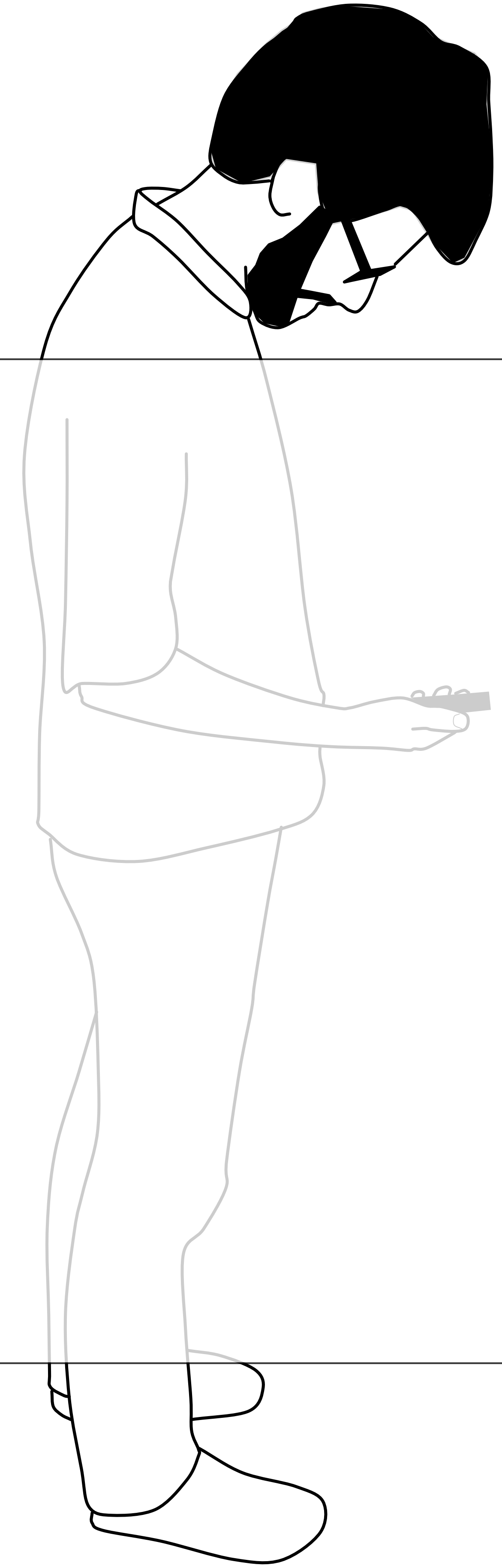
Mensch-Maschine-Interaktion 2

Interactive Environments

Prof. Dr. Andreas Butz, Dr. Julie Wagner

Interactive Environments



- context and task
- challenges
- input technologies
- challenges in interaction design
- **output technologies**

Display: Front Projection

- what we are doing here in class
- simplest way to produce visual output on any surface
- pro:
  - cheap, simple
  - even light distribution
  - no additional space needed
  - space for legs under the table

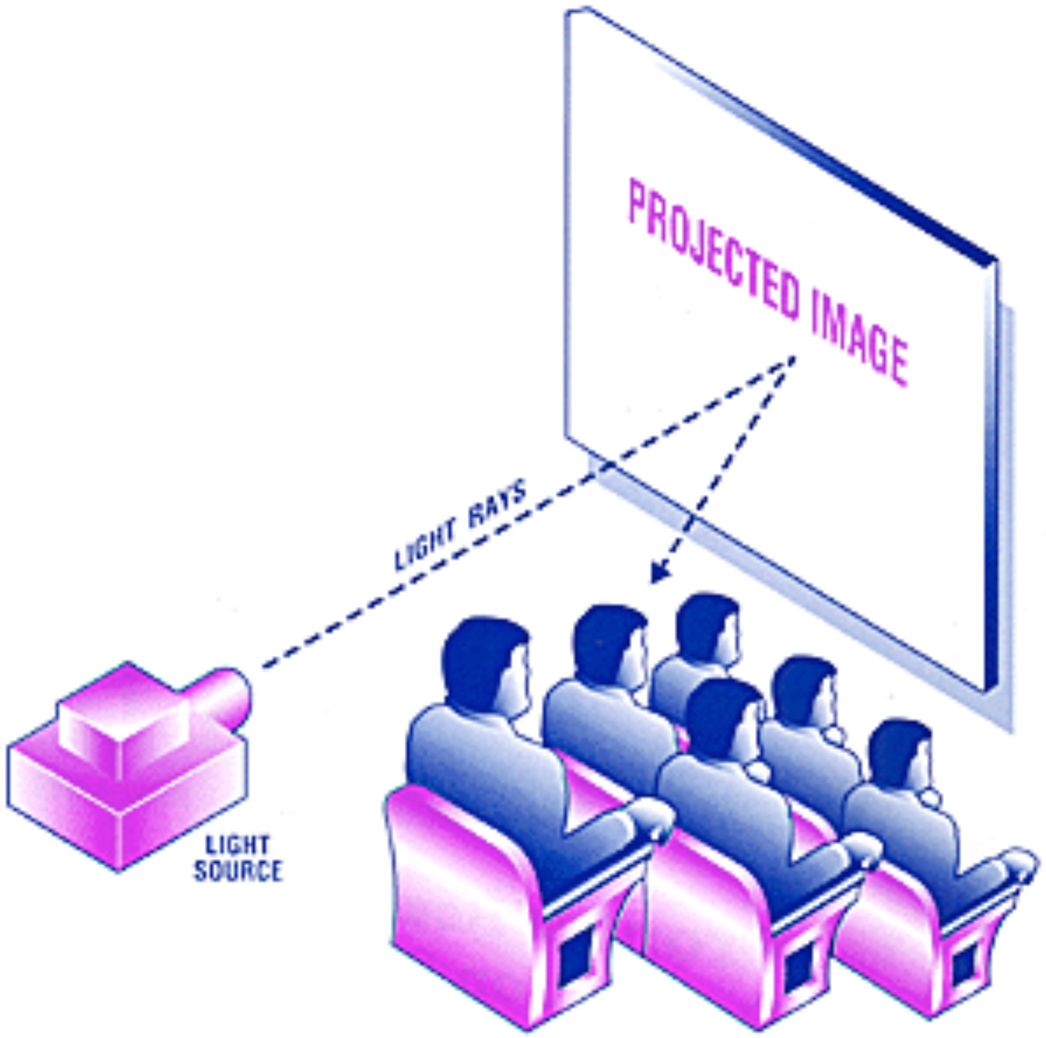
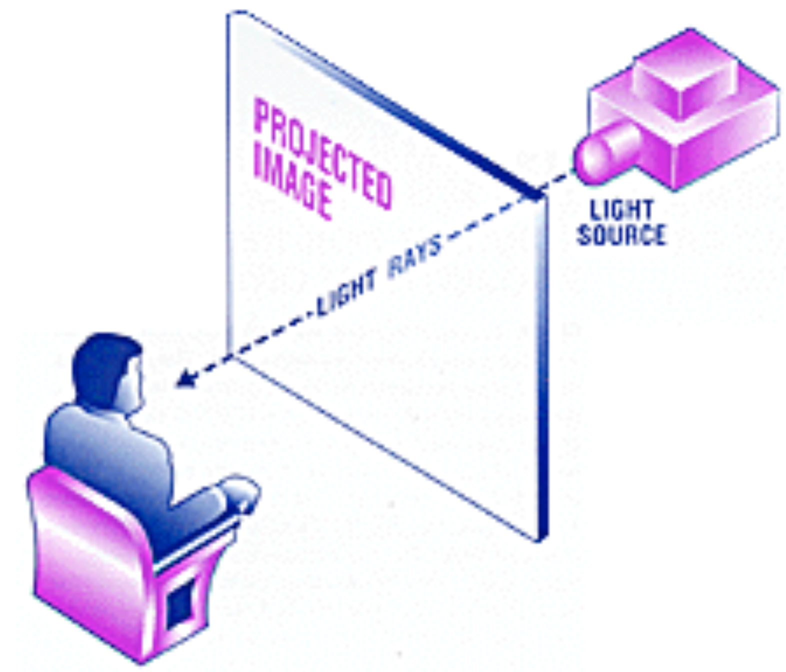


image source: http://www.rosco.com/

- contra
  - interacting hand and person cast a shadow
  - only feasible for tabletops when firmly mounted

Display: Rear Projection

- Pro:
  - projector is hidden, space in front empty
  - no shadowing of the surface
- Contra:
  - Can only be done with space behind
  - complex mirror construction for tabletops
  - can create „hot spot“ with cheap screen



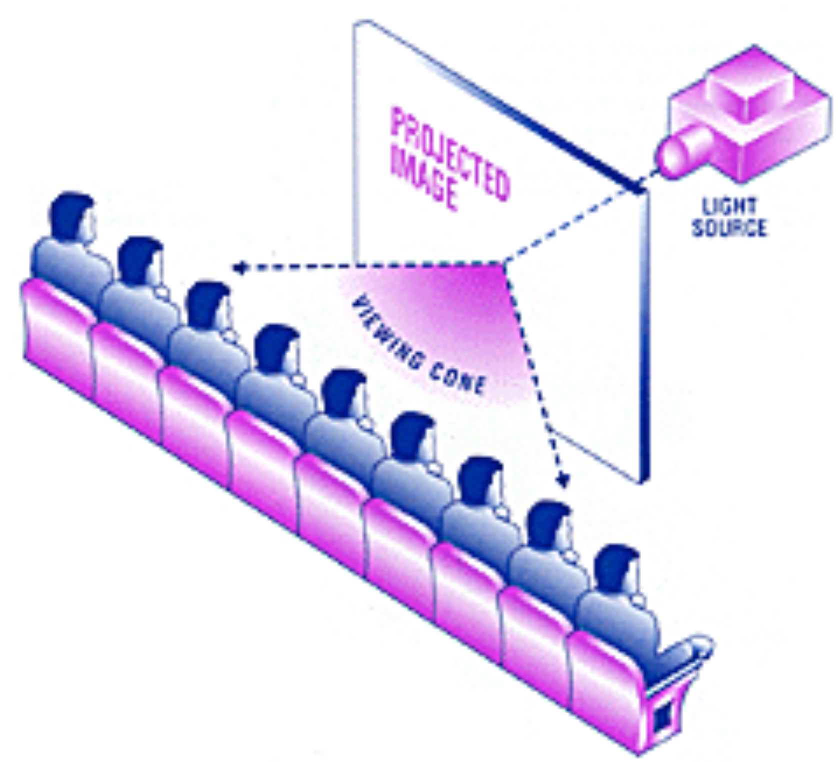
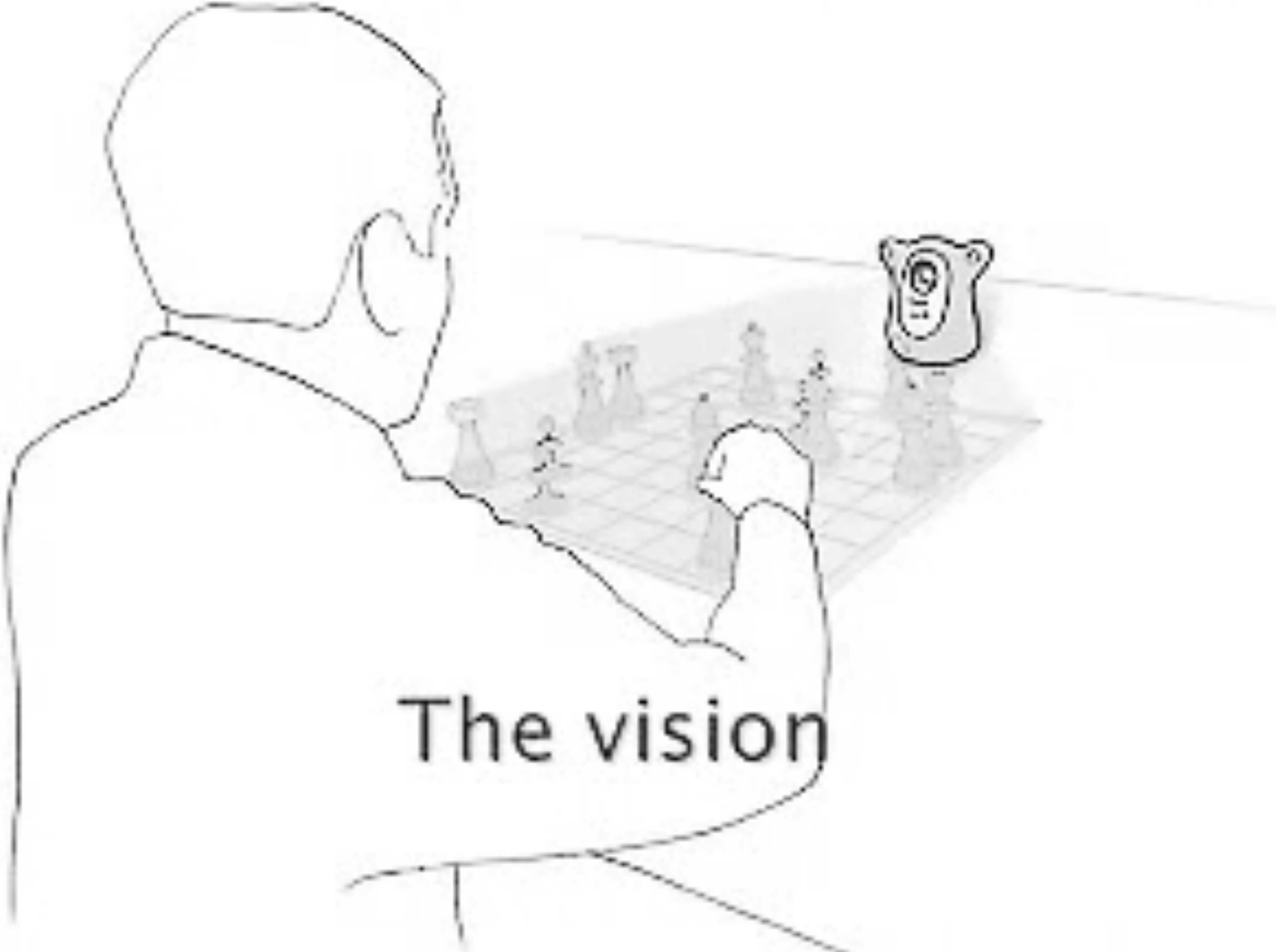


