

Multi-Touch surfaces

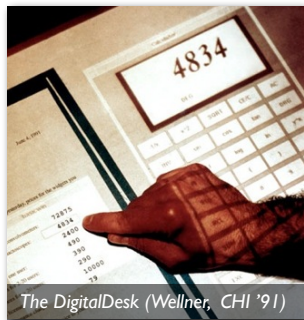
Simon Voelker <voelker@cs.rwth-aachen.de>



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2 **RWTH**

Multi-touch Workspaces



The DigitalDesk (Wellner, CHI '91)



Living with a Tabletop '04

Interactive tables and walls



Interactive wall



Interactive tabletop



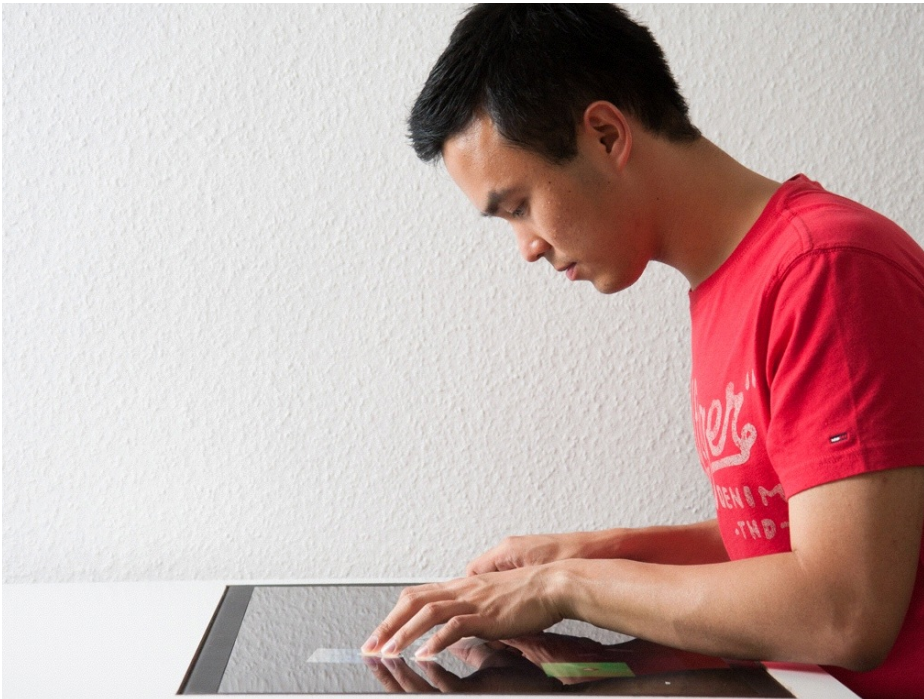
Microsoft Surface

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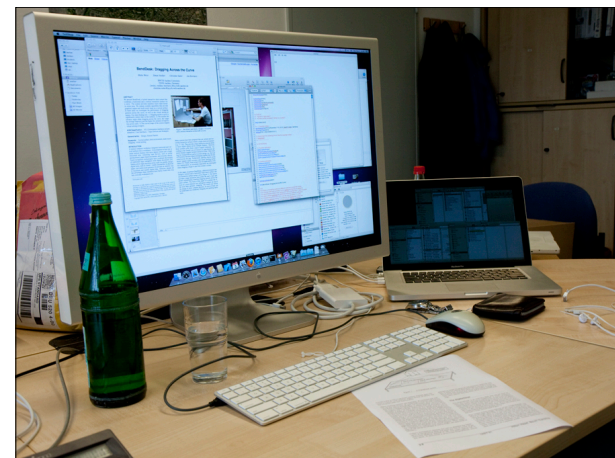
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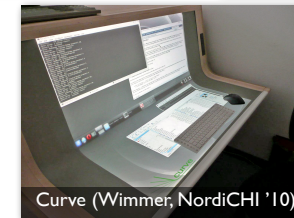
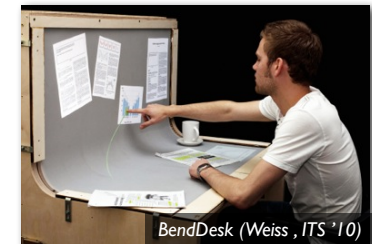
Multi-touch Workspaces



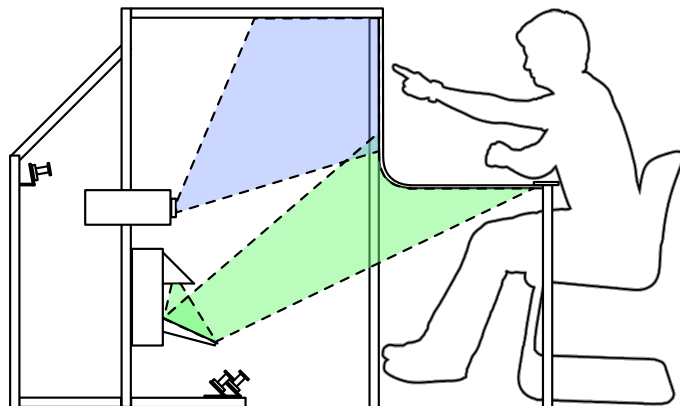
Combining Horizontal and Vertical Surfaces



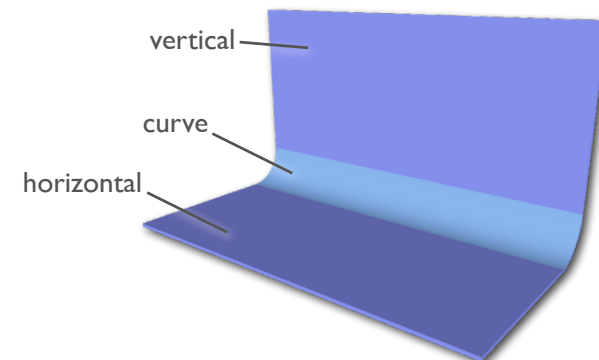
Curved Surfaces



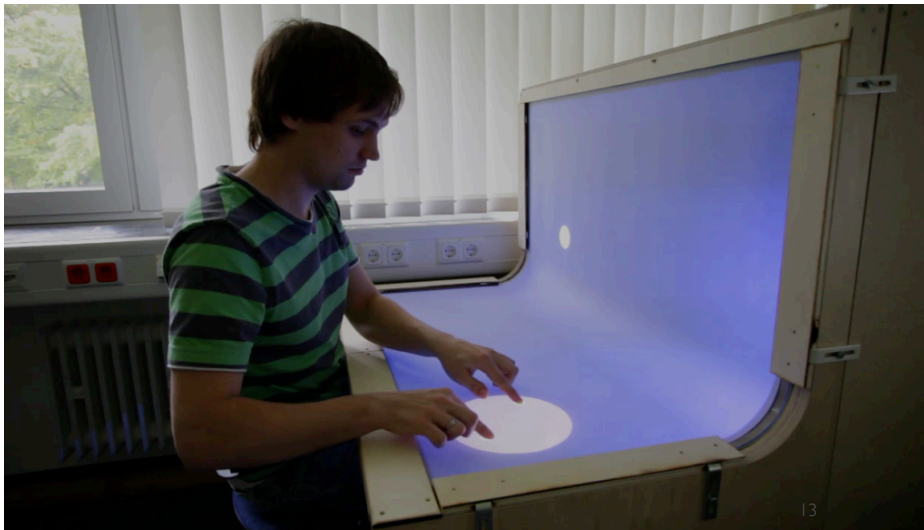
BendDesk System Overview



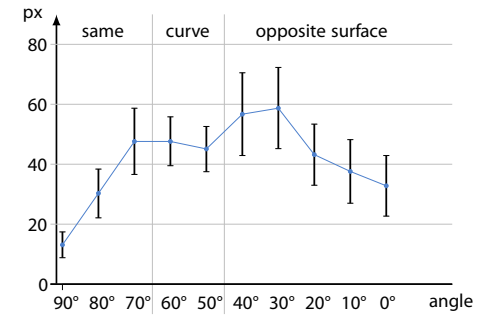
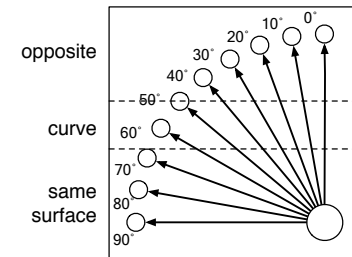
BendDesk System Overview



