ME 420
Sustainable Technology

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Mechanical Design and Production

- All engineering studies base their goal in creation.
- In mechanical engineering and specifically in the orientation of Design and Production (Conception et Production), the focus lies in the scientific and practical approach
- To address the design process that include creating the models, setting up experiments, analyzing, evaluating hypothesis and results.
- To introduce, in production and manufacturing, the physics, limitations, optimization of bringing actual issues involved with design solutions.

New “Mechanical” Engineering Criteria

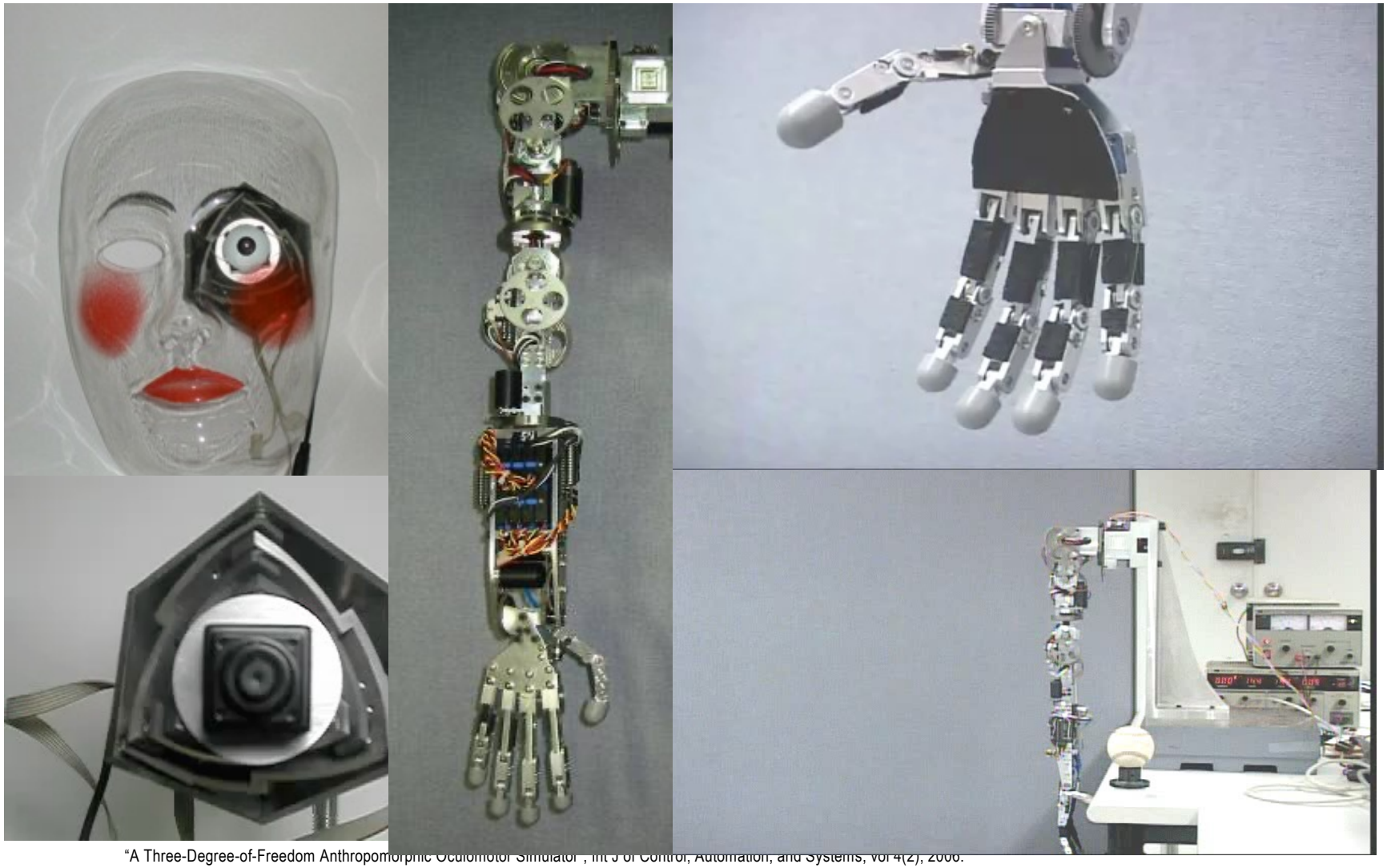
industrial environment → **real-world environment**