image source: http://www.rosco.com/

Display: Projection from the side ;-)

- PlayAnywhere, Andy Wilson (Microsoft Research), 2005
- Uses commercial short throw projector for front projection at an angle of 40 degrees
- Uses cameras for sensing
  - mounted off axis from the projection
  - can see shadows caused by front projection
  - can recognize fingers and markers
- Turns any flat surface (e.g., table) into an interactive surface



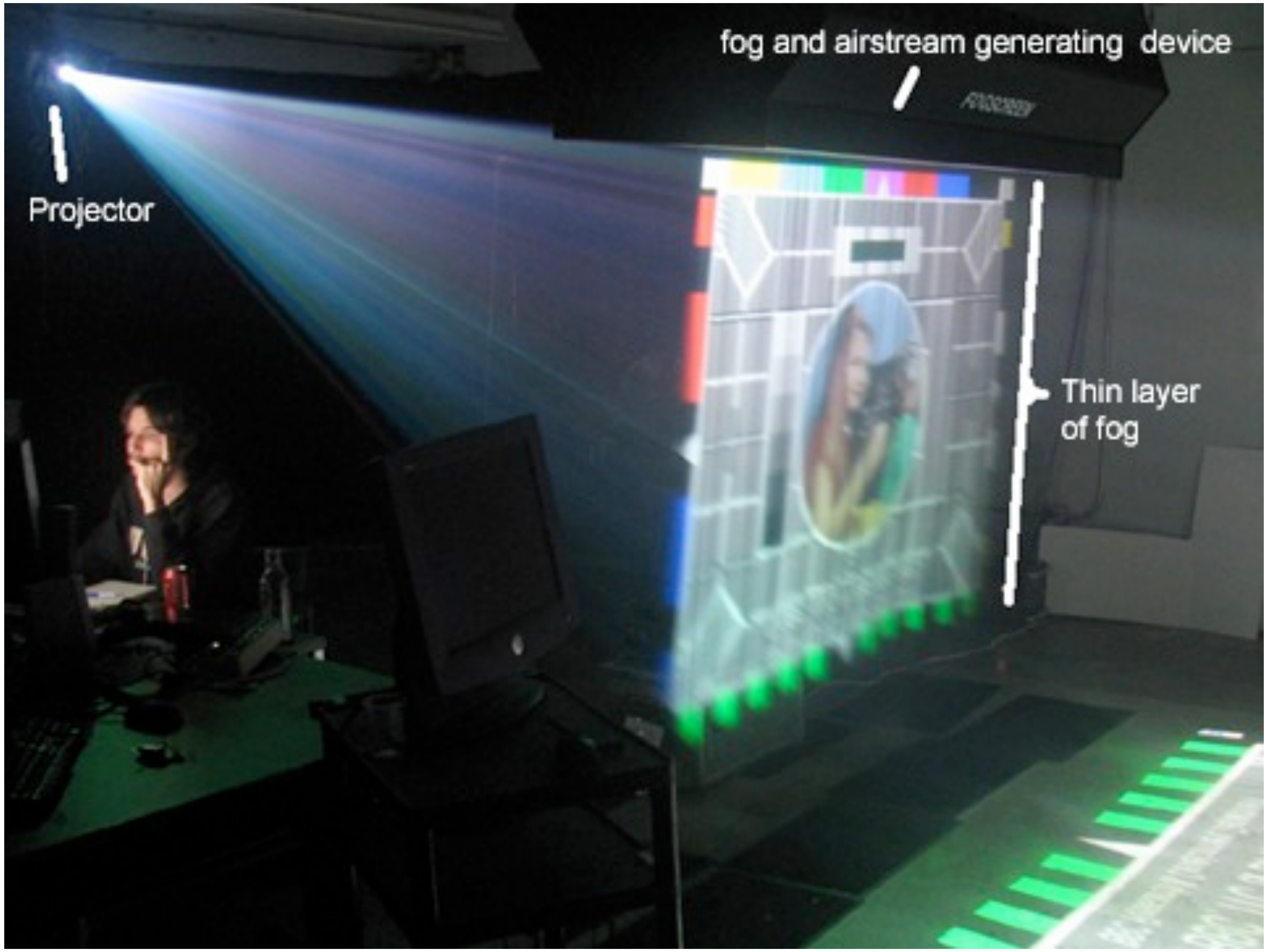
The vision

Display: Screens

- What we initially used in our tabletop research @LMU
  - High resolution and contrast + great color
  - Insensitive to ambient light
  - Can be bought with touch overlay for sensing

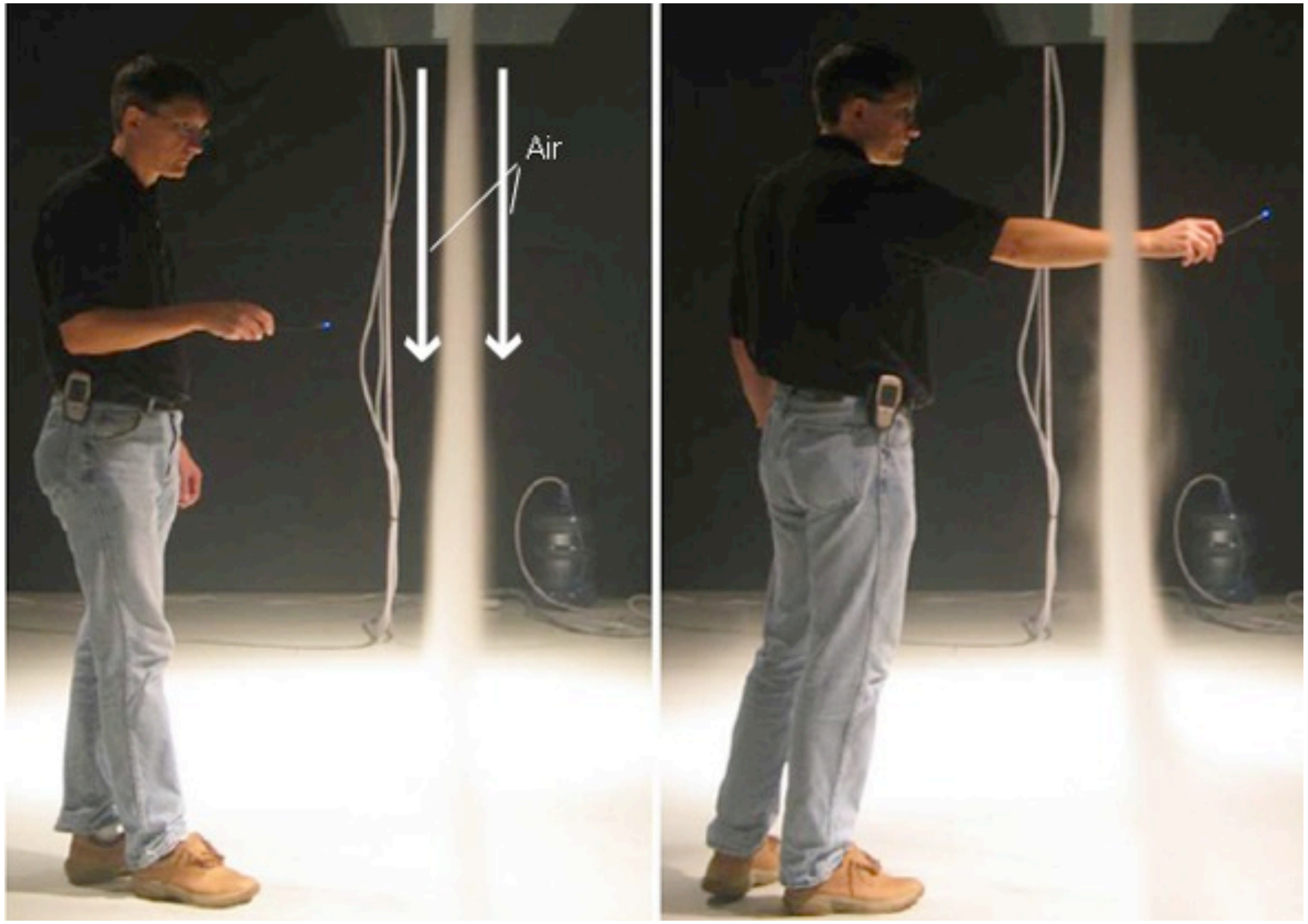
FogScreen

- A wall sized, immaterial projection display
- Image projected on dry, non-hazardous fog (pure water)
- Inventor: Ismo Rakkolainen



FogScreen (2)

- Fog sandwiched between airstreams
- Immaterial → user can reach or walk through unhindered