Perception



Perception



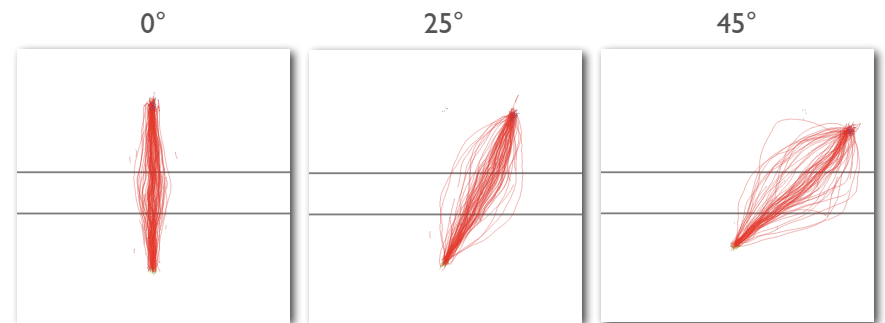
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Interaction



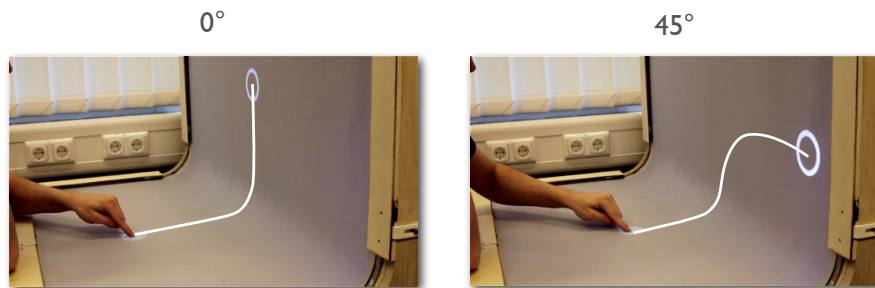
Interaction



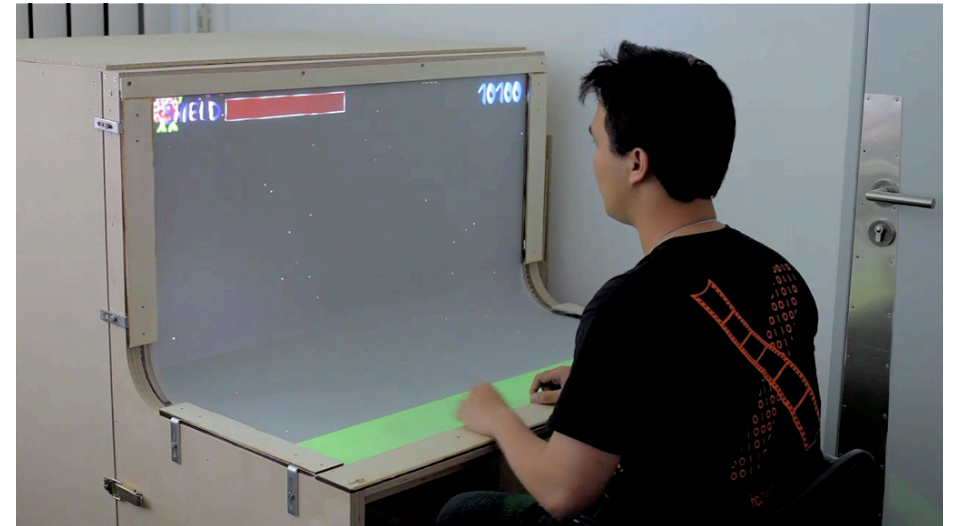
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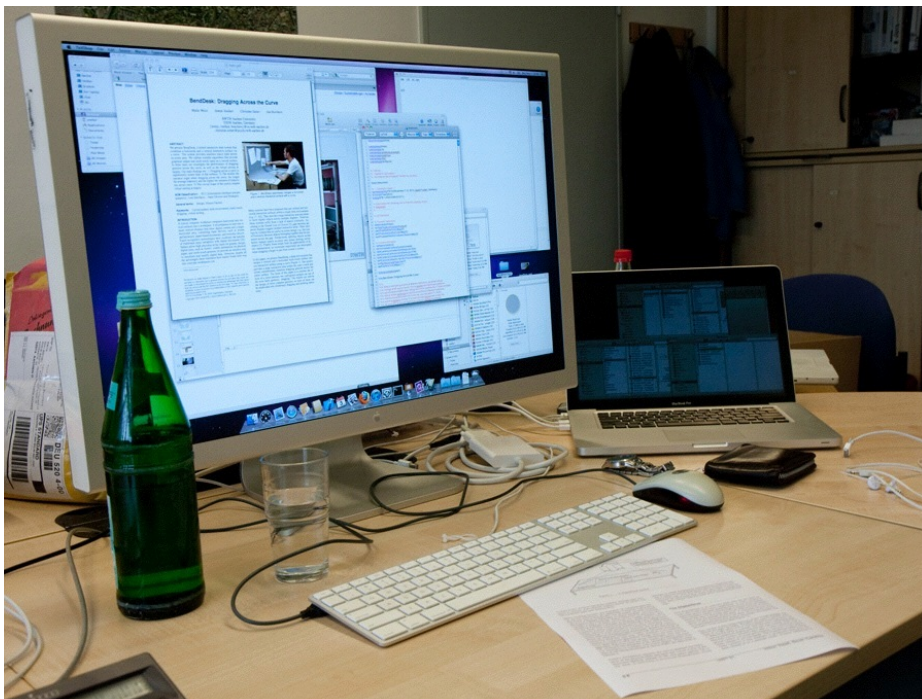
Interaction



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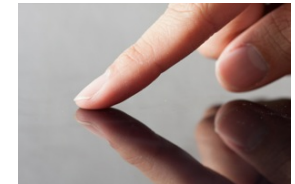
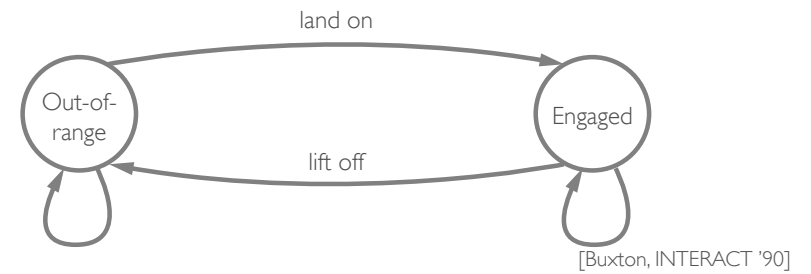
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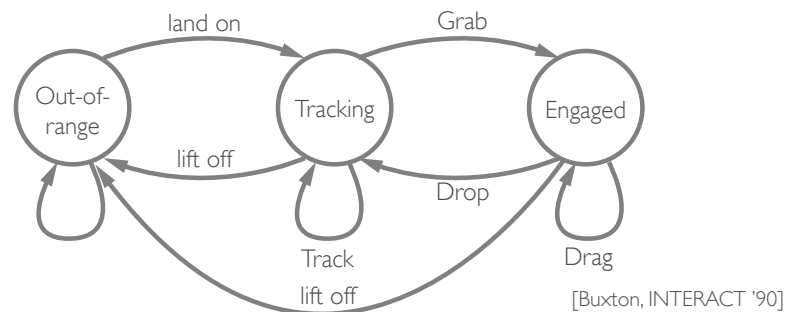
Two-State Touch Model



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Three-State Touch Model



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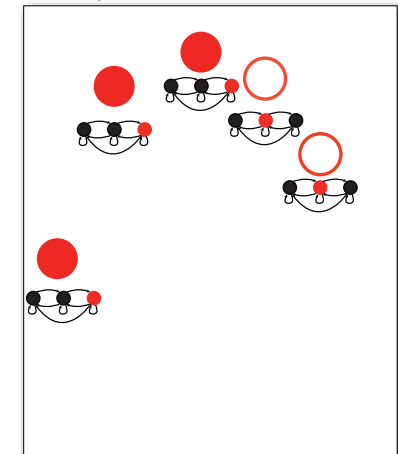
23 **RWTH**

Multiple State Machines

Input



Output



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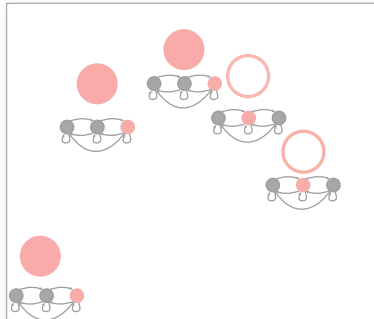
24 **RWTH**

Multiple State Machines

Input



Output



In class:

What is the best state-switching method
for indirect multitouch system?

