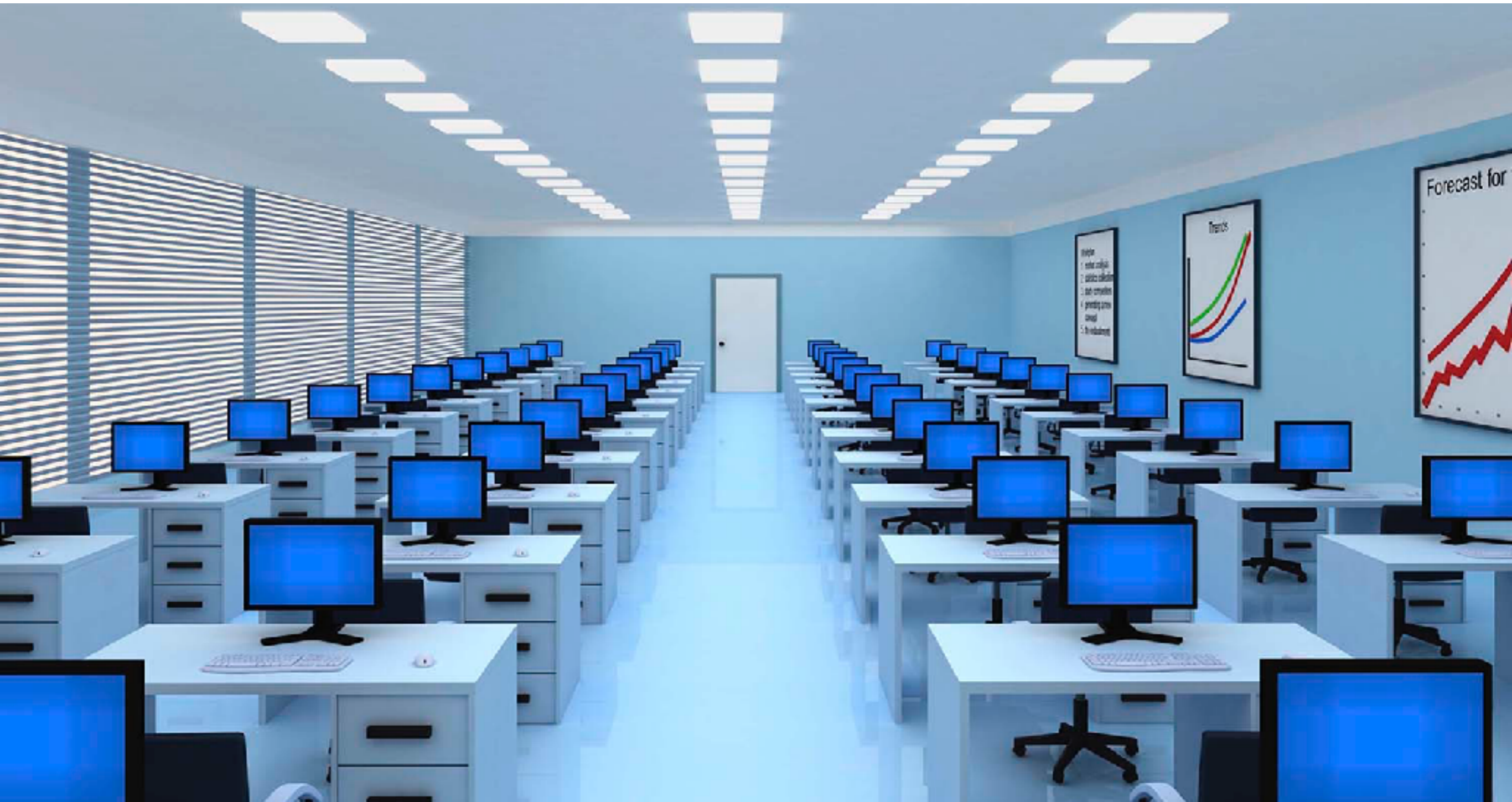


# Next generation tangible interaction

Céline Coutrix  
[Celine.Coutrix@imag.fr](mailto:Celine.Coutrix@imag.fr)

# Graphical > Tangible?



# Graphical > Tangible?

- Dynamicity, Flexibility
- Price

# **Balance between graphical and tangible**

As each have benefits and drawbacks

# Reality Based Interaction

Compromise with software when it brings benefit

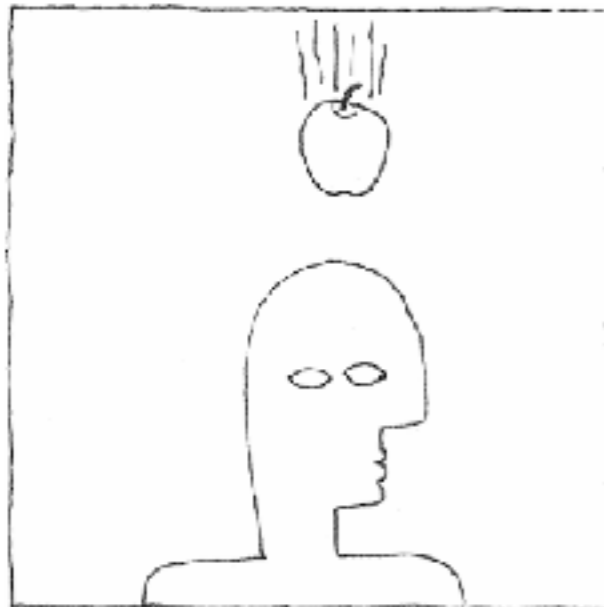
<http://dl.acm.org/citation.cfm?doid=1357054.1357089>

# Reality Based Interaction

## Interface design

- Build on 4 themes (= human capabilities) from the “real” world
- Compromise with 6 tradeoffs in order to reach design goal

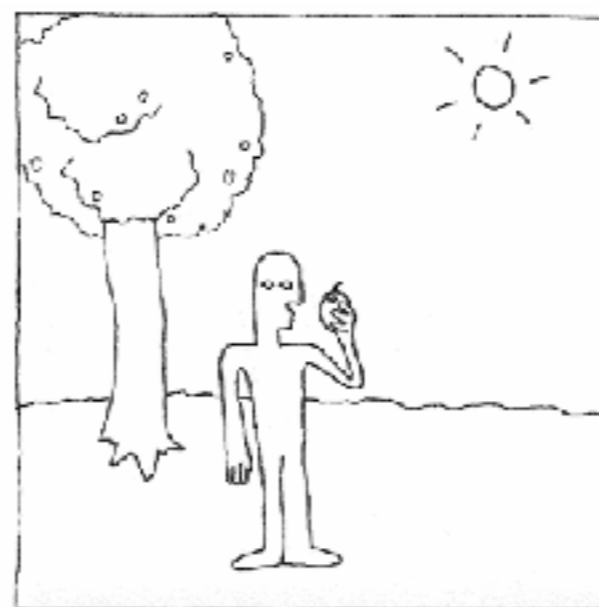
# Reality Based Interaction



Naïve Physics



Body Awareness & Skills

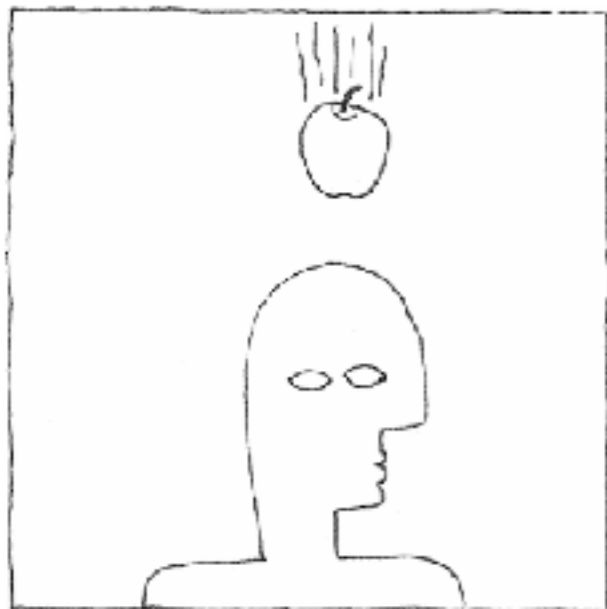


Environment Awareness & Skills



Social Awareness & Skills

# Reality Based Interaction



Naïve Physics

E.g., gravity, friction, velocity

Example of interfaces using users' knowledge of naive physics?



