Threa-D Printing Tunable Bistable Mechanisms

UNIVERSITY OF COPENHAGEN

ATHINA PANOTOPOULOU[1], VALKYRIE SAVAGE[1], DANIEL LEE ASHBROOK[1]

[1]HUMAN CENTRED COMPUTING, DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY OF COPENHAGEN

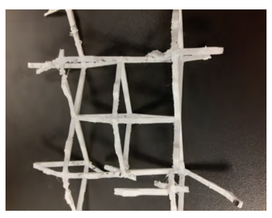
SCF 2024
Aarhus 7-10 July

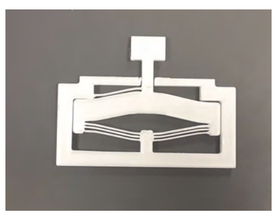
Problem

Creating artifacts with integrated functionality is challenging for hobbyists, because:

- Thin flexible elements, i.e., **flexures**, do not scale well.
- They are not easily and richly **modifiable**.

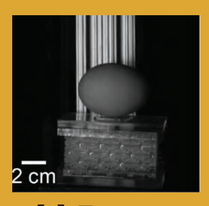
We introduce versatile post-fabrication tuning to robust bistable mechanisms using **threads** and **sliders**.
We discuss the fulfillment of various **motion**, **size**, and **stiffness** requirements.



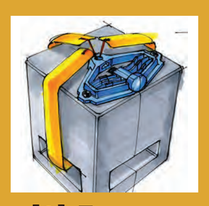


Background

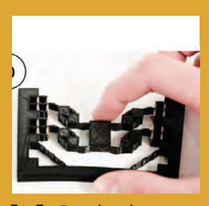
Bistable mechanisms have two positions where no input energy is required to maintain them.



[1] Energy Absorption



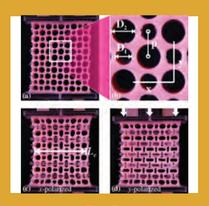
[2] Energy Release



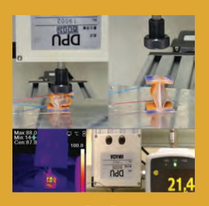
[3] Switches

[4] Signal Propagation

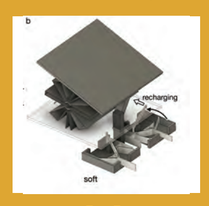
Tunable mechanisms are modifiable post-fabrication.



[5]



[6]



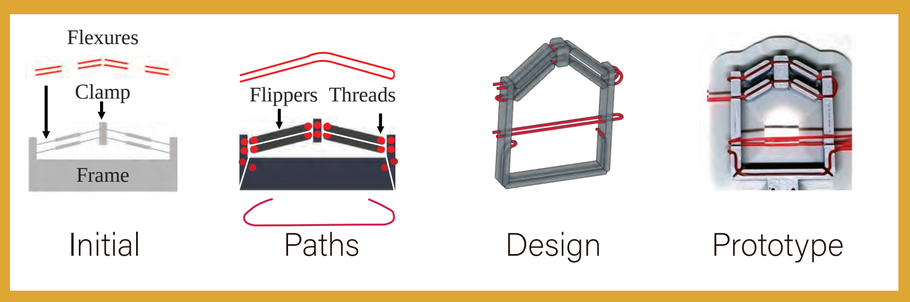
[7]

[8]

Goal: Tuning Versatility and Accessibility

Approach

Threads and **sliders** allow robust functioning in different sizes, and affordable, quick, and versatile tuning



Initial | Paths | Design | Prototype

References

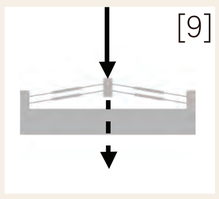
[1] Shan et al., 2015
[2] Zirbel et al., 2016
[3] Gong et al., 2021
[4] Ion et al., 2017
[5] Florijn et al., 2014
[6] Tokuda et al., 2023
[7] Jiang et al., 2023
[8] Yang et al., 2022
[9] Zirbel et al., 2016
[10] Merkle et al., 2018
[11] Follador et al., 2015
[12] Pan et al., 2022

[Info] https://atpanot.bitbucket.io/

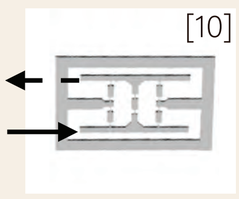
Requirements

- **Motion**

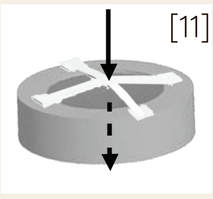
Existing Designs



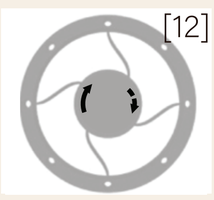
[9]



[10]



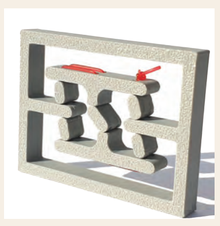
[11]



[12]