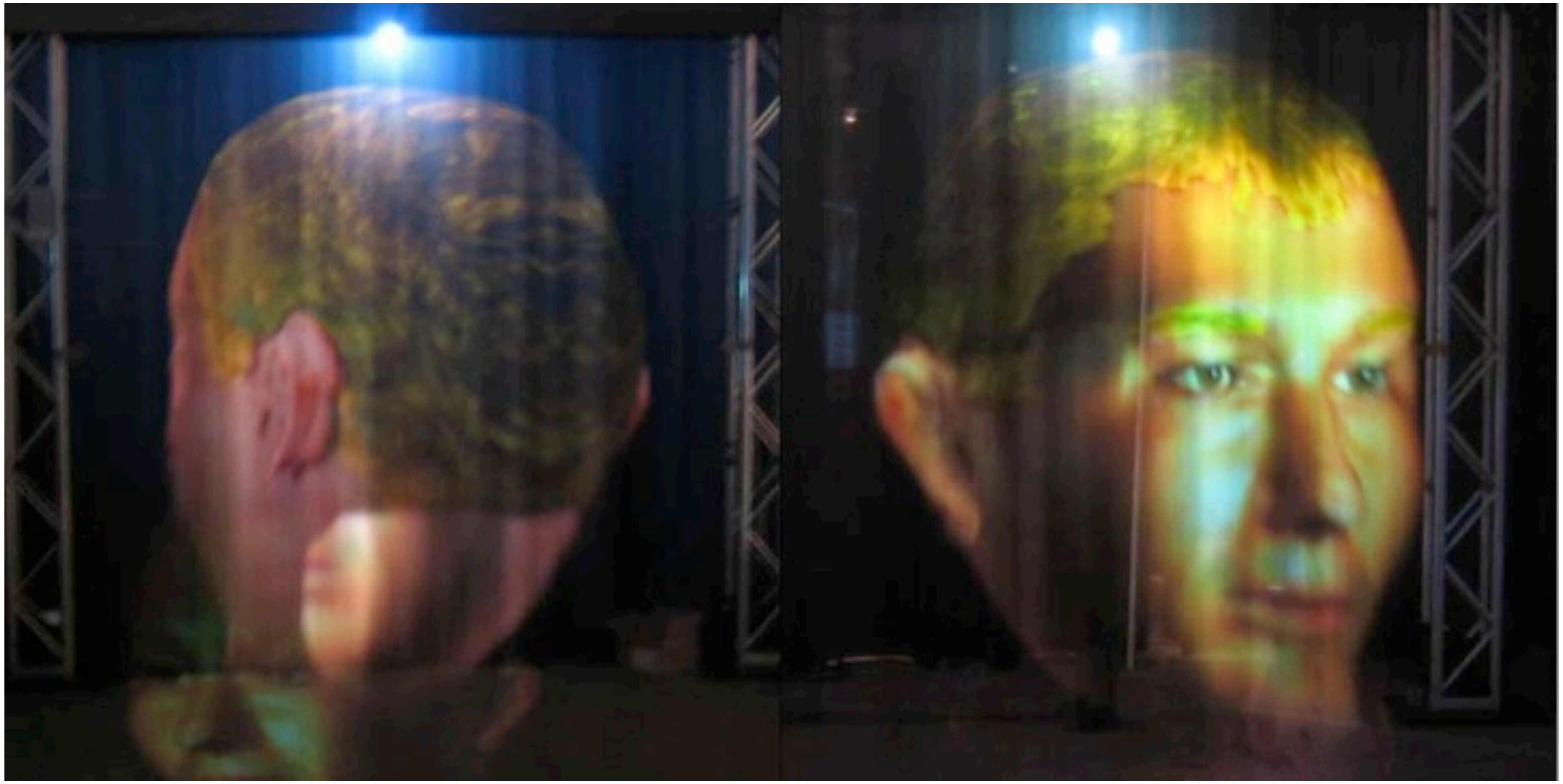


FogScreen (3)

- Technical Details
  - First introduced at UIST 2004
  - So far only 9 FogScreens in the world
  - Price: 100k $
  - Weight: around 100 kg
  - Needs: 10L/h, 300W

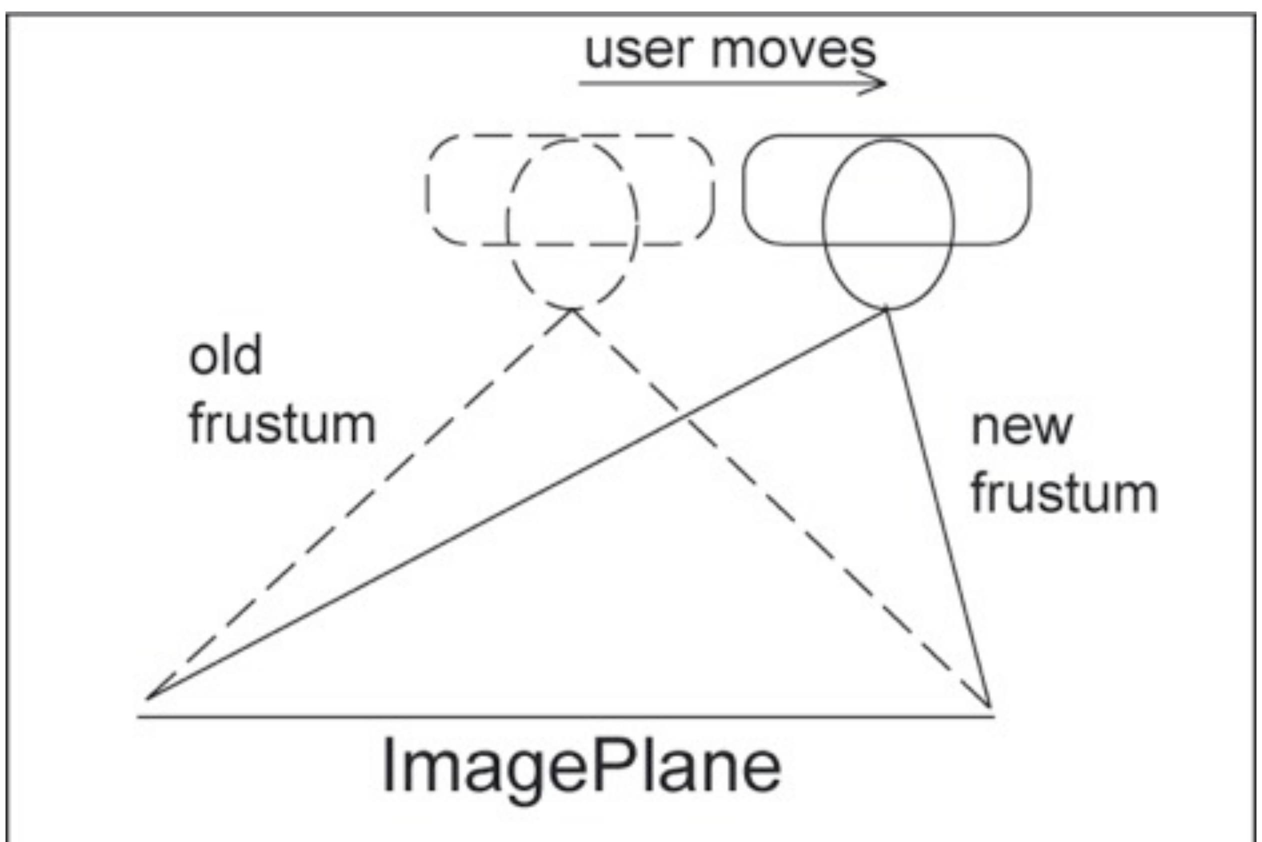
FogScreen (4)

- Pseudo 3D
  - Double sided projection possible
  - E.g. opposite views of the same scene



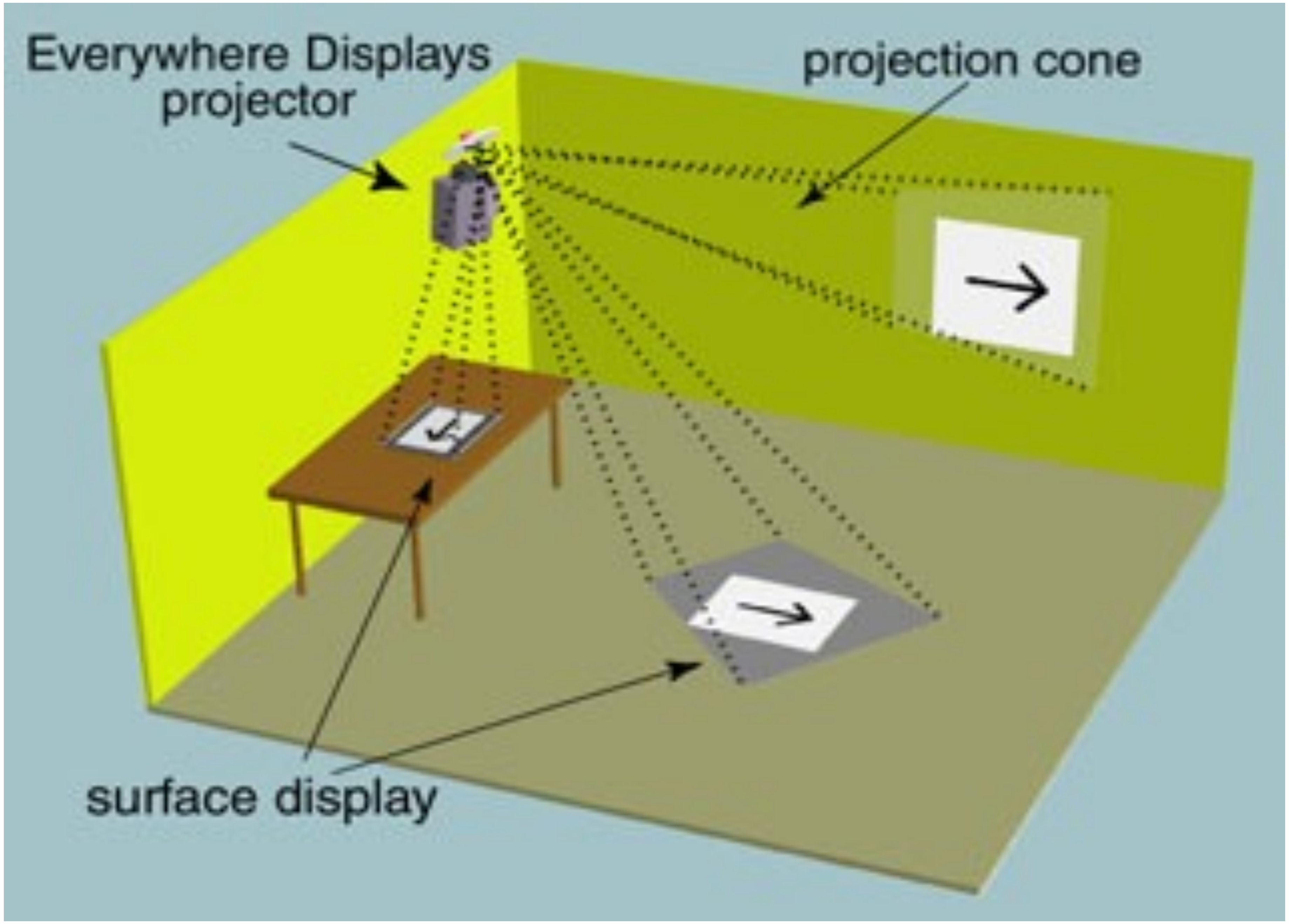
FogScreen(4)

- Pseudo 3D – HeadTracking (S. DiVerdi)
  - Tracking the users Head
  - Input used for adapting the frustum for accurate perspective rendering



