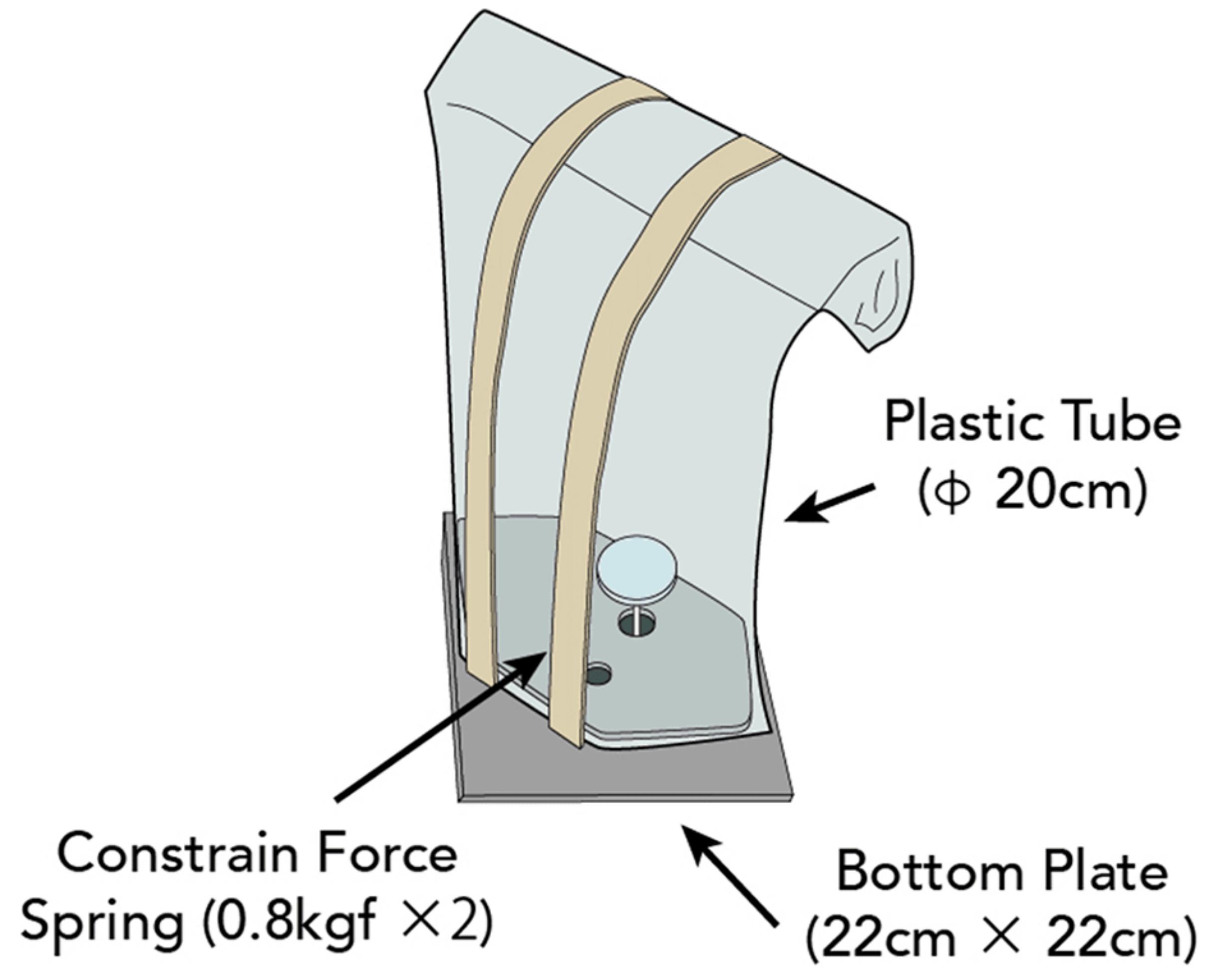
# **Additional Slides**



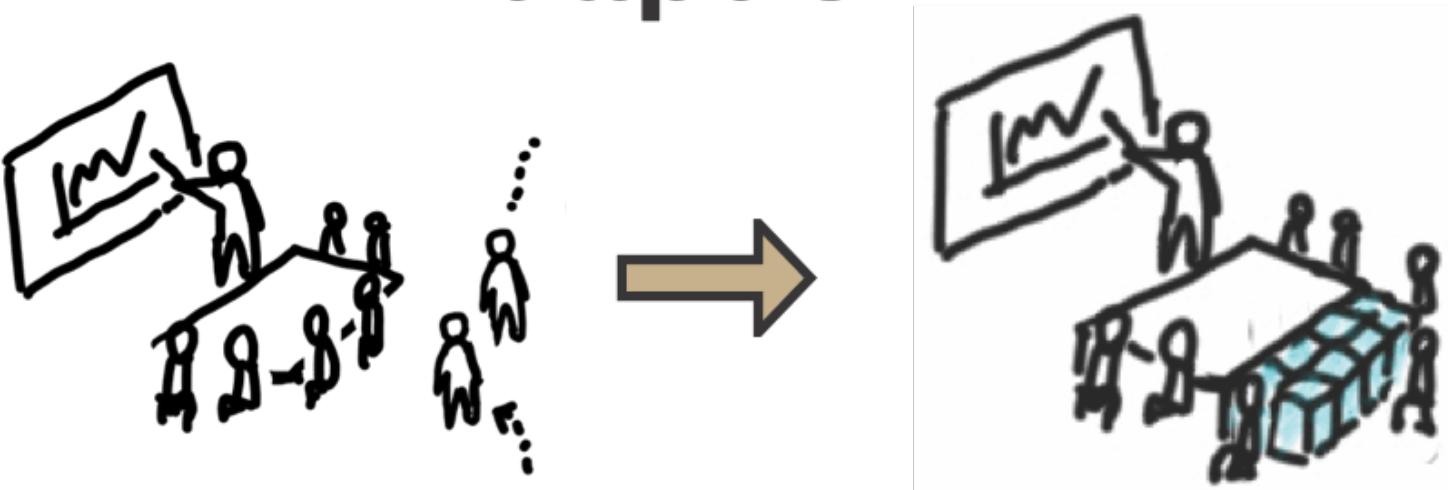




