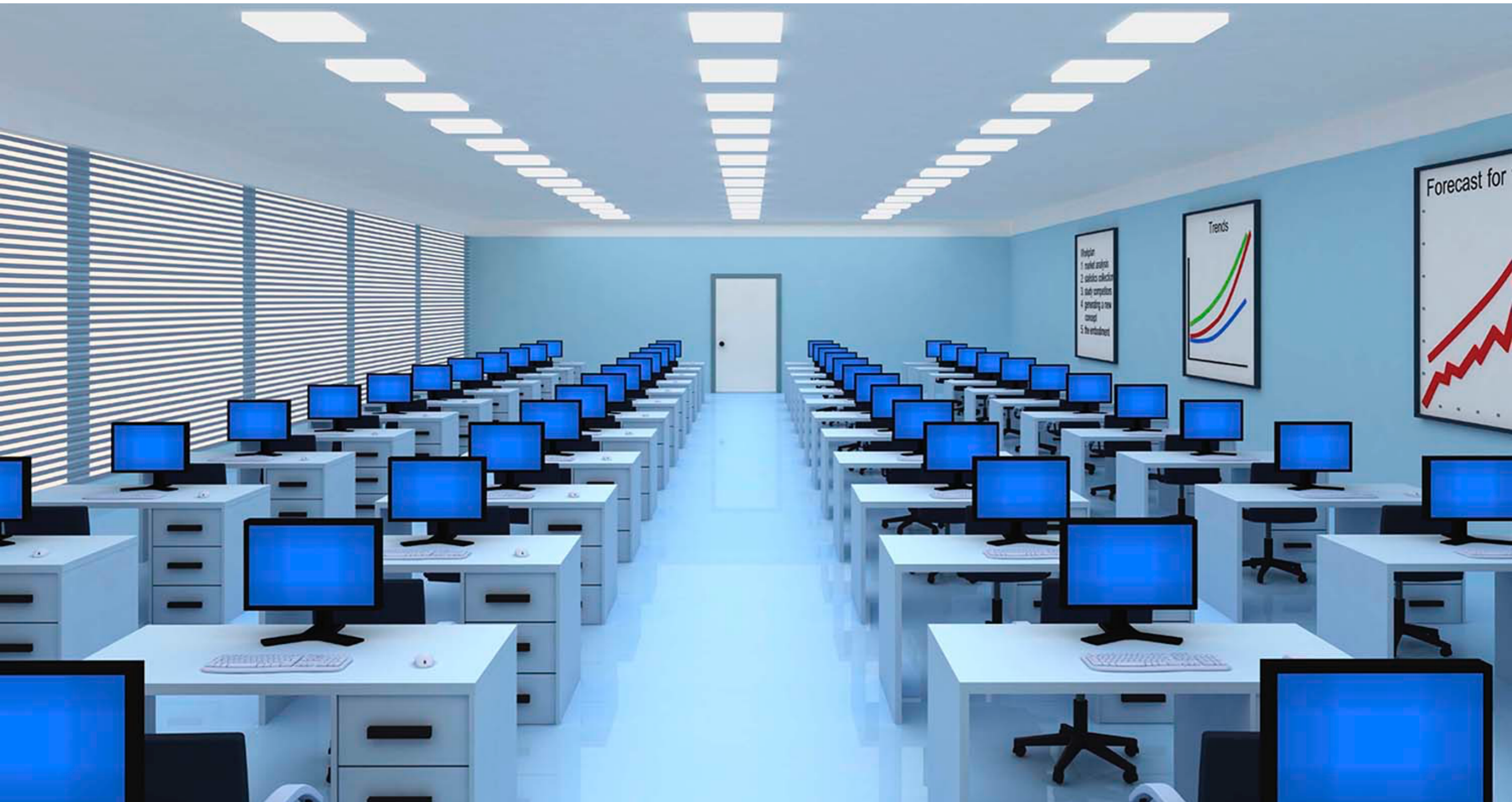


Next generation tangible interaction

Céline Coutrix
Celine.Coutrix@imag.fr

Graphical > Tangible?



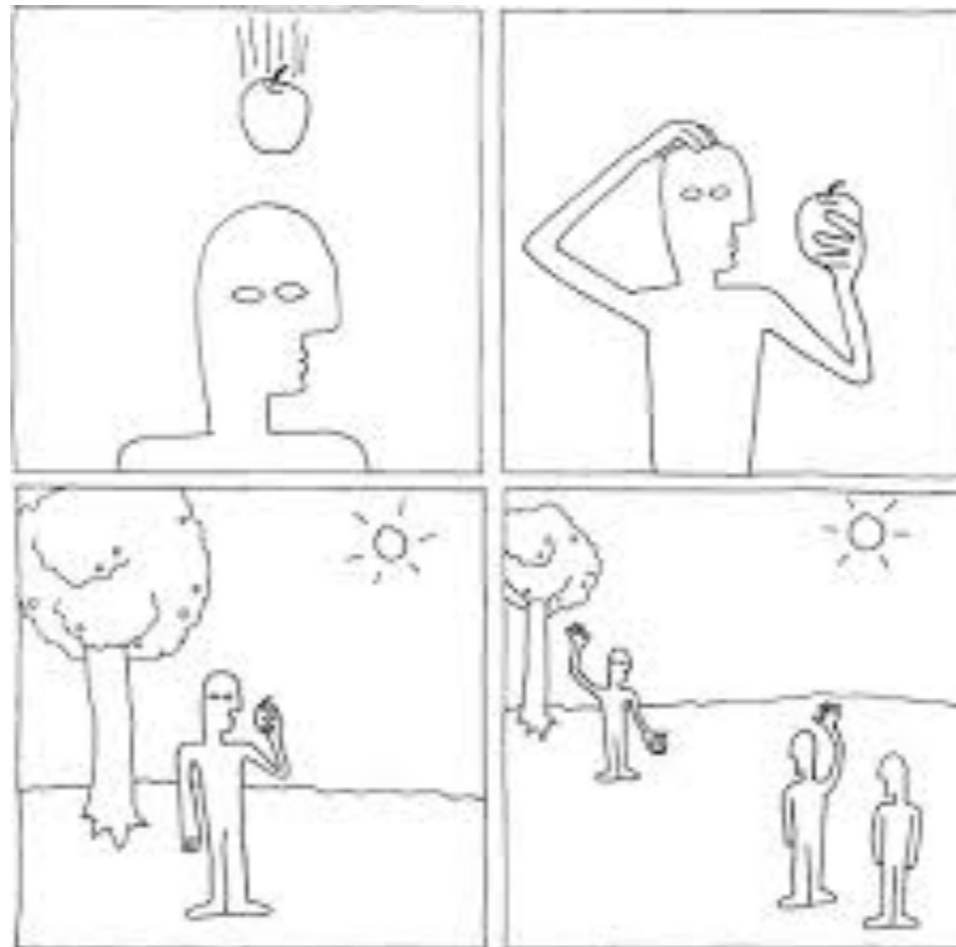
Graphical > Tangible?

- Dynamicity, Flexibility
- Price

Balance between graphical and tangible

As each have benefits and drawbacks

Reality Based Interaction



Compromise with software when it brings benefit

Reality Based Interaction

Interface design

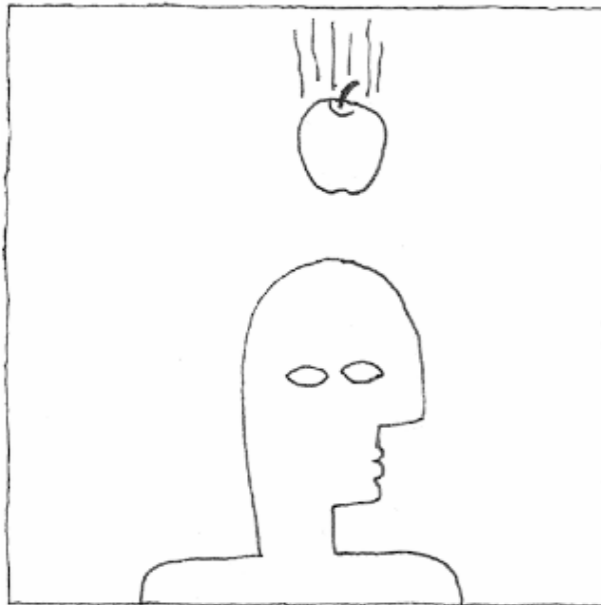
- Build on 4 themes (= **human capabilities**) from the “real” world
- Compromise with 6 **tradeoffs** in order to reach design goal



Which human capabilities from the physical world do these UIs leverage?