- Highly predictable
- Programmable

Augmented performance : force, speed, precision

- Highly unpredictable
- Random tasks and uncertainties

Augmented interactivity : Conformity, Reconfigurability, Safety

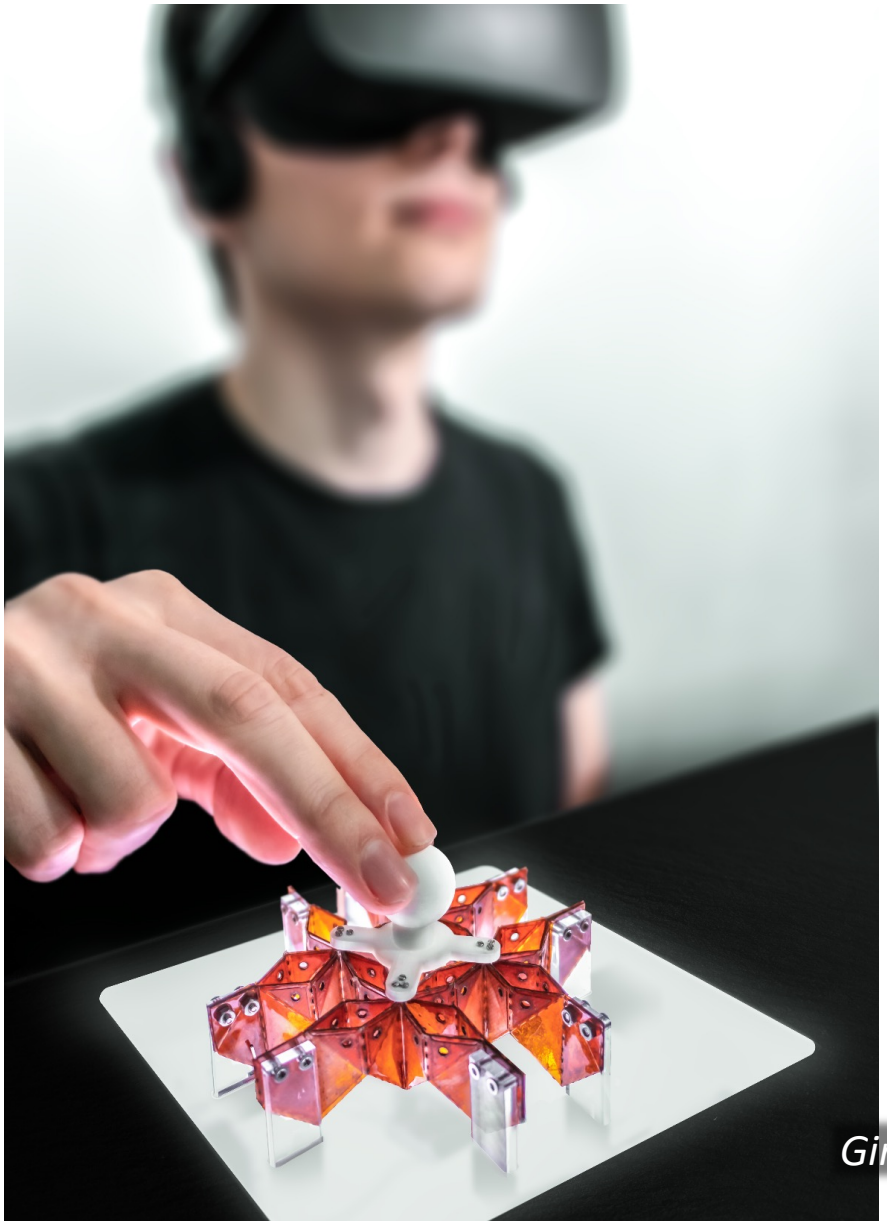


"A Three-Degree-of-Freedom Anthropomorphic Oculomotor Simulator", Int J of Control, Automation, and Systems, vol 4(2), 2006.
"Experimental Evaluation of Several Strategies for Human Motion Based Transparency Control", Trans. in Advanced Robotics,Vol 54, 2009.
"How Can Human Motion Prediction Increase Transparency?" ICRA 2008.
"Design and Acceptability Assessment of a New Reversible Orthosis" IROS 2008.
"Anthropomorphic Robot Arm and Hand for Interactive Humanoids", J of Bionic Engineering, 9(2), 2012.
"Motion Teaching Method for Complex Robot Links Using Motor Current", Int J of Control, Automation, and Systems, 8 (5), 2010.