# Reality Based Interaction

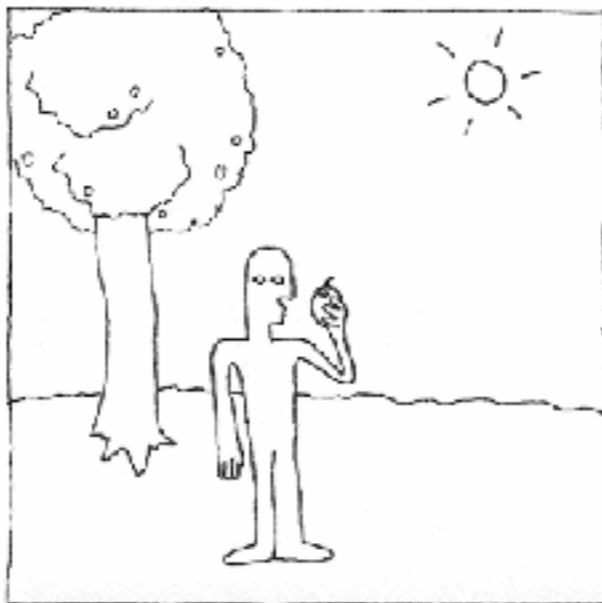


Body Awareness & Skills

E.g., relative position of body parts, range of motion, skills to coordinate movements (to walk, kick a ball)

Example of interfaces using users' body awareness and skills?

# Reality Based Interaction

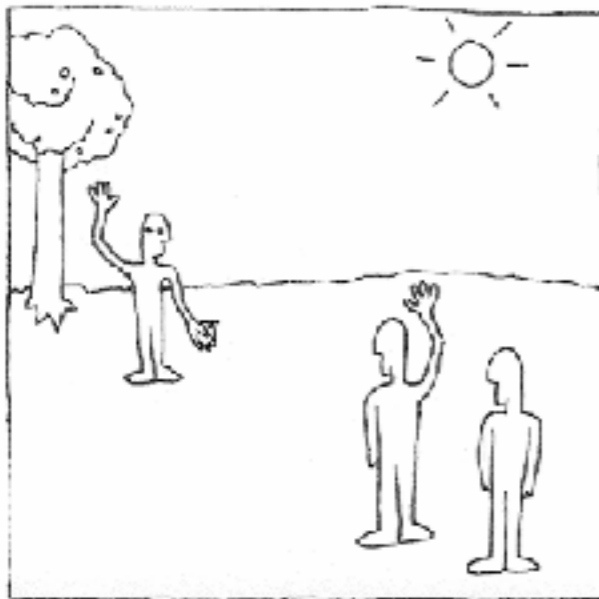


Environment Awareness & Skills

E.g., horizon gives a sense of directional information, lighting and shadow provide depth cues

Example of interfaces using users' environment awareness and skills?

# Reality Based Interaction



**Social Awareness & Skills**

E.g., verbal and non-verbal communication, exchange objects, ability for collaboration

Example of interfaces using users' social awareness and skills?

# Reality Based Interaction: Six tradeoffs

## **Expressive power**

ability to perform a variety of tasks within the application domain

## **Efficiency**

ability to perform a task rapidly

## **Versatility**

ability to perform many tasks from different application domains

## **Ergonomics**

ability to perform a task without physical injury or fatigue

## **Accessibility**

ability to perform a task when handicapped

## **Practicality**

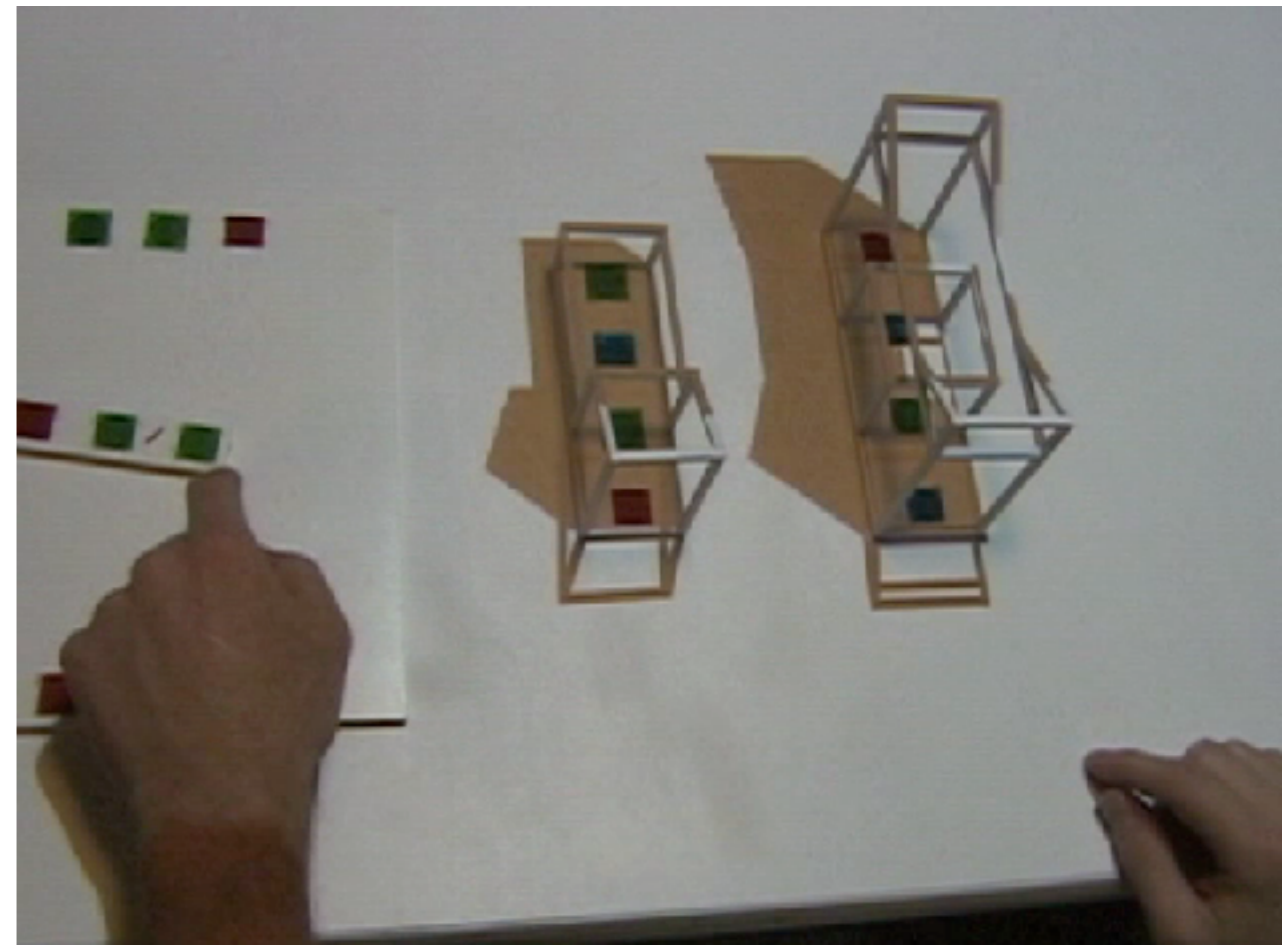
(designers) ability to produce the system

# Reality Based Interaction

Case study: URP

What themes does URP use?

- Naive Physics
- Body
- Environment
- Social Awareness



# Reality Based Interaction

What does URP sacrifice for which benefit?

