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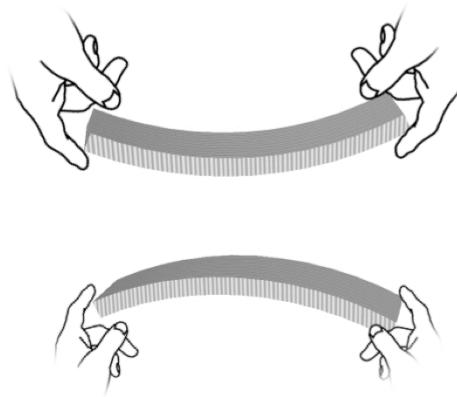
Moving from Mechanical to Organic Wearables

Eve Hoggan

Aalto Science Institute

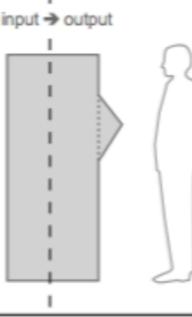
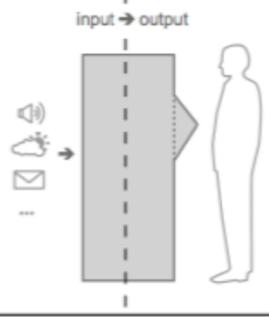
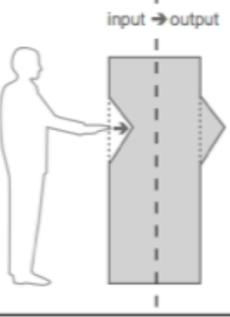
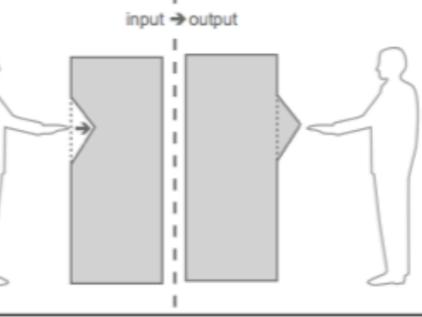
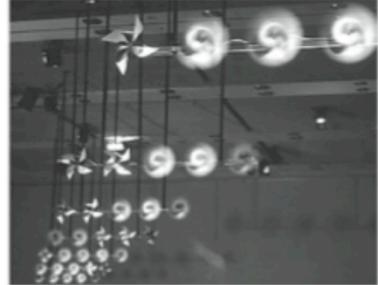
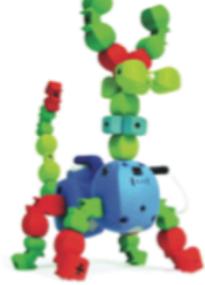
Organic User Interfaces (OUI)

OUIs have non-planar displays that actively or passively change shape via analogue physical inputs¹



The shape of the device itself is a variable of interactivity

1. Holman, D., & Vertegaal, R. (2008). Organic user interfaces: designing computers in any way, shape, or form. Communications of the ACM, 51(6), 48-55.! Proc. CHI (pp. 593-602). ACM.