1. Balance game: <https://www.youtube.com/watch?v=fWOGxhEfvNE&t=27s> (6'42")
2. Xbox: <https://www.youtube.com/watch?v=oyjNqksc-m8> (0'32")
3. AR T-rex: https://www.youtube.com/watch?v=_tS37IOsLeE
4. Xbox: <https://www.youtube.com/watch?v=oyjNqksc-m8> (1'31")

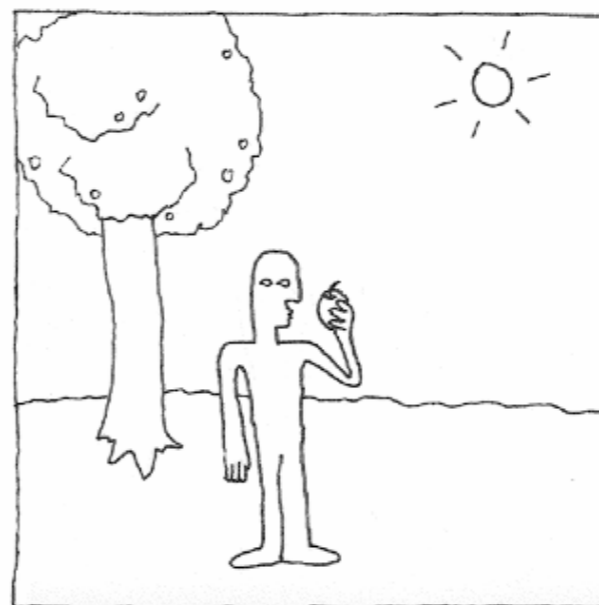
Reality Based Interaction



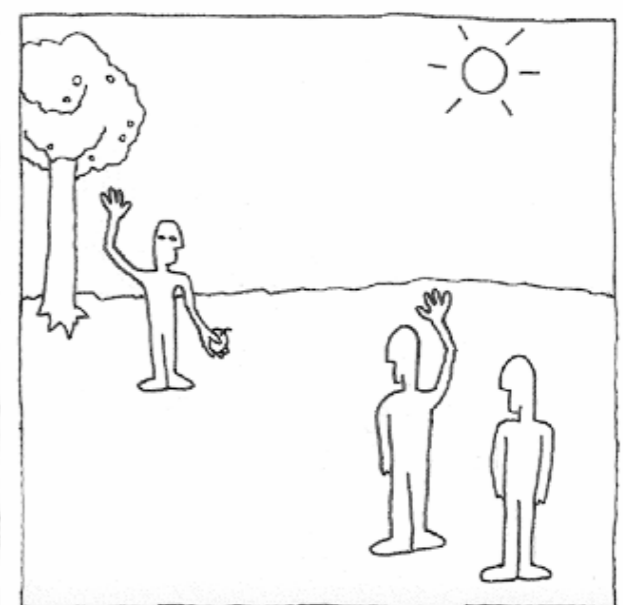
Naïve Physics



Body Awareness & Skills

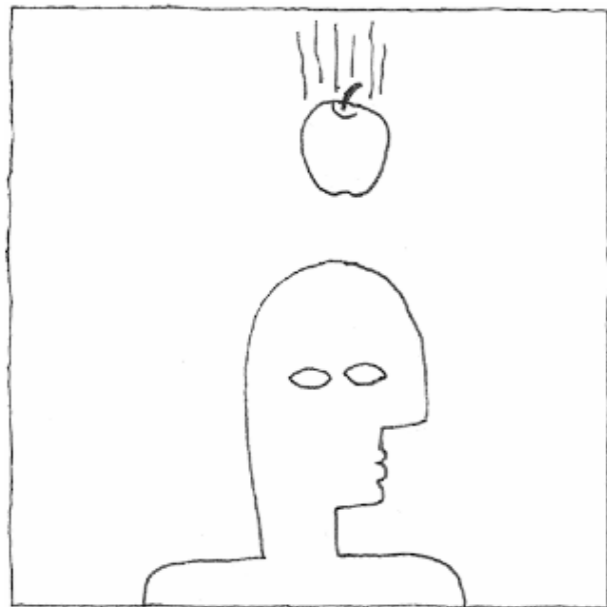


Environment Awareness & Skills



Social Awareness & Skills

Reality Based Interaction

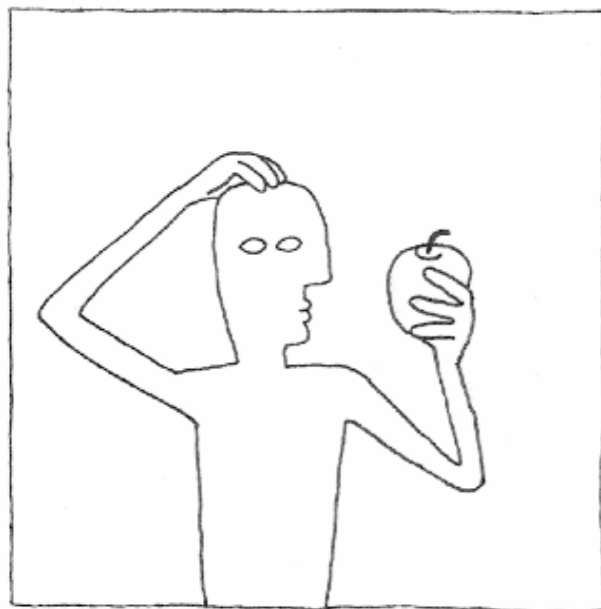


Naïve Physics

E.g., gravity, friction, velocity

Example of interfaces using users' knowledge of naive physics?

Reality Based Interaction

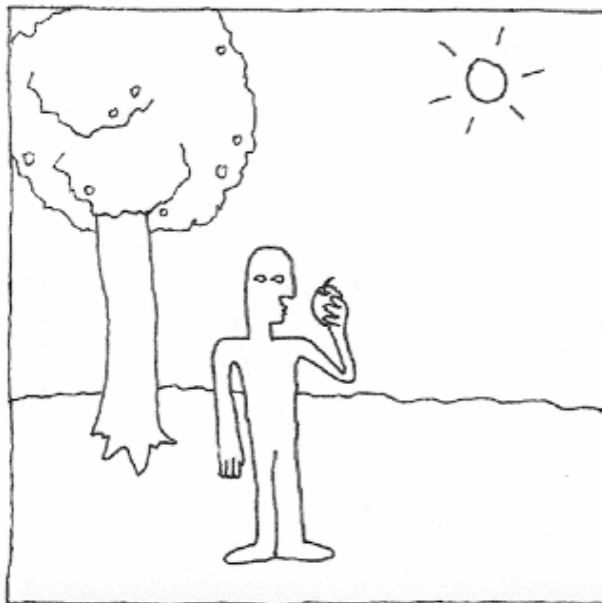


Body Awareness & Skills

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

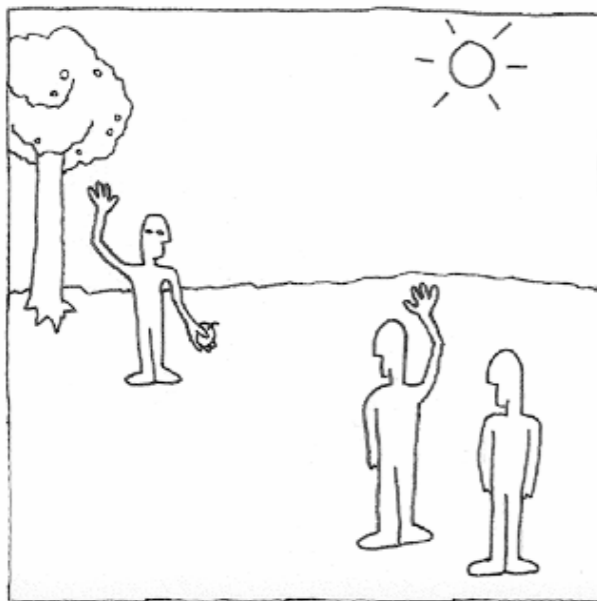


Environment Awareness & Skills

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?



**Why not copying the
physical world?**



Why not copying the physical world?



vs.





Why not copying the physical world?

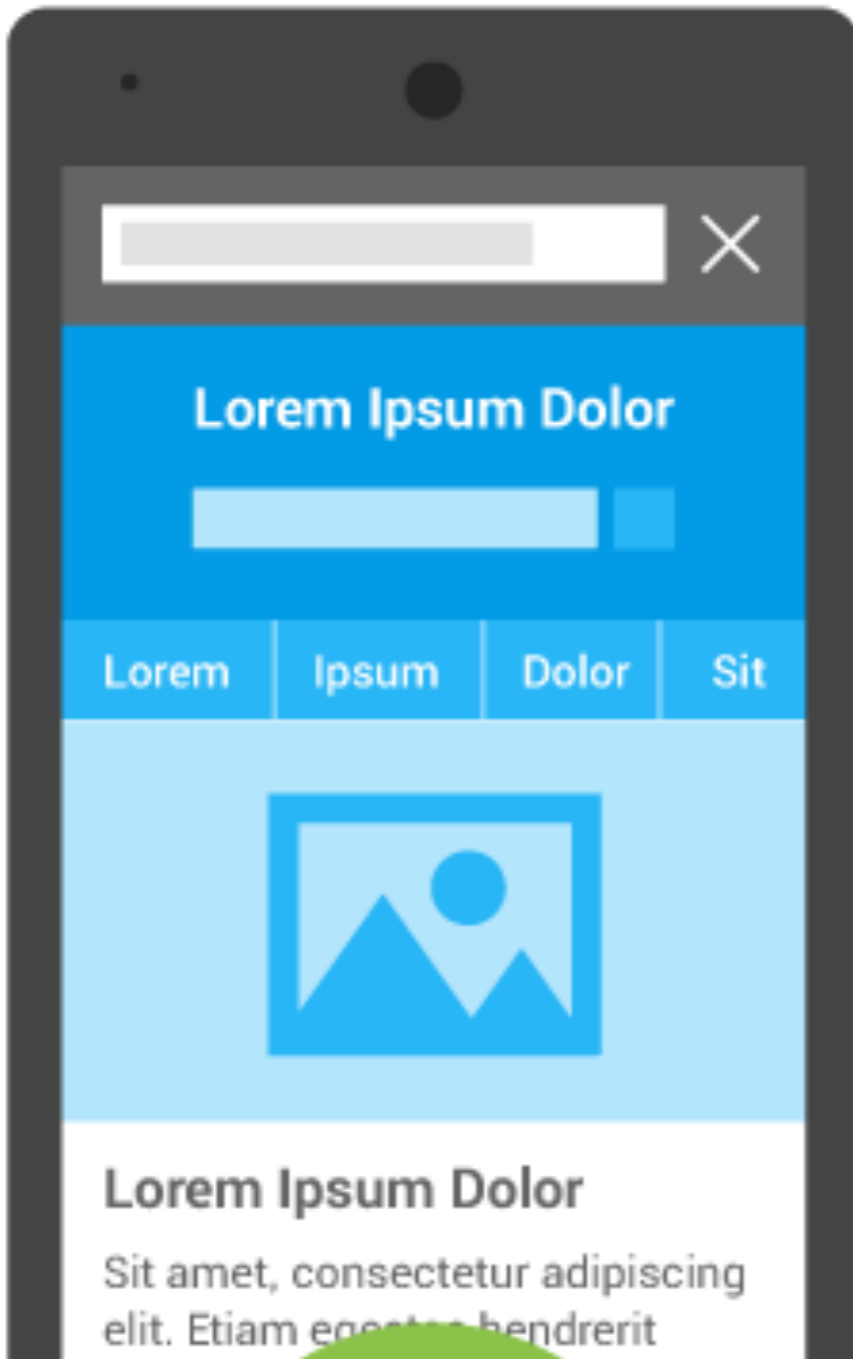


vs.