- Expressive power
- Efficiency
- Versatility
- Ergonomics
- Accessibility
- Practicality

# Balance between graphical and tangible:

## Maybe we went too far



**Slate Media Technology RAVEN MTi2**



**THALES Avionics 2020**

# Balance between graphical and tangible

Software mouse+touch GUI took over

Tangible might be coming back

E.g., induction hub  
with removable magnetic tangible knob





# Industry



**Palette Gear (2012)**

# Industry



Microsoft Surface Studio (2016)



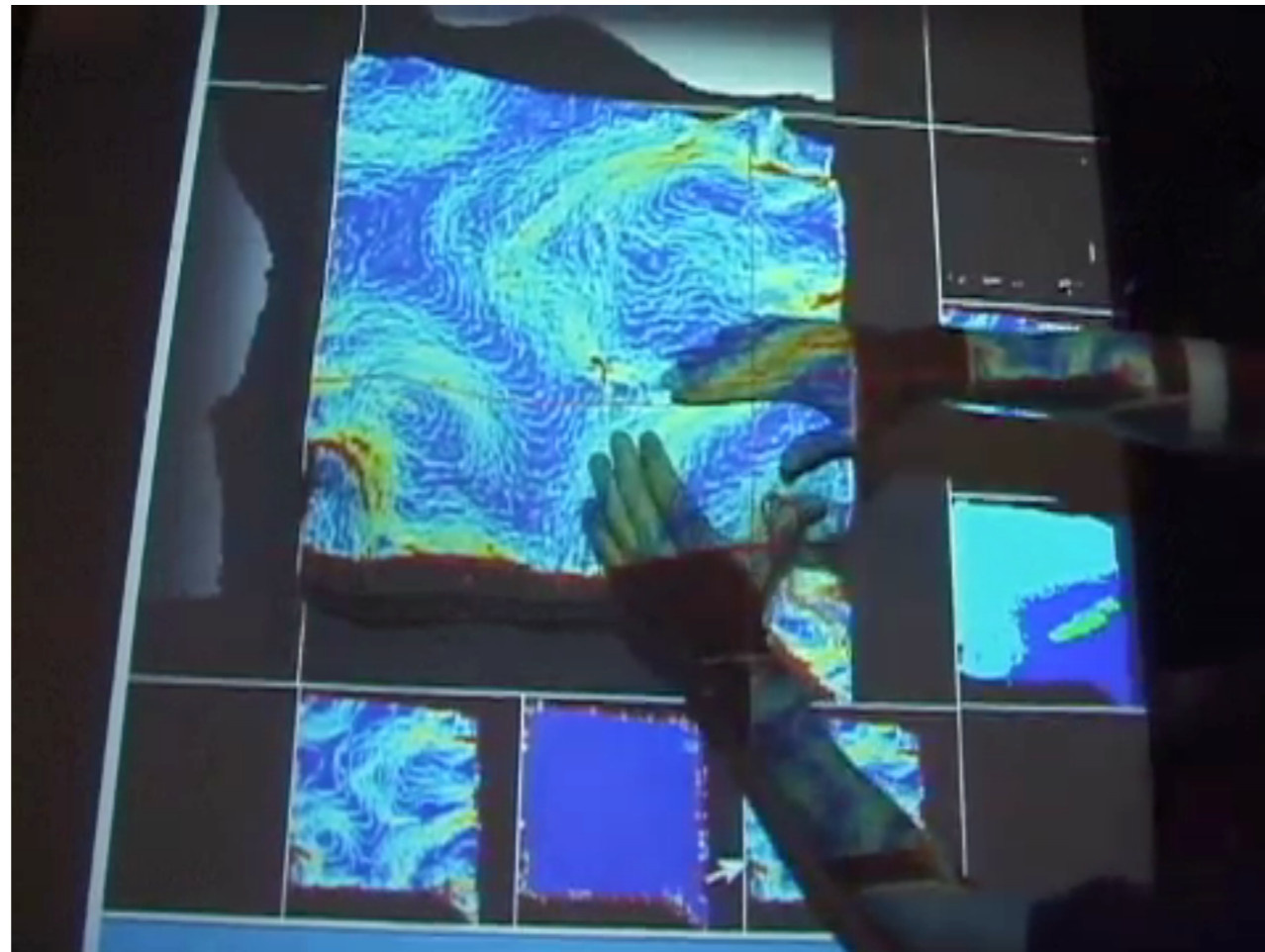
# How can we benefit again from Tangibility?