A. Behrman et al (2000)

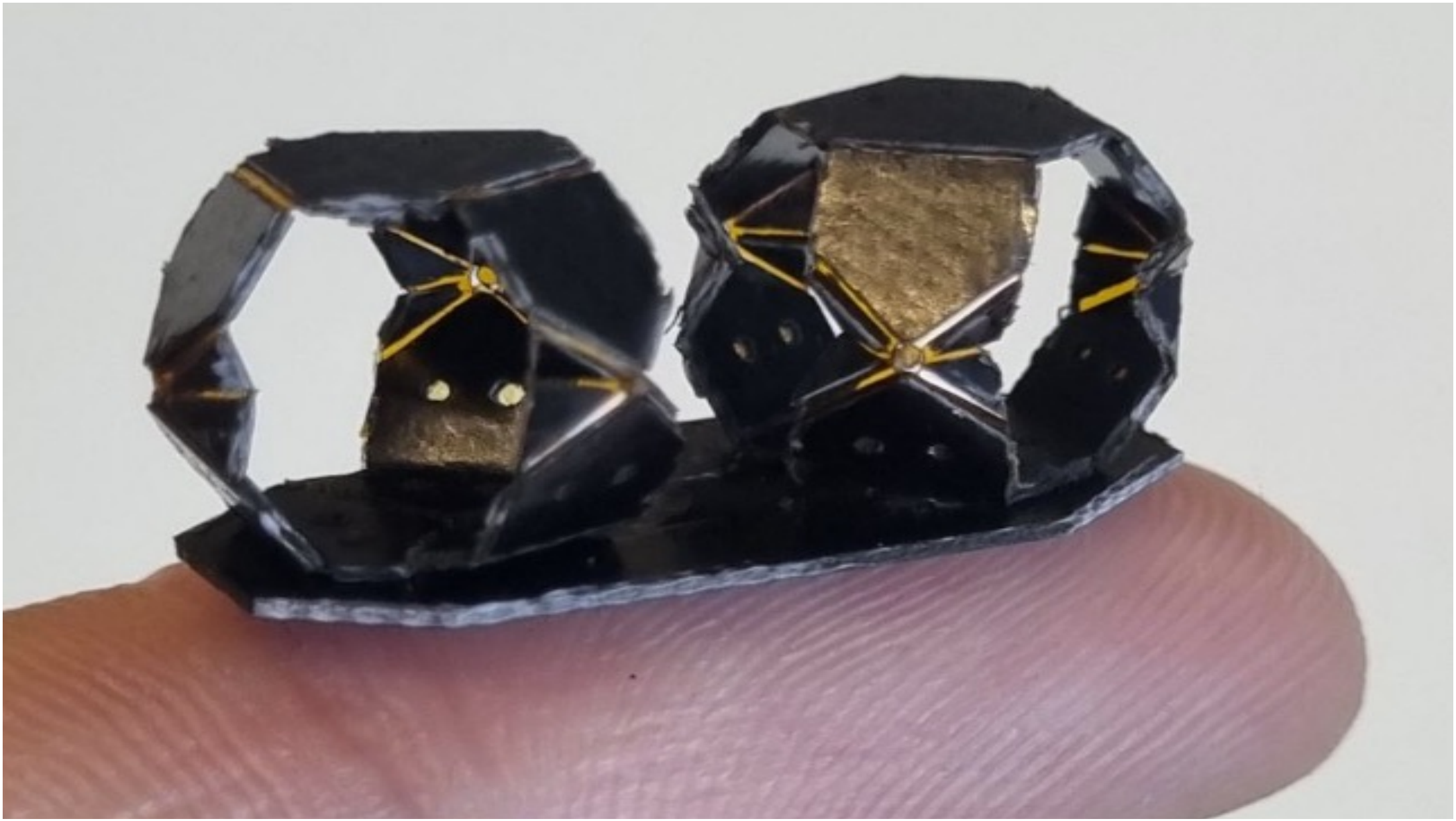
Project motivation

- We live in the fast paced environment that demands interactive technology that can blend effortlessly into our lives
- Light, conforming, dynamic and interactive technologies are the key physical attributes for a product to be closer to the users.
- We also need them to be sustainable! (not just in scope 1 and 3)



Scalable platform for modulable interactions

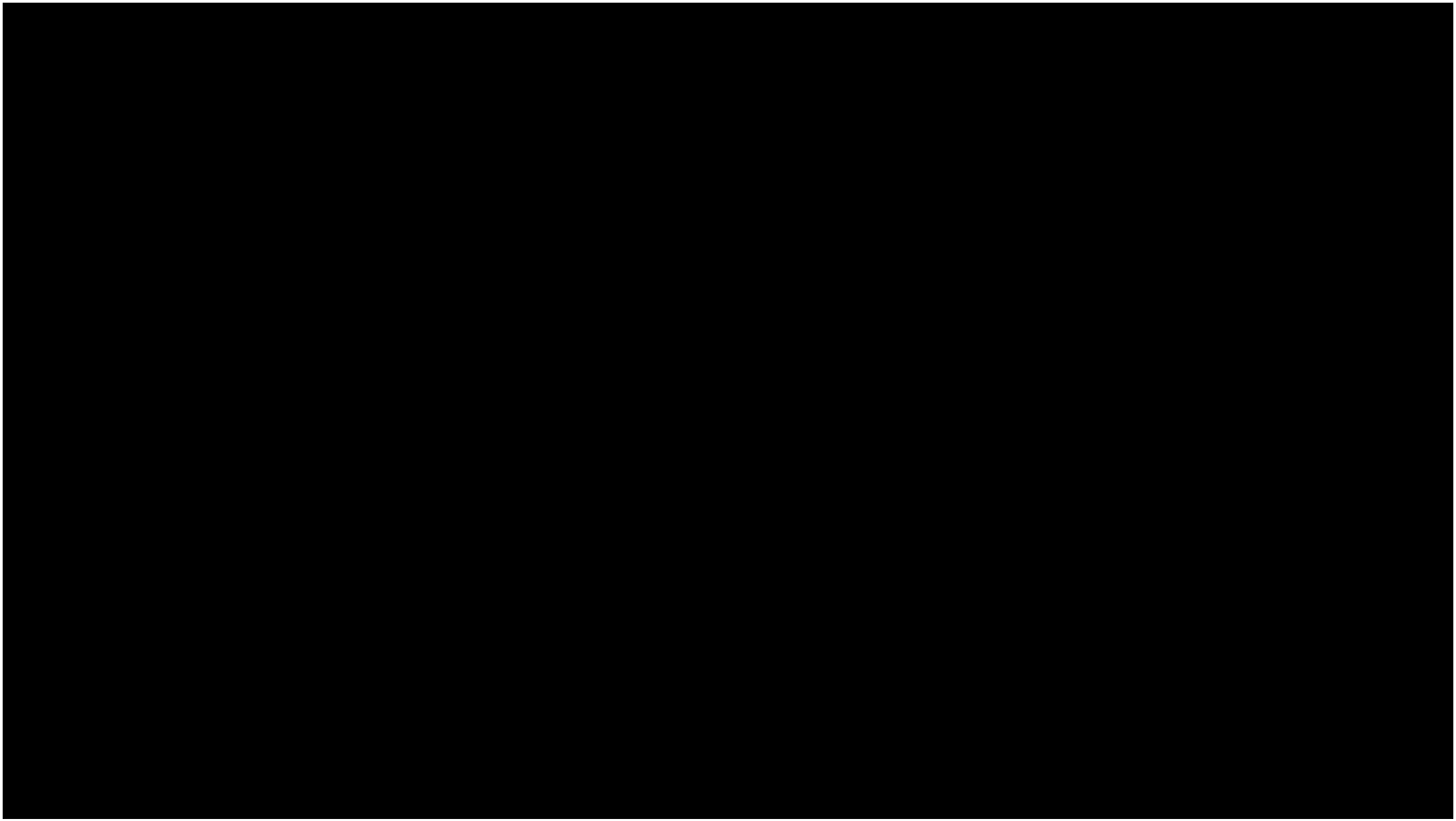
Giraud, Mete & Paik, ***Advanced Intelligent Systems***, Cover Page (2022)