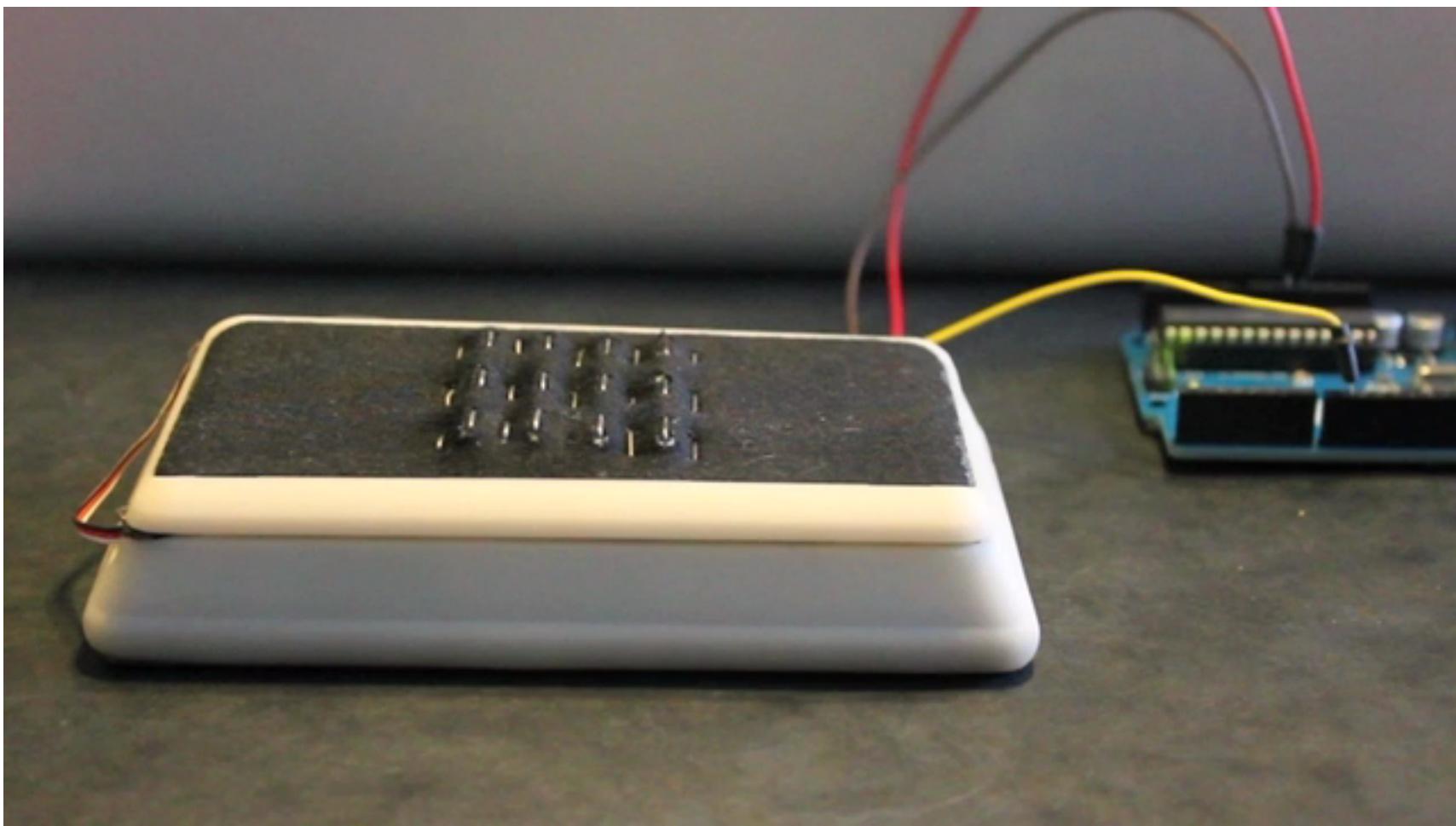
No interaction	Indirect interaction	Direct interaction	
Shape-changing output only	Implicit input and shape-changing output	Shape-changing input and output	Shape-changing input and remote output
			
 SlowFurl [47]	 Pinwheels [22]	 Topobo [39]	 Lumen [36]

Rasmussen, M. K., Pedersen, E. W., Petersen, M. G., & Hornbæk, K. (2012, May). Shape-changing interfaces: a review of the design space and open research questions. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 735-744). ACM.



Image from http://en.wikipedia.org/wiki/Apple_Watch

MECHANICAL ACTUATION





Sean Follmer, Daniel Leithinger, Alex Olwal, Nadia Cheng, and Hiroshi Ishii. 2012. Jamming user interfaces: programmable particle stiffness and sensing for malleable and shape-changing devices. In Proceedings of the 25th annual ACM symposium on User interface software and technology (UIST '12). ACM, New York, NY, USA, 519-528.

Motorised Clothing



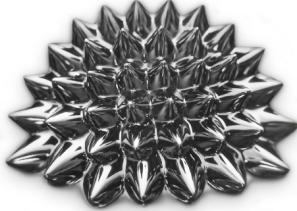
테스트 베드

"Transforming Dress" CrossDesignlab Project 2011~2013
<https://vimeo.com/99401323>

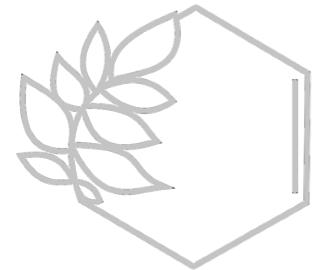
Sea Cucumbers!