Why not copying the physical world?

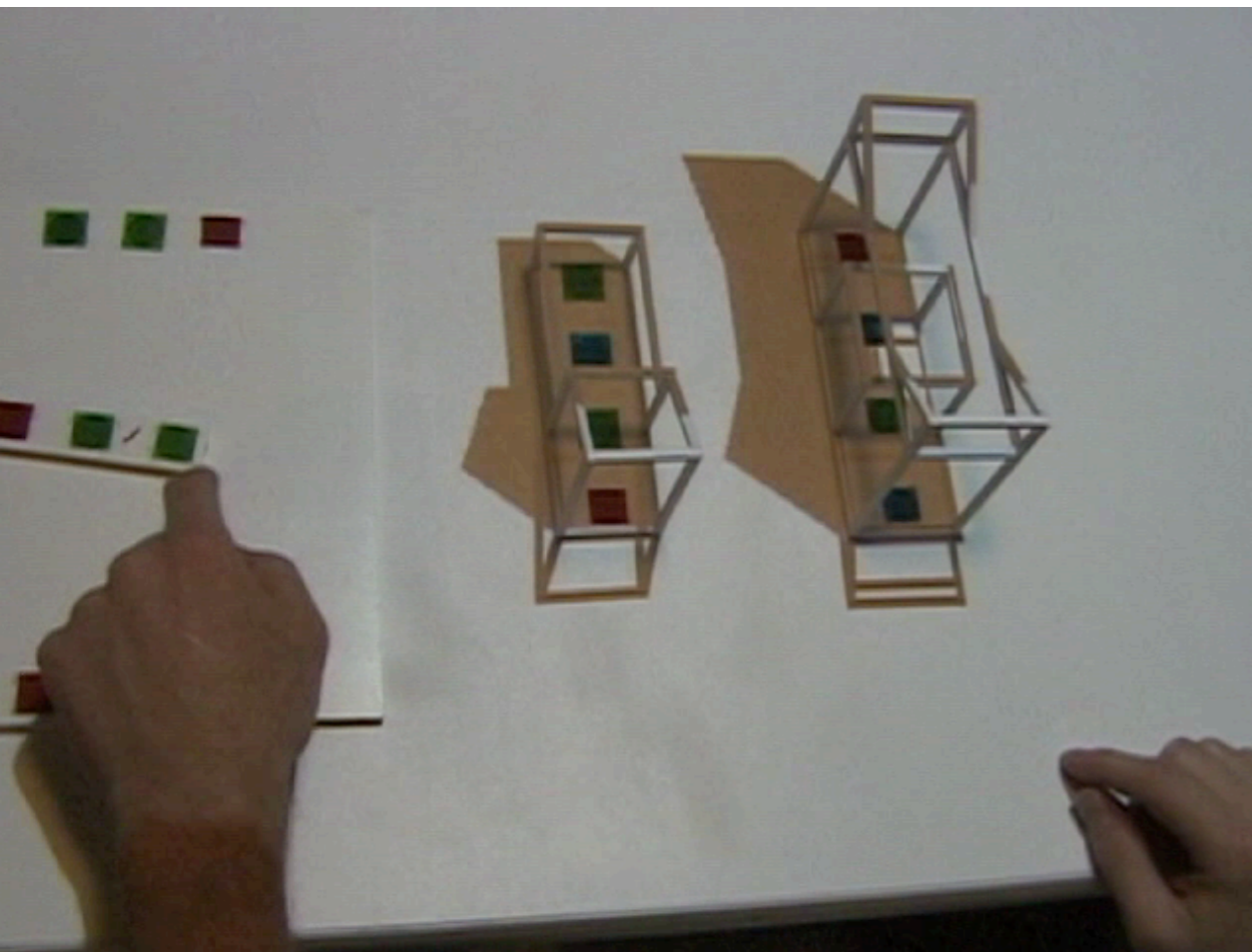


vs.





Why not copying the physical world?



vs.





Why not copying the physical world?



vs.



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

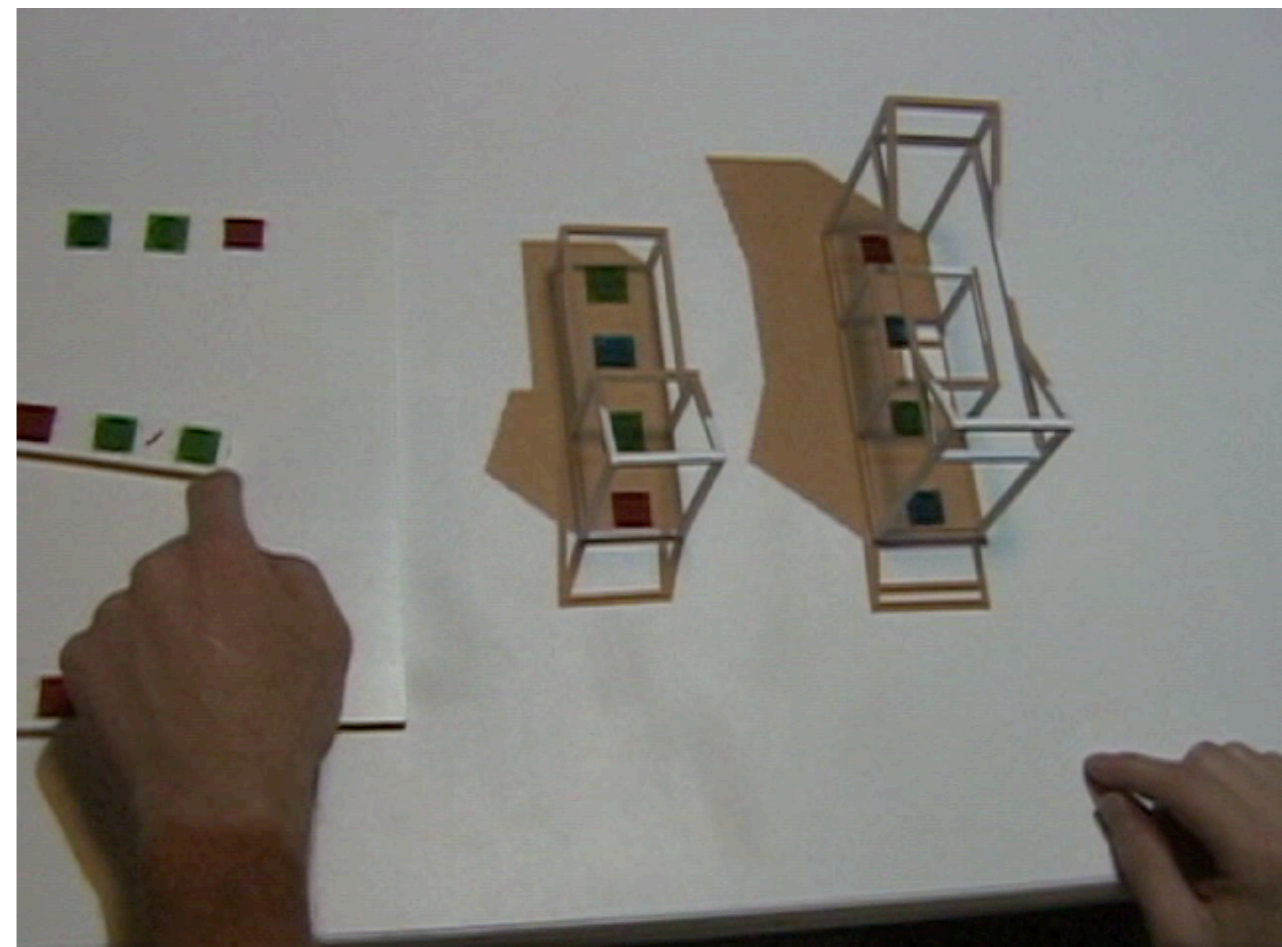
(designers) ability to produce the system

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?