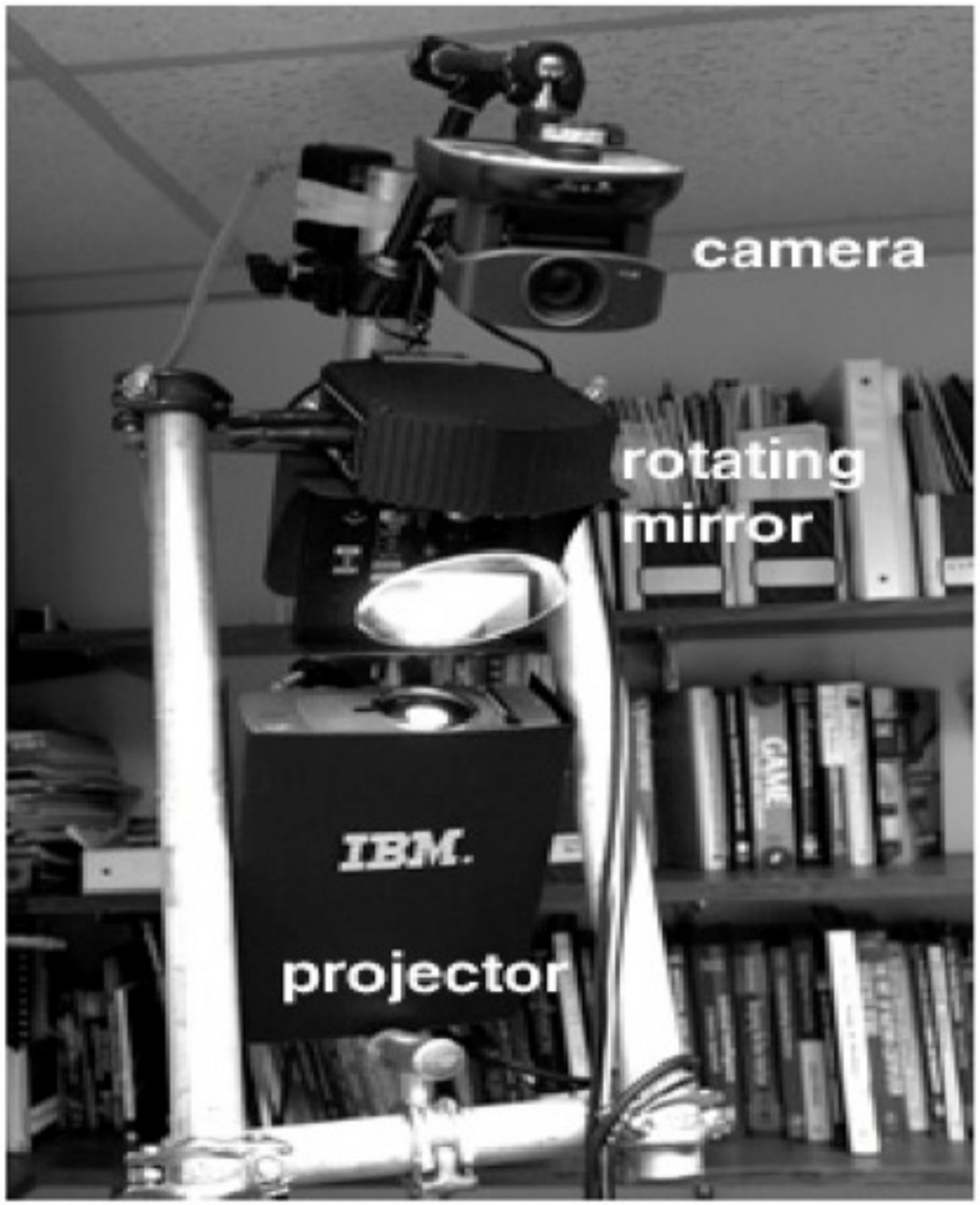
Everywhere Display Projector (IBM)

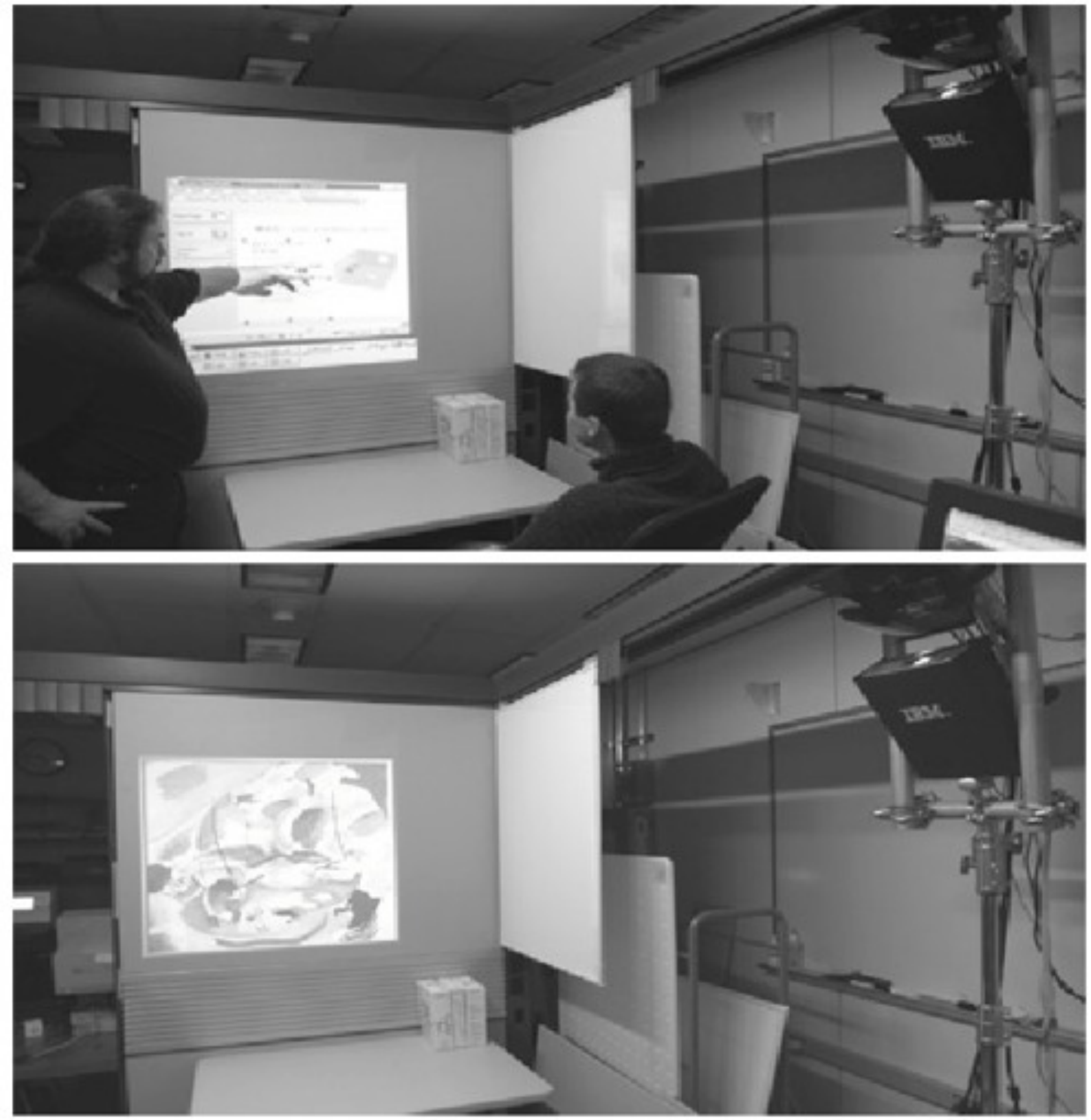
http://www.research.ibm.com/ed/



Claudio Pinhanez

Everywhere display (cont.)

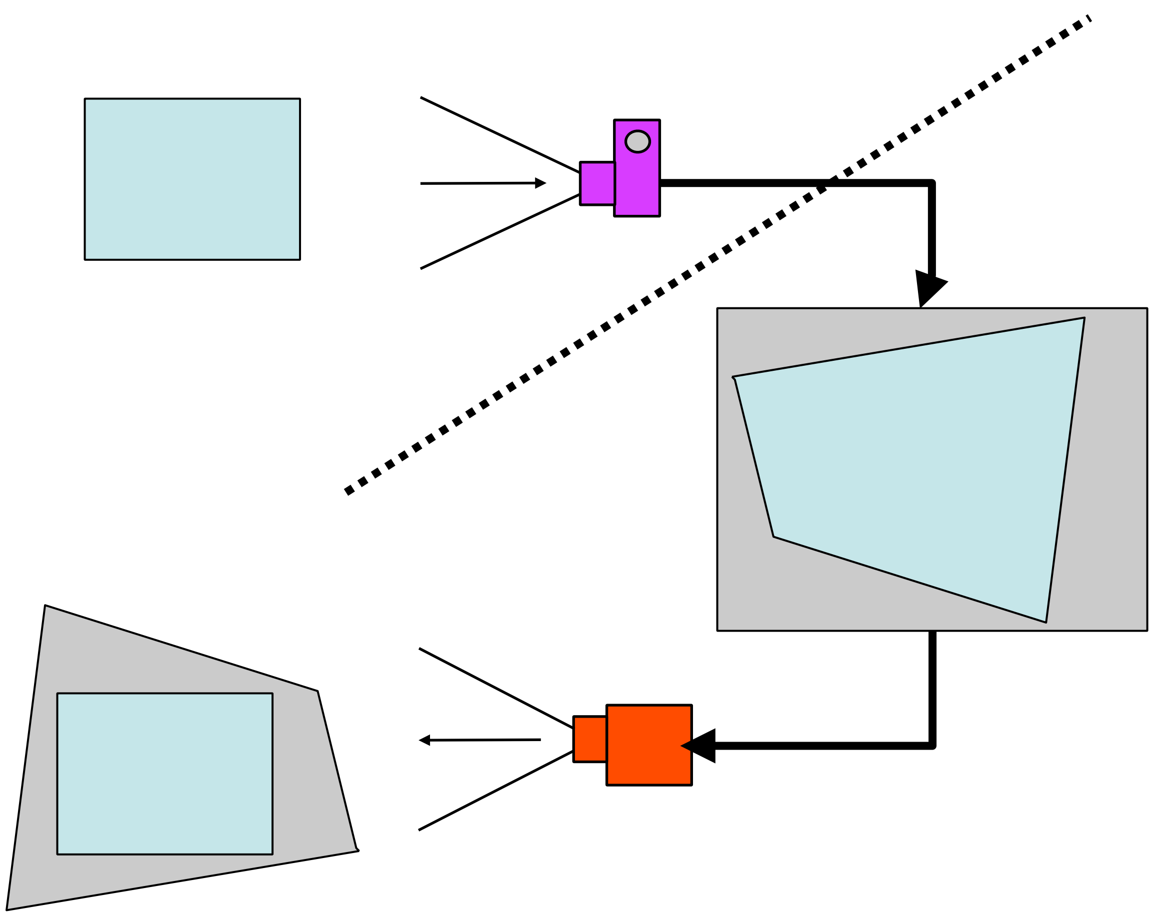




Output: a projector and a rotating mirror

Input: a camera for interaction, NOT for image rectification!

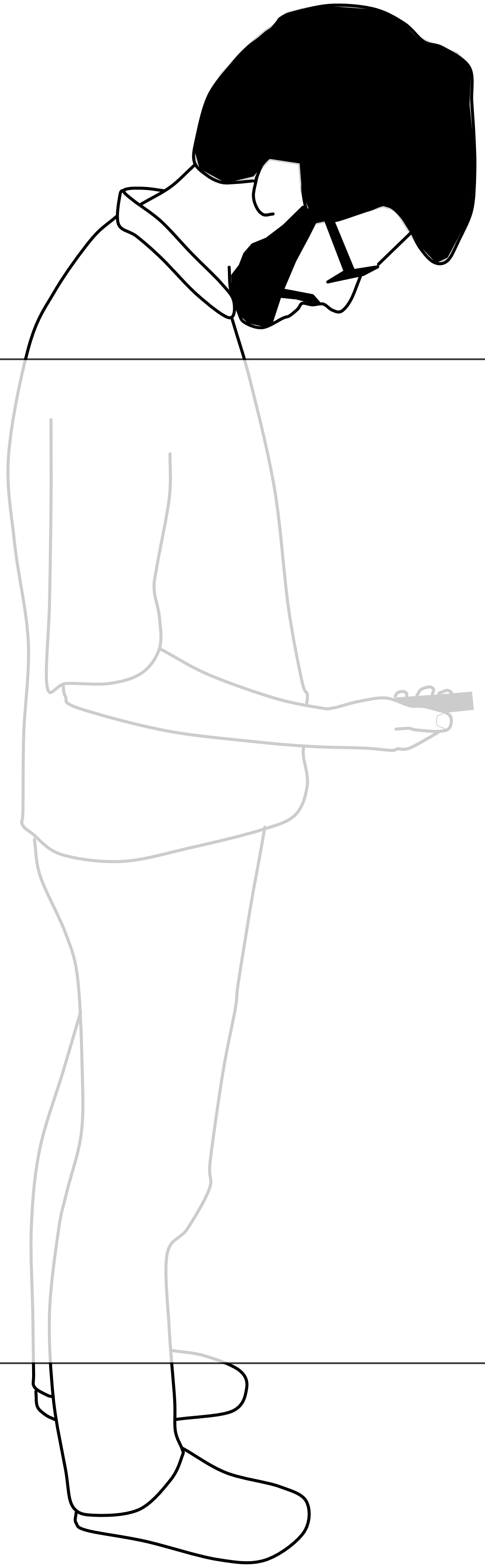
Undistorting the projected image



- Place original image in the 3D model
- Virtual camera image shows it distorted
- Project the distorterd image from 3D model with the Real projector into the real world