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25 RWTH

Properties of Each Individual Finger

[Wang and Ren, CHI '09]

- Position
- Motion
- Event Properties

Tap	Hold	Flick
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- Physical Properties

Pressure
Size of the Contact Area
Orientation
On/off the surface



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26 RWTH

Properties of Each Individual Finger

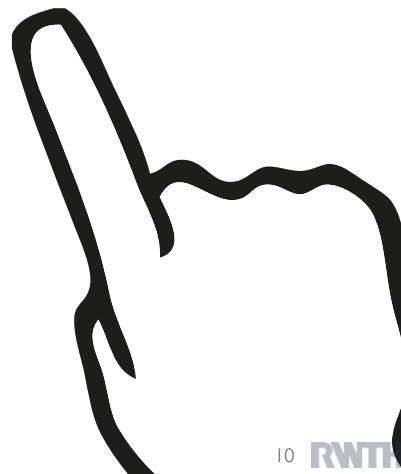
[Wang and Ren, CHI '09]

- ~~Position~~
- ~~Motion~~
- Event Properties

Tap	Hold	Flick
-----	------	------------------

- Physical Properties

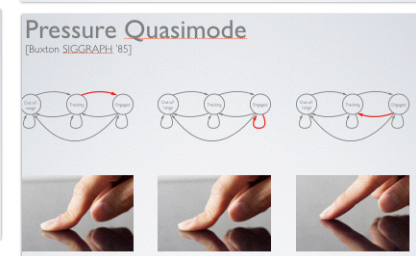
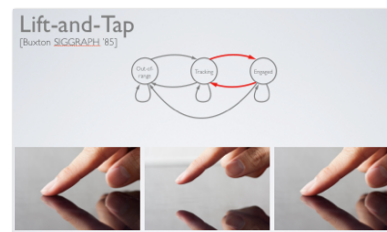
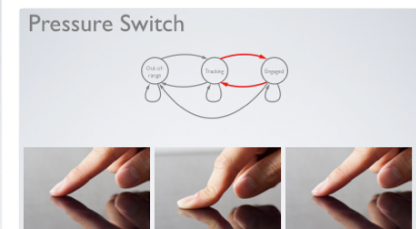
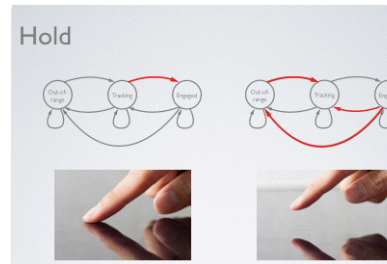
Pressure
Size of the Contact Area
Orientation
On/off the surface



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Evaluation

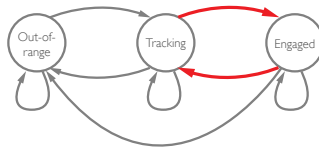


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28 RWTH

Lift-and-Tap

[Buxton, SIGGRAPH '85]



What to do with it?



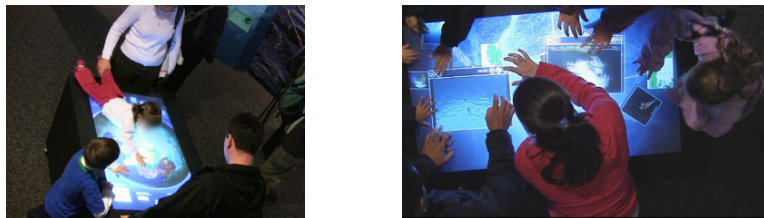
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29 **RWTH**

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30 **RWTH**

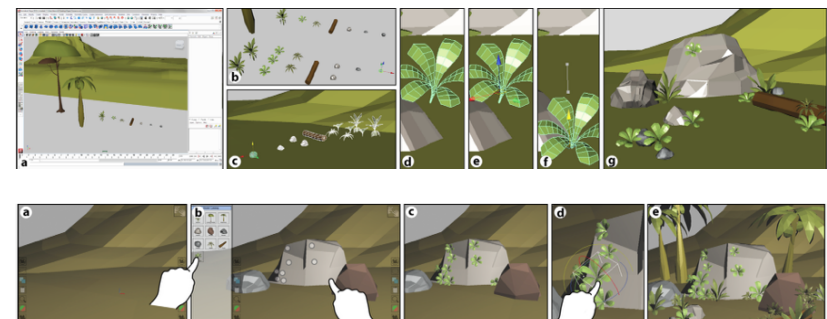
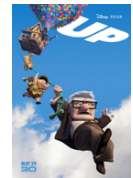
Museum Exhibitions



[Hinrichs and
Carpendale, CHI '11]

Single-user Applications

Eden: A Professional Multitouch Tool for Constructing
Virtual Organic Environments



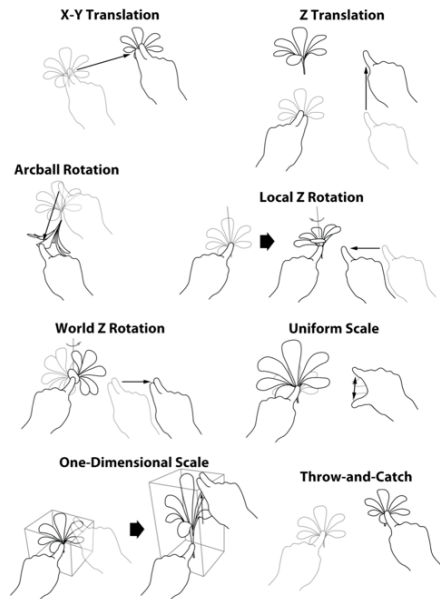
[Kin et al., CHI '11]

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32 **RWTH**



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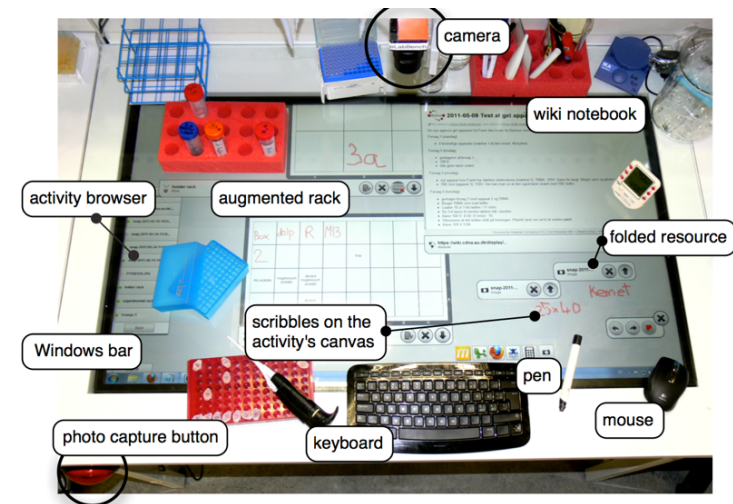
The eLabBench



[Tabard et al. ITS '11]

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The eLabBench



[Tabard et al. CHI '12]

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Physical Object on the table?