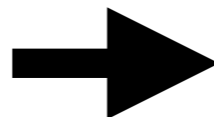
- Expressive power
- Efficiency
- Versatility
- Ergonomics
- Accessibility
- Practicality

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



Industry



Palette Gear (2012)

Industry



Microsoft Surface Studio (2016)



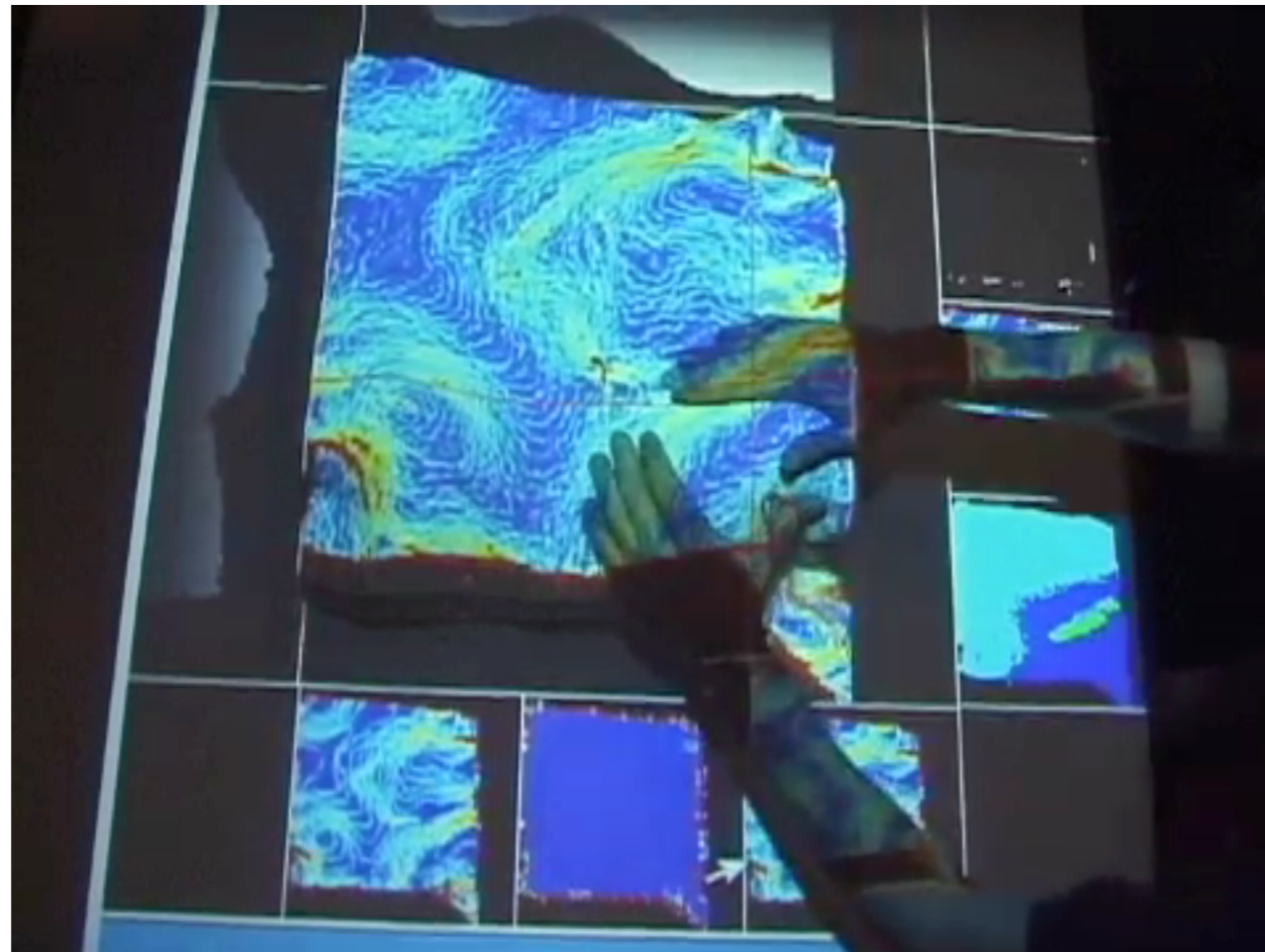
How can we benefit again from Tangibility?



