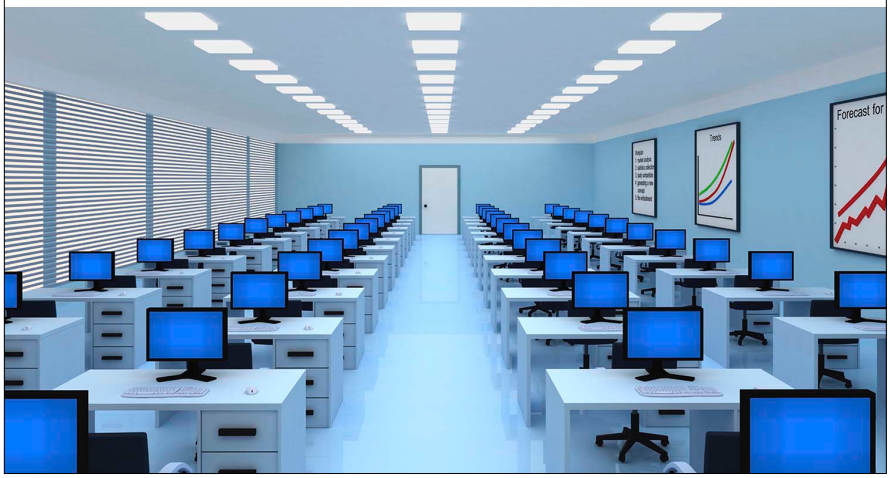
Tangible User Interfaces
What are their limitations?

Graphical > Tangible?



Graphical > Tangible?

- Dynamicity, Flexibility
- Price

Graphical > Tangible?

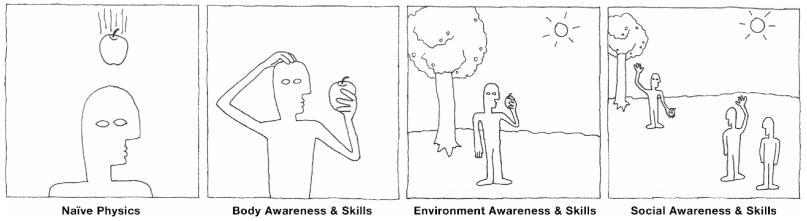
- Reality based interaction
  - Compromise with software when it brings benefit

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

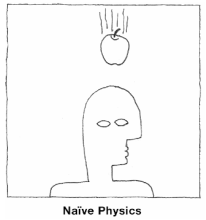
Reality Based Interaction

- 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



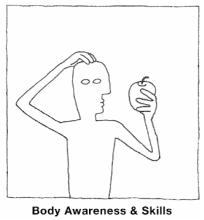
Reality Based Interaction



E.g., gravity, friction, velocity

Example of interfaces using users’ knowledge of naive physics?

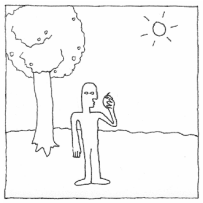
Reality Based Interaction



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?

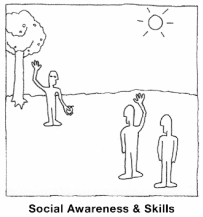
Reality Based Interaction



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



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

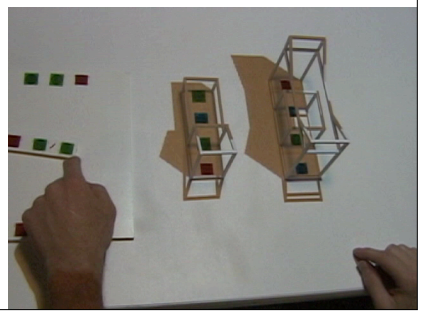
Practicality
(designers) ability to produce the system

Reality Based Interaction

Case study: URP

What themes does URP use?

- Naive Physics
- Body
- Environment
- Social Awareness



Reality Based Interaction

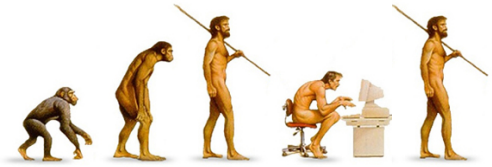
What does URP sacrifice for which benefit?