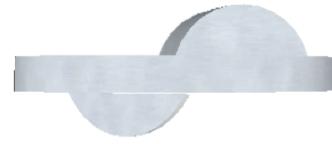
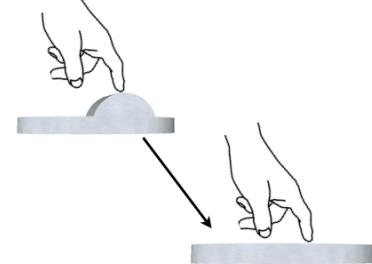
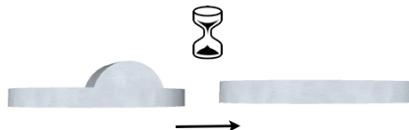
From commons.wikipedia.org



Smart Materials



- Materials that have one or more properties that can be dynamically altered when controlled by external stimuli:
 - colour
 - shape
 - conductivity
- Potential applications include a dynamic braille display, handheld tools and furniture that can adapt to each user's body to provide the most ergonomic fit, and clothes that can adapt their shape to accommodate changes in the weather.

Size	Granularity	Amplitude
		
Porosity	Strength (Newton)	Speed
		

Types of Smart Material

- Smart materials may be polymers, ceramics, memory metals, semiconductors, gels or composites, which fit in different categories according to their properties:
 - electrochromic - electrically-induced colour change
 - magnetostrictive - shape change in response to magnetic fields
 - temperature responsive polymers - shape change through temperature variation
 - dielectric electroactive polymers - large strains through electric fields
 - piezoelectrics - shape change through voltage.

Shape-Memory Alloys

- Shape-Memory Alloys (SMA) and polymers are materials in which a deformation can be induced and recovered through temperature changes.

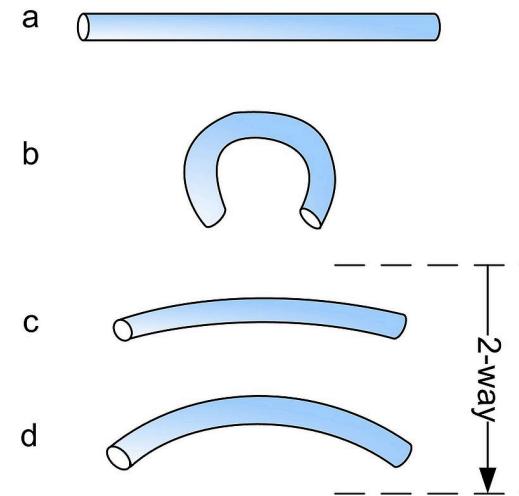
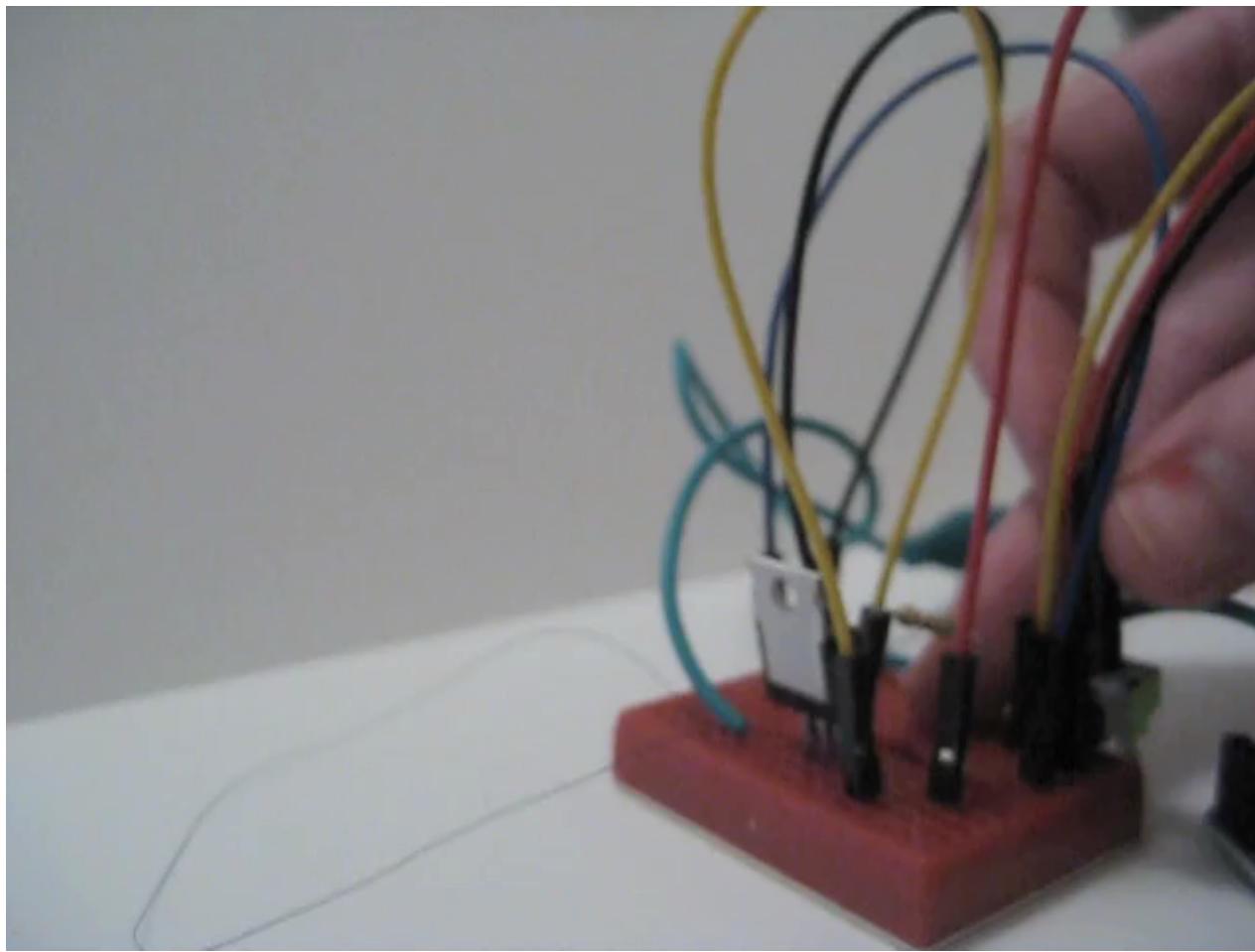