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

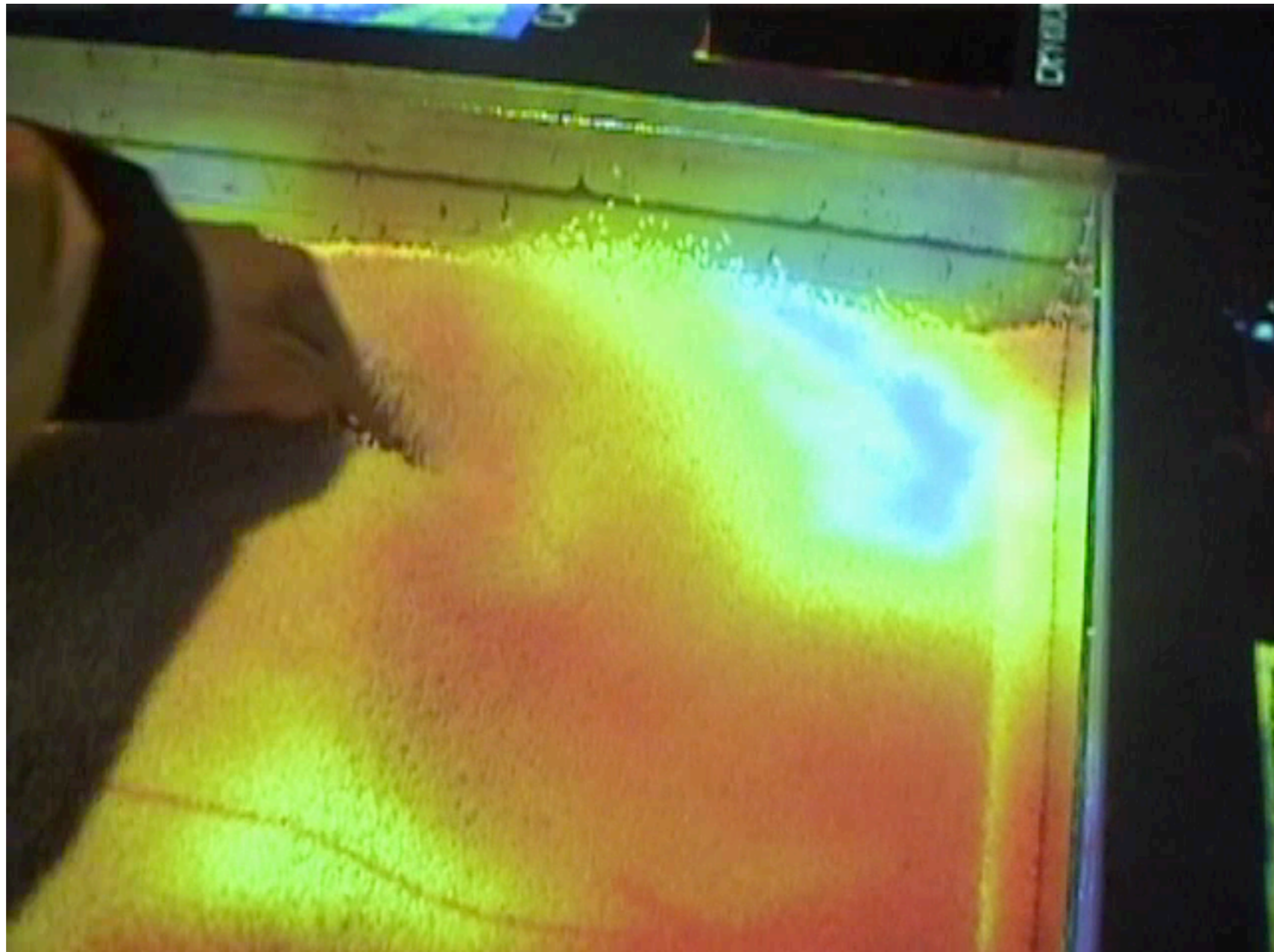
Dynamicity & Flexibility: Shape

Illuminating Clay



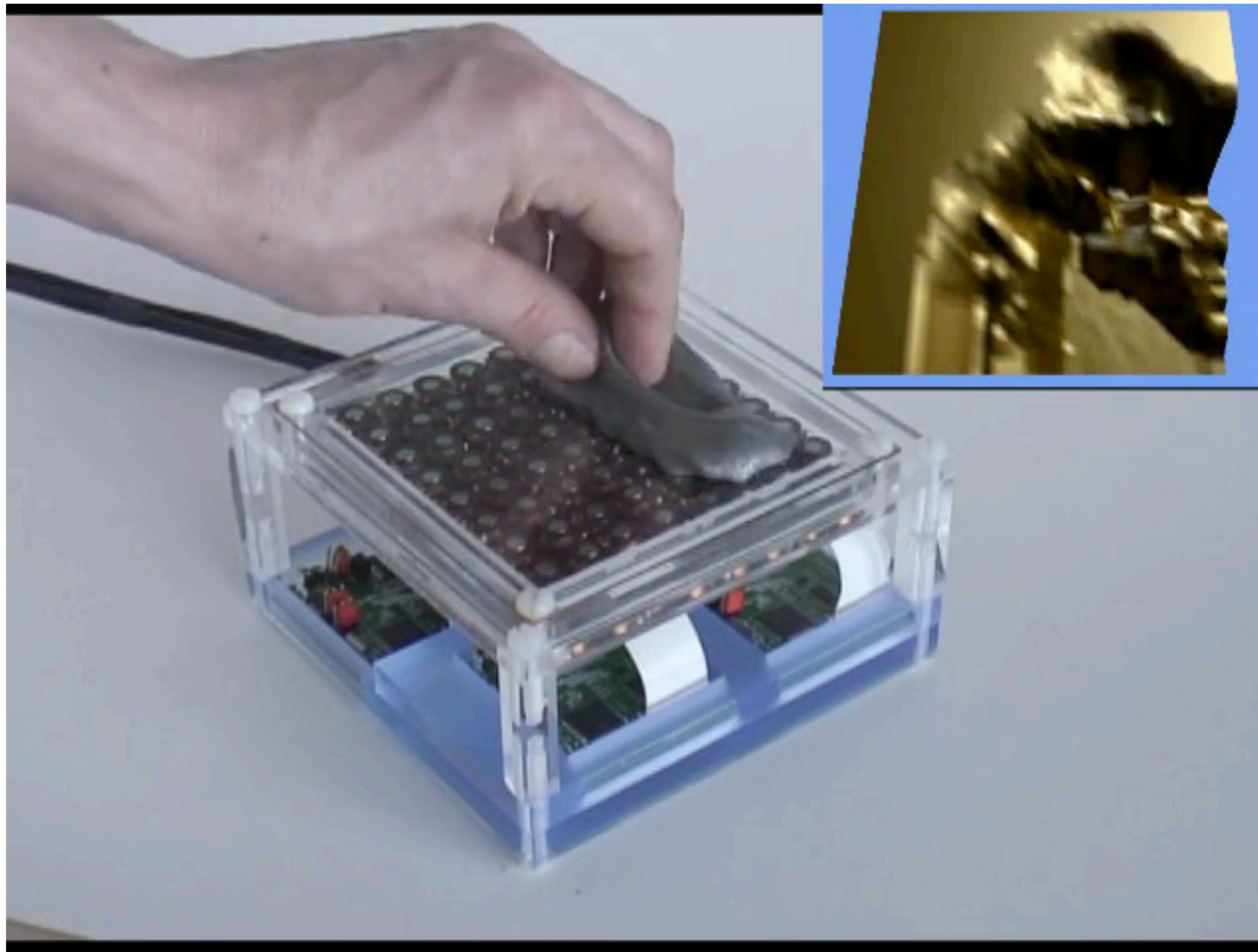
Dynamicity & Flexibility: Shape

SandScape



Dynamicity & Flexibility: Shape

A Reconfigurable Ferromagnetic Input Device



Dynamicity & Flexibility: Shape

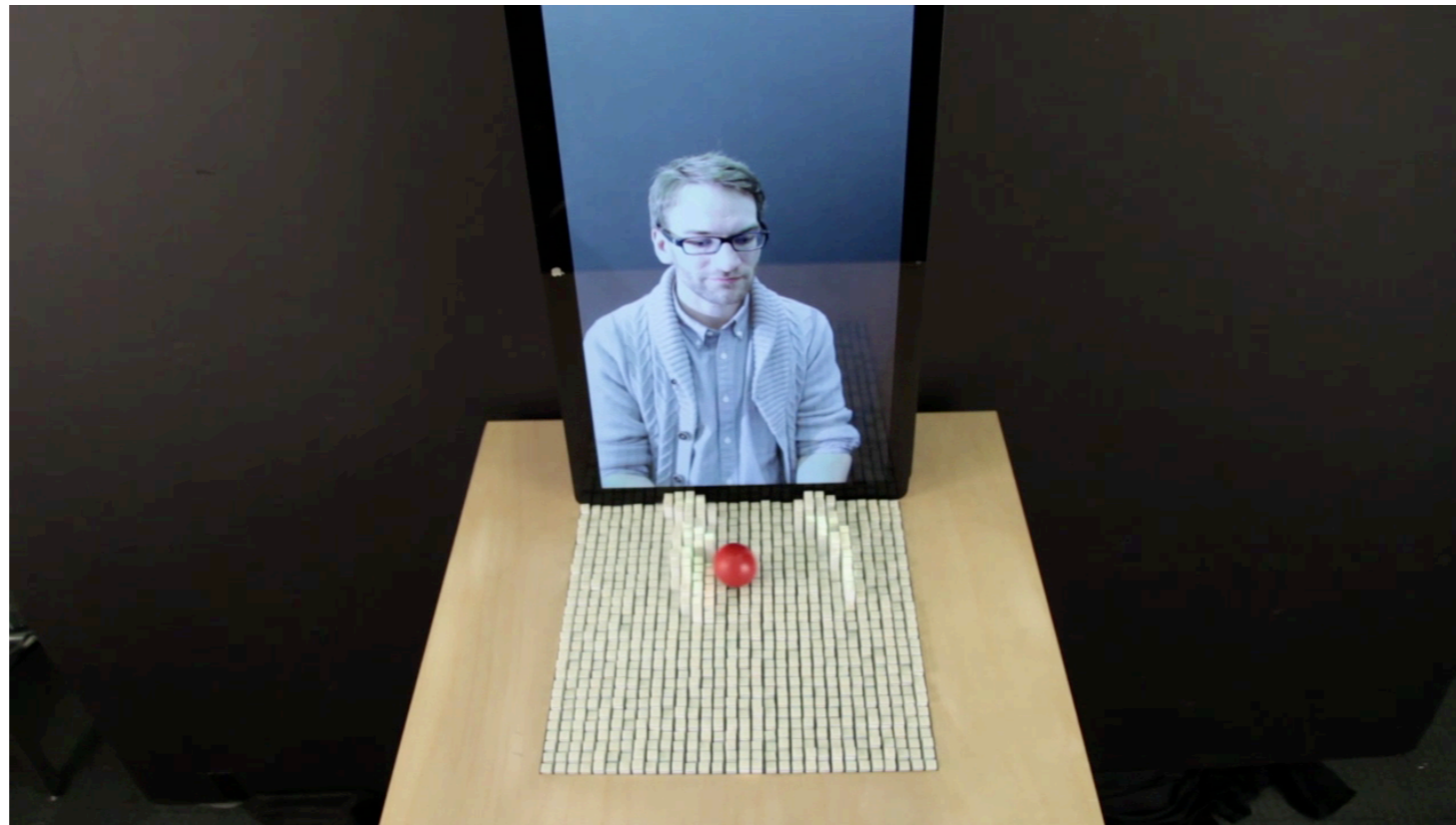
Dynamically changeable buttons:
http://www.youtube.com/watch?v=Smai_Z_galE

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

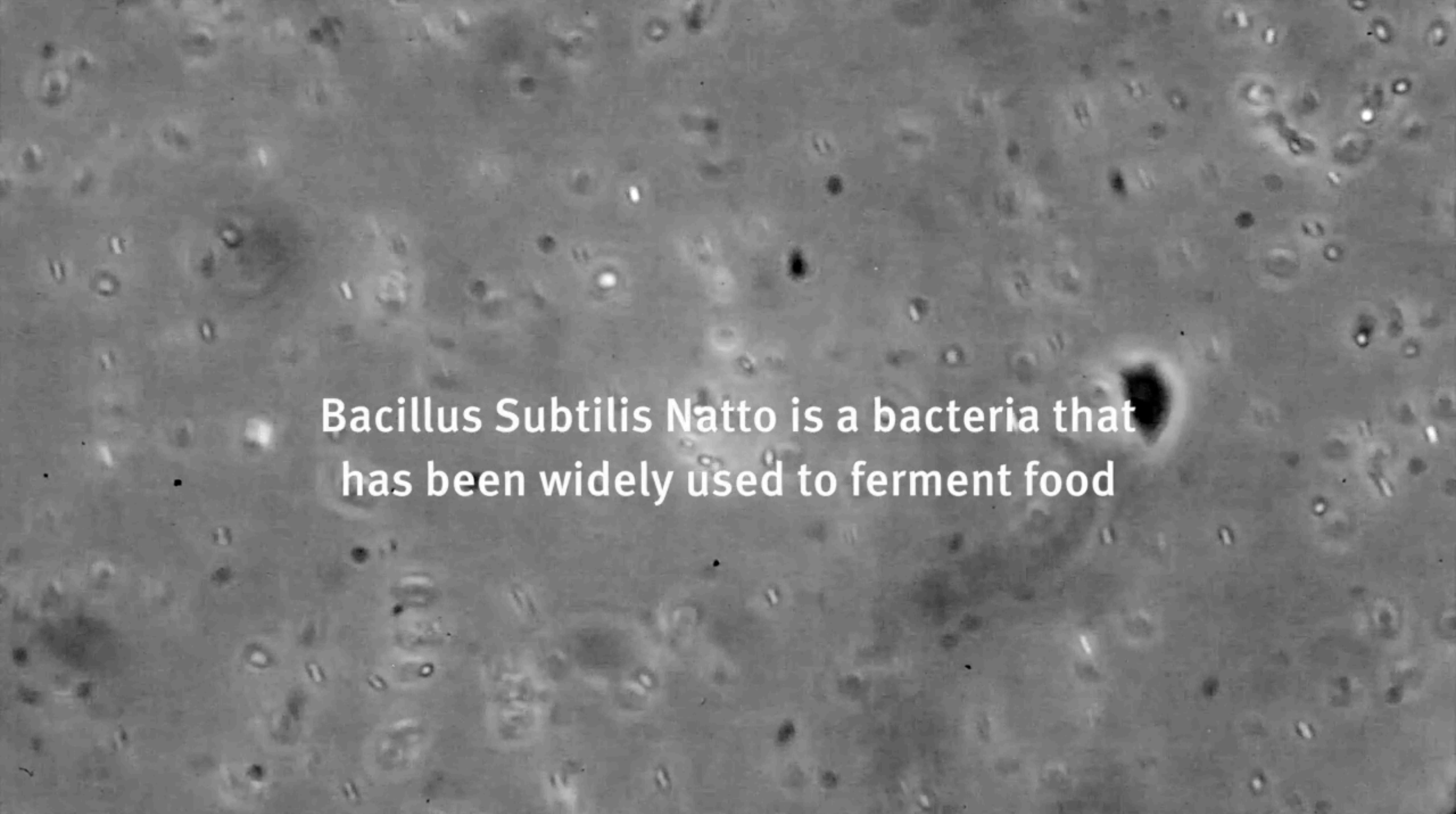
FLOWER



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 scattered across the field of view, with some appearing as bright, distinct spots and others as faint, elongated structures. The background is a uniform, light gray color.