**New and Open research areas  
that bring tangibles closer to software**

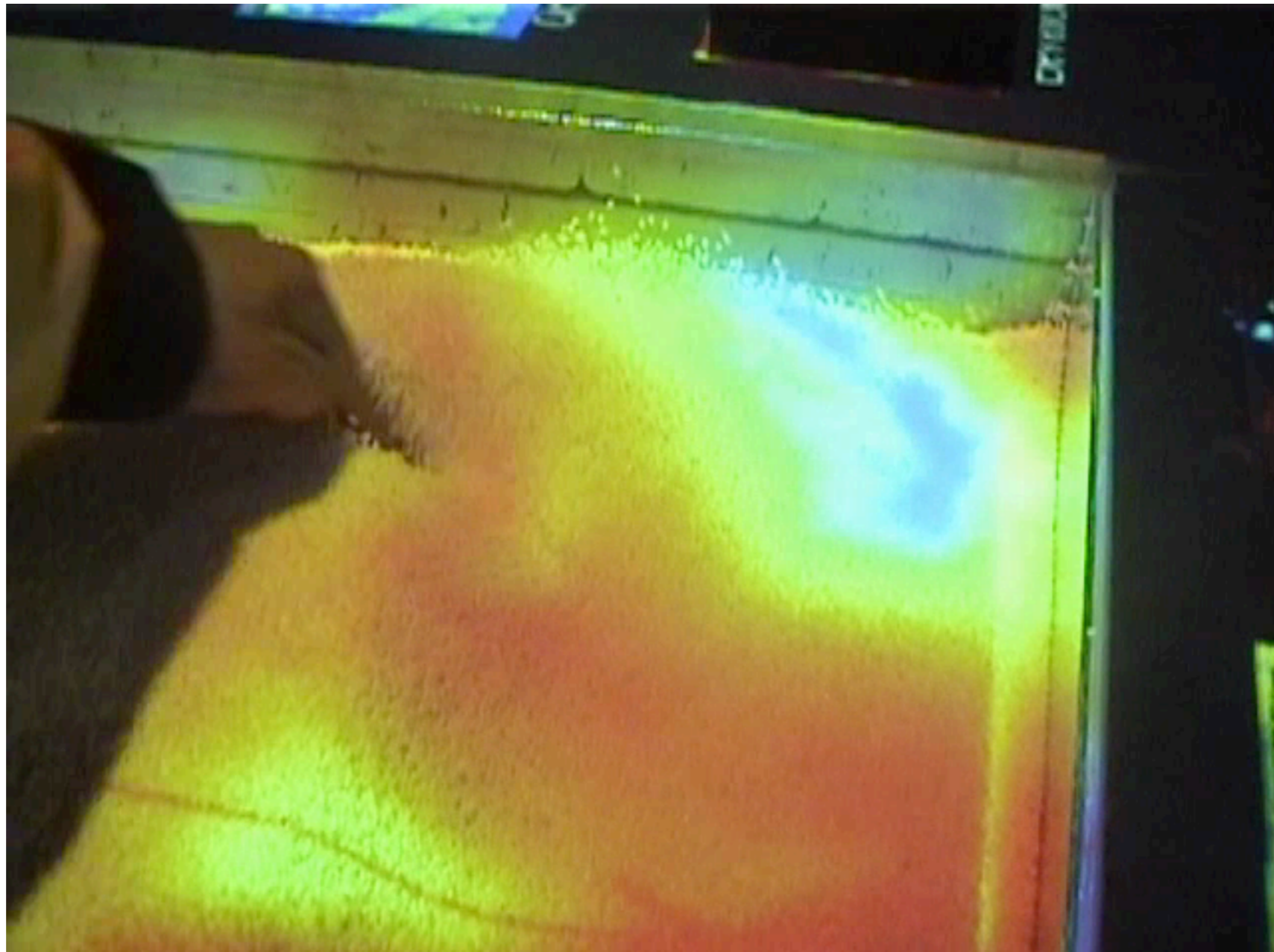
# Dynamicity & Flexibility: Shape

Illuminating Clay



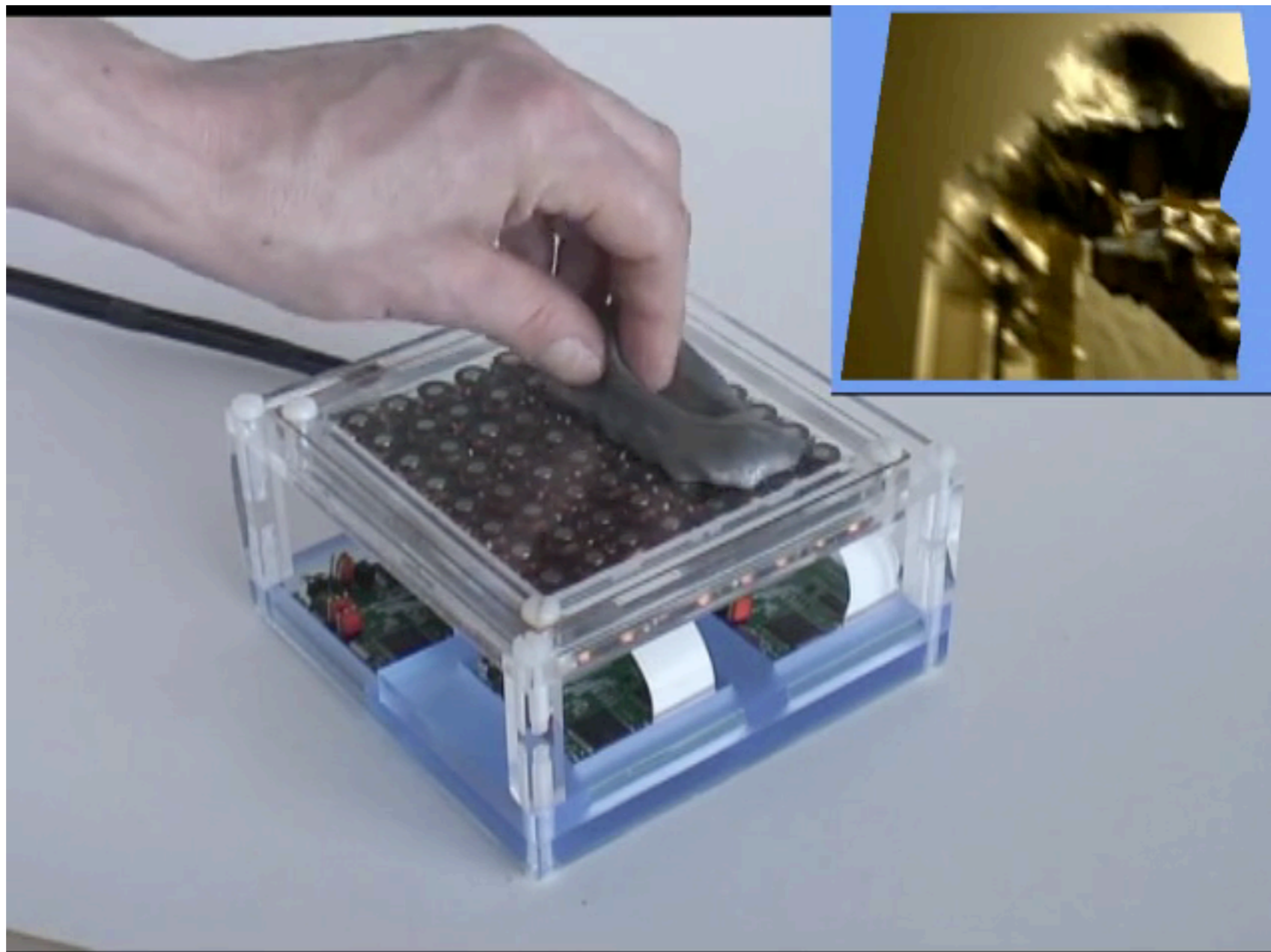
# Dynamicity & Flexibility: Shape

SandScape



# Dynamicity & Flexibility: Shape

A Reconfigurable Ferromagnetic Input Device



# Dynamicity & Flexibility: Shape

Dynamically changeable buttons:  
[http://www.youtube.com/watch?v=Smai\\_Z\\_galE](http://www.youtube.com/watch?v=Smai_Z_galE)