Salerno, Mintchev & Paik, ***IEEE Haptics Symposium*** *Best Demo Award (2018)*

Nature Machine Intelligence *Cover Page, (2019)*

IEEE RA-L *(2020)*

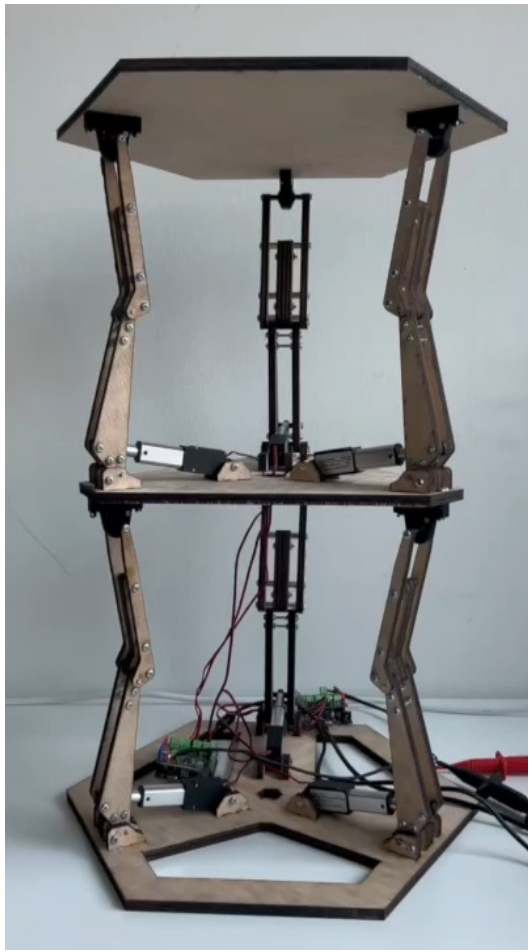


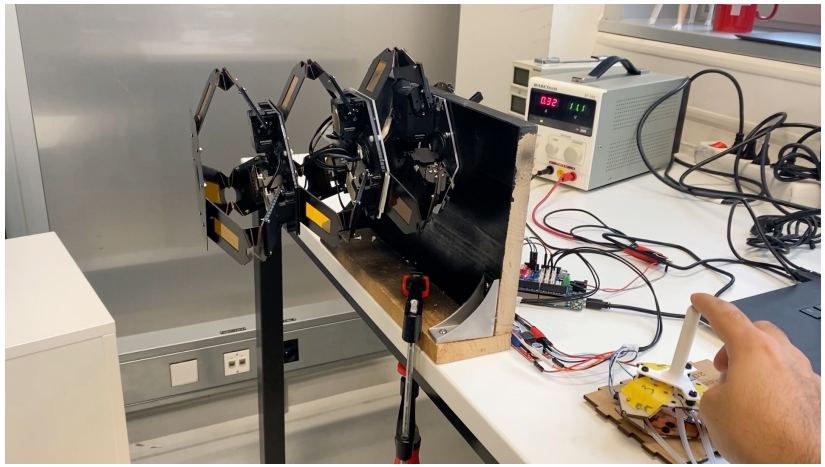
Scaling up workspace via distribution

AVTR, Mercedez-Benz @ ***CES 2020***

FOLDAWAY haptics

Scaling up workspace via assembly





Mete, Huang & Paik, **RoboSoft** (2023)
Mete & Paik, **RA-L** (2021)