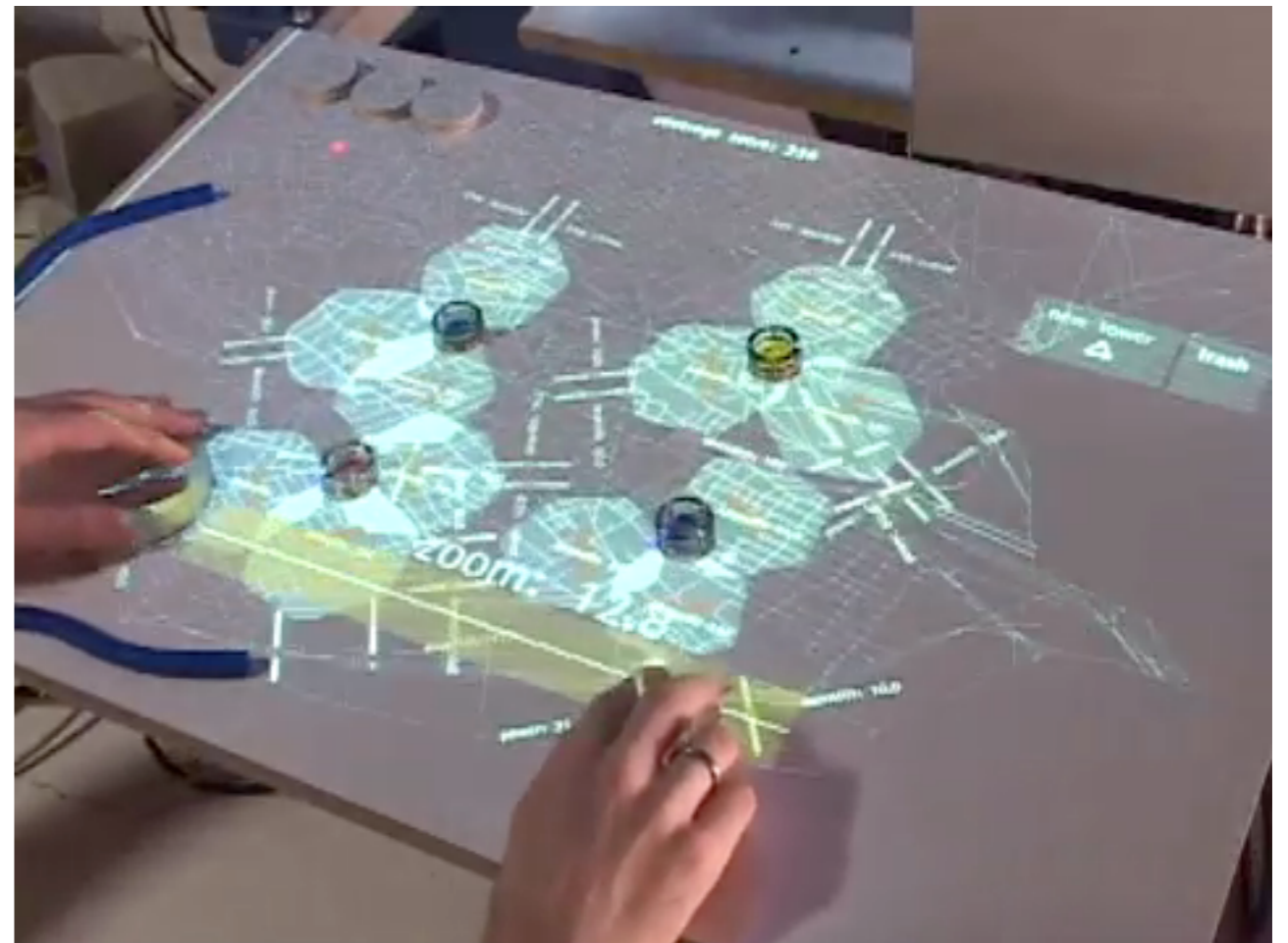
Bacillus Subtilis Natto is a bacteria that
has been widely used to ferment food

Dynamicity & Flexibility: 2D location

Actuated workBench



PICO



Dynamicity & Flexibility: 2D location

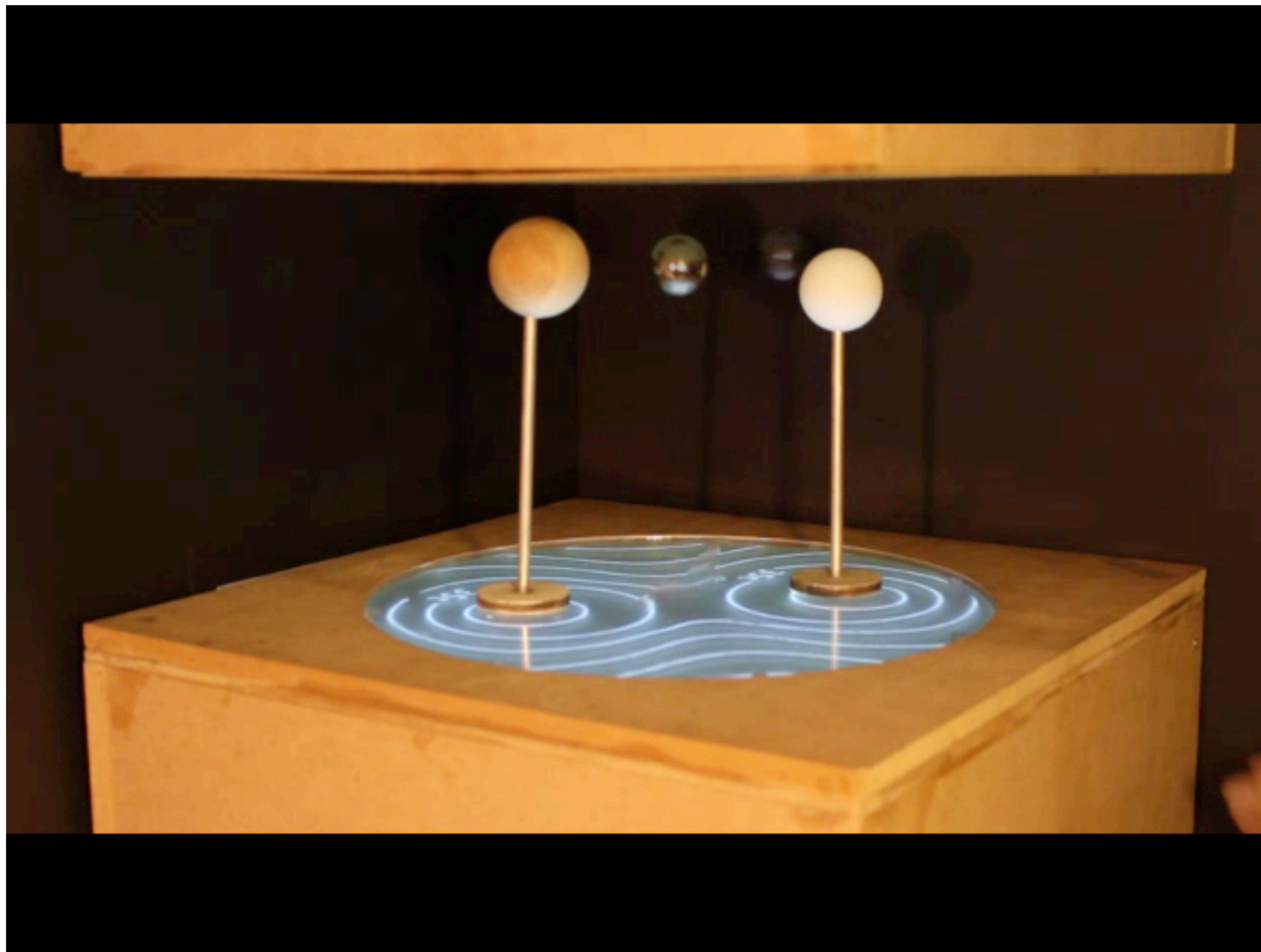


SwarmUI

<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

Dynamicity & Flexibility: 3D location

Intel Drone display

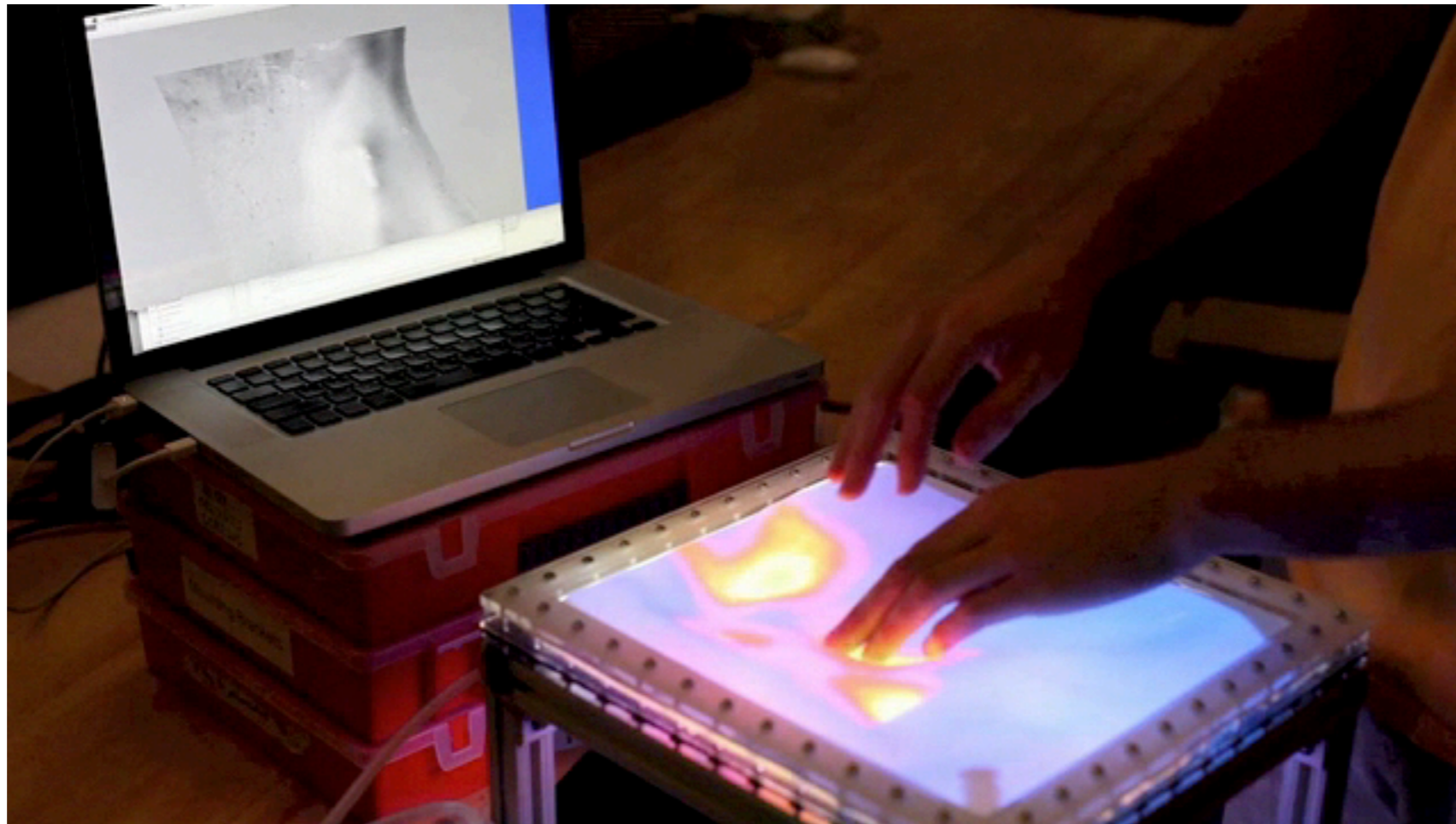
https://www.youtube.com/watch?v=aOd4-T_p5fA