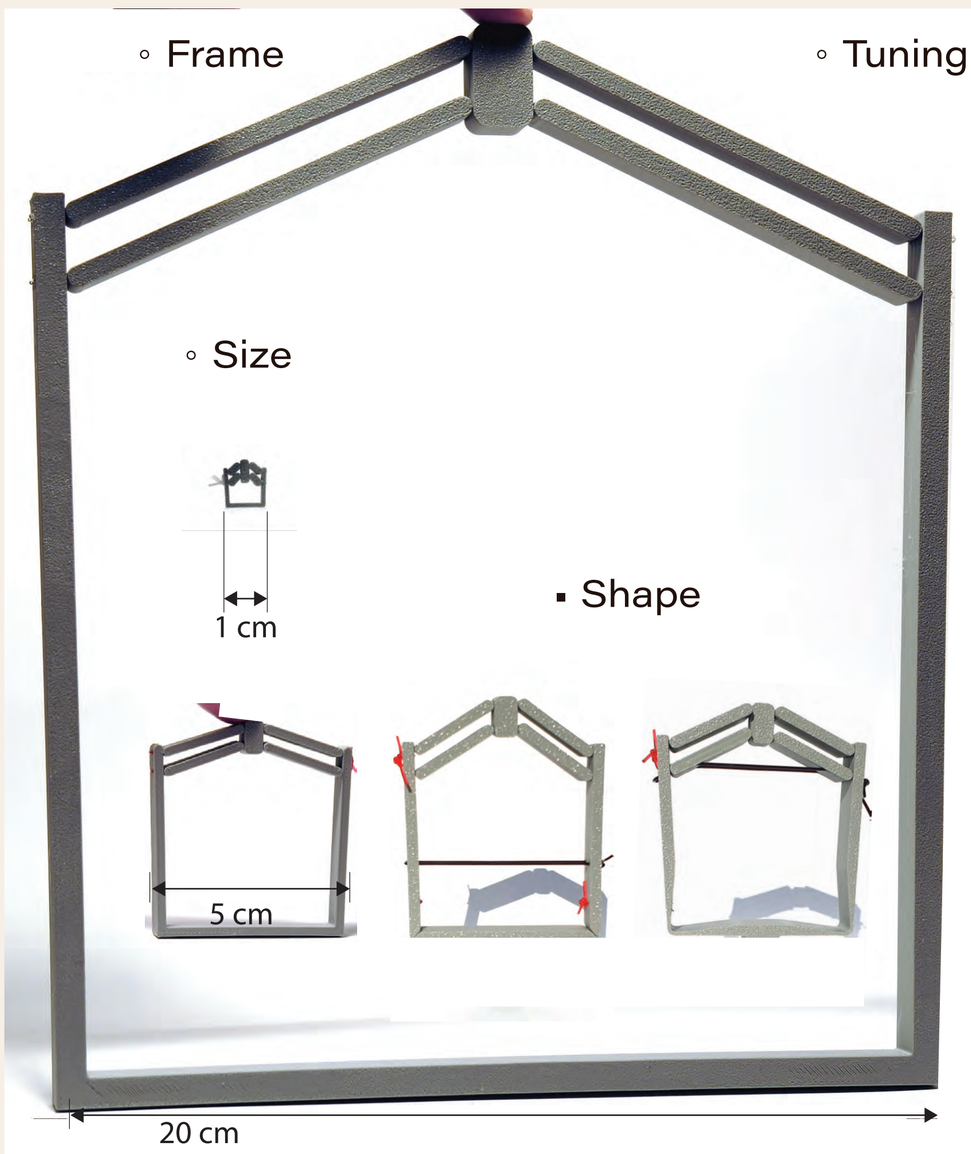
- **Robustness**

Threaded Designs



- **Stiffness**

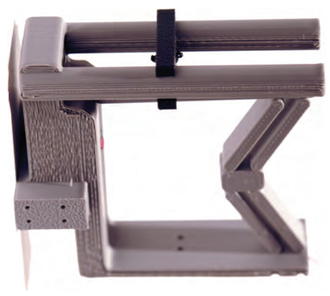
◦ **Frame**



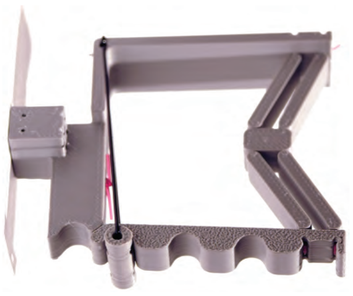
◦ **Size**

▪ **Shape**

◦ **Tuning**



Continuous Levels



Discrete Levels

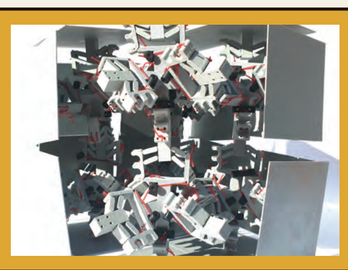
Reset/Monostability

Compositions

Metamaterial

Dial

Switch



Discussion

\+

- Hobbyist machinery
- Adaptation for various requirements
- Functionality tuning

\-

- Manual design and fabrication
- Lack of synchronization
- Out-of-plane motion
- Friction