Image from wikipedia.org



From Liz Taylor, Vimeo
<https://vimeo.com/19691896>



Stimuli-Responsive Polymer Nanocomposites Inspired by the Sea Cucumber Dermis
Jeffrey R. Capadona, Kadhiravan Shanmuganathan, Dustin J. Tyler, Stuart J. Rowan, Christoph Weder

Temperature Responsive Polymers

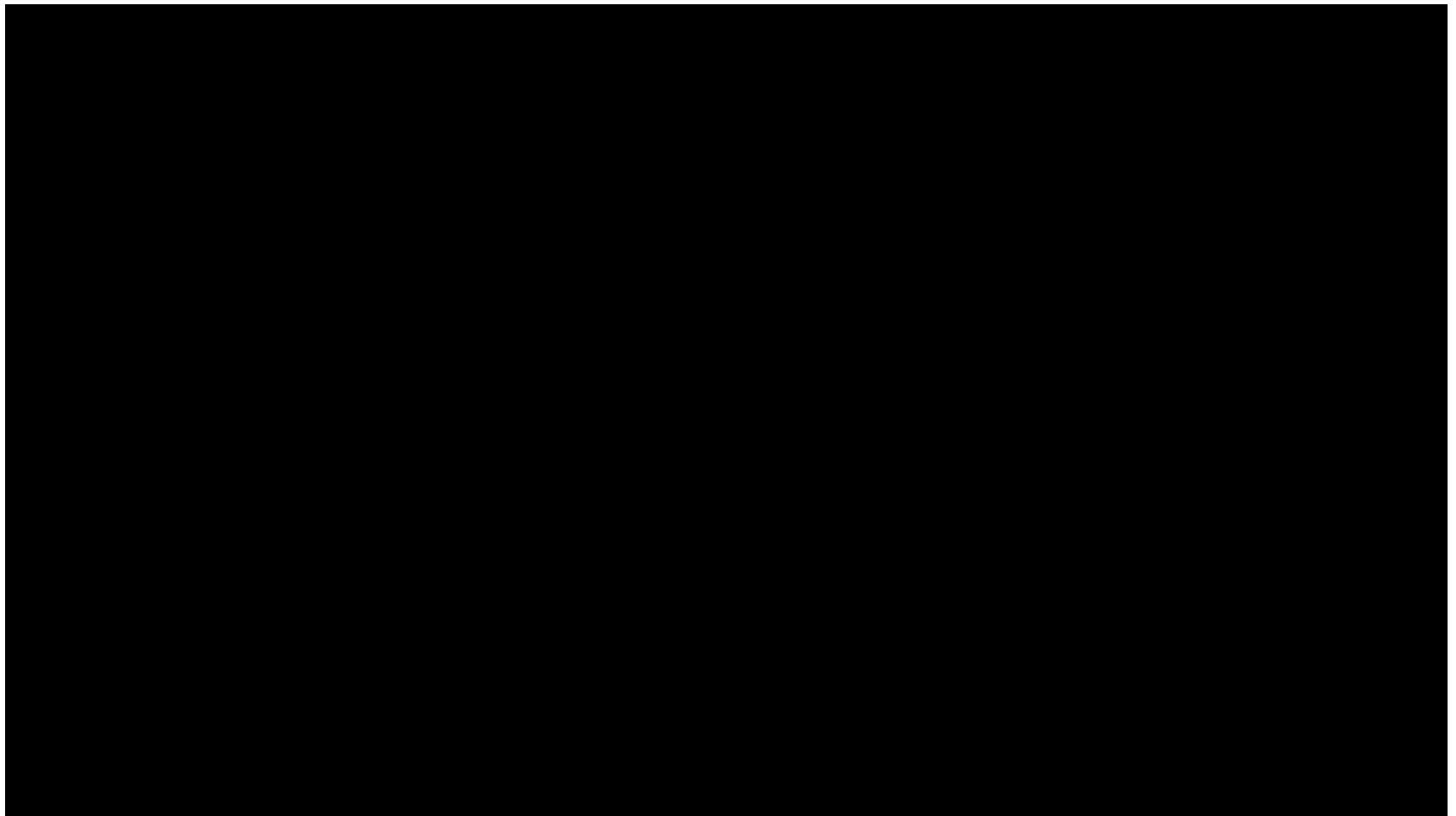


Sensitive Humidity-Driven Reversible and Bidirectional Bending of Nanocellulose Thin Films as Bio-Inspired Actuation

Miao Wang, Xuelin Tian, Robin H. A. Ras and Olli Ikkala

Chromogenic Materials

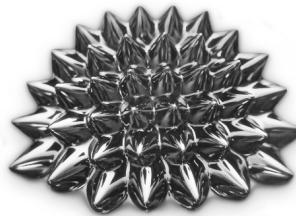
- Electrochromic materials change colour or transparency by the application of a voltage
- Photochromic materials change colour in response to light (e.g., sunglasses).
- Thermochromic materials change in color depending on their temperature (e.g., graphical thermometer).



Catarina Mota, Vimeo
<https://vimeo.com/44354467>

Magnetoresistive Materials