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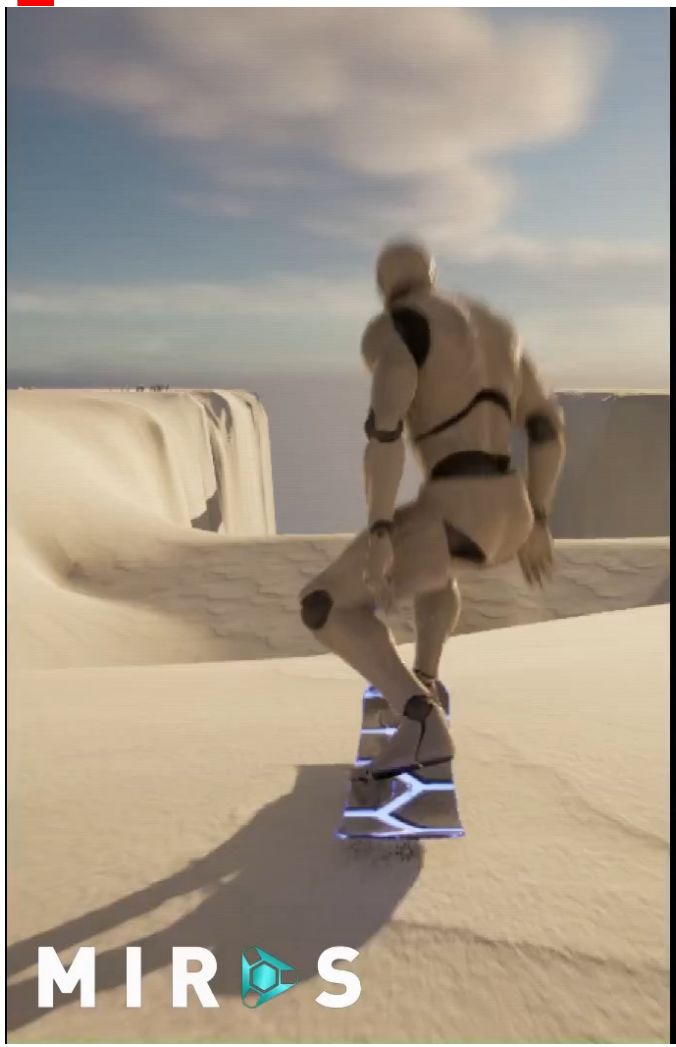