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

Graphical > Tangible?

- Software mouse+touch GUI took over
- Tangible might be coming back
  E.g., induction hub
  with removable magnetic tangible knob
- New and Open research areas
  that bring tangibles closer to software

How can we benefit again from Tangibility?

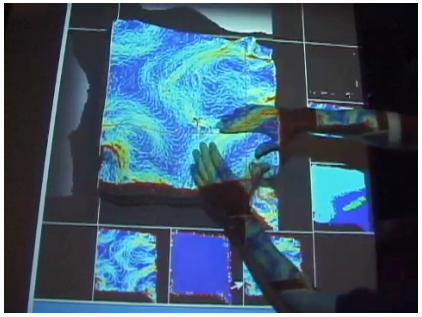


BREAK

- Focus group

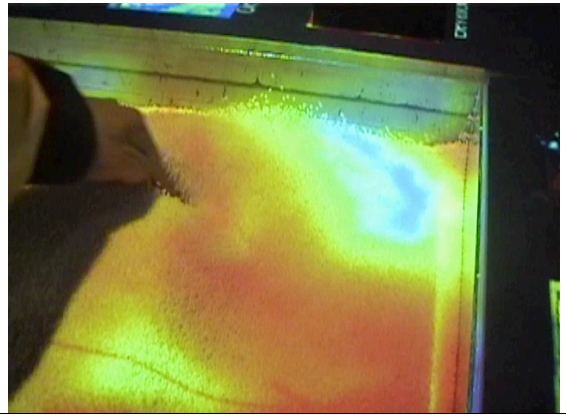
Dynamicity & Flexibility: Shape

Illuminating Clay



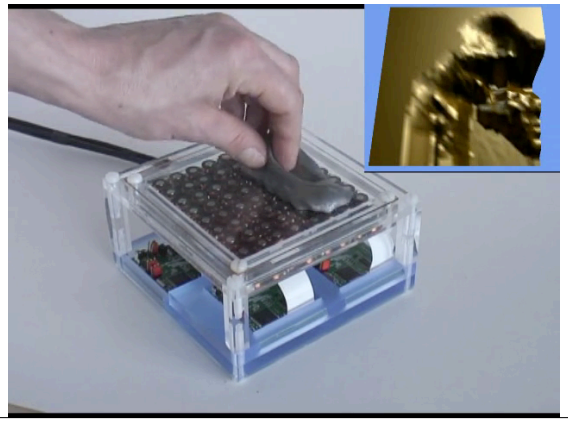
Dynamicity & Flexibility: Shape

SandScape



Dynamicity & Flexibility: Shape

A Reconfigurable Ferromagnetic Input Device



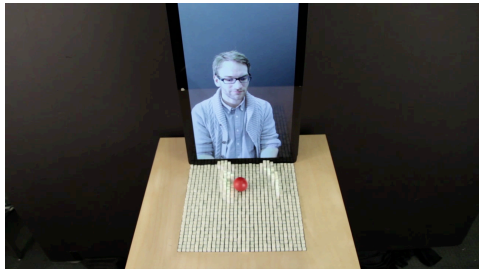
Dynamicity & Flexibility: Shape

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