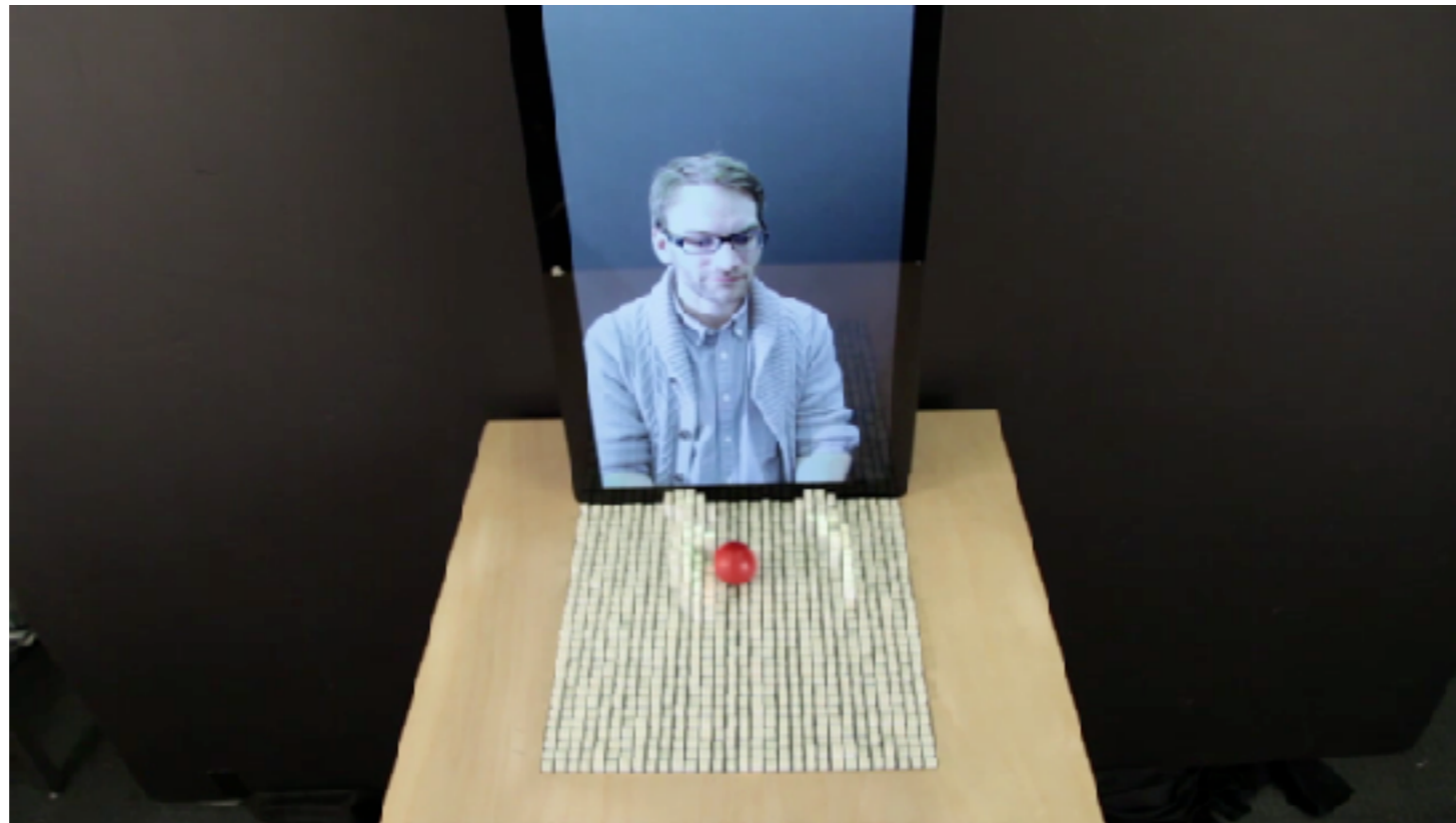
# Dynamicity & Flexibility: Shape

Shutters with shape memory alloy





# Dynamicity & Flexibility: Shape



# Dynamicity & Flexibility: Shape



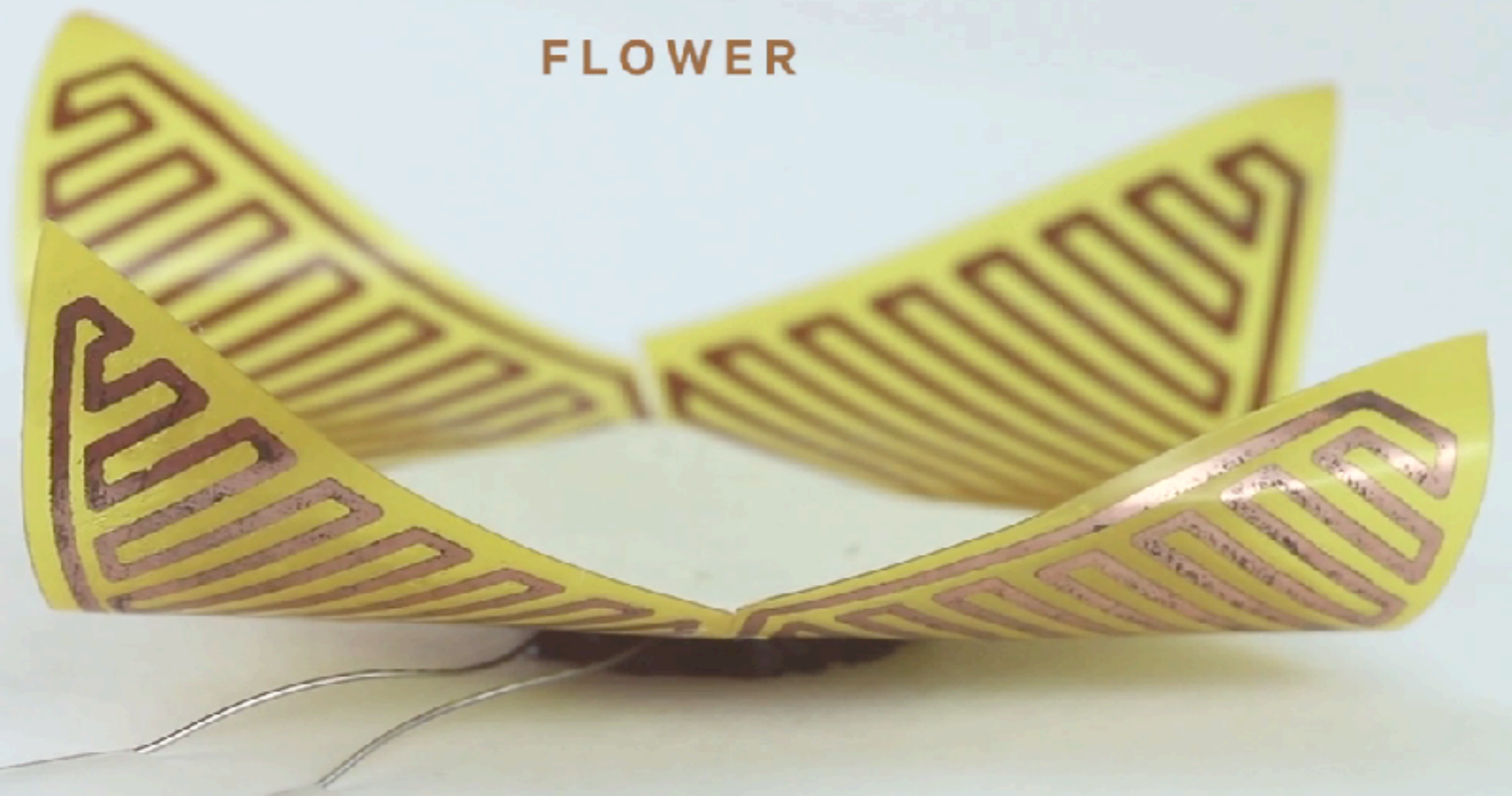
# Dynamicity & Flexibility: Shape



non-elastic airbag + plain paper

# Dynamicity & Flexibility: Shape


FLOWER



# Dynamicity & Flexibility: Shape



# Dynamicity & Flexibility: Shape with nanoscopic cells

A grayscale micrograph showing a dense population of small, rod-shaped bacterial cells. The cells are distributed across the field of view, with some appearing as bright, distinct spots and others as fainter, more diffuse shapes. The background is a uniform, light gray color.

Bacillus Subtilis Natto is a bacteria that  
has been widely used to ferment food

# Dynamicity & Flexibility: 2D location

**Actuated workBench**



**PICO**



# Dynamicity & Flexibility: 2D location



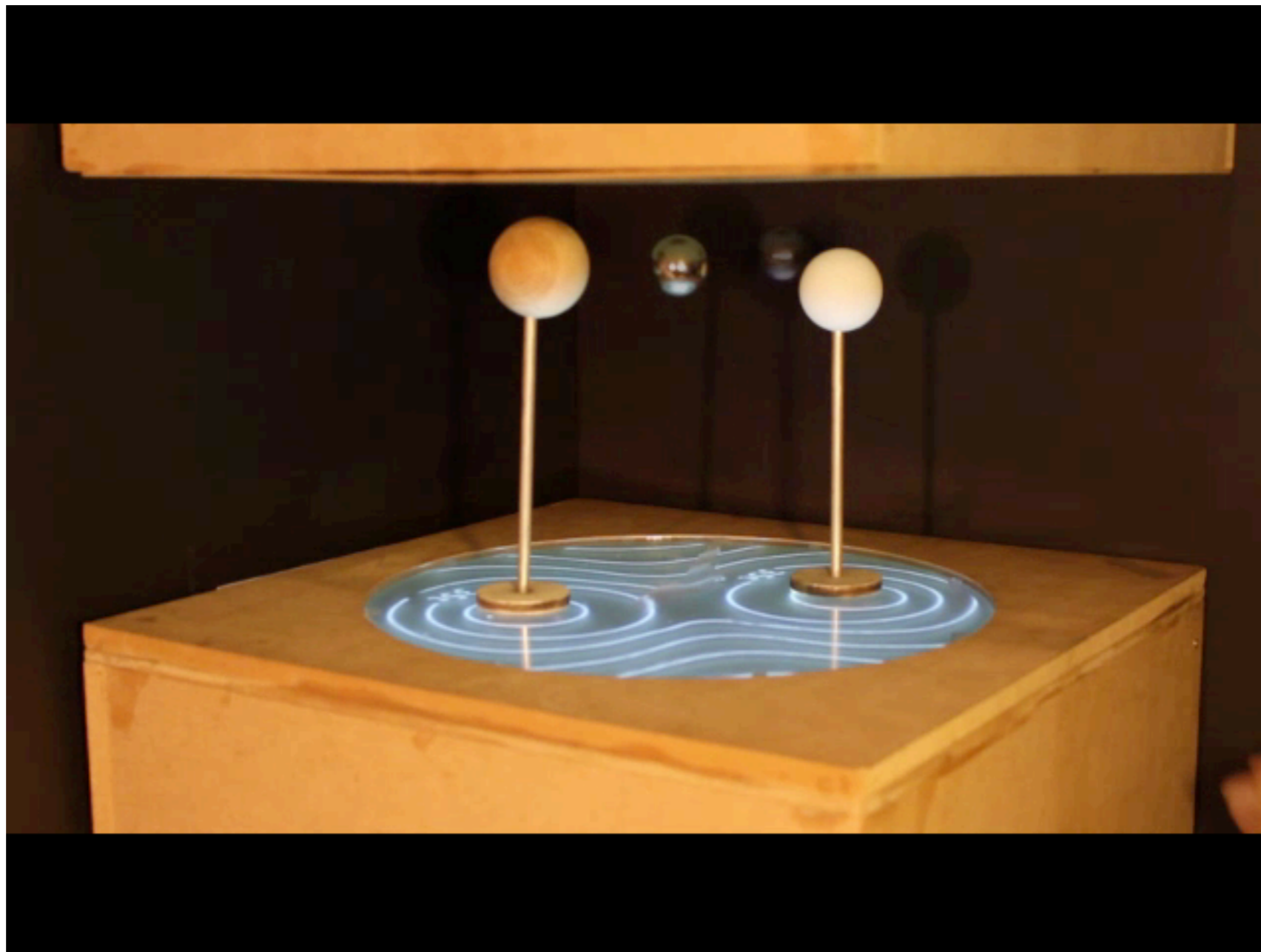
SwarmUI

<https://www.youtube.com/watch?v=ZVdAfDMP3m0>



# Dynamicity & Flexibility: 3D location

(magnetic)



# Dynamicity & Flexibility: 3D location

(ultrasonic)

[https://www.youtube.com/watch?v=g\\_EM1y4MKSc](https://www.youtube.com/watch?v=g_EM1y4MKSc)