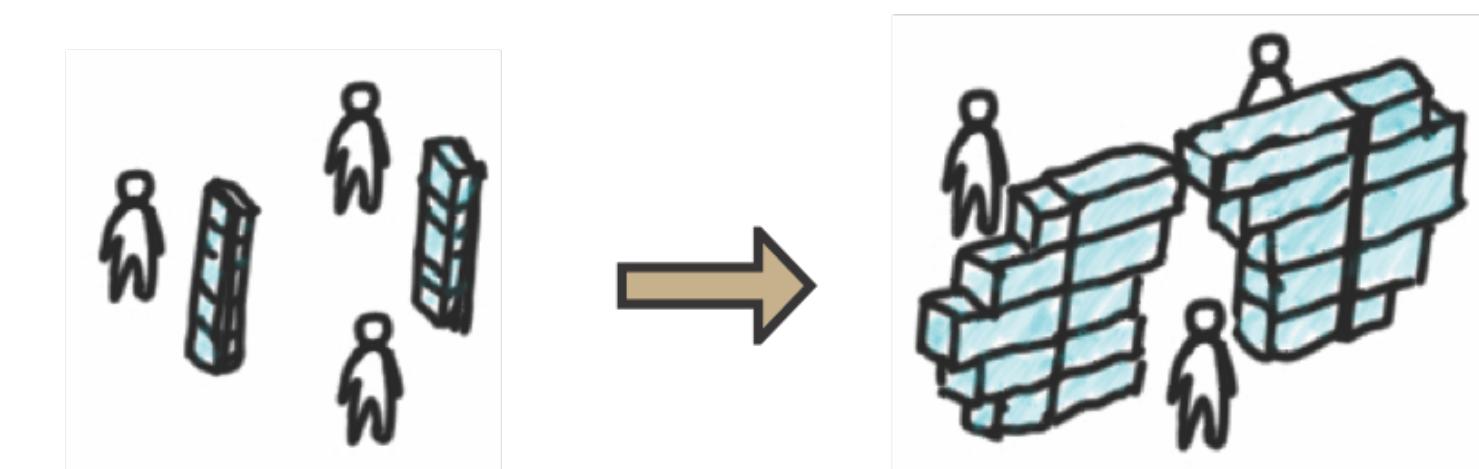




## Adaption

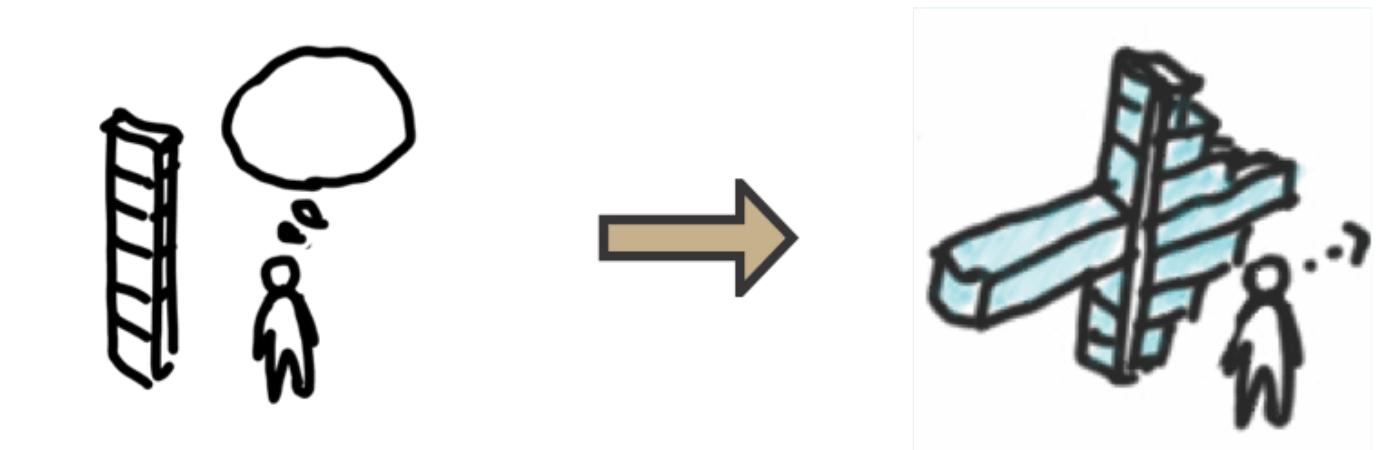


on-demand chair and table