Dynamicity & Flexibility: Shape

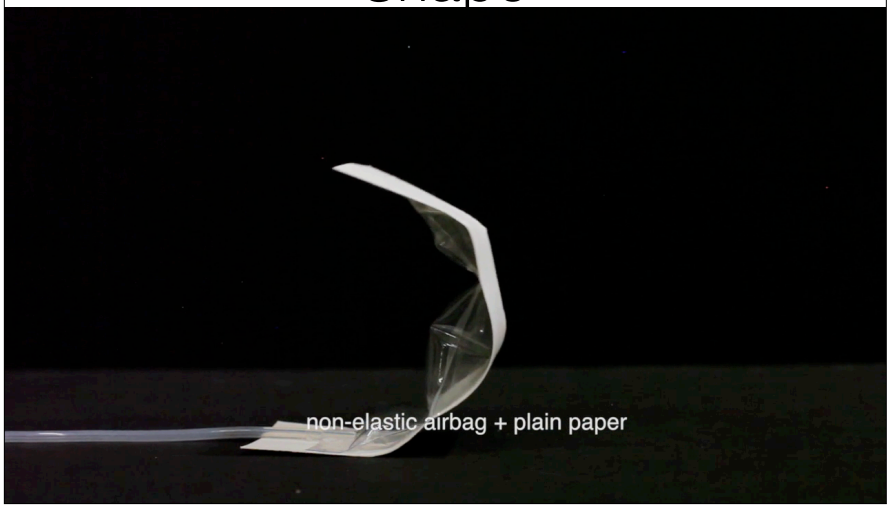
Shutters with shape memory alloy

Dynamicity & Flexibility: Shape



Dynamicity & Flexibility: Shape

Dynamicity & Flexibility: Shape



Dynamicity & Flexibility: Shape

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Dynamicity & Flexibility: Shape

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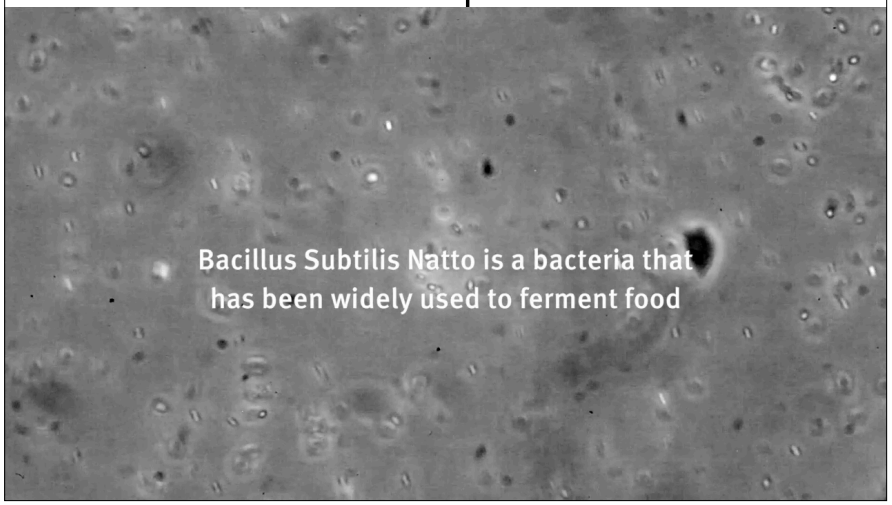
Dynamicity & Flexibility: Shape with nanoscopic cells



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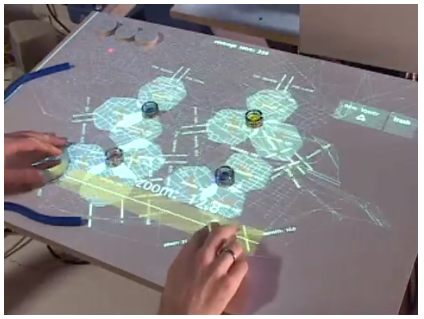
Dynamicity & Flexibility: 2D location

Actuated workBench

PICO



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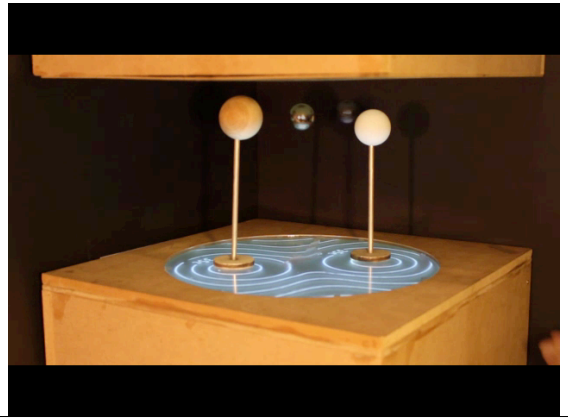
Dynamicity & Flexibility: 3D location

(several technologies)