Dynamicity & Flexibility: 3D location

bitDrones

<https://www.youtube.com/watch?v=hHBYMWc3ux8>

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

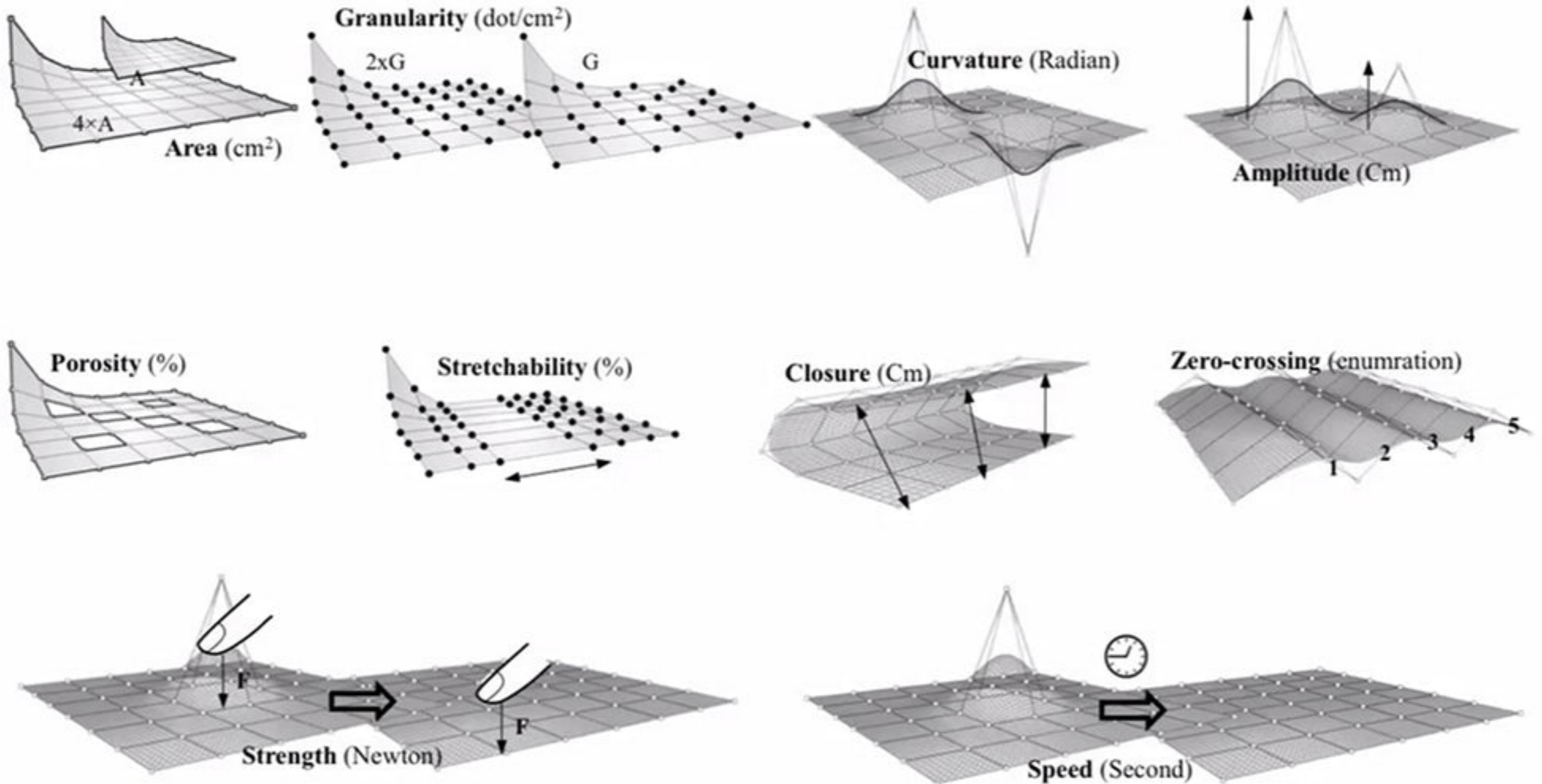
- Shape
- 2D location
- 3D location
- Stiffness
- Weight
- ...

Many dimensions, Many technologies

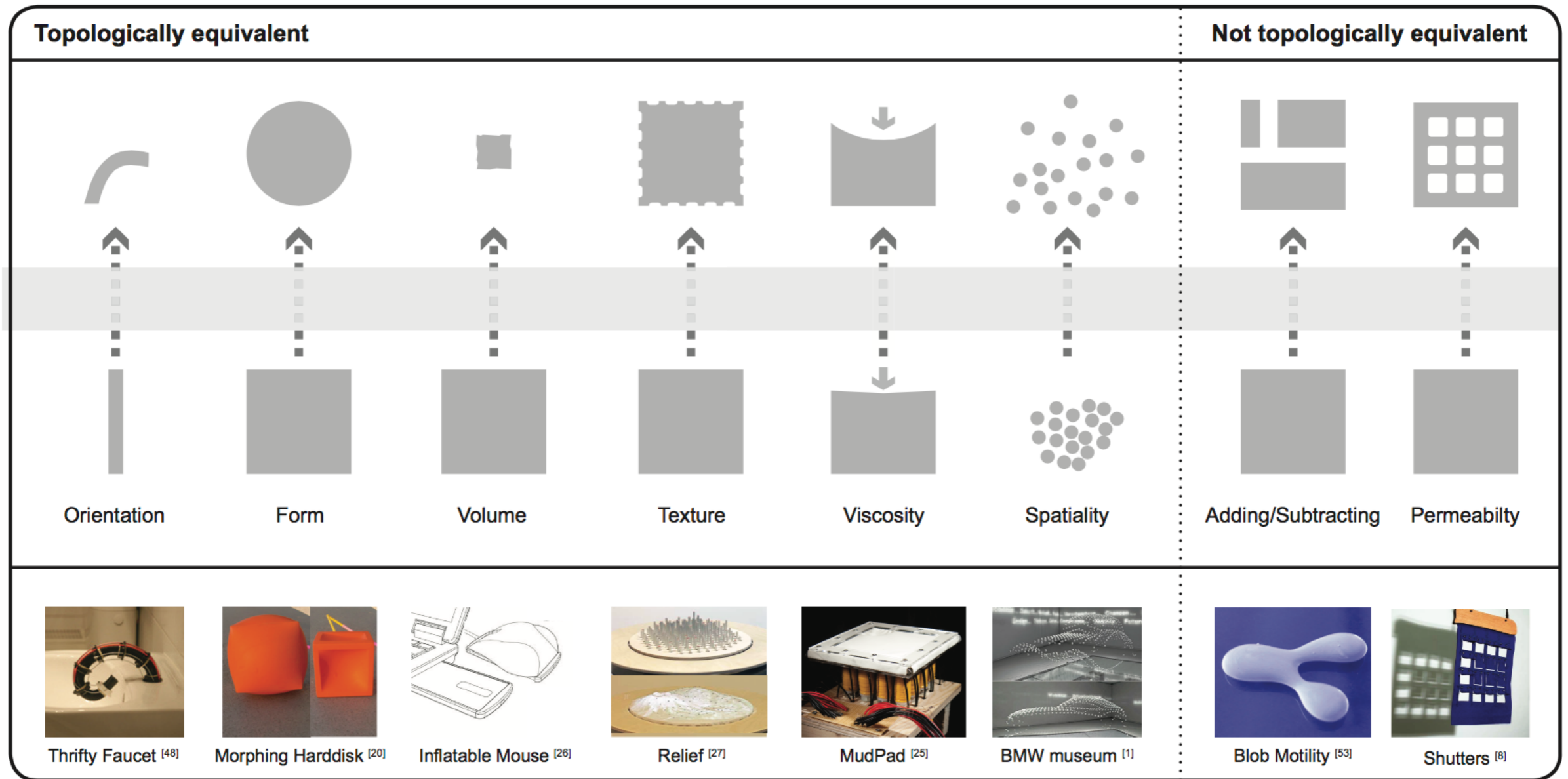
How to make sense of it?