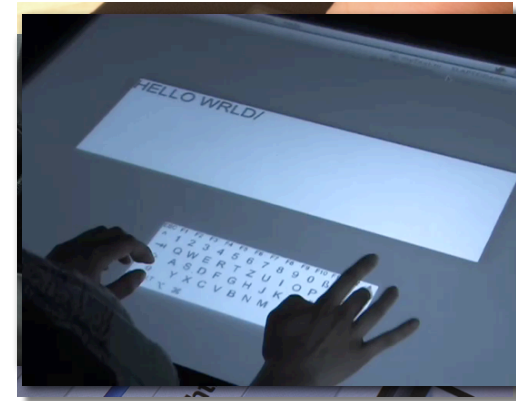


[Tabard et al. ITS '11]

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Limited Haptic Feedback



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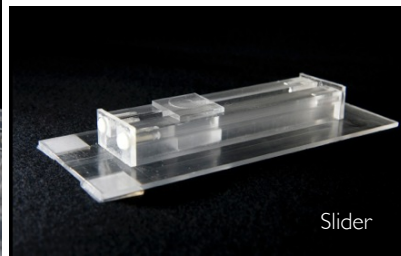
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SLAP Widgets

[Weiss et al. CHI '09]



Keyboard



Slider



Keypads

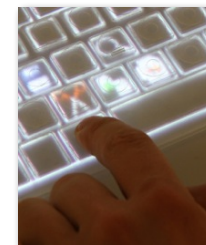
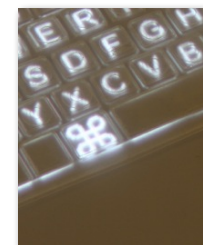
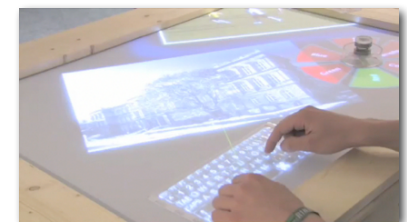


Knob

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SLAP Keyboard



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40 **RWTH**

SLAP Knob



jog wheel mode

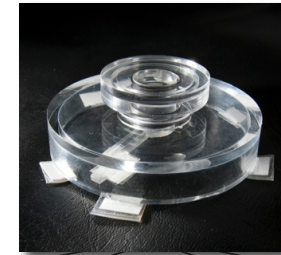


menu/value mode

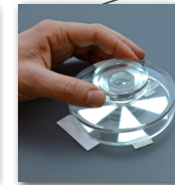
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SLAP Knob



value



jog wheel



menu

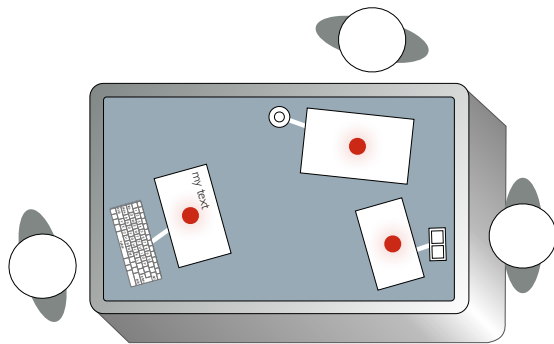


hue

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Multi-Focus Policy



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43 **RWTH**

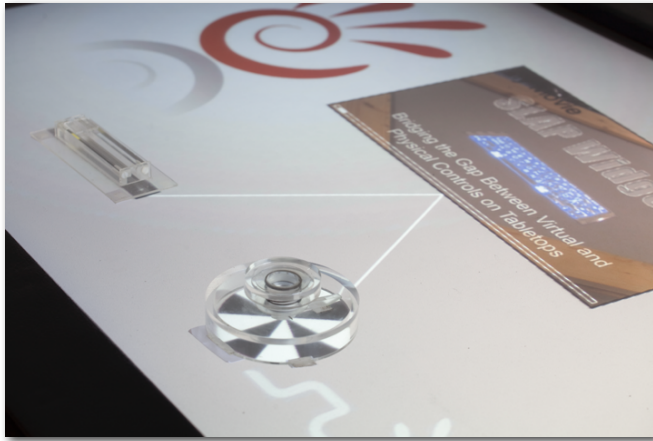
Pairing



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44 **RWTH**

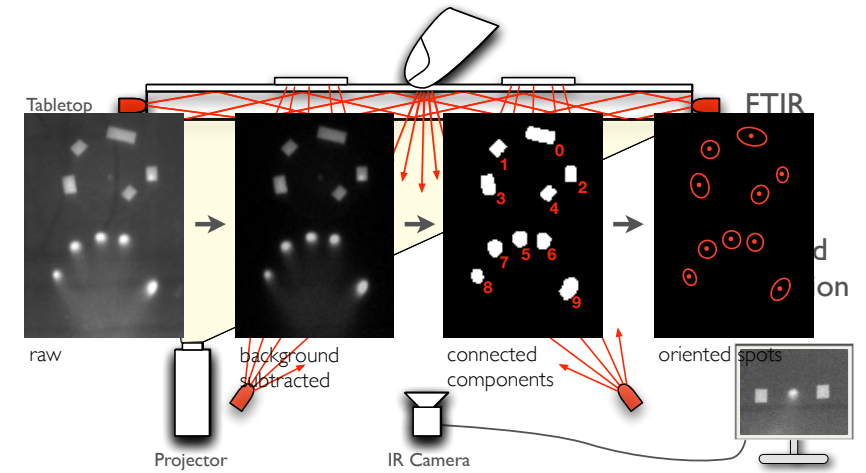
Pairing



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45 **RWTH**

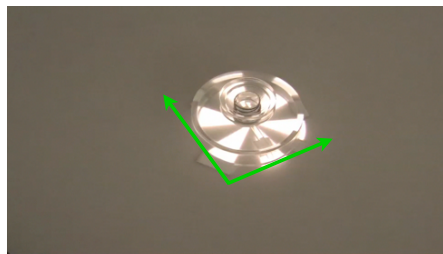
Multi-Touch Table



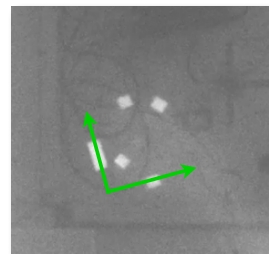
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Widget Detection



Tabletop view



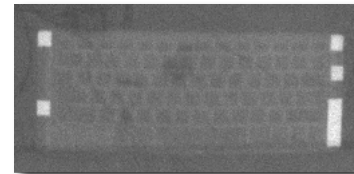
IR camera view
(640x480, 120fps)

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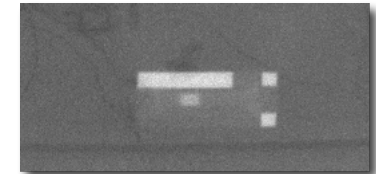
47 **RWTH**

Widget Detection

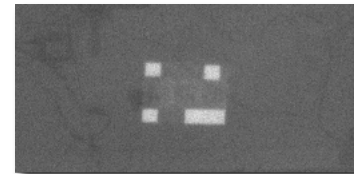
Keyboard



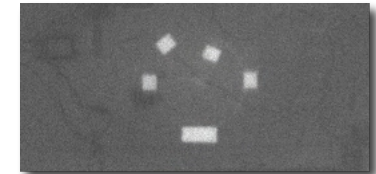
Slider



Keypad



Knob



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48 **RWTH**

Unidirectional Interaction

SLAP Widget

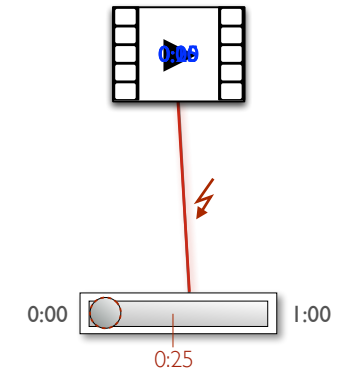


Physical

Digital

Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update



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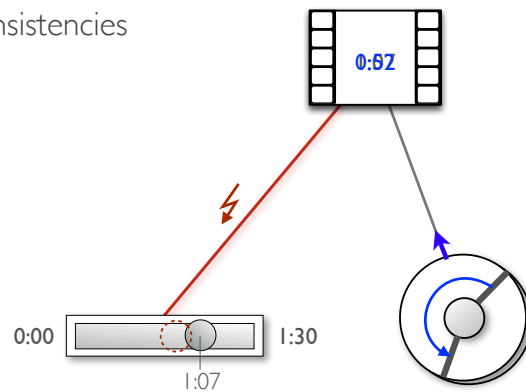
49 RWTH

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50 RWTH

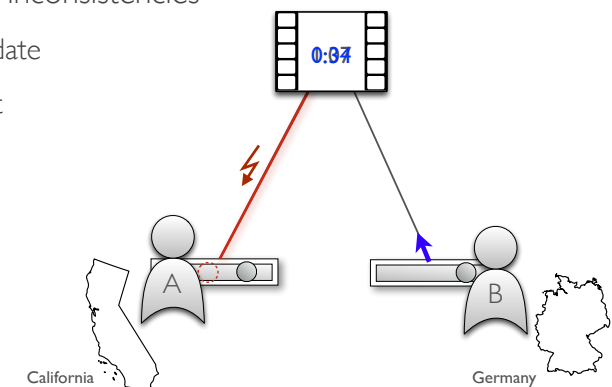
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget