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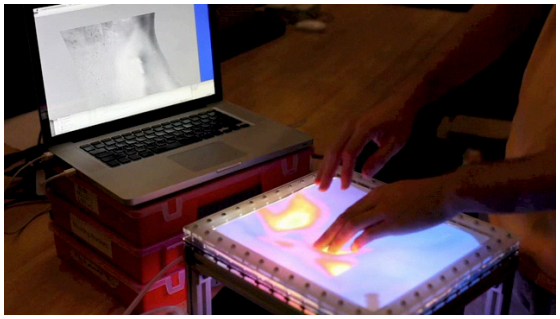
Dynamicity & Flexibility: Stiffness



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Dynamicity & Flexibility: Stiffness

3D Printing Pneumatic Device Controls
with Variable Activation Force Capabilities

https://youtu.be/-4gFYvhkz0Y

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Dynamicity & Flexibility: Weight

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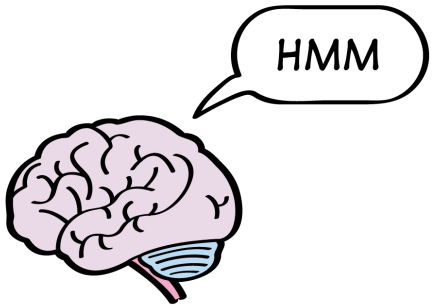
Dynamicity & Flexibility: What is is good for?



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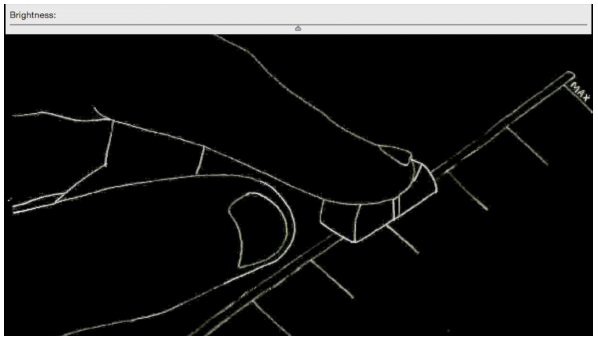

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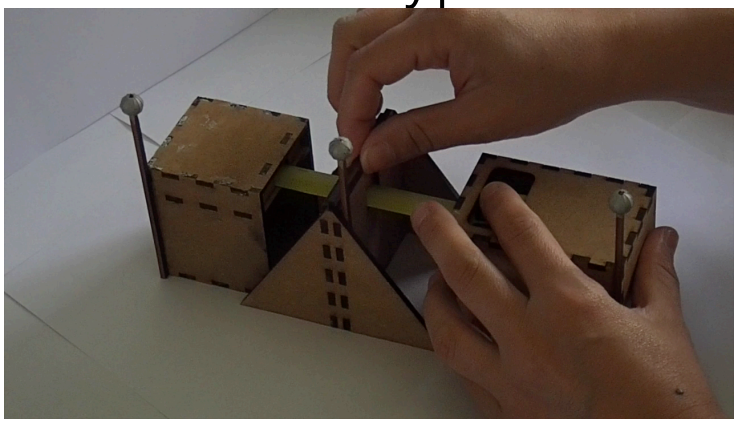
Prototype



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Prototype

resolution: 2822 dpi

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Benefit of Multiple Sizes: Experiment 1

How much more efficient are users
with a large slider than a small slider?

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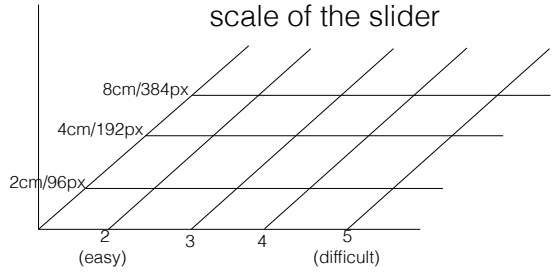
Benefit of Multiple Sizes: Experiment 1