– Distortions cancel each other out IF virtual camera and real projector are in the same location

Interactive Environments



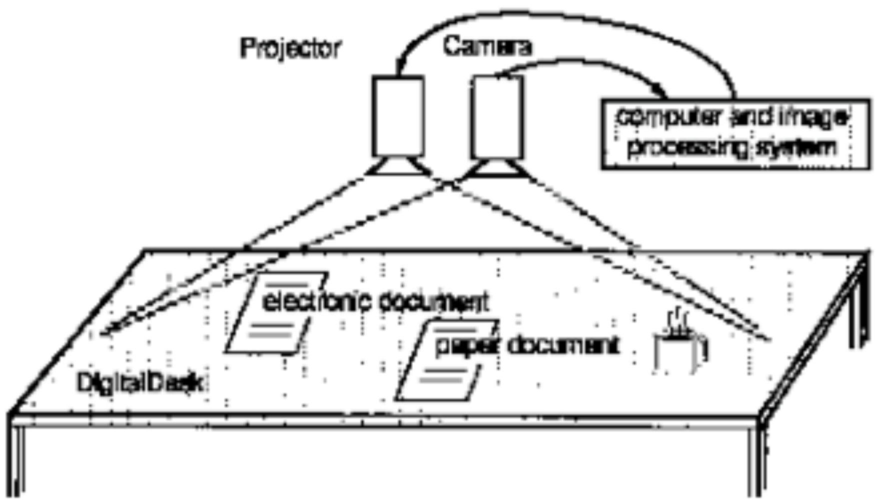
- context and task
- challenges
- input technologies
- **challenges in interaction design**
- output technologies

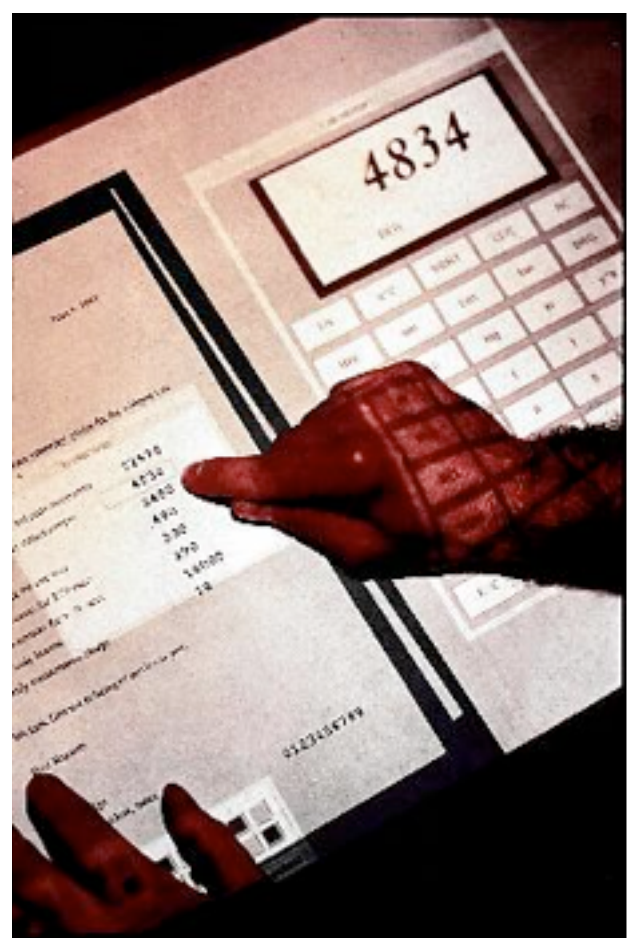
Introduction and History

- Early Research
  - The MIT MetaDesk
  - Pierre Wellner‘s Digital Desk

Historic Interactive Surfaces

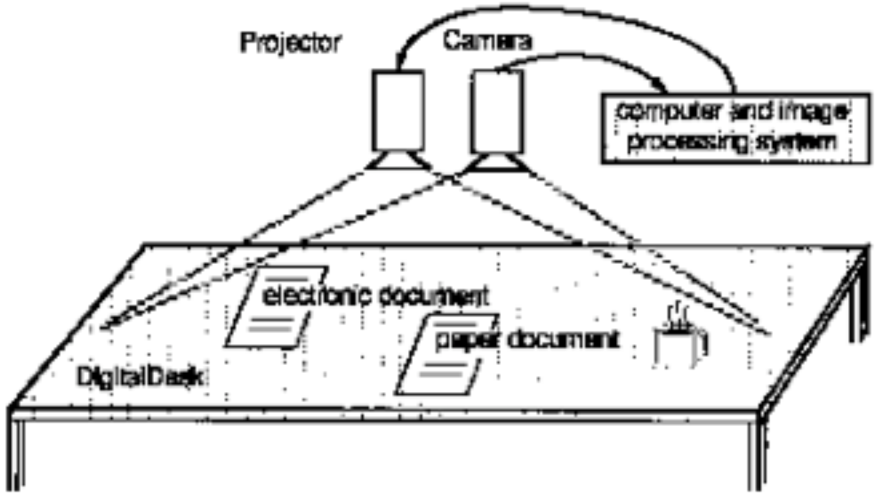
- read http://www.billbuxton.com/multitouchOverview.html !
- early experiments with multi touch in the 1980ies
- For this lecture: 2 prominent historic examples:
  - Pierre Wellner‘s Digital Desk
  - MIT MetaDesk

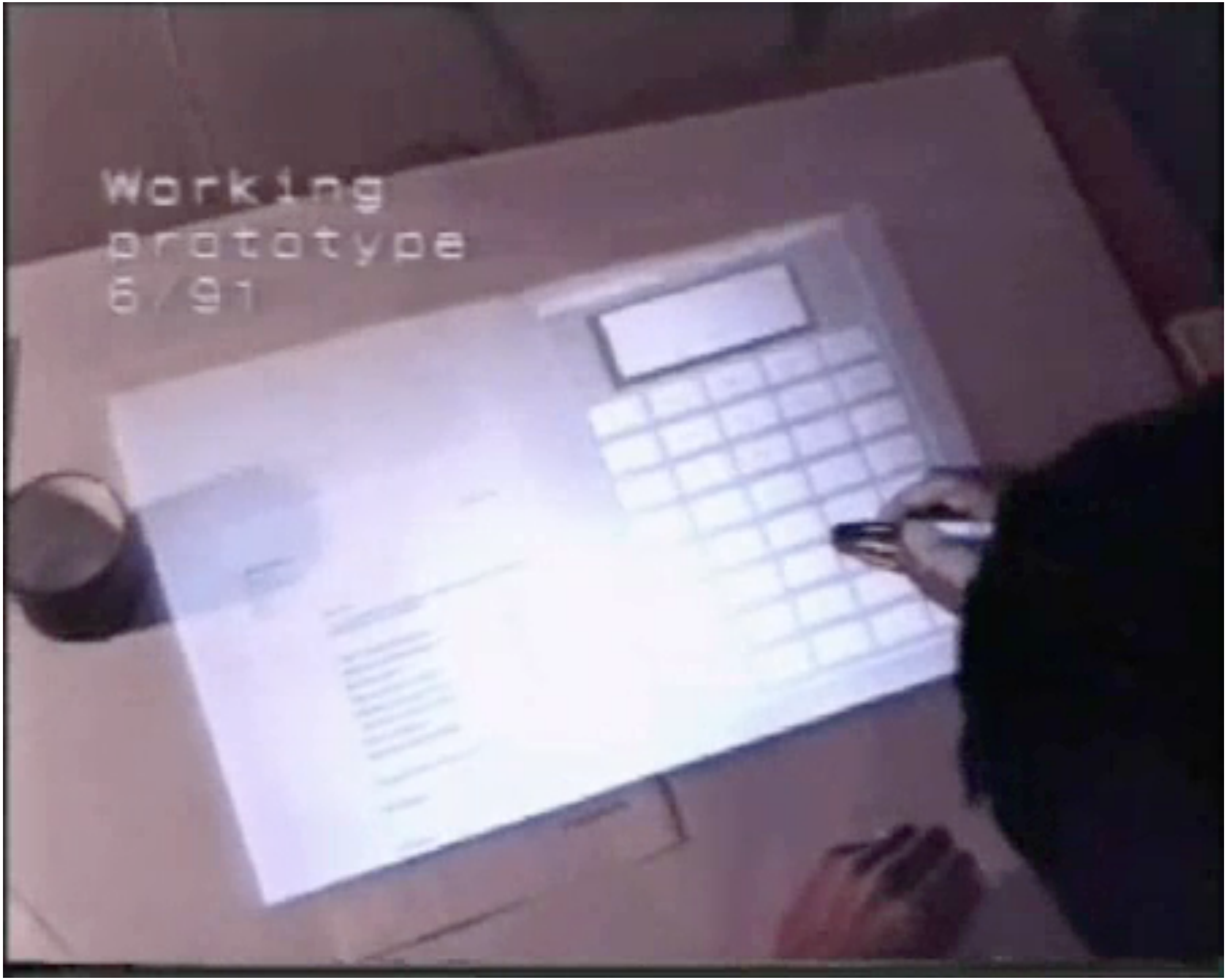




Pierre Wellner‘s Digital Desk

- Working prototype in 1991
- Regular table with top projection
- Overhead camera to detect fingers
- Camera can also scan paper on the desk
- Interaction with printed paper and digital applications on the same surface




Working
prototype
6/91

The MIT MetaDESK

- Platform for exploring Tangible UIs (Ullmer & Ishii, 1997)
- Also uses top projection
- Various projects built on top of it

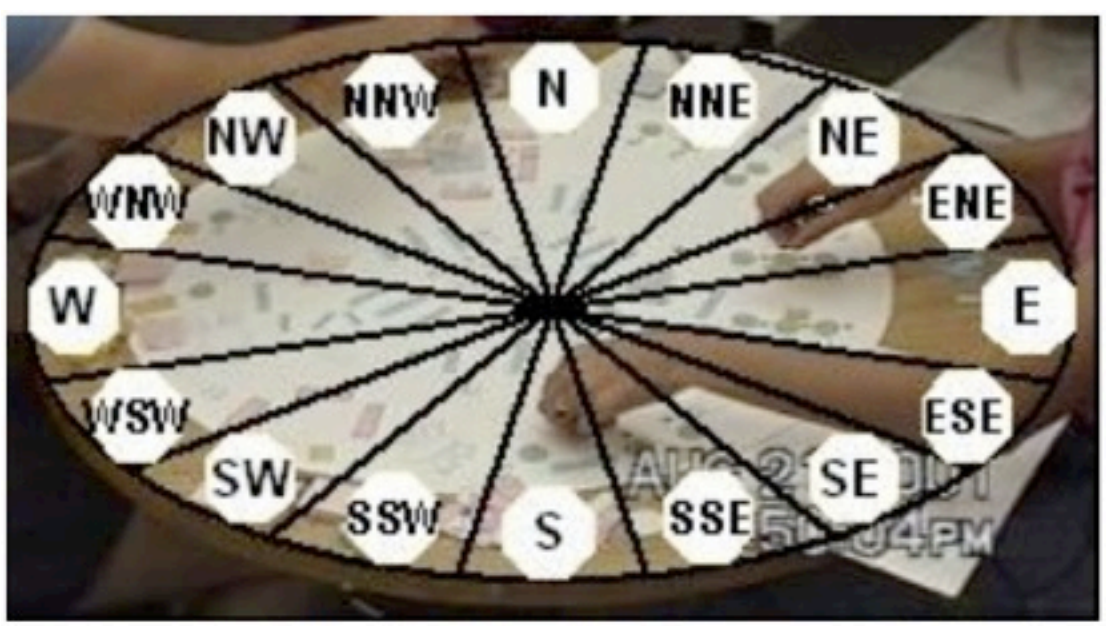
Problems and Particularities

- Asymmetric bimanuality
- Territoriality on tables
- Direction and orientation on tables