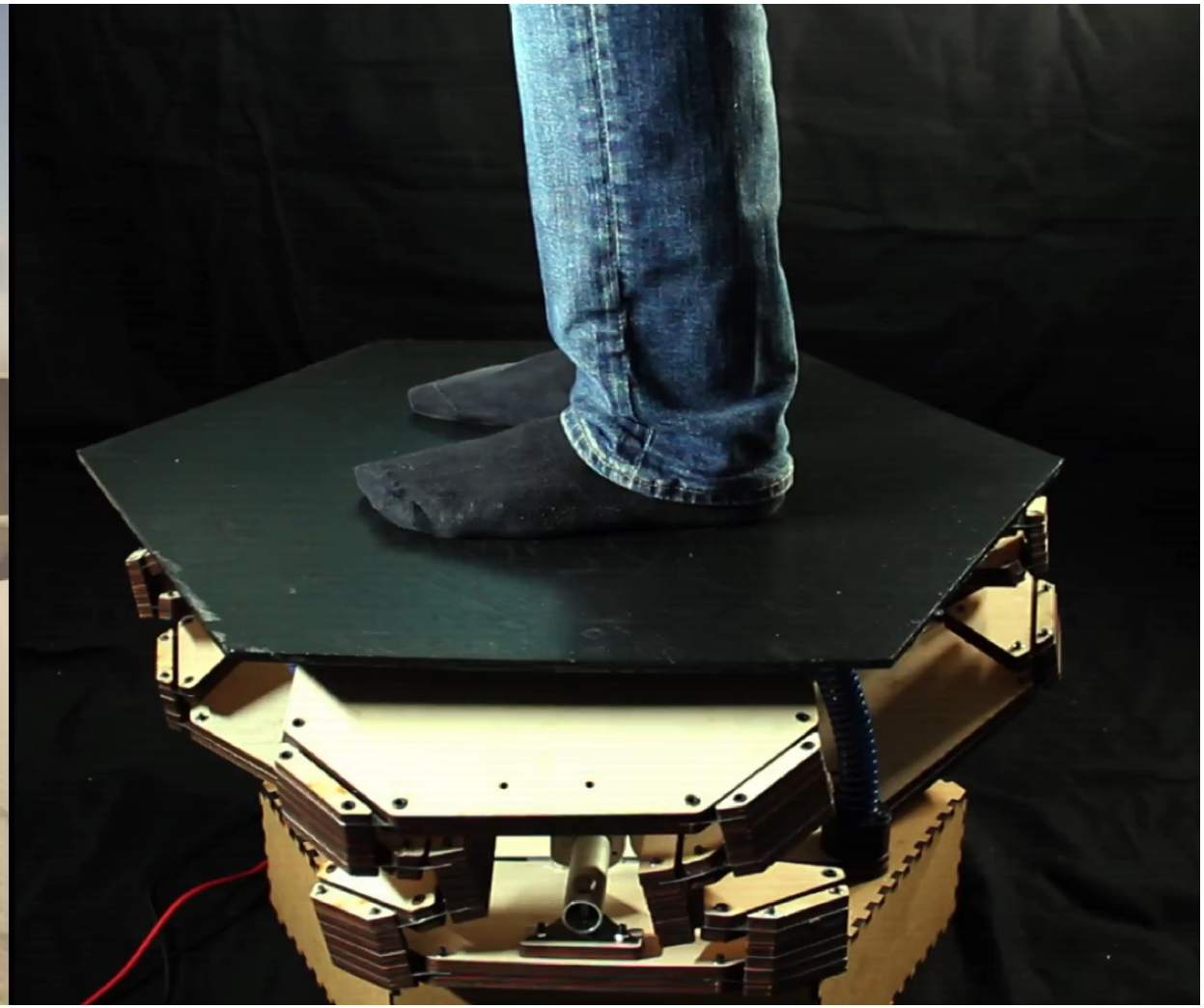
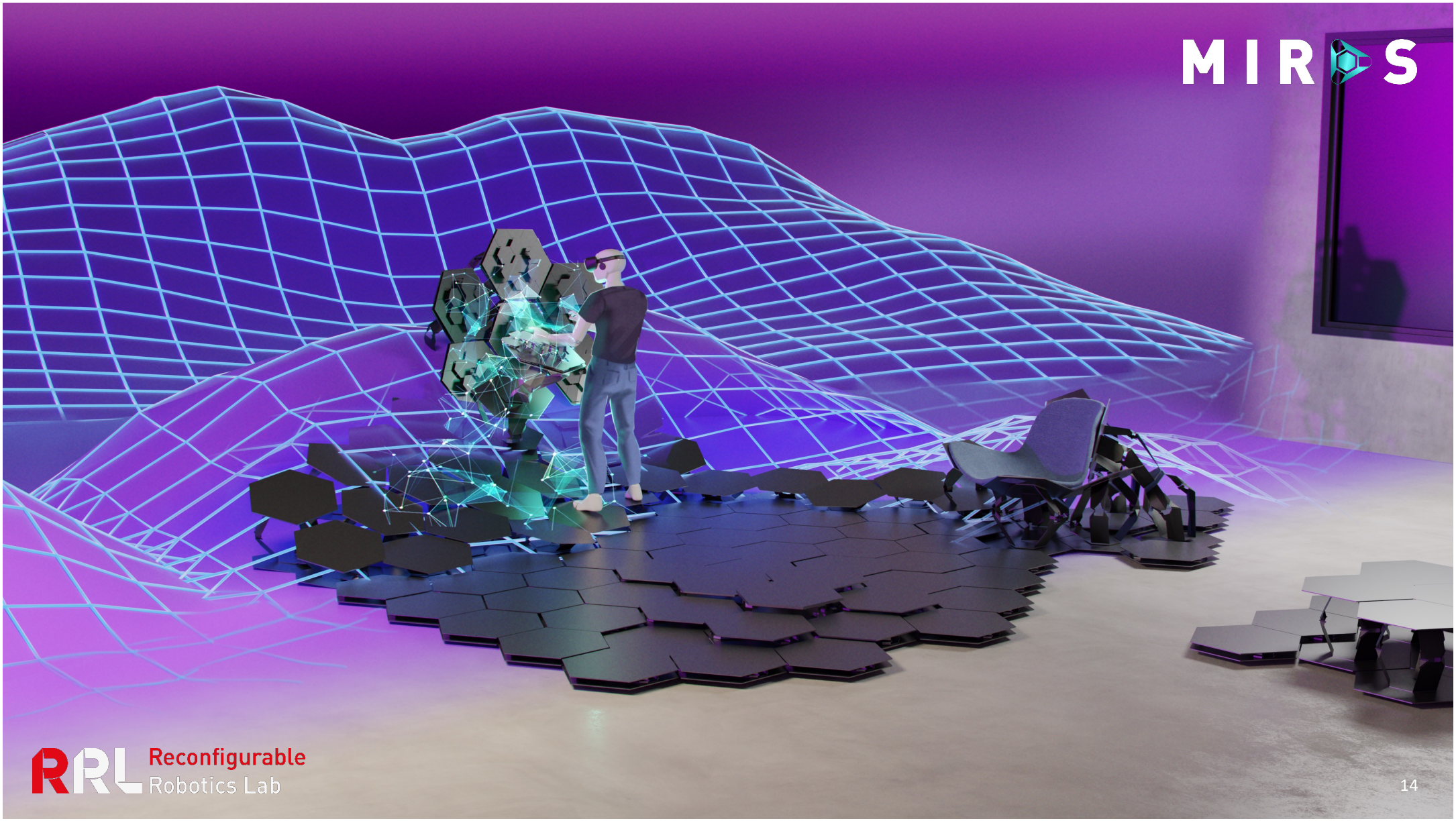