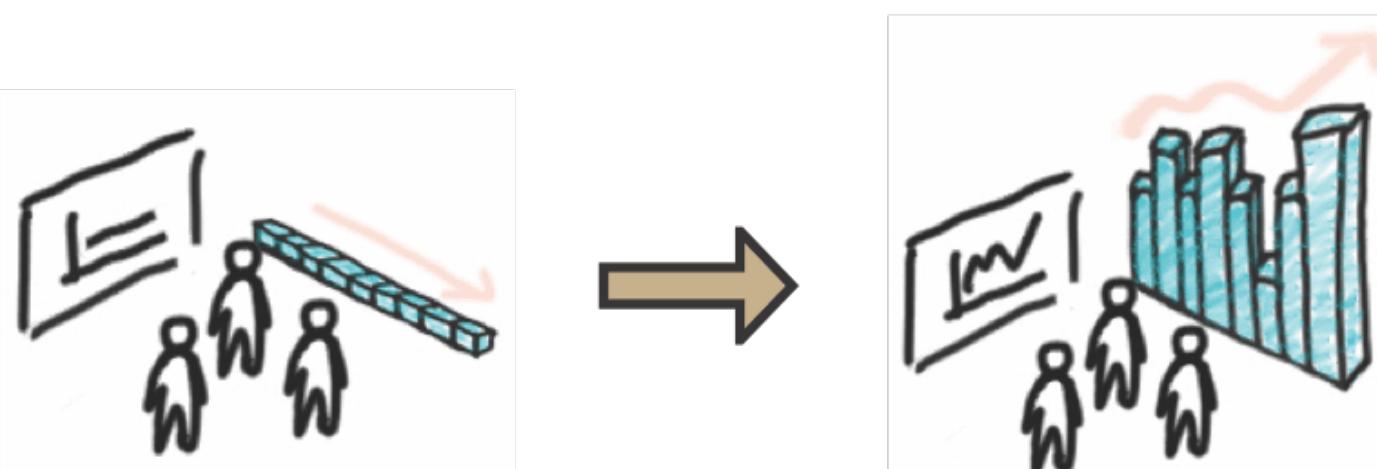


situated space separation

## Display

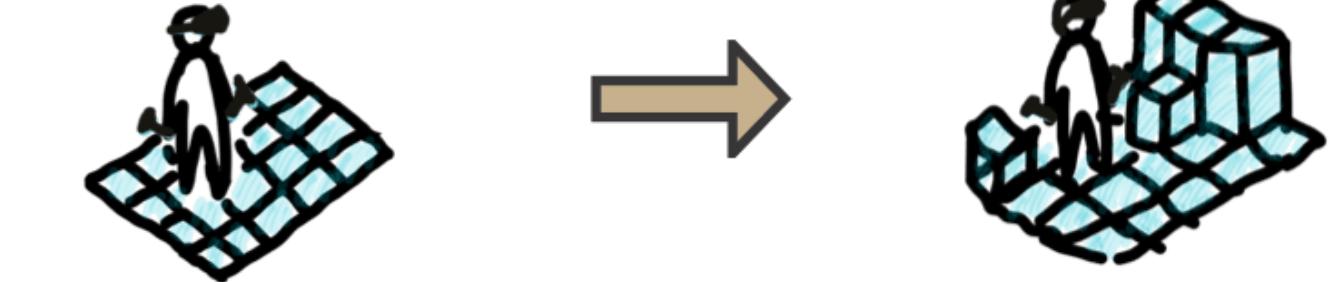


public signage