→ Taxonomies and Design spaces

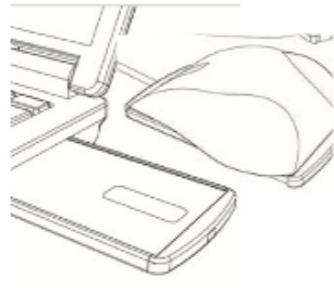

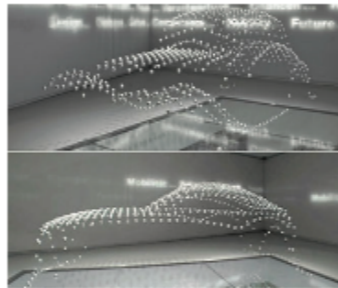
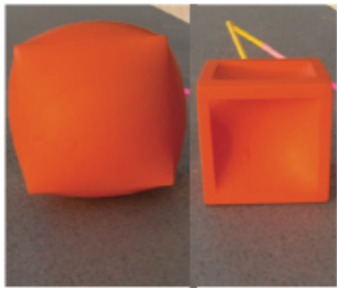
Roudaut's Shape Resolution



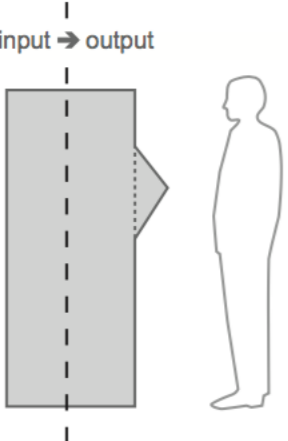
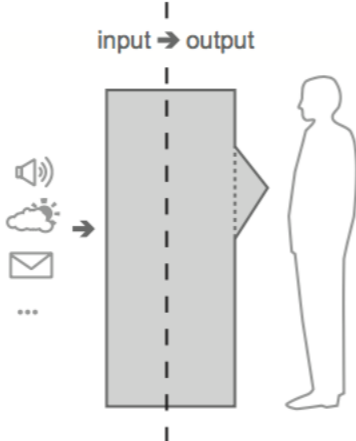
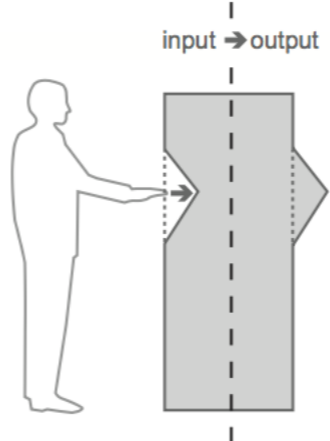
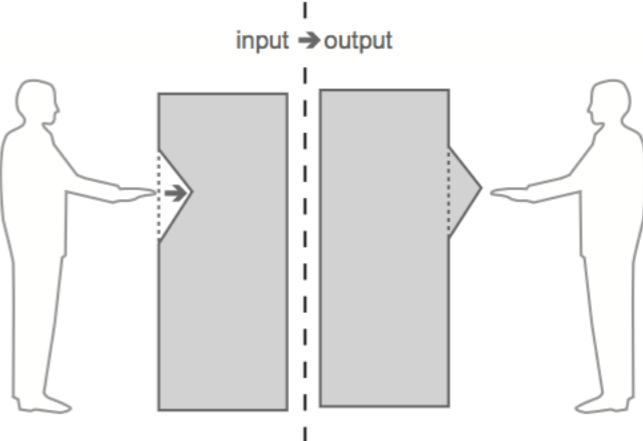


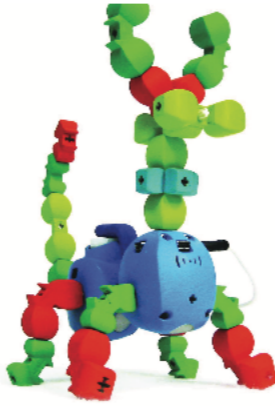

Rasmussen



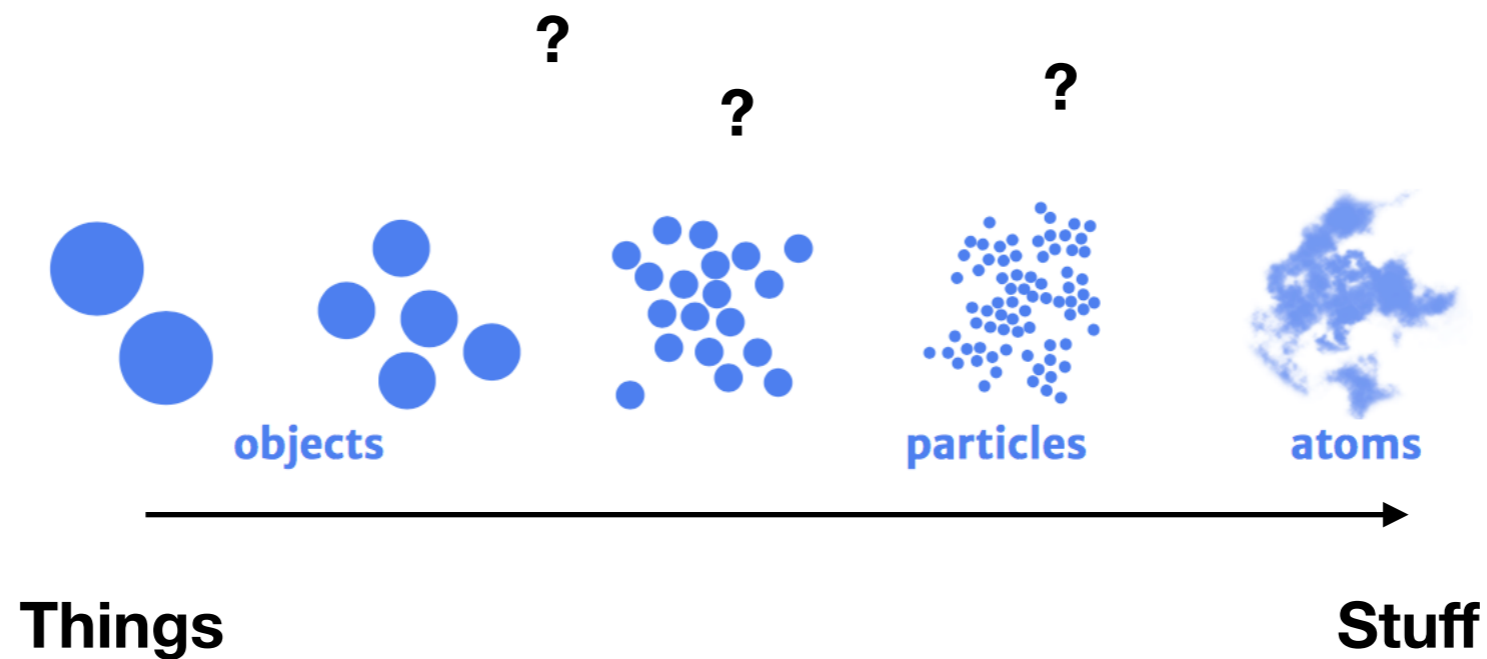
Rasmussen

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 ^[26]	Muscle Tower 2 ^[31]	BMW museum ^[1]	Morphing Harddisk ^[20]

Rasmussen

No interaction	Indirect interaction	Direct interaction	
<p>Shape-changing output only</p> <p>input → output</p> 	<p>Implicit input and shape-changing output</p> <p>input → output</p> 	<p>Shape-changing input and output</p> <p>input → output</p> 	<p>Shape-changing input and remote output</p> <p>input → output</p> 
 <p>SlowFurl ^[47]</p>	 <p>Pinwheels ^[22]</p>	 <p>Topobo ^[39]</p>	 <p>Lumen ^[36]</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.”

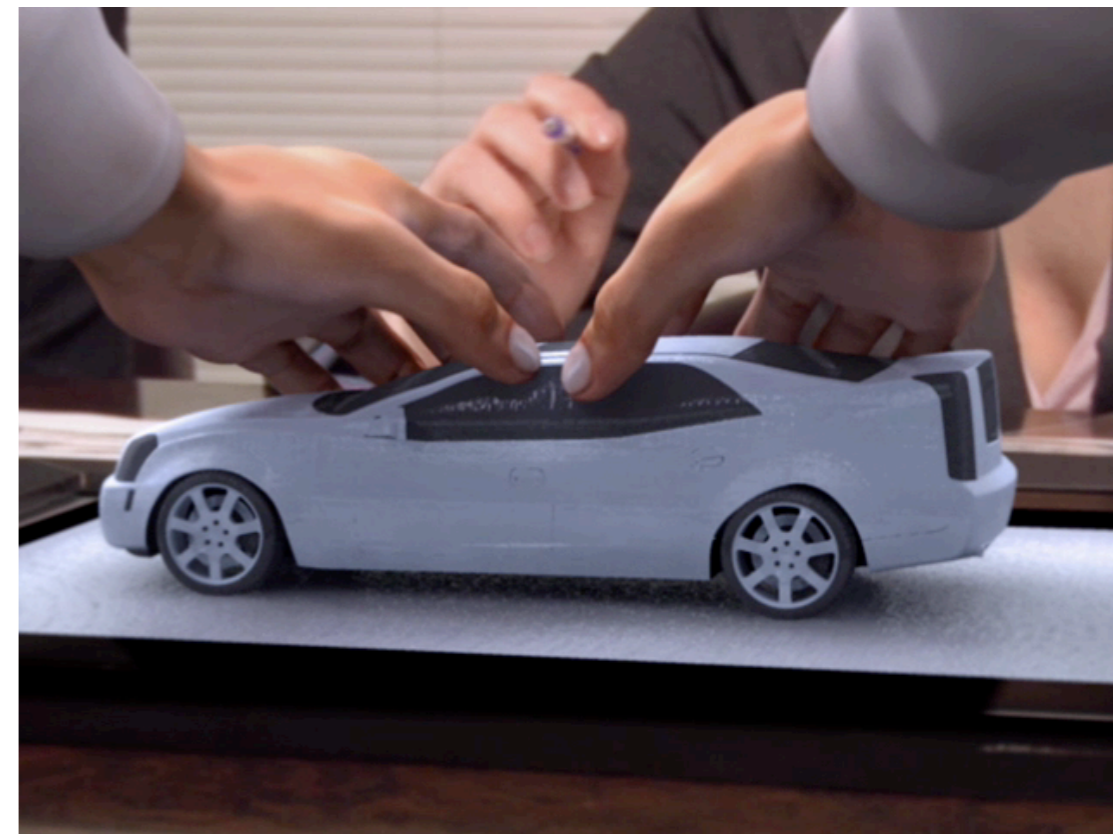
Ivan Sutherland 1965

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

Imagine a shape-changing mobile phone



When is the shape of your phone a problem?