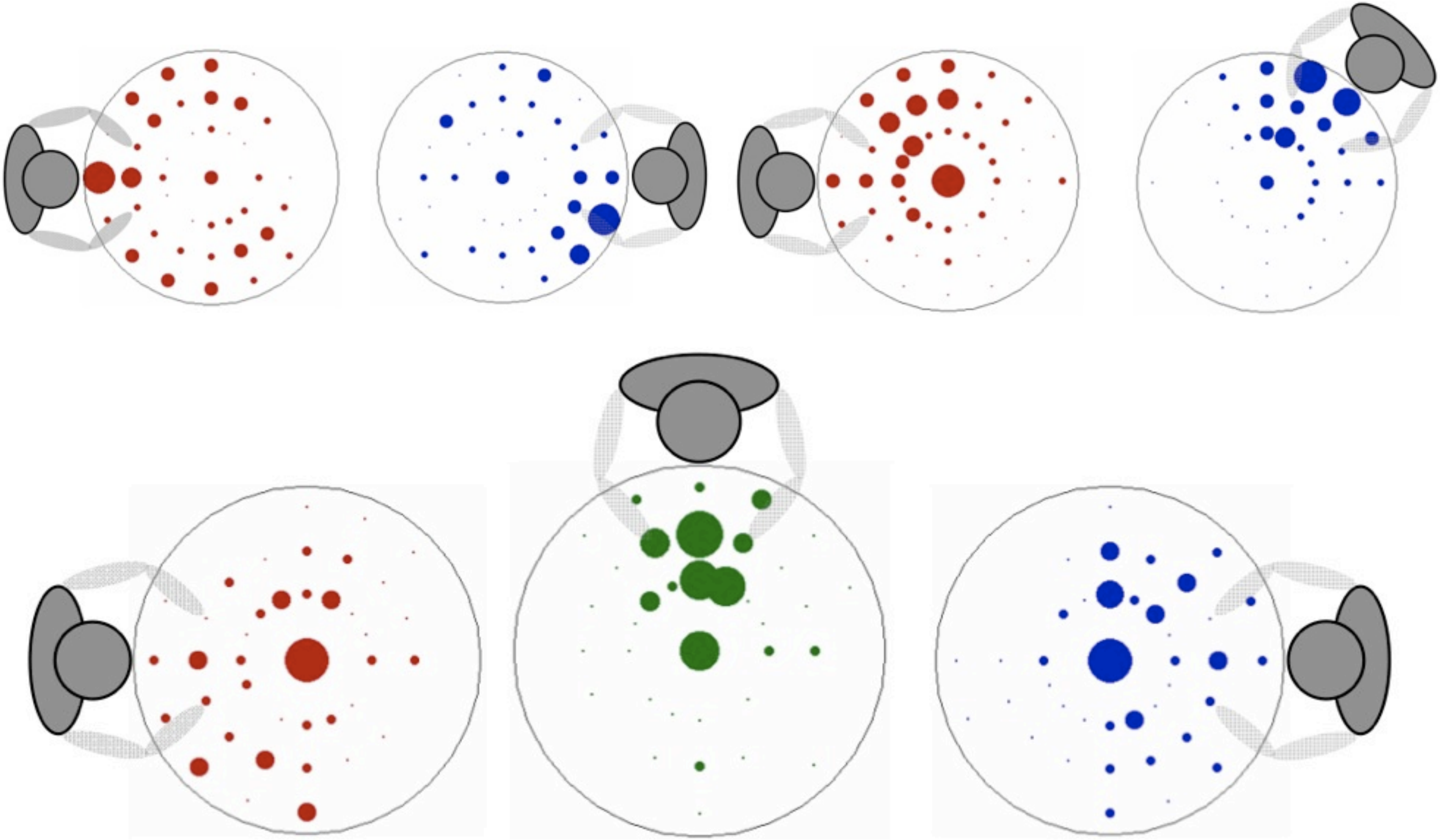
- Midas Touch Problem
- Occlusion Problem
- Fat Finger problem

Territoriality on tables (Scott 2004)

- Studies on how people use the space on a table
  - puzzle, game, Lego activities + room planning on round tables
- Different areas on the table surface
  - personal space (directly in front of person)
  - group space (reachable by all members)
  - storage space (in the periphery)
- Boundaries between areas are flexible



Territoriality on tables (Scott 2004)

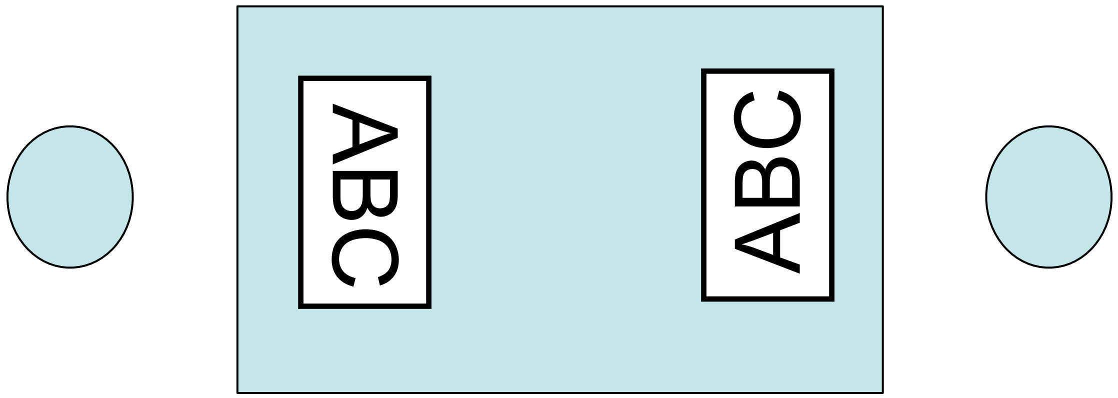


Territoriality on tables (Scott 2004)

- Design Implications:
  - Provide visibility and transparency of action
  - Provide appropriate table space
  - Provide functionality in the appropriate locality
  - Allow casual grouping of items and tools in the workspace

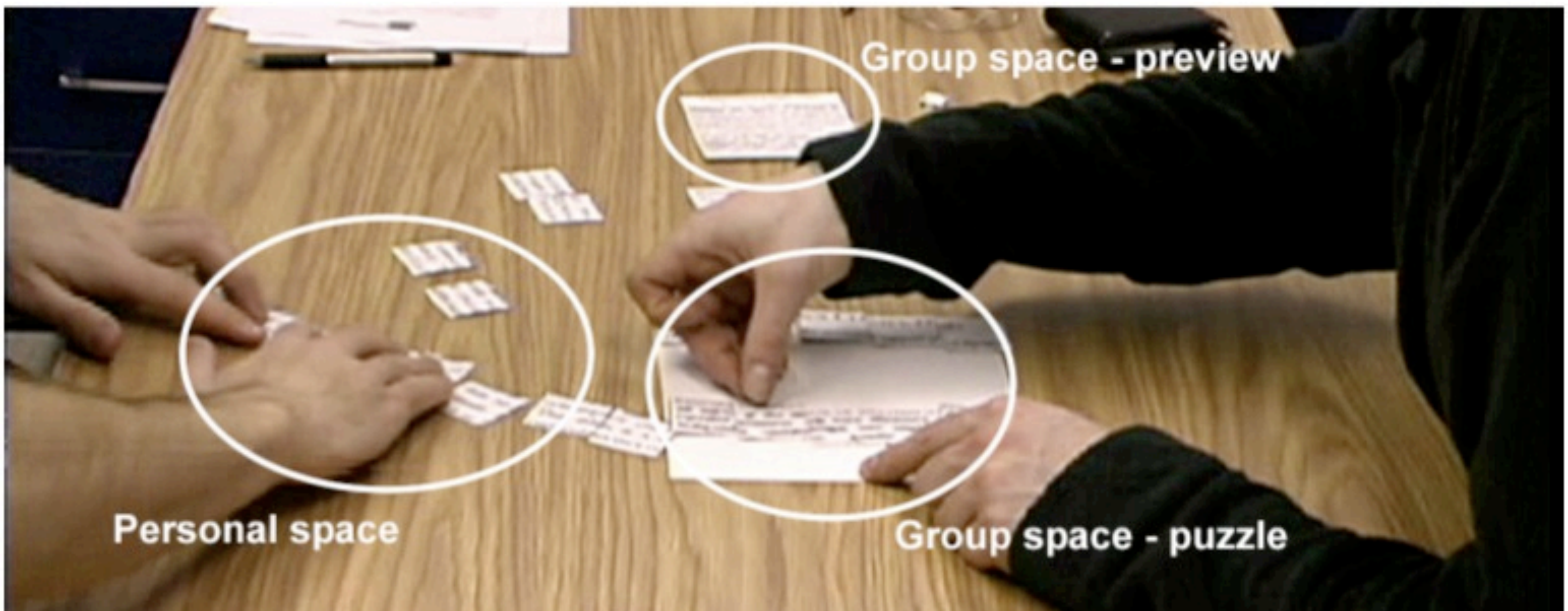
Orientation on tables (Kruger 2003)

- Basic problem: no clearly defined „up“ direction when interacting with multiple users around a table
- Known approaches:
  - Fixed orientation
  - Manual orientation
  - Person-based automatic orientation
  - Environment-based automatic orientation



Orientation on tables (Kruger 2003)

- Orientation can serve as a collaborative resource:
  - Using someone else's alignment conveyed support
  - Orientation could establish the intended audience
  - Orientation was also used to create a personal space.



Orientation on tables (Kruger 2003)

- 3 main roles of orientation:
- Comprehension
  - Ease of reading
  - Ease of task
  - Alternate perspective
- Coordination
  - Establishment of personal spaces
  - Establishment of group spaces
  - Ownership of objects
- Communication
  - Intentional communication
  - Independence of orientation

Midas Touch Problem

- General problem with touch input:
  – positioning and selection is the same
  – cannot position the pointer without selecting
  – there is no „hover“ state

- Name goes back to king Midas
  – everything he touched turned to gold
  – ...also food, so he was in danger to starve...

- Straightforward solution: dwell time
  – trigger a function only after a certain time
  – introduces artificial delays, disturbs the flow

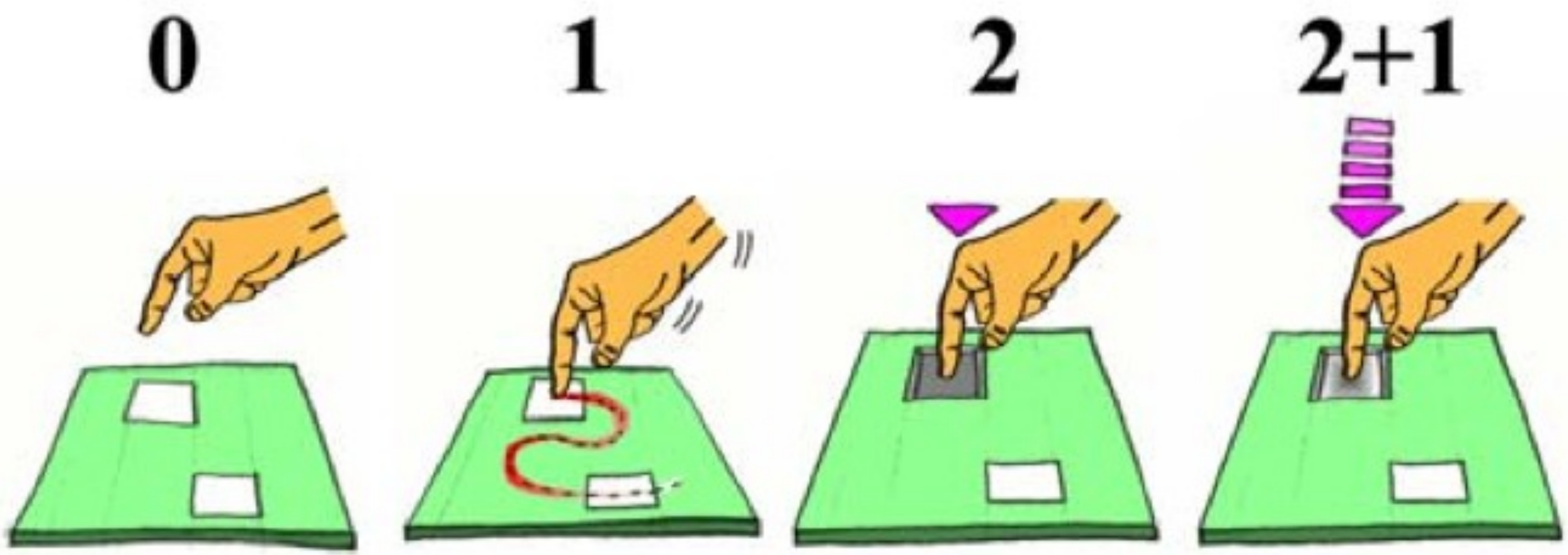
- Also well-known in gaze-based interaction (eye tracking)