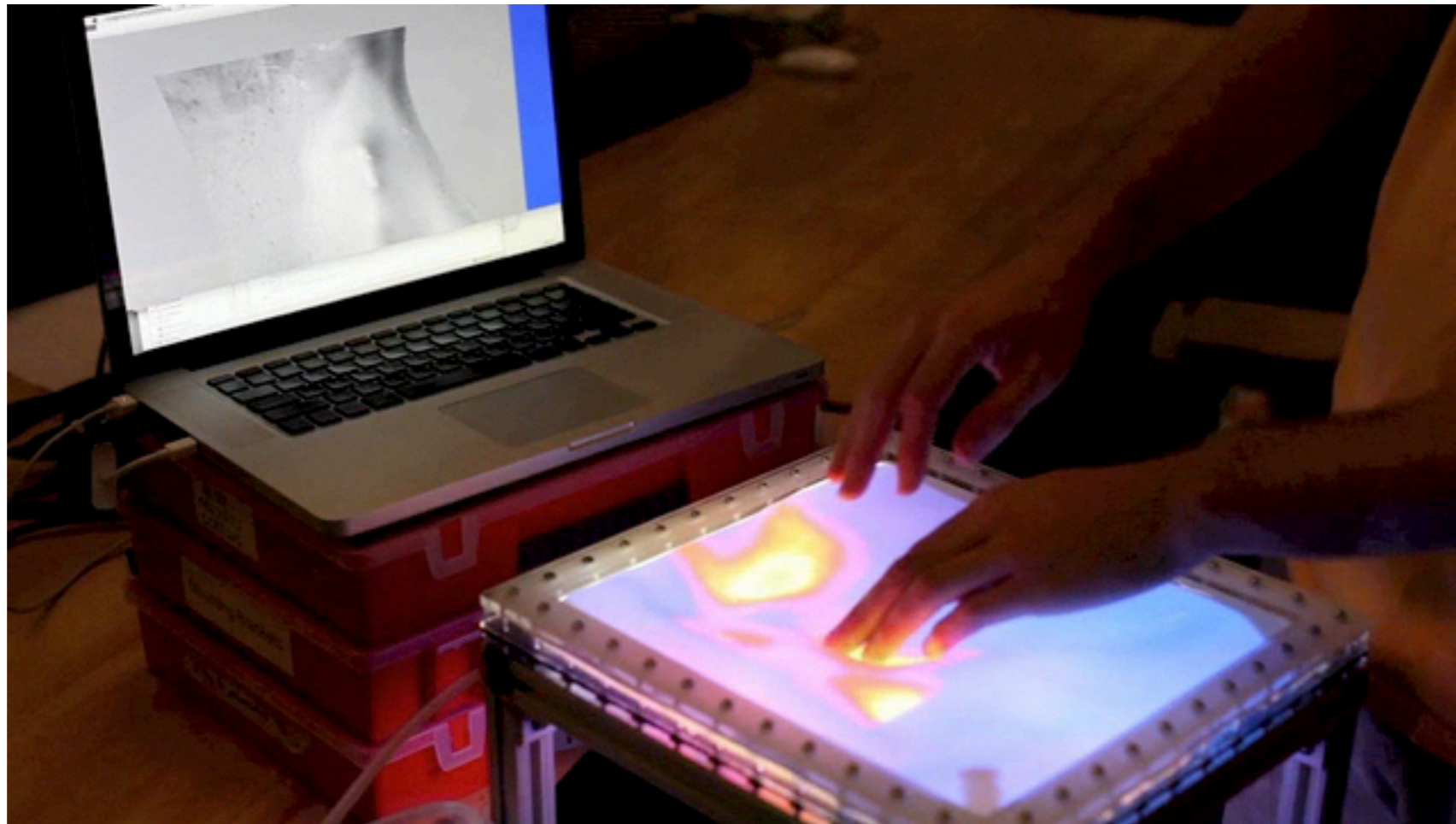
# **Dynamicity & Flexibility: 3D location**

**Intel Drone display**

**[https://www.youtube.com/watch?v=aOd4-T\\_p5fA](https://www.youtube.com/watch?v=aOd4-T_p5fA)**

# **Dynamicity & Flexibility: 3D location**

# Dynamicity & Flexibility: Stiffness



# Dynamicity & Flexibility: Stiffness

3D Printing Pneumatic Device Controls  
with Variable Activation Force Capabilities

<https://youtu.be/-4gFYvhkz0Y>

# Dynamicity & Flexibility: Weight

**Mechanism:**  
Mass Transfer with Liquid Metal



# Dynamicity & Flexibility

- Shape
- 2D location
- 3D location
- Stiffness
- Weight
- ...