Unidirectional Interaction

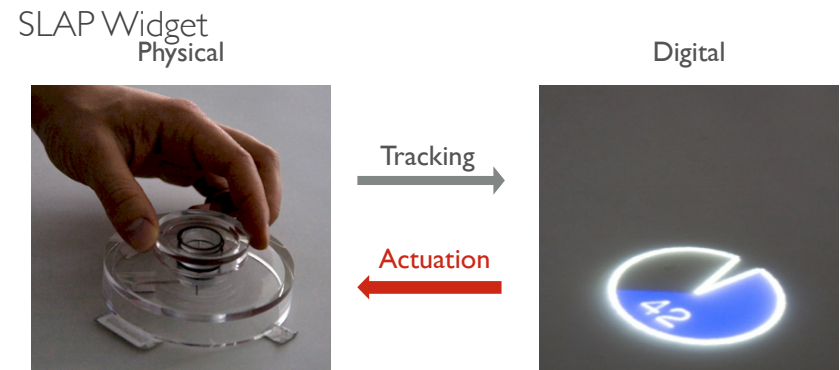
- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget
 - Remote



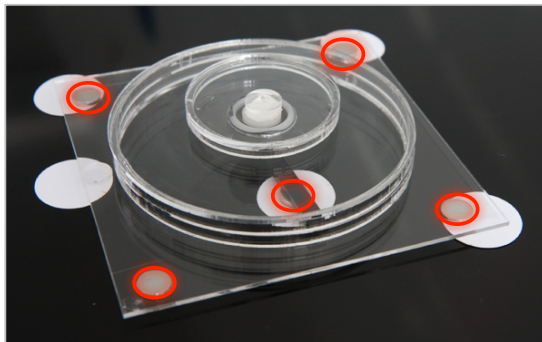
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
 - Internal update
 - Inter-widget
 - Remote
- SLAP Widgets require **exclusive access** to parameters
- No UI adaption, load/save, undo/redo, ...
- ▶ **Software** should be able to change **physical UI**