movement time
error rate



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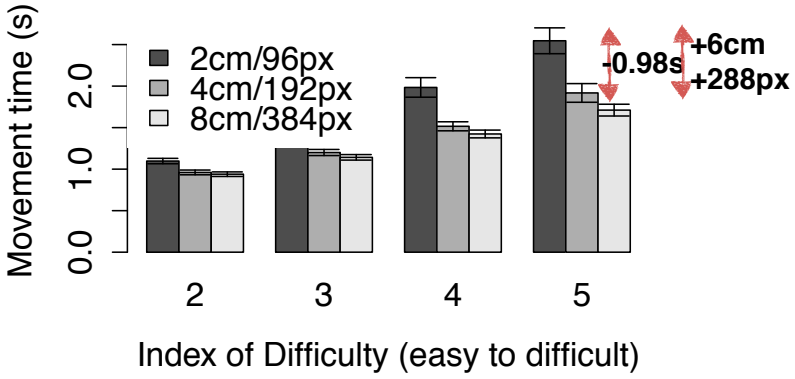

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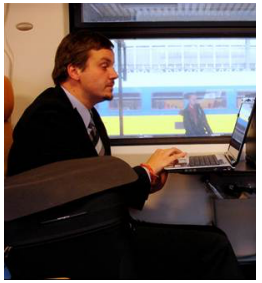
Zoomed in is better



not possible when workspace is restricted

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Drawback of resizing: Experiment 2

Impact of resizing on performance

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Drawback of resizing: Experiment 2

Need to measure
the limit of usability

?

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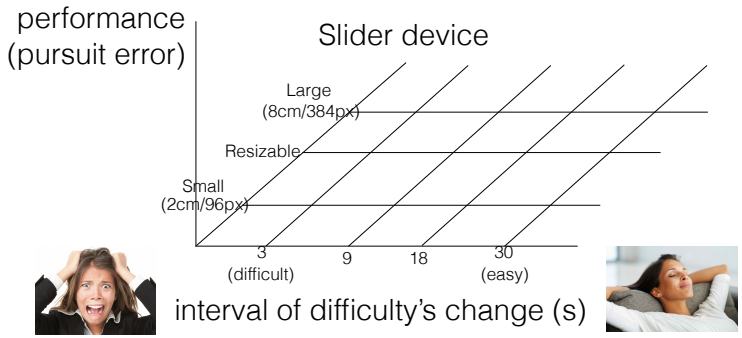
Drawback of resizing: Experiment



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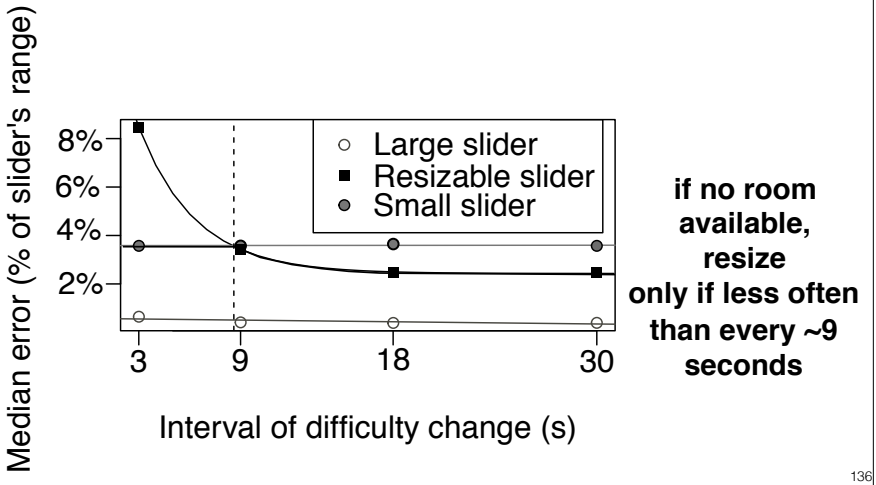

if no room available, resize only if less often than every ~9 seconds

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Resizing brings benefits
If less often than every ~9 seconds

~9s

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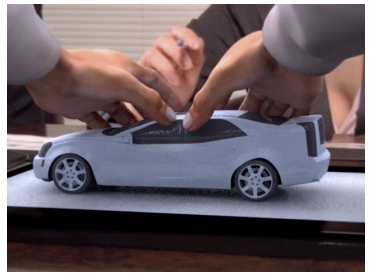
Future of Tangible Interaction

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