- Magnetostrictive materials change shape under a magnetic field and also change their magnetization under mechanical stress.



- Ferrofluid is a liquid which becomes strongly magnetized in presence of a magnetic field.

Piezoelectric Materials

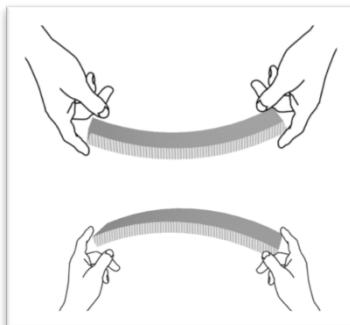
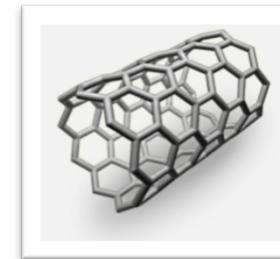
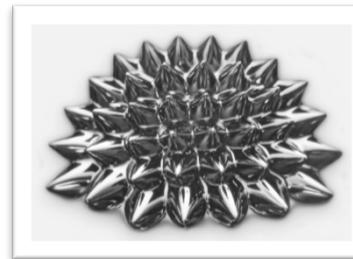
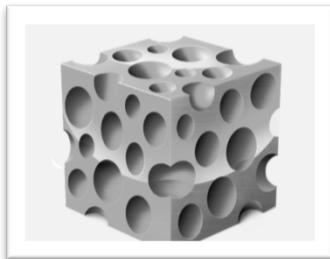
- Piezoelectric materials can generate an electrical charge when force is applied (e.g., in micro- phones), and can generate forces when an electrical charge is applied (e.g., speakers).
- Your t-shirt can be used to charge your electronic device.



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In The Future

Wearables made with smart materials (inspired by nature) could be an expressive and robust alternative to mechanical designs.



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