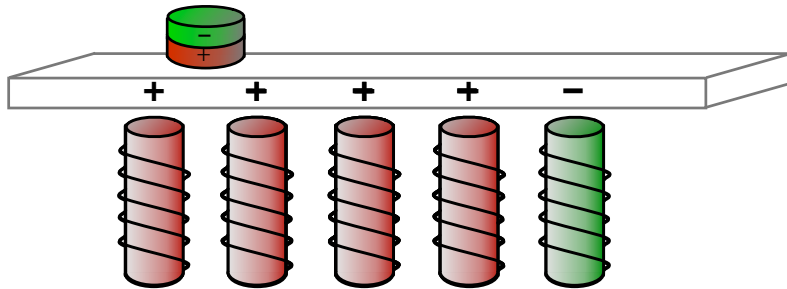
Bidirectional Interaction



Magnetic Widgets



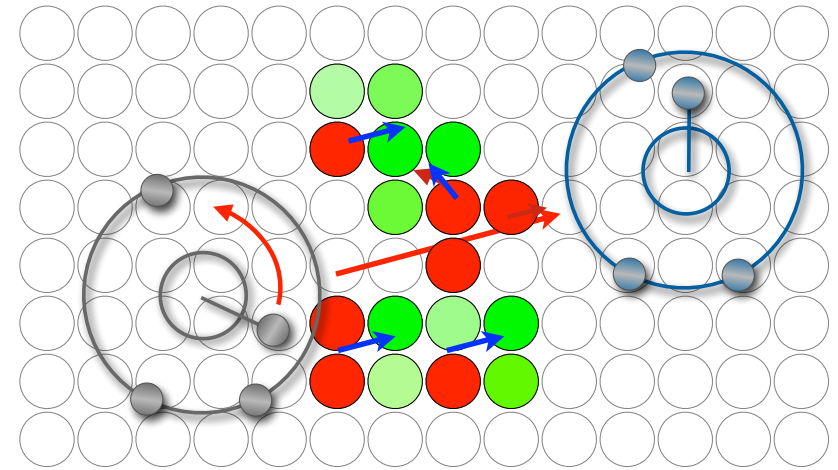
Actuation



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57 **RWTH**

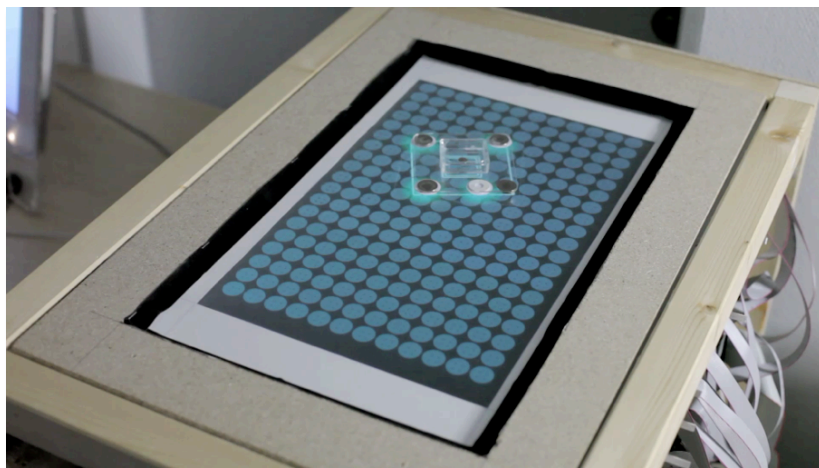
Actuation



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58 **RWTH**

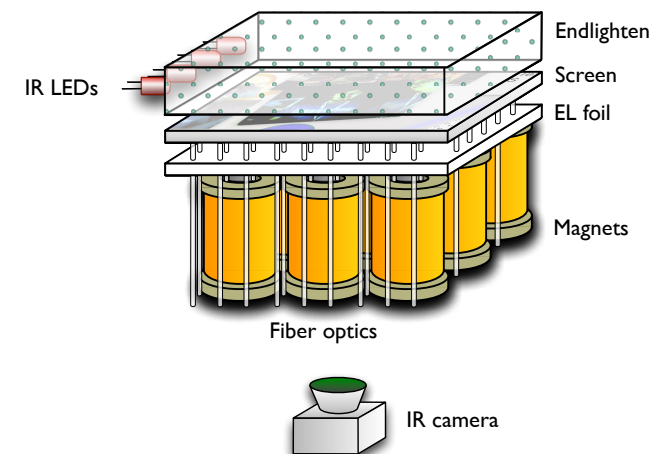
Actuation



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59 **RWTH**

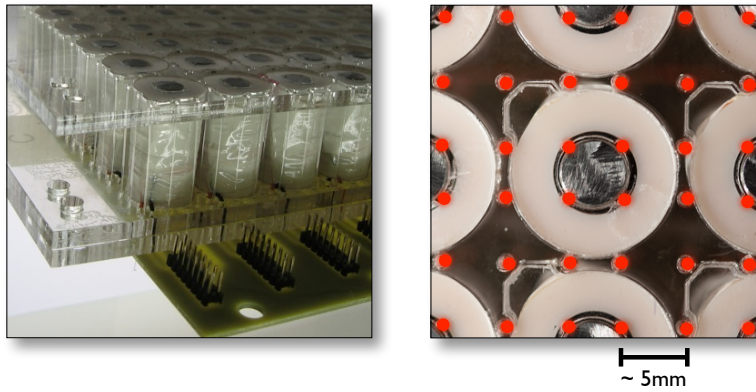
Tracking



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60 **RWTH**

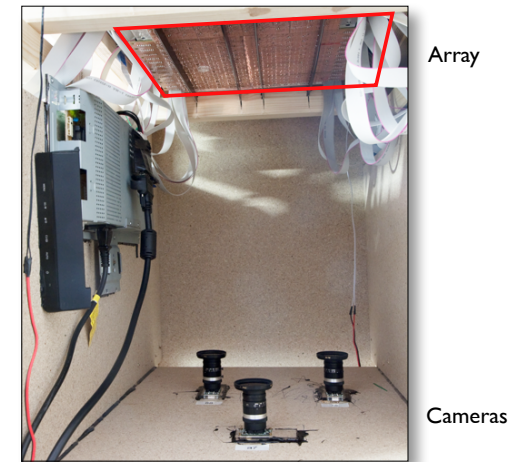
Tracking



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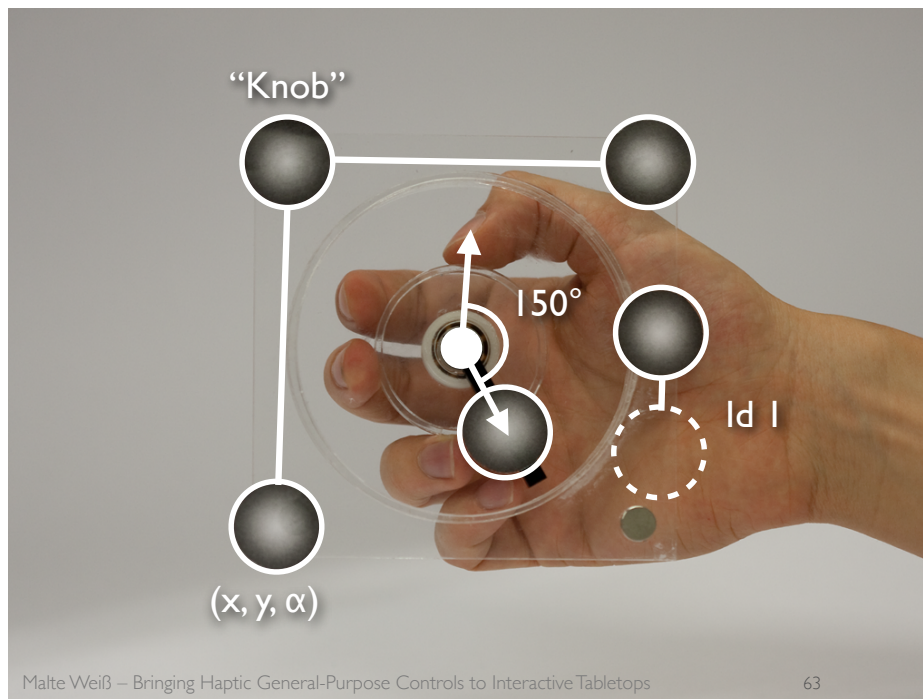
61 **RWTH**

Tracking



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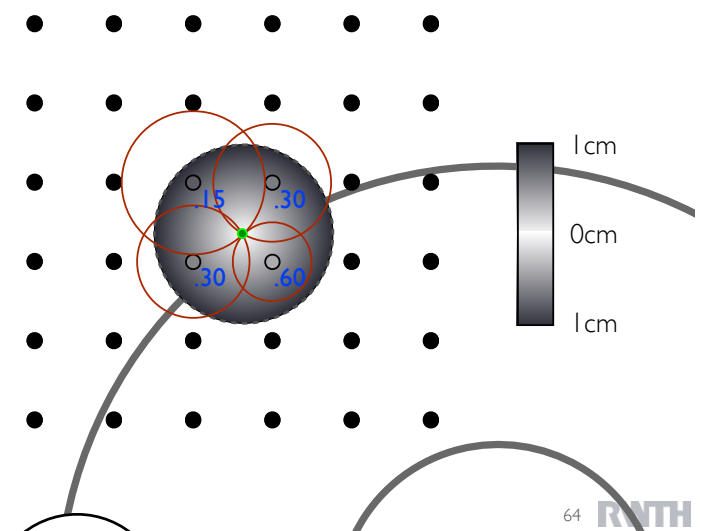
62 **RWTH**



Malte Weiß – Bringing Haptic General-Purpose Controls to Interactive Tabletops

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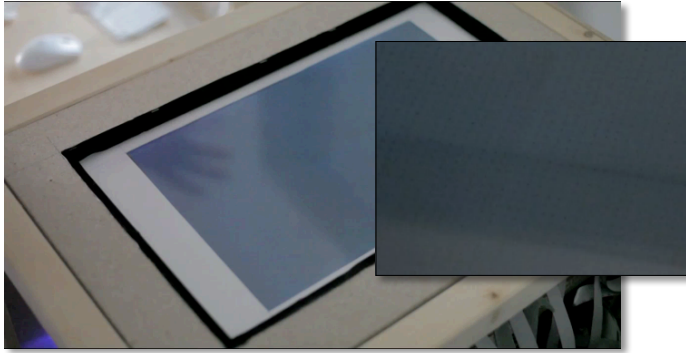
Gradient Markers



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64 **RWTH**

Tracking

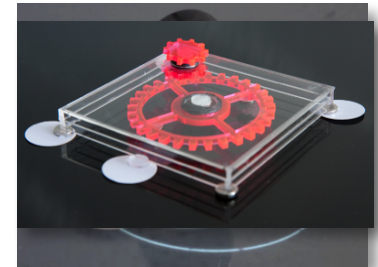
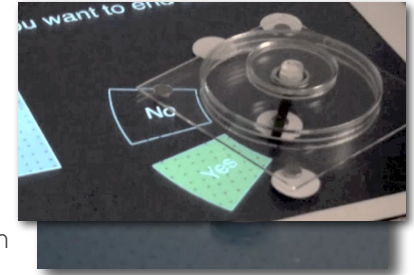


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65 **RWTH**

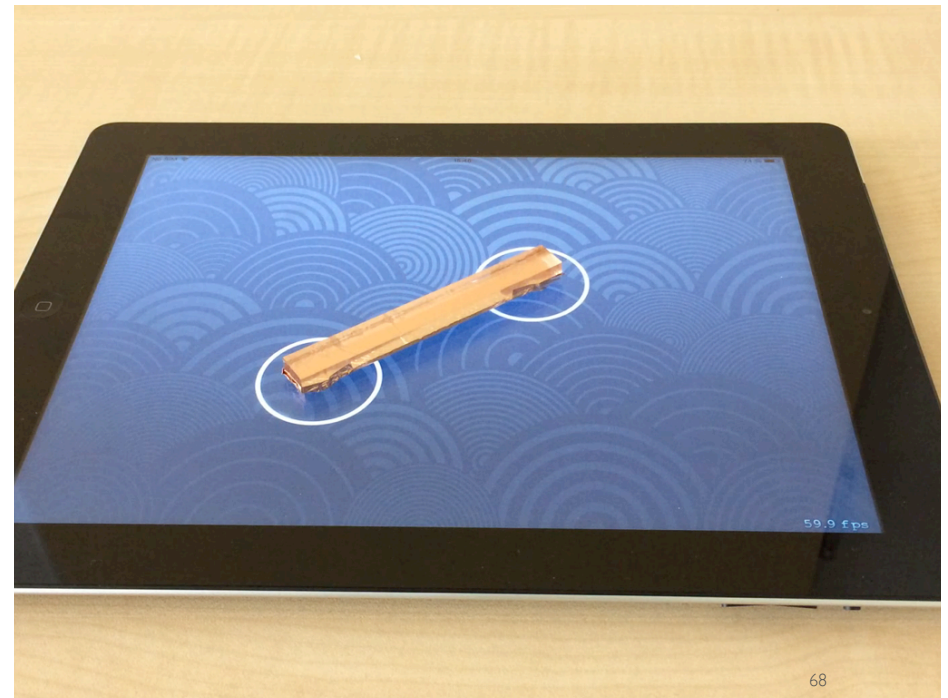
Applications

- Physical-visual consistency
 - Load/save, undo/redo
 - Remote tangible collaboration
- Height
- Power transfer