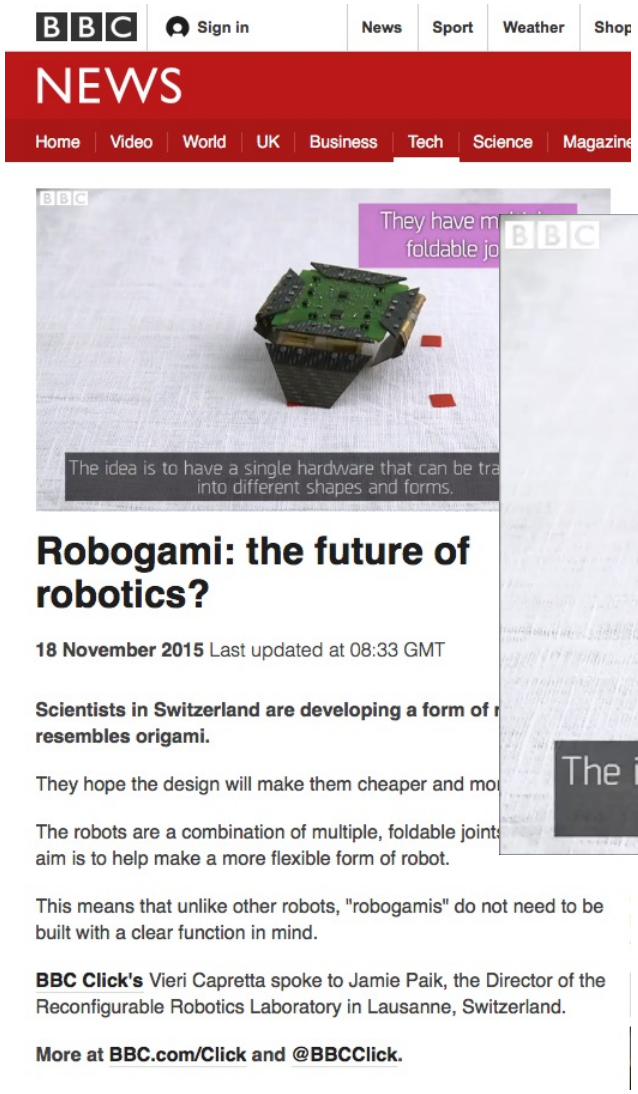
RRL Reconfigurable Robotics Lab

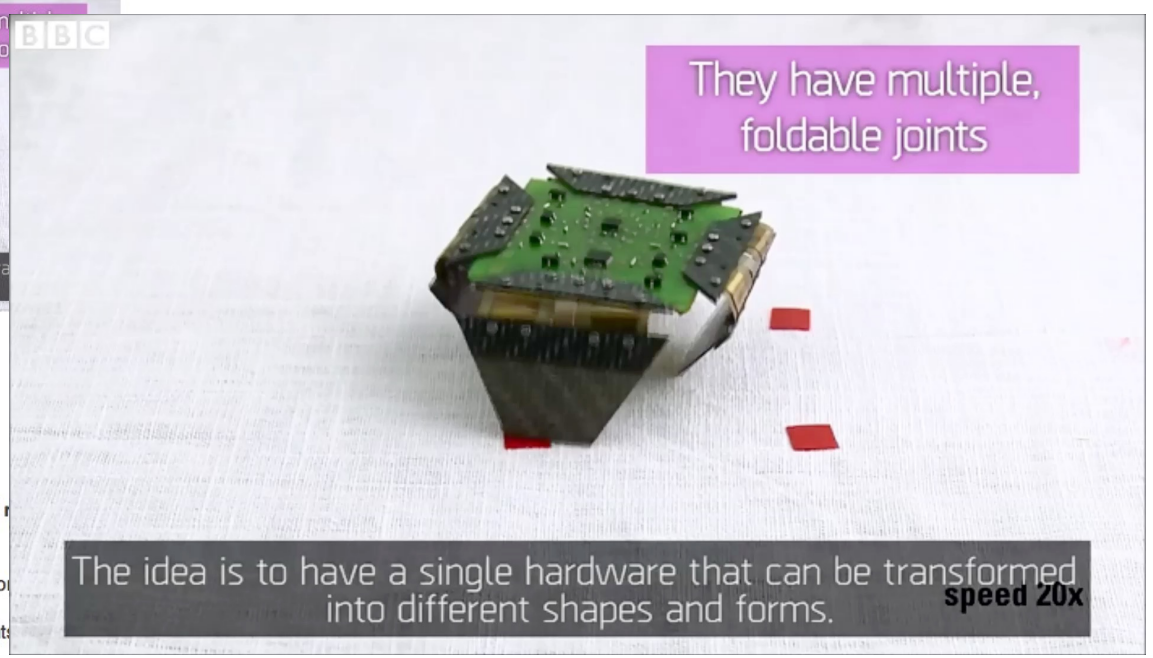
Applications

Origami Robots for Active, Adaptive and Wearable Interface

https://www.youtube.com/watch?v=Kmm9WmLd2Mo

Origami robots

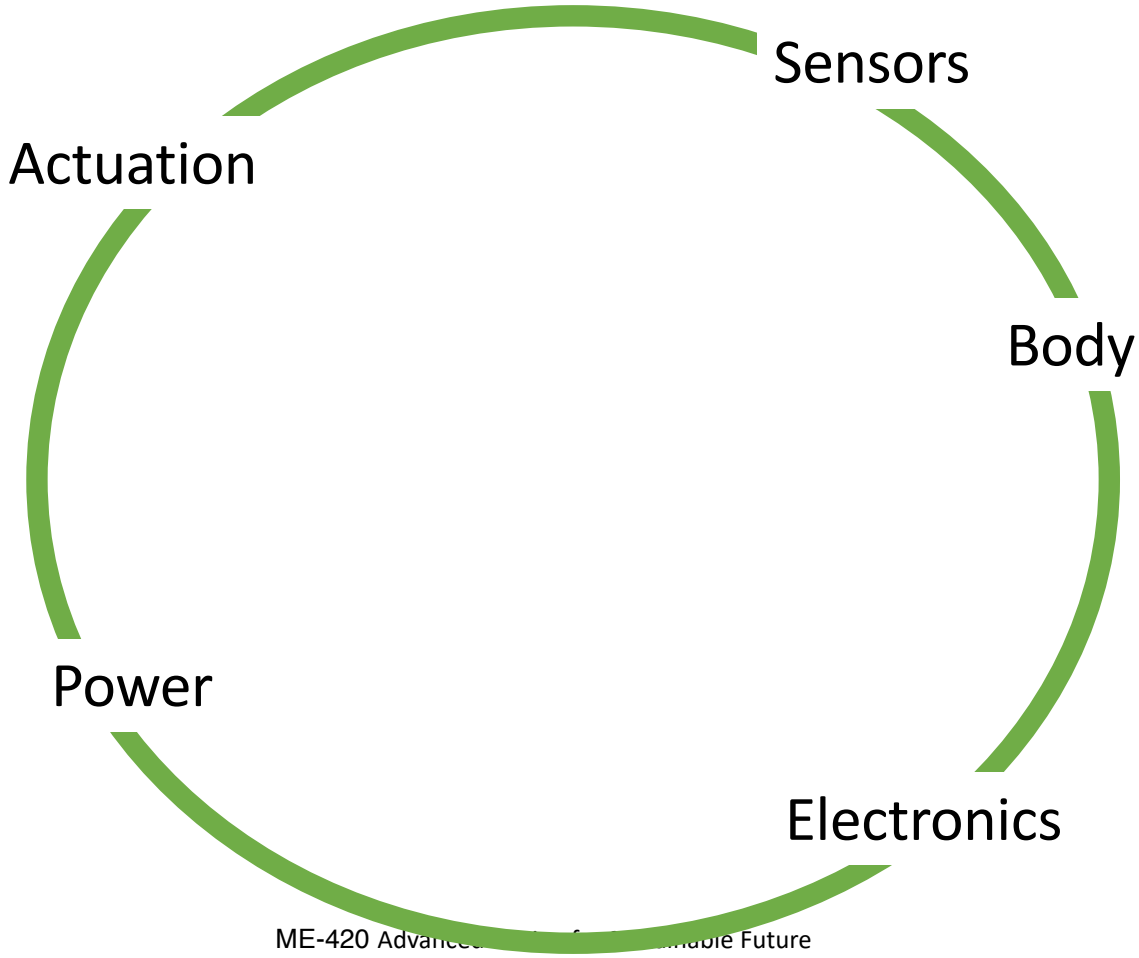




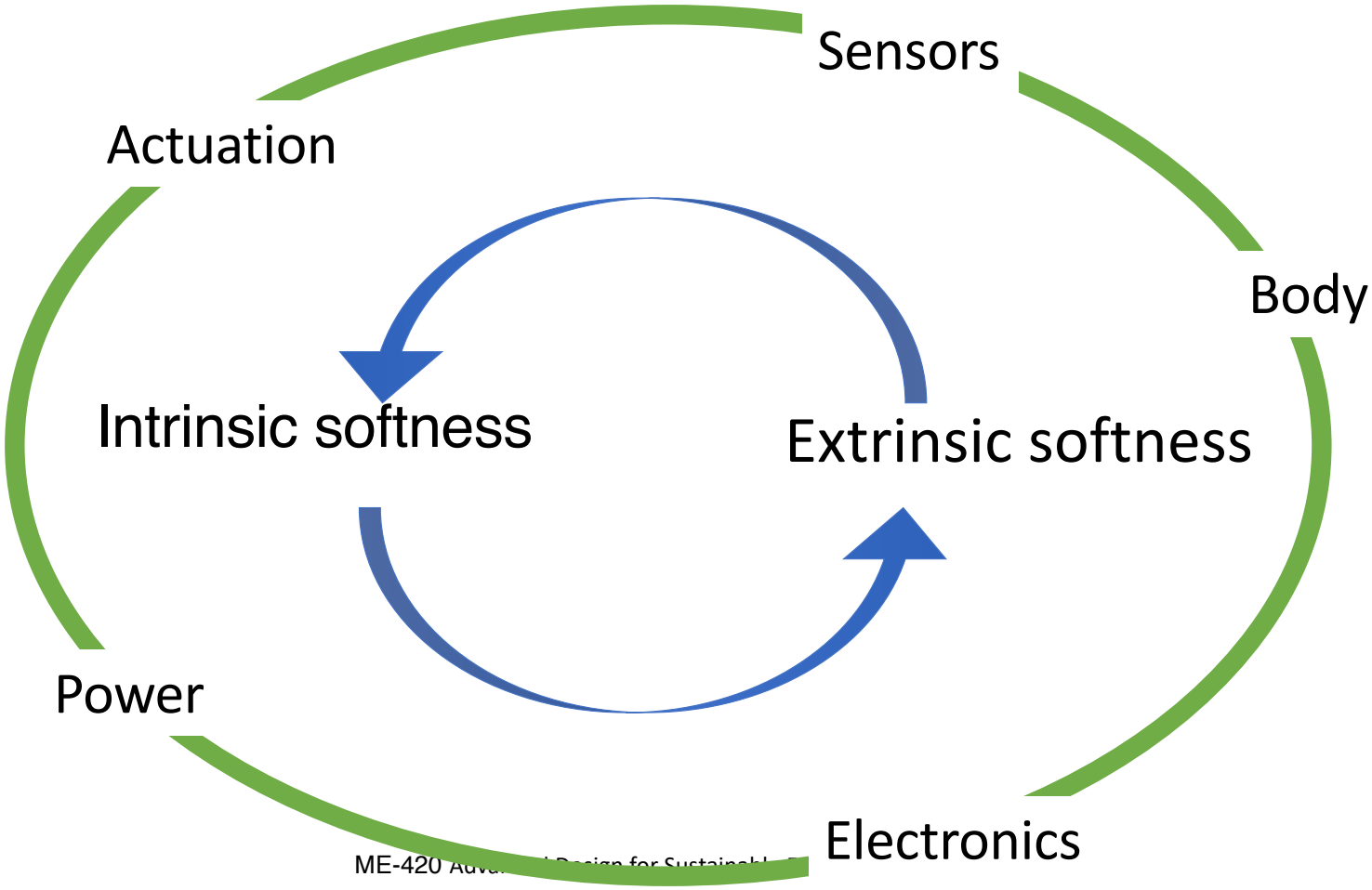
https://www.youtube.com/watch?v=IGe6bhJkTtk

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

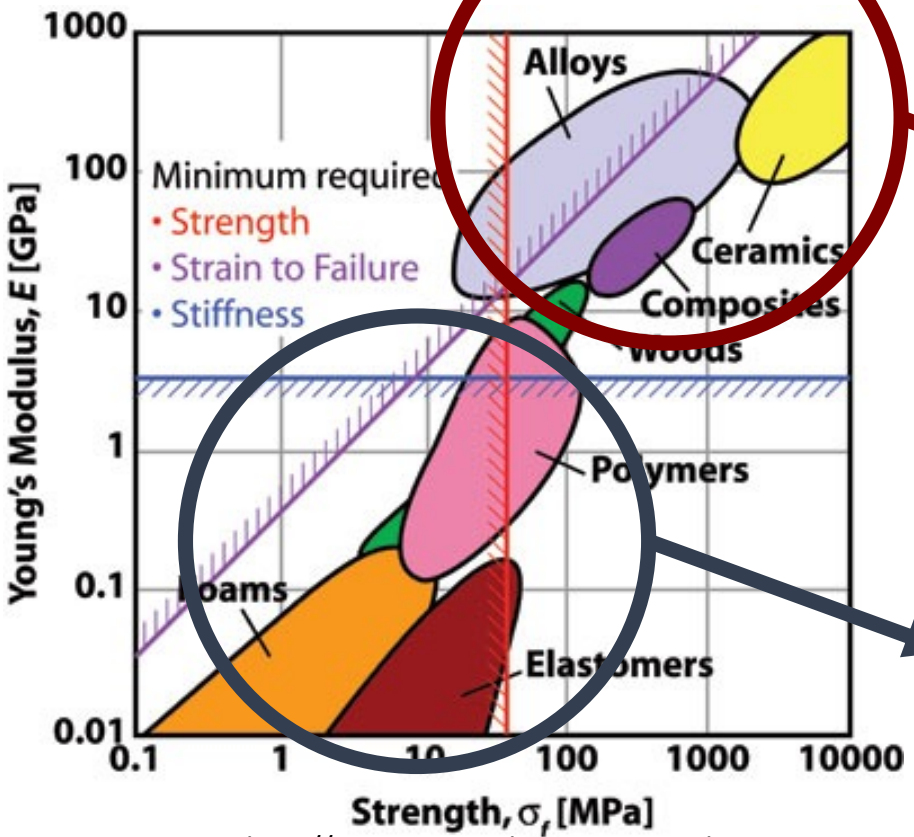
Softness in robotic components



Softness in robotic systems



Engineering materials



http://www-materials.eng.cam.ac.uk

Extrinsic softness:
Via design and control

Intrinsic softness:
Via material property

Robotic Technology Essentials

1) Design of soft **sensing**
2) Design of soft **actuators**
3) Design of soft **controllers**

Wearable Technlogy Essentials

1) Design of soft **sensing**
2) Design of soft **actuators**
3) Design of soft **controllers**

Full Integration