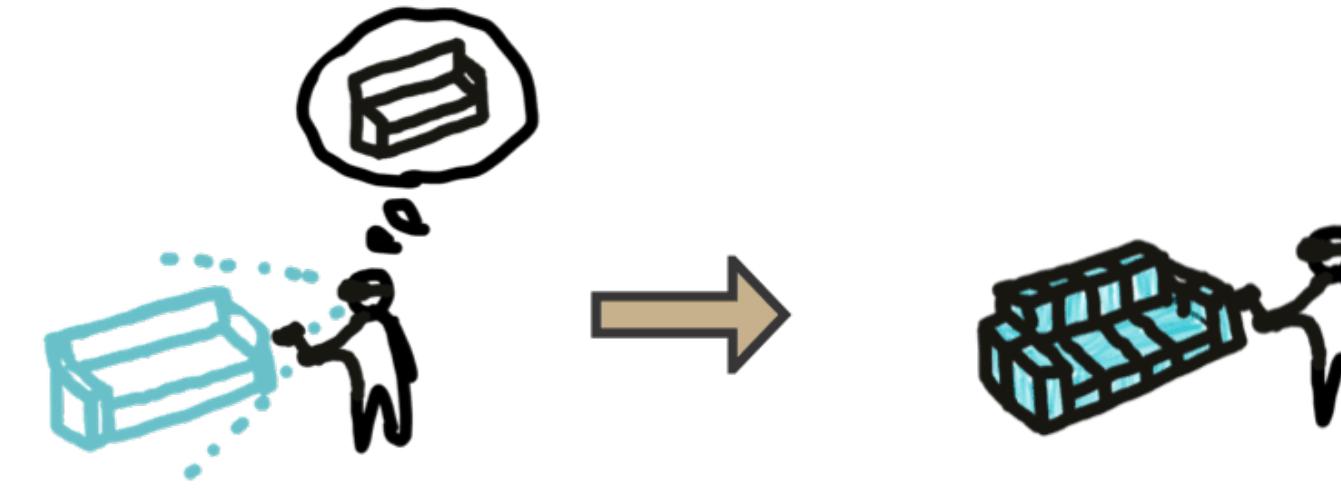


dynamic data physicalization

## Haptics



haptics for VR



furniture design with AR/VR