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66 **RWTH**



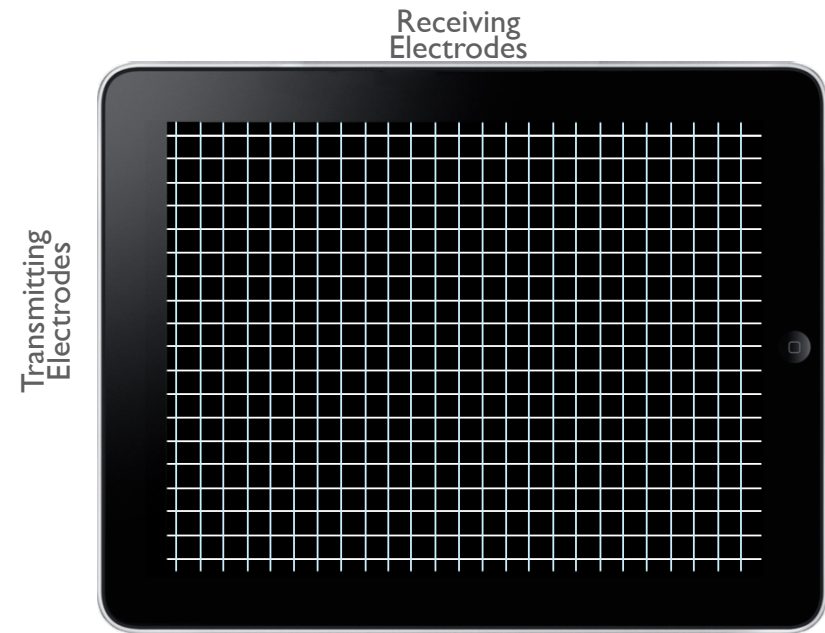
68

PUCs Bridge



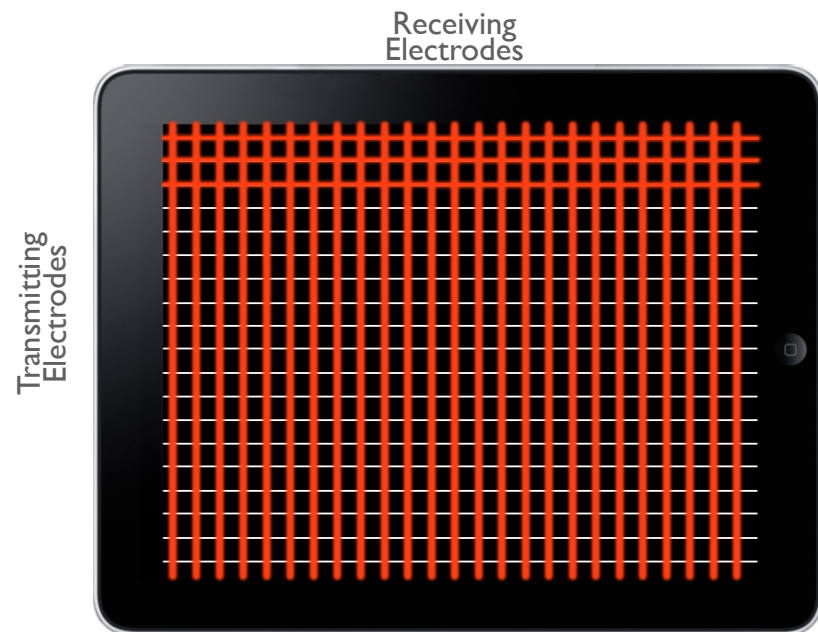
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69 **RWTH**



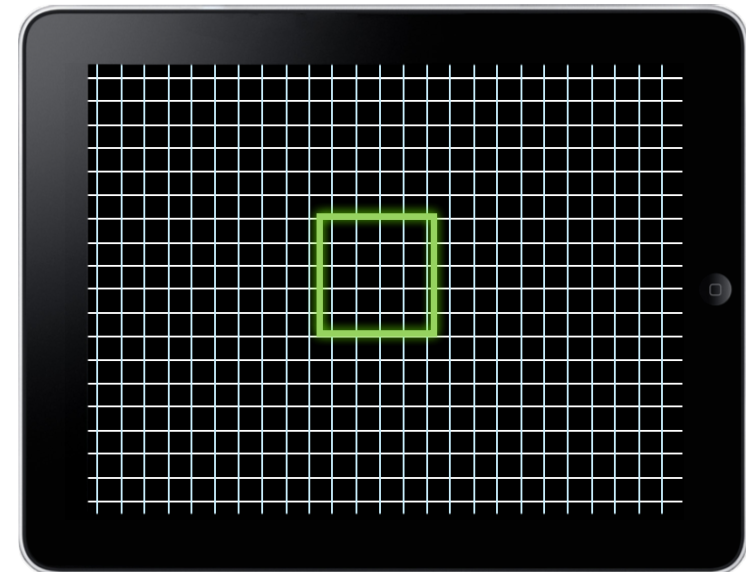
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70 **RWTH**



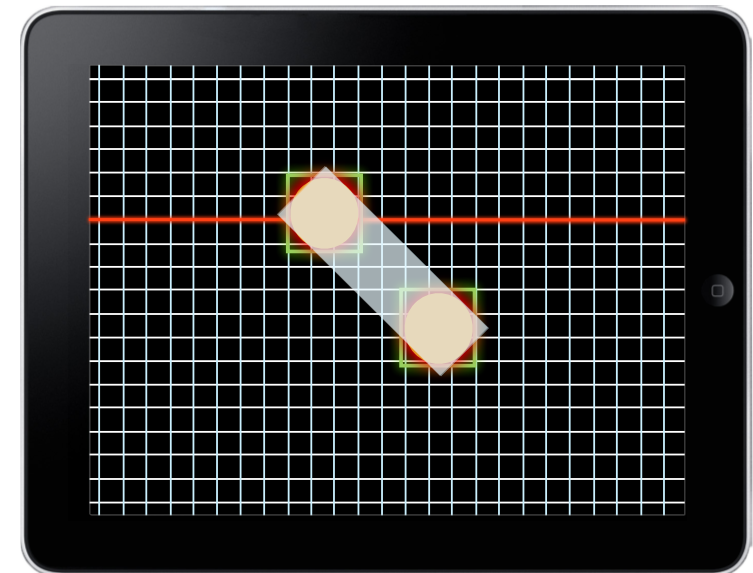
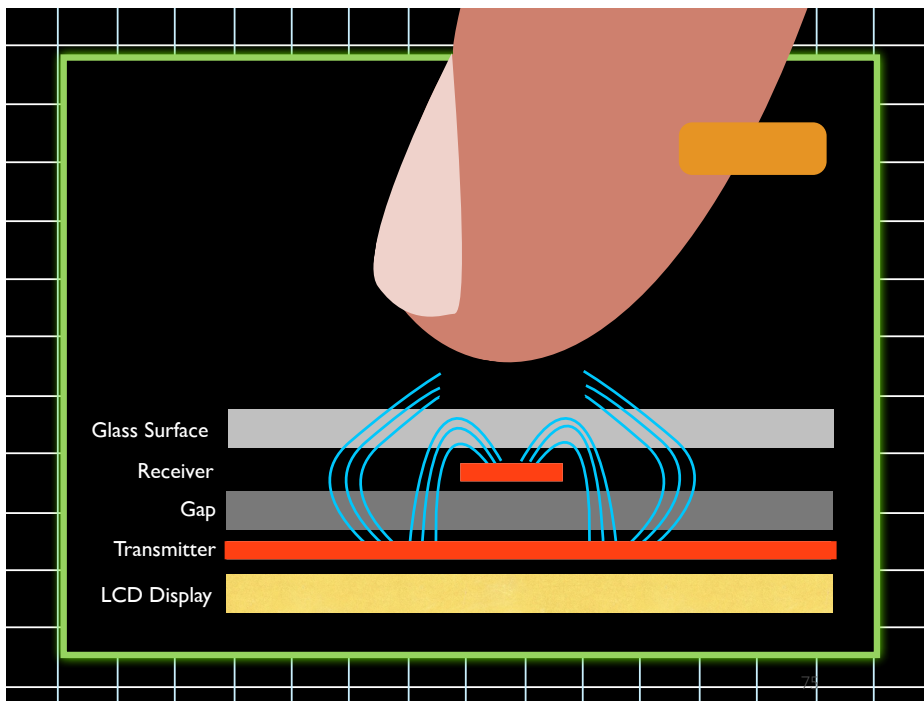
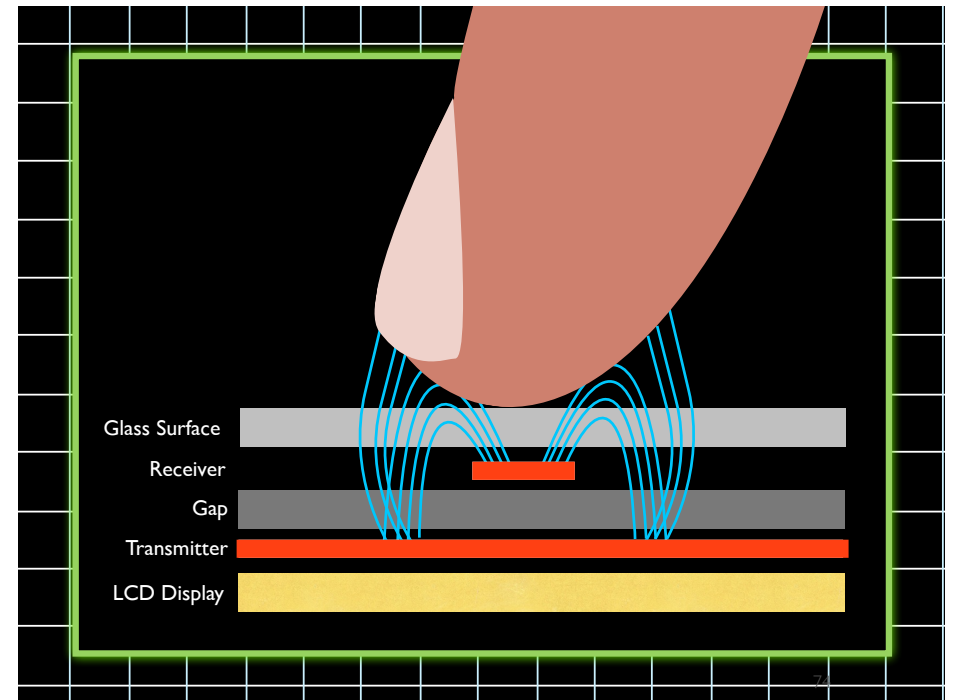
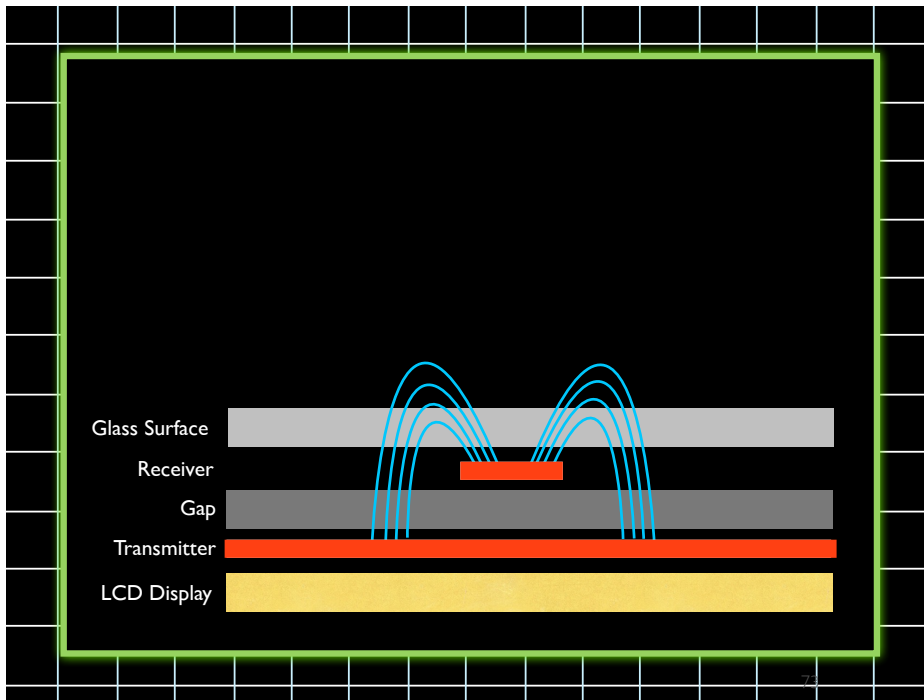
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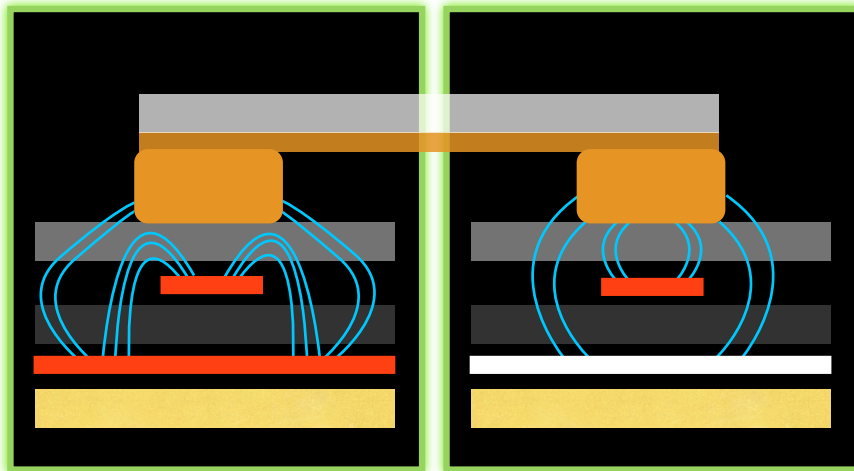
71 **RWTH**