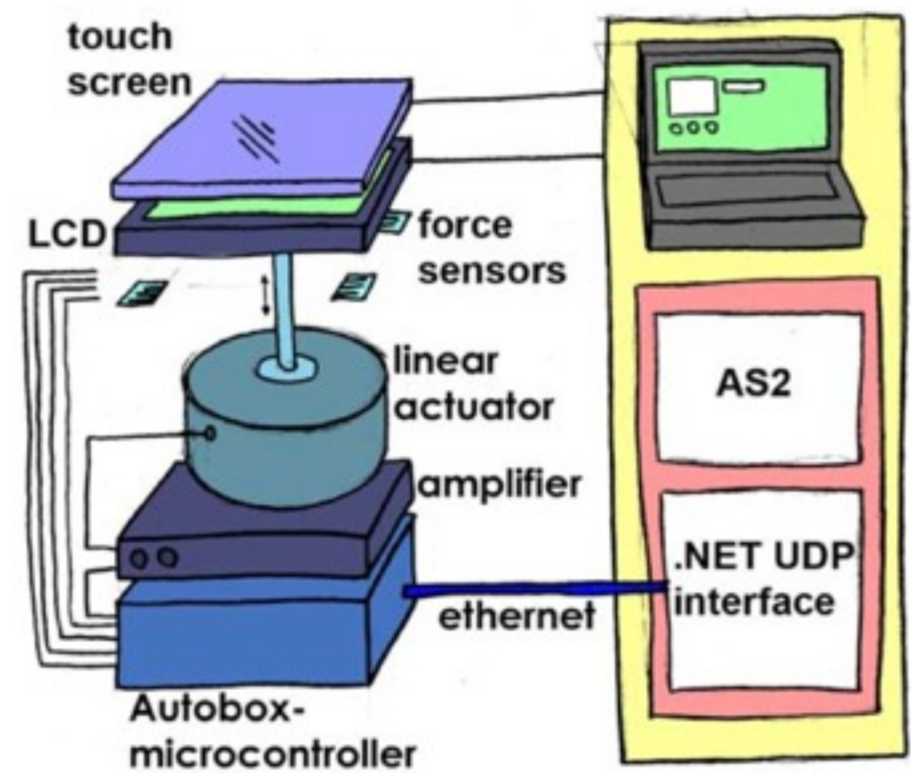
http://de.wikipedia.org/wiki/Midas

Dealing with the Midas Touch Problem

- Lift-off techniques (e.g., Potter et al. CHI 1988)
  - cursor is offset from the finger and displayed during exploration
  - function is only triggered when the finger leaves the surface
  - can be observed in the video on „shift“, earlier in this class

- Pressure sensing (e.g., Richter et al. AutoUI 2010)
  - finger can explore the screen in hover state
  - selection by pressing harder





Interaction Techniques on Int. Surfaces

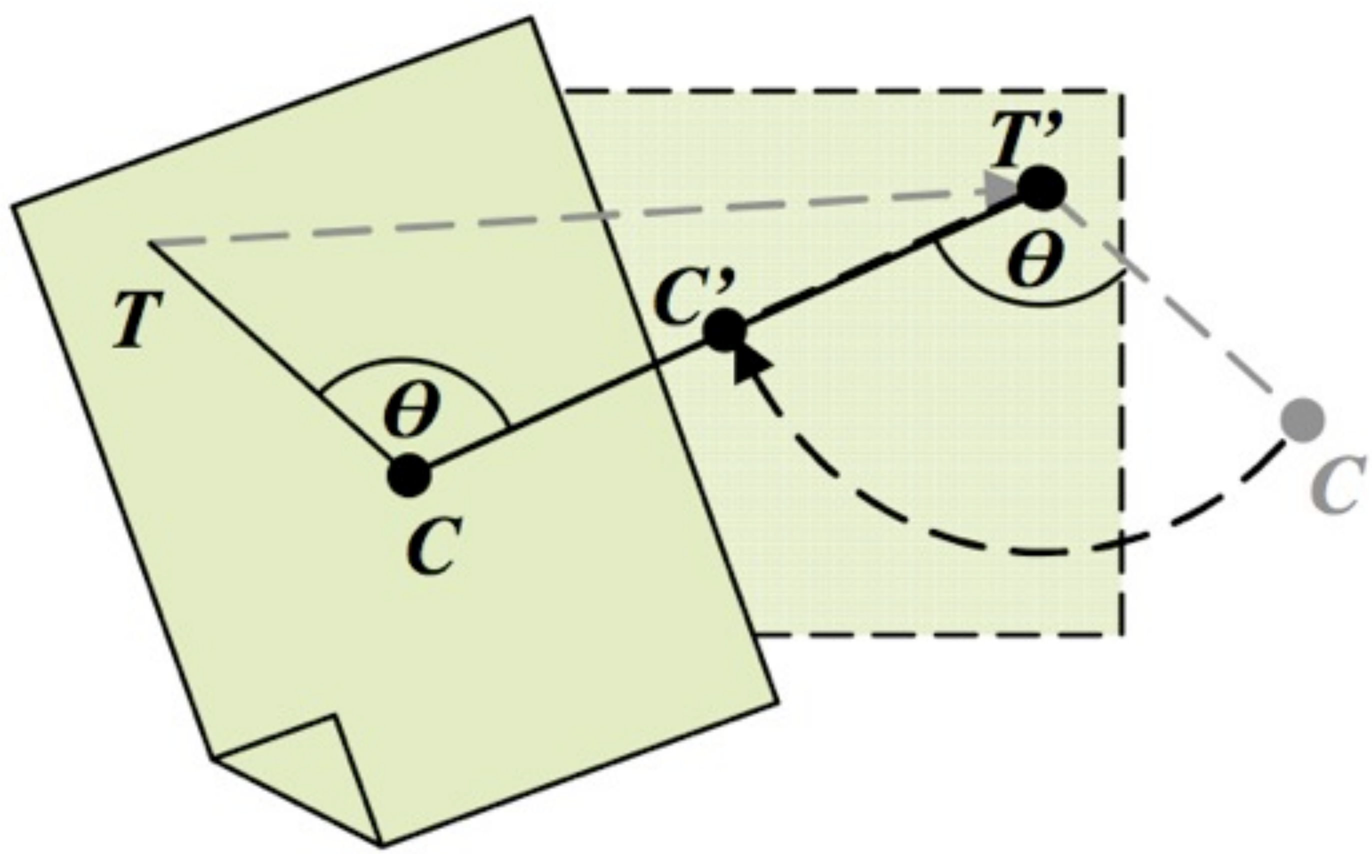
- Motivation: thinking about bumptop
- Single touch
  - RNT
- Dual touch
  - The Pinch etc.
- Multi touch
  - possible contradictions
- Shape-based
  - Bringing physics to the surface
- Tangible UIs on surfaces
  - URP, illuminating light, SLAP, eLabBench

Bumptop - the original video

Making fun of Bumptop - discussion

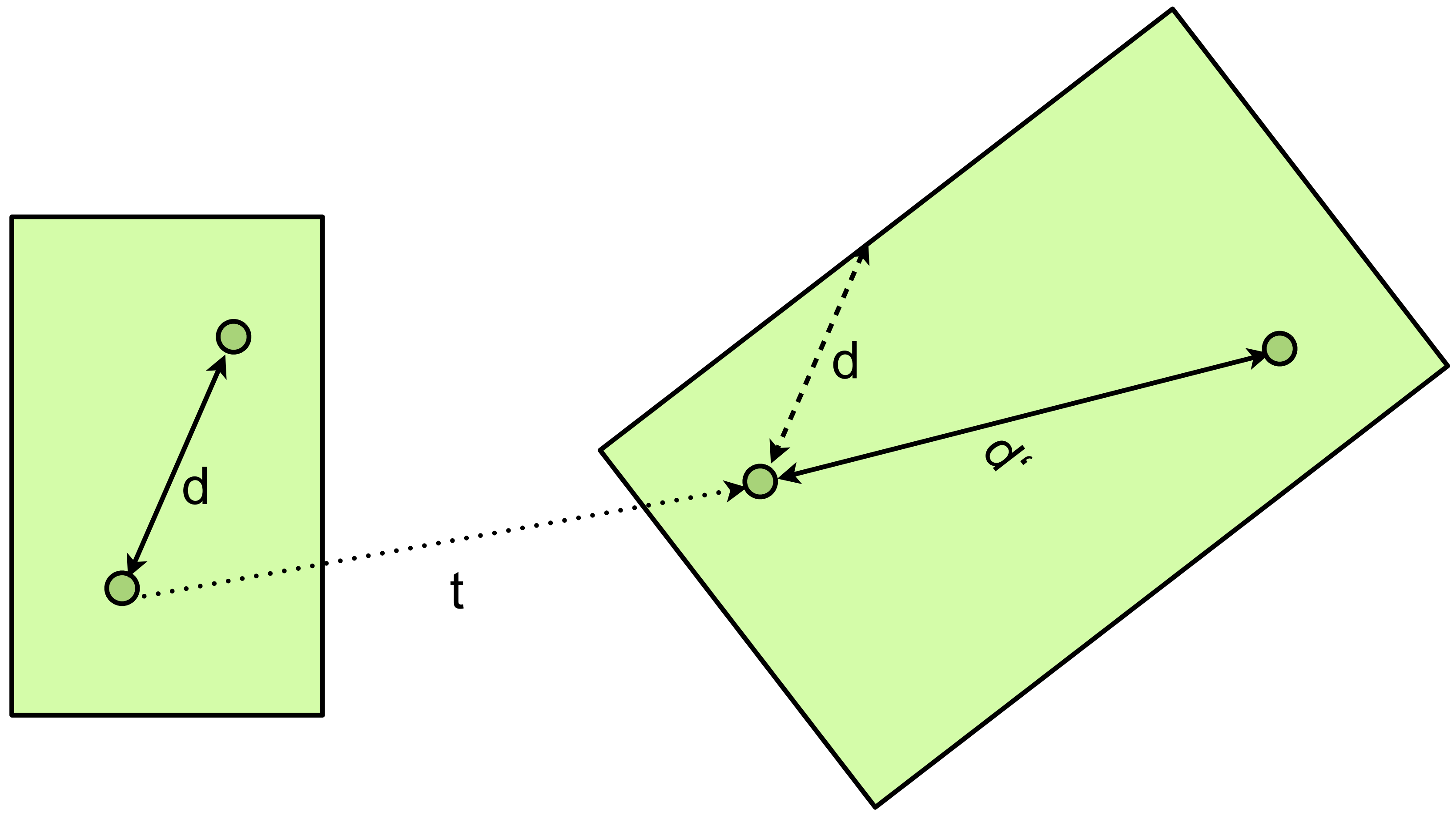
RNT - Rotate and Translate with 1 Touch Point

- Problem: only 1 touch point (= mouse)
- Goal: rotate and translate in a single gesture
- Idea: use a physical model (inertia, friction)
  - friction force is opposite to the direction of movement
  - rotation is recalculated in every frame