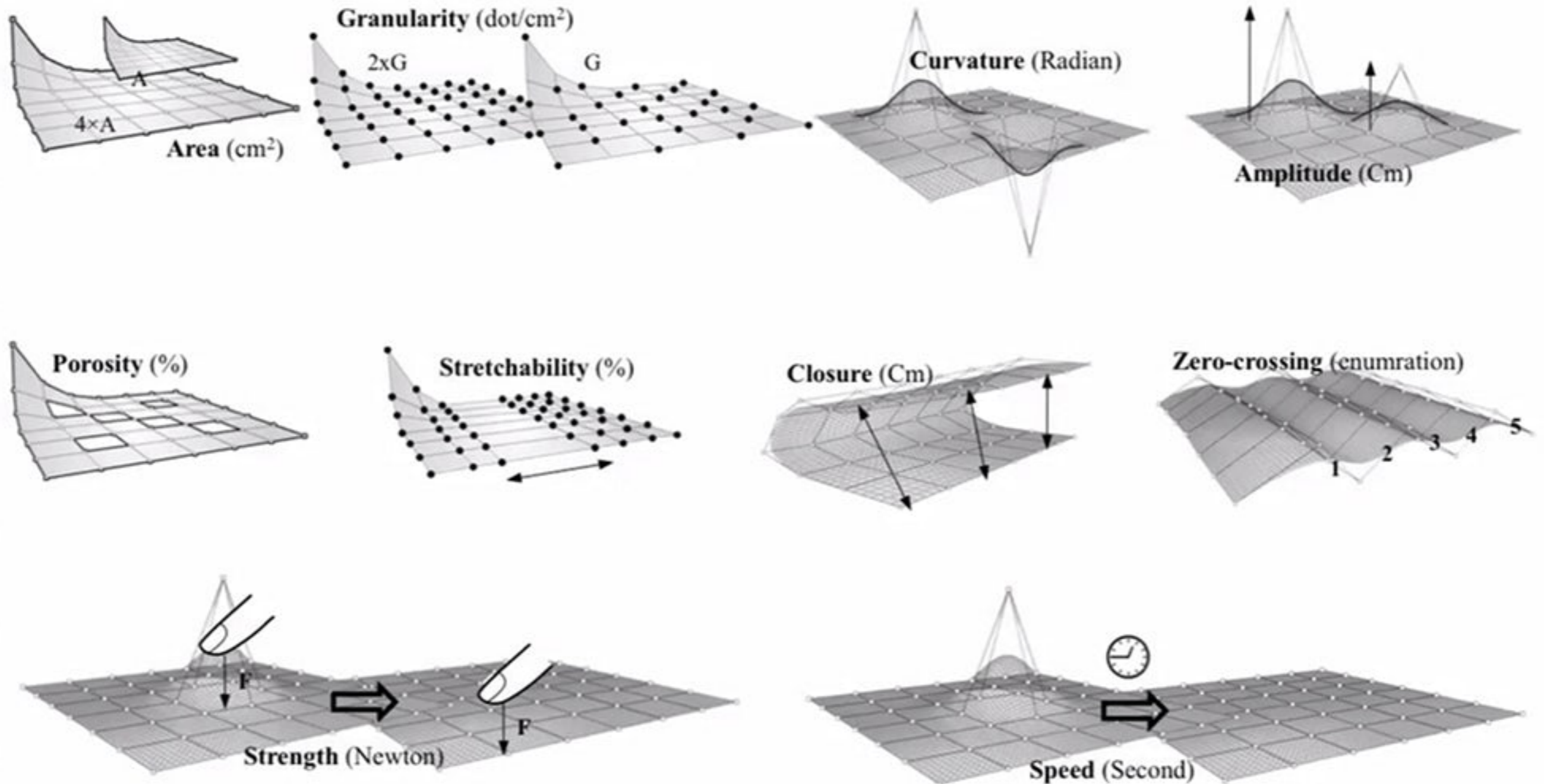


# Many dimensions, Many technologies

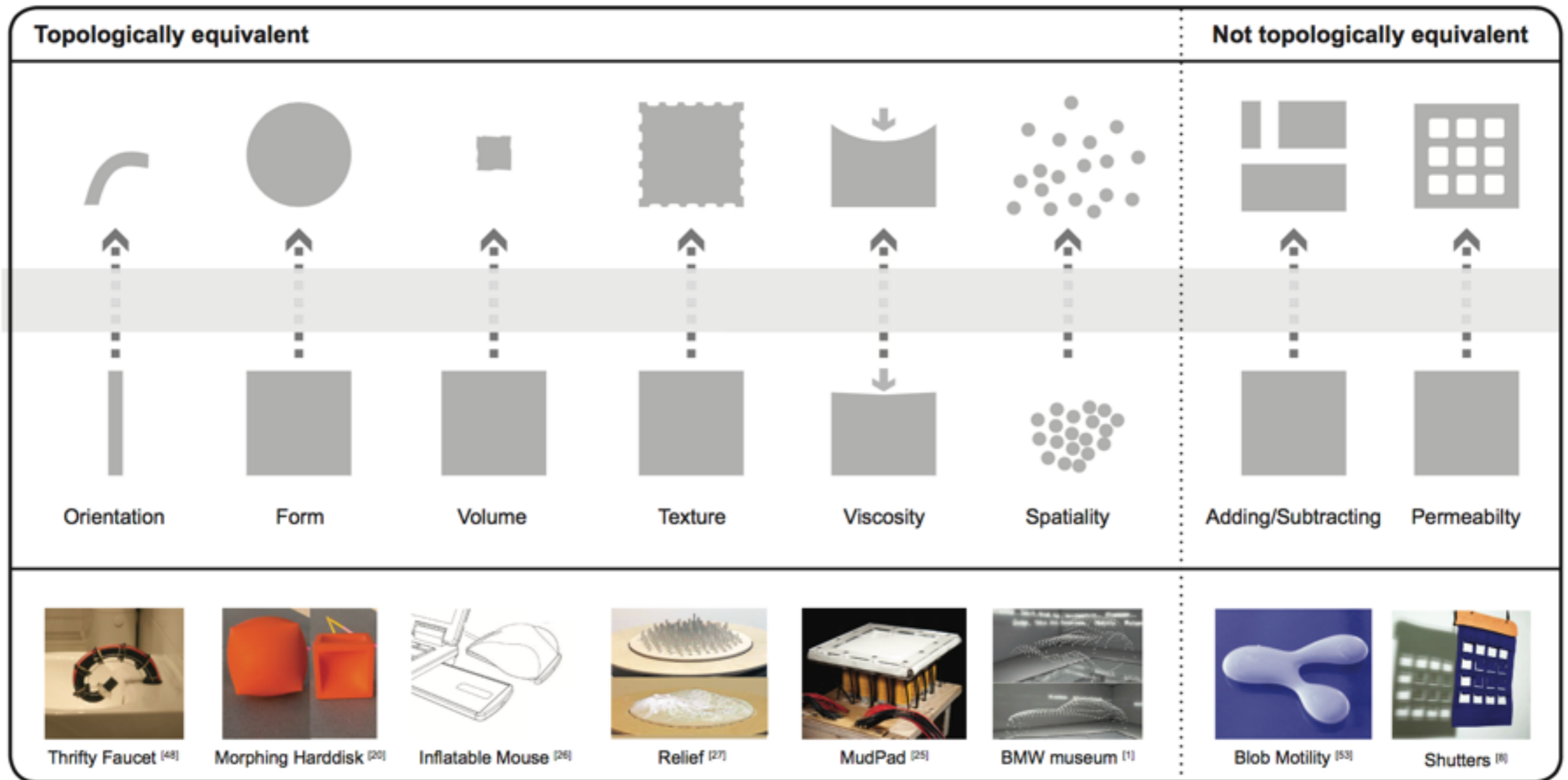
How to make sense of it?

→ Taxonomies and Design spaces



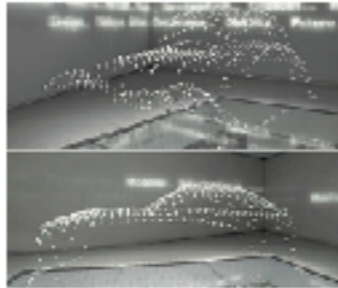
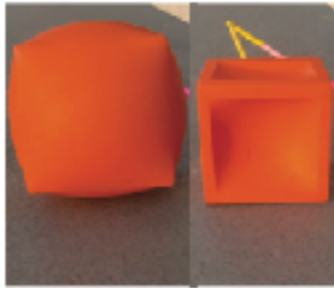
# Roudaut's Shape Resolution



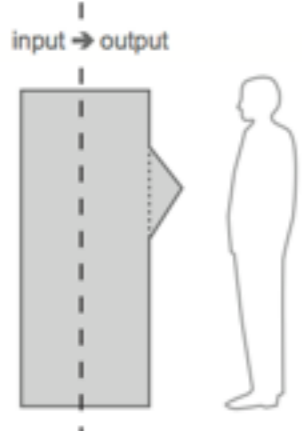
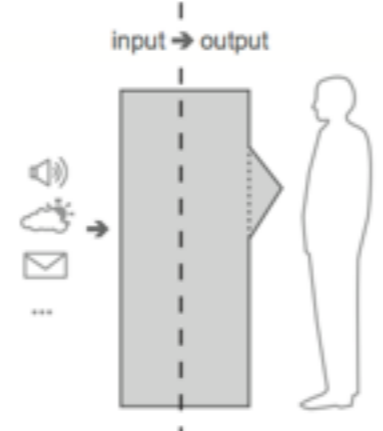
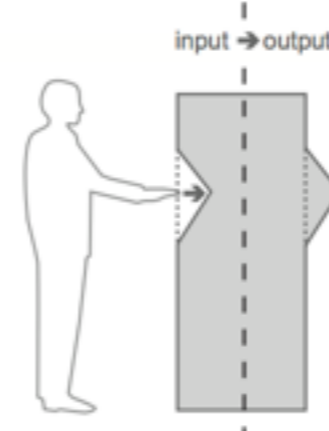
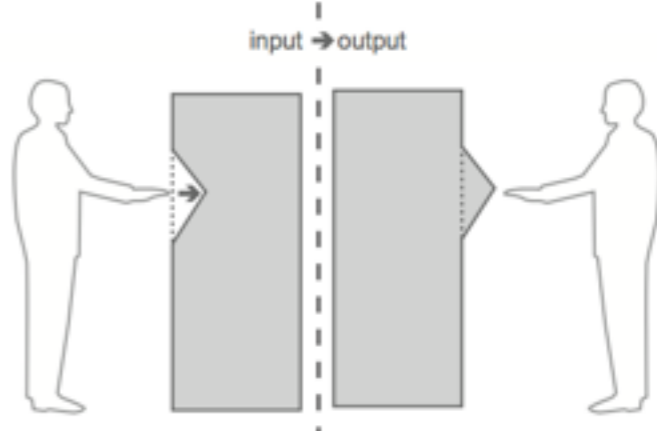

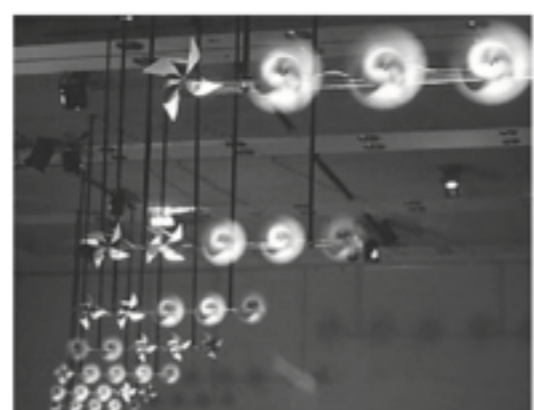
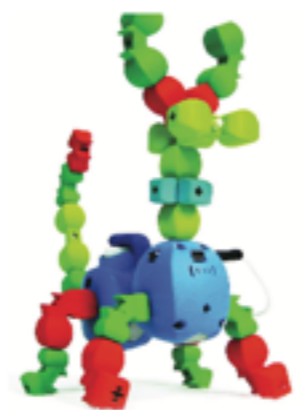