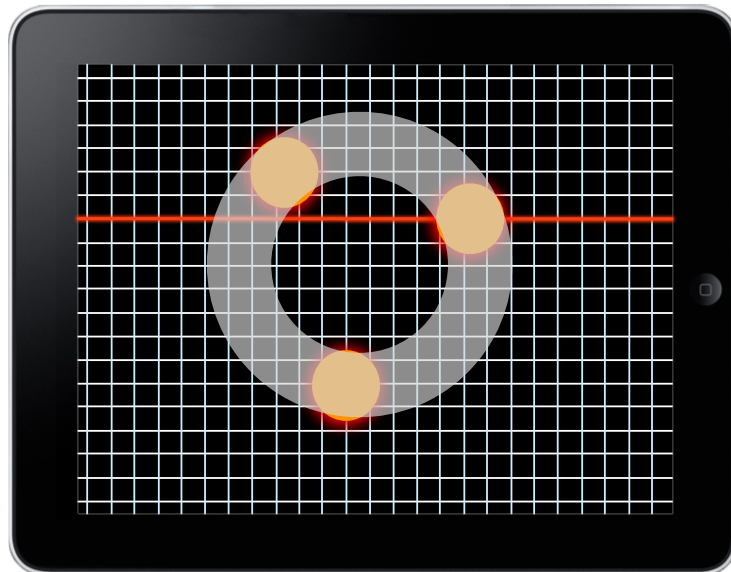
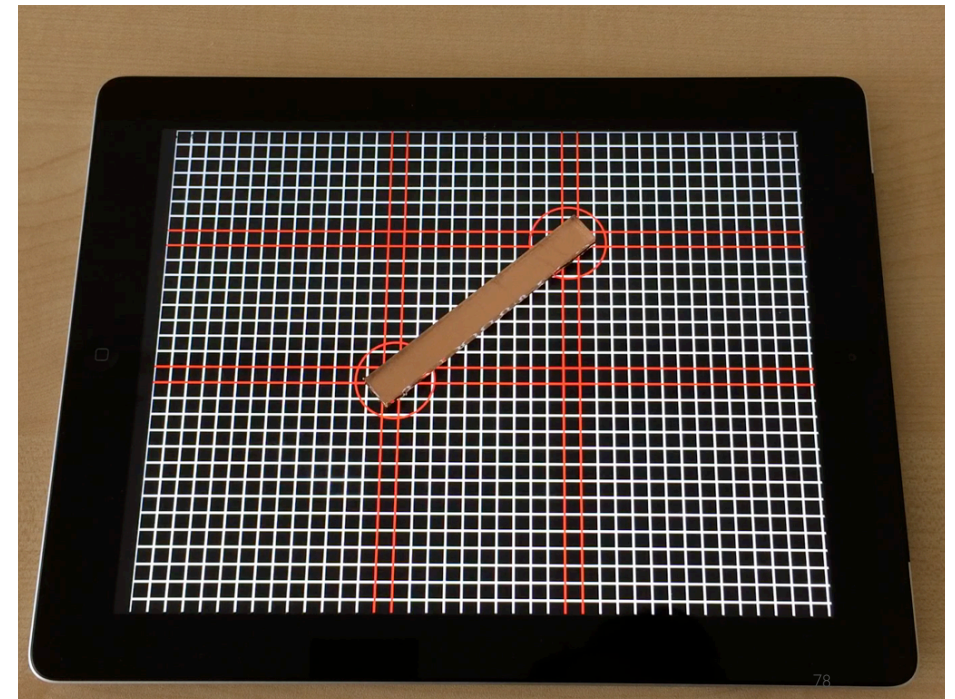
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72 **RWTH**





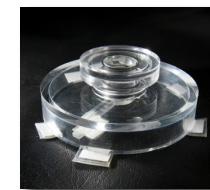
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Multi-Touch Summary

- Form factor matters
- Rethink applications
- Tangible can help!



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