# Rasmussen



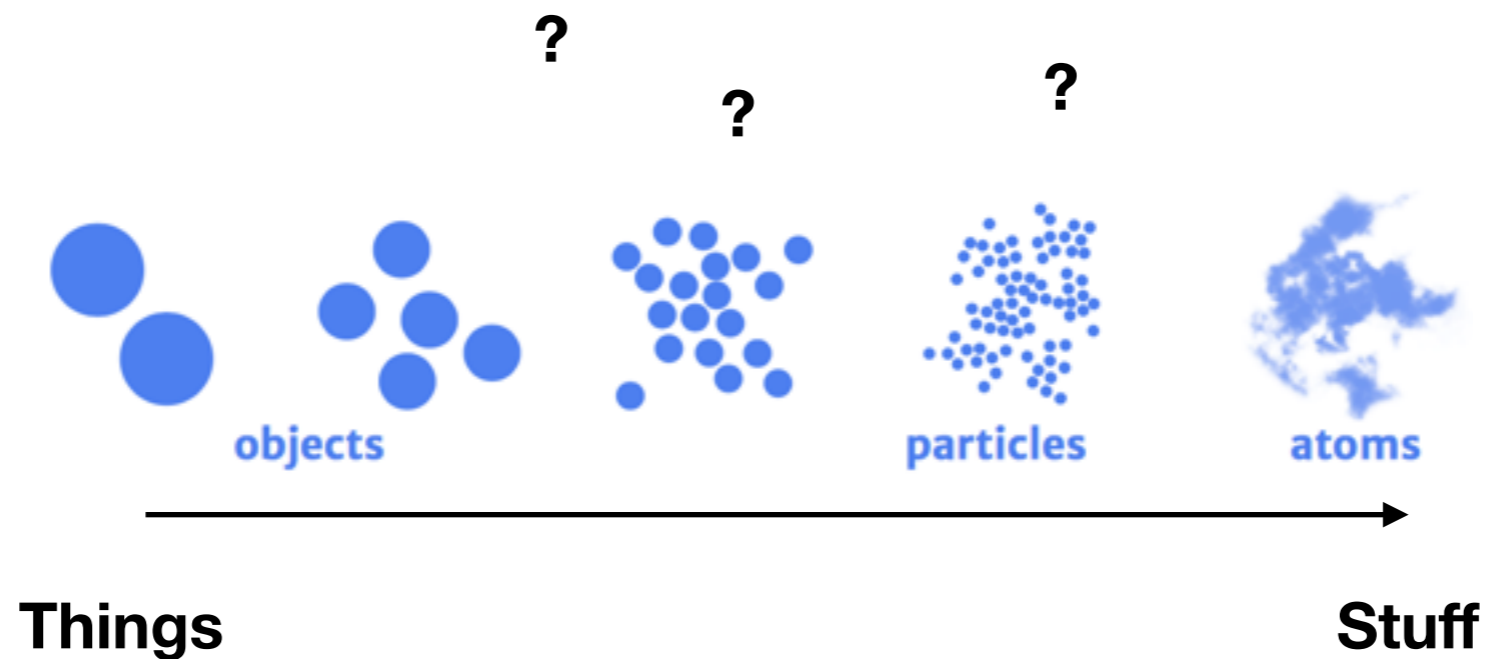
# Rasmussen

Kinetic parameters			
Velocity	Path	Direction	Space
<i>speed</i> <i>acceleration</i> <i>tempo</i> <i>twitter</i> <i>frequency</i>	<i>linear/curved</i> <i>continuous/intermittent</i> <i>smooth/jerky</i> <i>pattern/random</i>	<i>up/down</i> <i>right/left</i> <i>forward/backwards</i>	<i>scale</i> <i>form</i> <i>kinesphere</i>
			
Inflatable Mouse <sup>[26]</sup>	Muscle Tower 2 <sup>[31]</sup>	BMW museum <sup>[1]</sup>	Morphing Harddisk <sup>[20]</sup>

# Rasmussen

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
			
 <p>SlowFurl <sup>[47]</sup></p>	 <p>Pinwheels <sup>[22]</sup></p>	 <p>Topobo <sup>[39]</sup></p>	 <p>Lumen <sup>[36]</sup></p>

# Dynamicity & Flexibility: Toward programmable matter



# **Dynamicity & Flexibility: Toward programmable matter**

“The **ultimate display** would, of course, be a room within which **the computer can control the existence of matter**. A chair displayed in such a room would be good enough to sit in.

Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal.

With appropriate programming such a display could literally be the Wonderland into which Alice walked.”

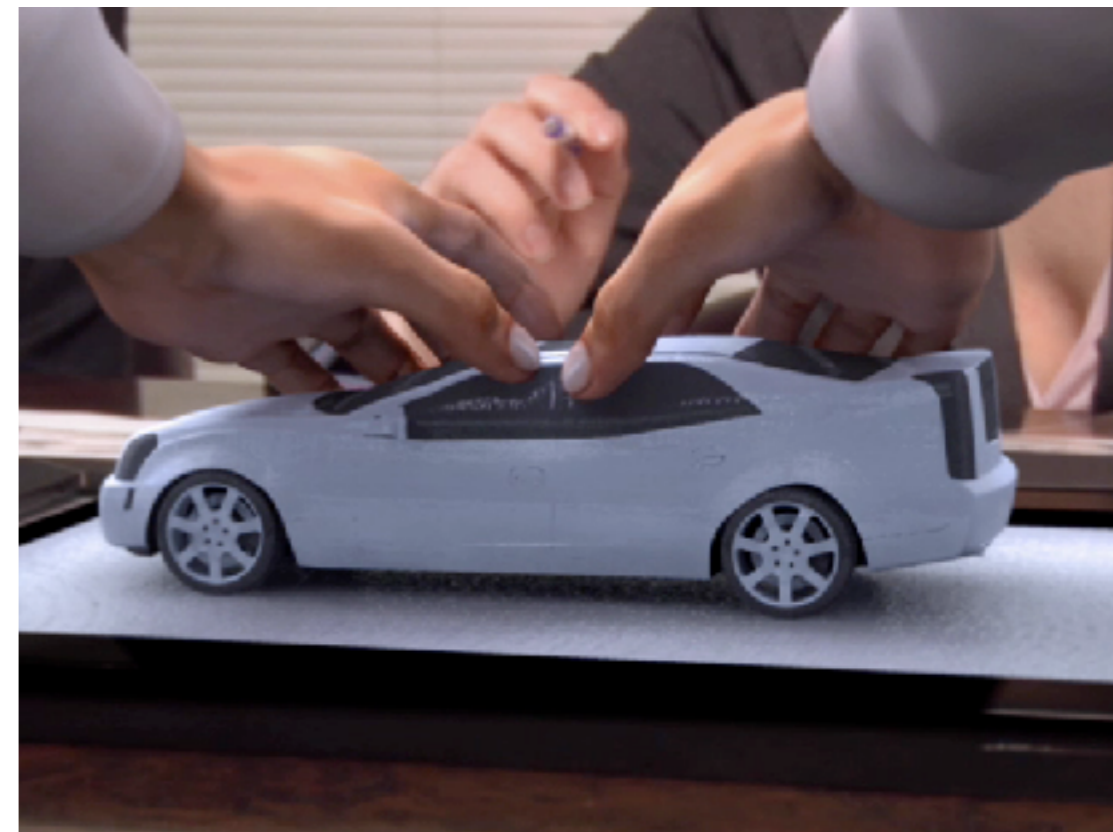
Ivan Sutherland 1965

# Dynamicity & Flexibility: Toward programmable matter

Flexibility will not be software's monopoly  
and will reach Tangibles



Radical Atoms & Perfect Red  
<https://vimeo.com/61141209>



Claytronics

[http://www.cs.cmu.edu/~claytronics/movies/carDesign\\_12\\_vo\\_H264.mov](http://www.cs.cmu.edu/~claytronics/movies/carDesign_12_vo_H264.mov)



# Imagine a shape-changing mobile phone