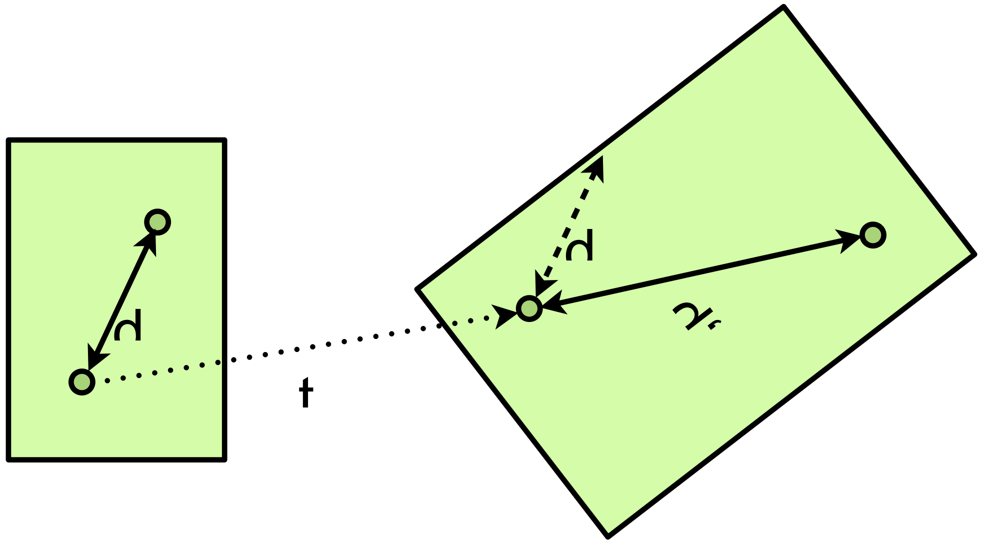
Rotate, Translate and Scale with 2 Touch Points

- track 2 points from frame to frame
- compute scaling from change in distance d to d‘
- compute rotation from angle between <d,d‘>
- compute translation t and use directly



Possible Contradictions with >2 Touch Points

- Consider R+T+S method for 2 TP
- With 3 TP we can find 3 pairs
- they will almost certainly yield
  - different d, d‘
  - different orientation
  - possibly even different translations
- How to deal with this?
  - ignore 1 point ;-) looks weird in certain cases
  - use mean R,T,S to minimize error
  - deform the underlying object



Shape-based interaction

- Interaction in the real world uses not just contact points
- We use whole hands, arms, tools
- Cannot be adequately expressed using just contact points
- How can we deal with this?

- Remember the lava lamp in Jeff Han‘s TED talk?
- Seriously: How can we do useful stuff with this?

Tangible UIs on Interactive Surfaces

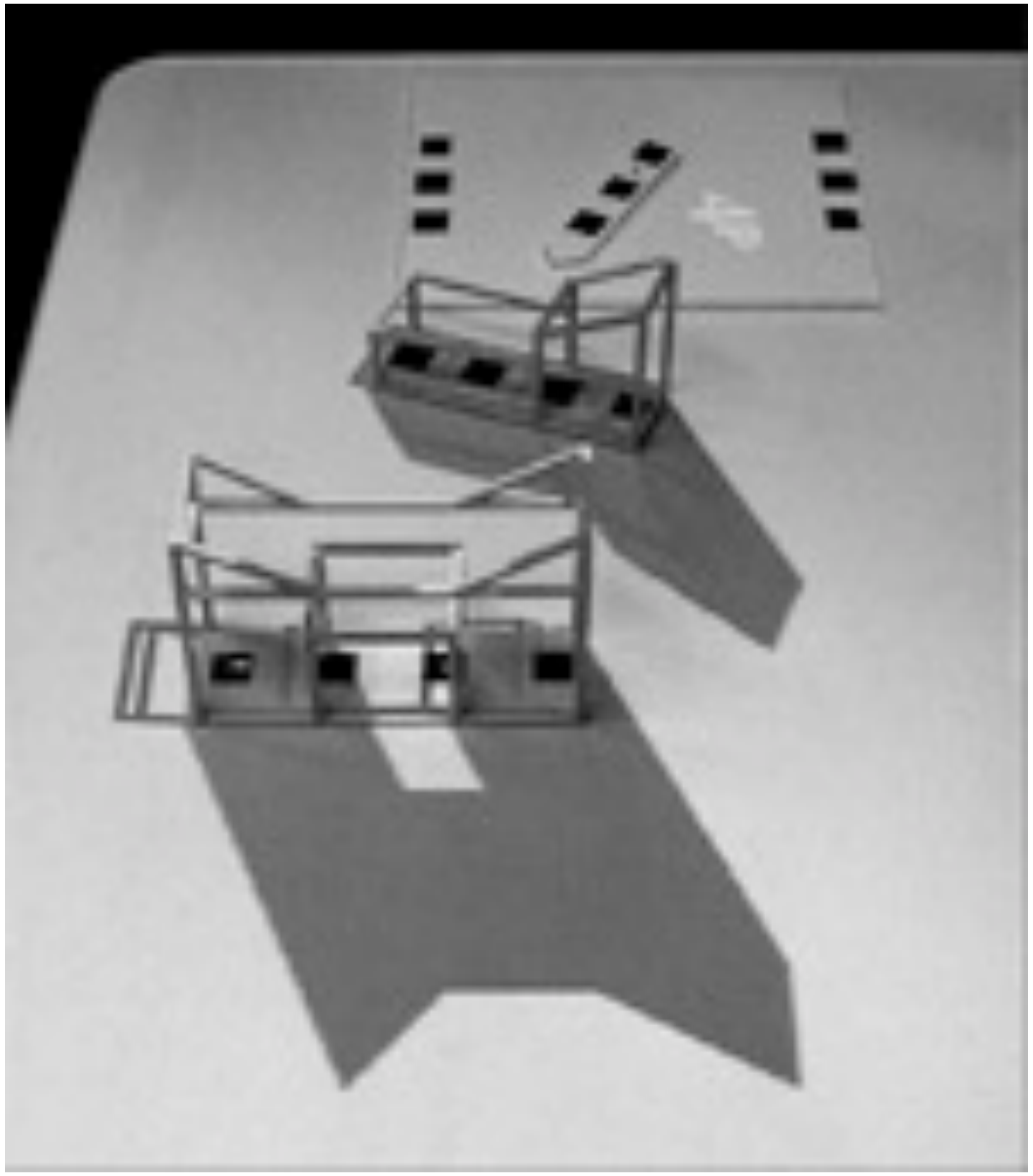
- classic TUI project: URP
- another classic: illuminating light
- SLAP widgets

- Other examples already seen (hence not repeated):
  - MetaDesk
  - PhotoHelix

Luminous room: Urban Planning (URP)

(John Underkoffler and Hiroshi Ishii, CHI 99)

- Move physical models of houses on a desk surface
- Simulate in the computer:
  - Shadows
  - Window reflections
  - Air flow and wind



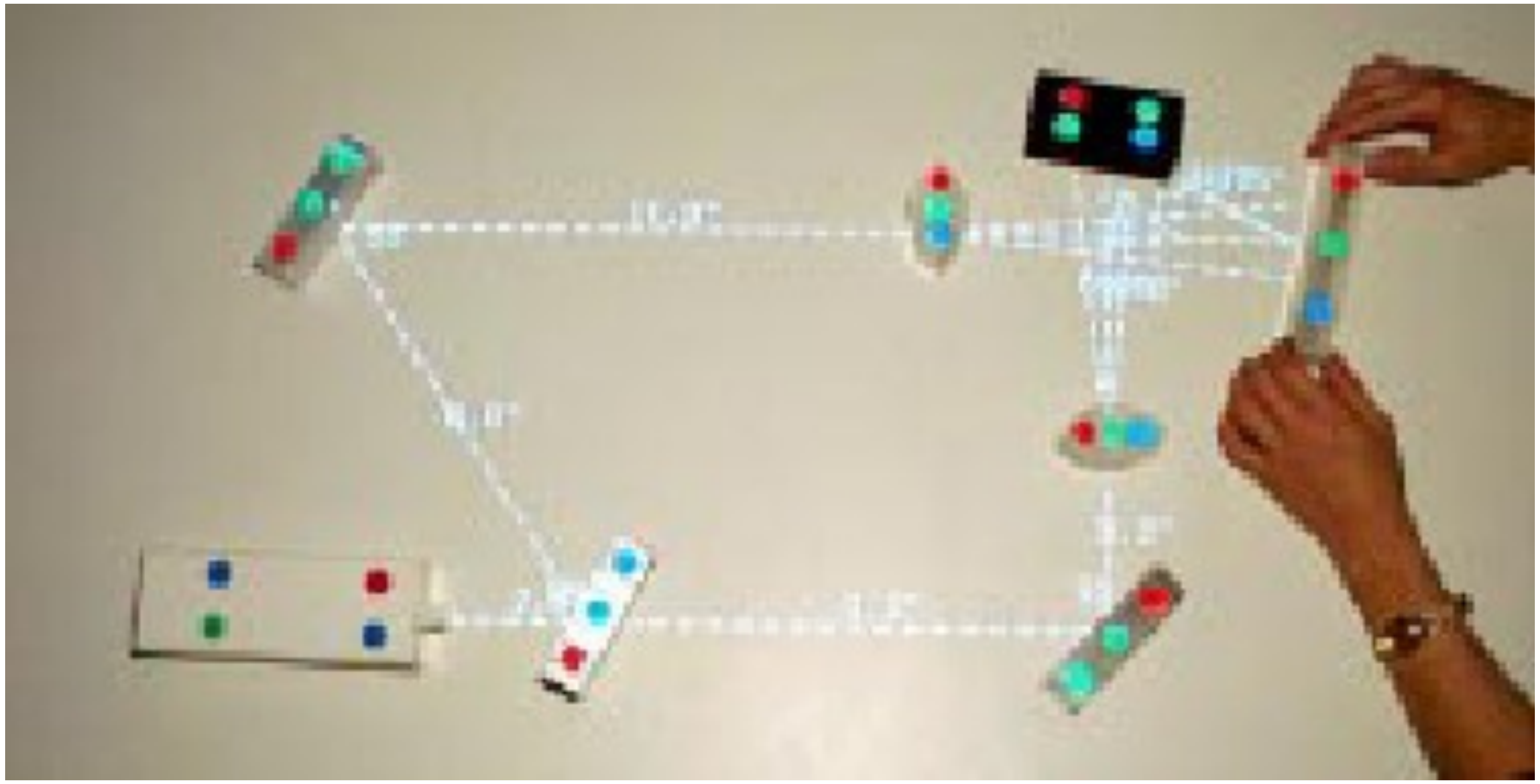
urp:

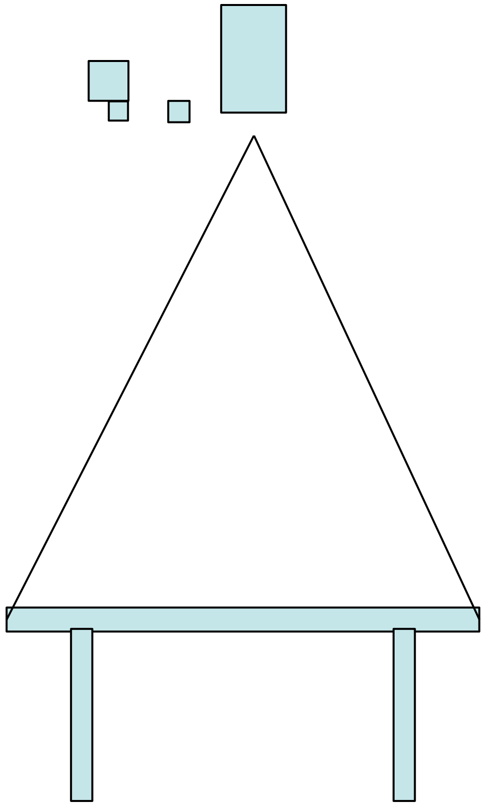
an integrated
urban planning tool
with a physical interface

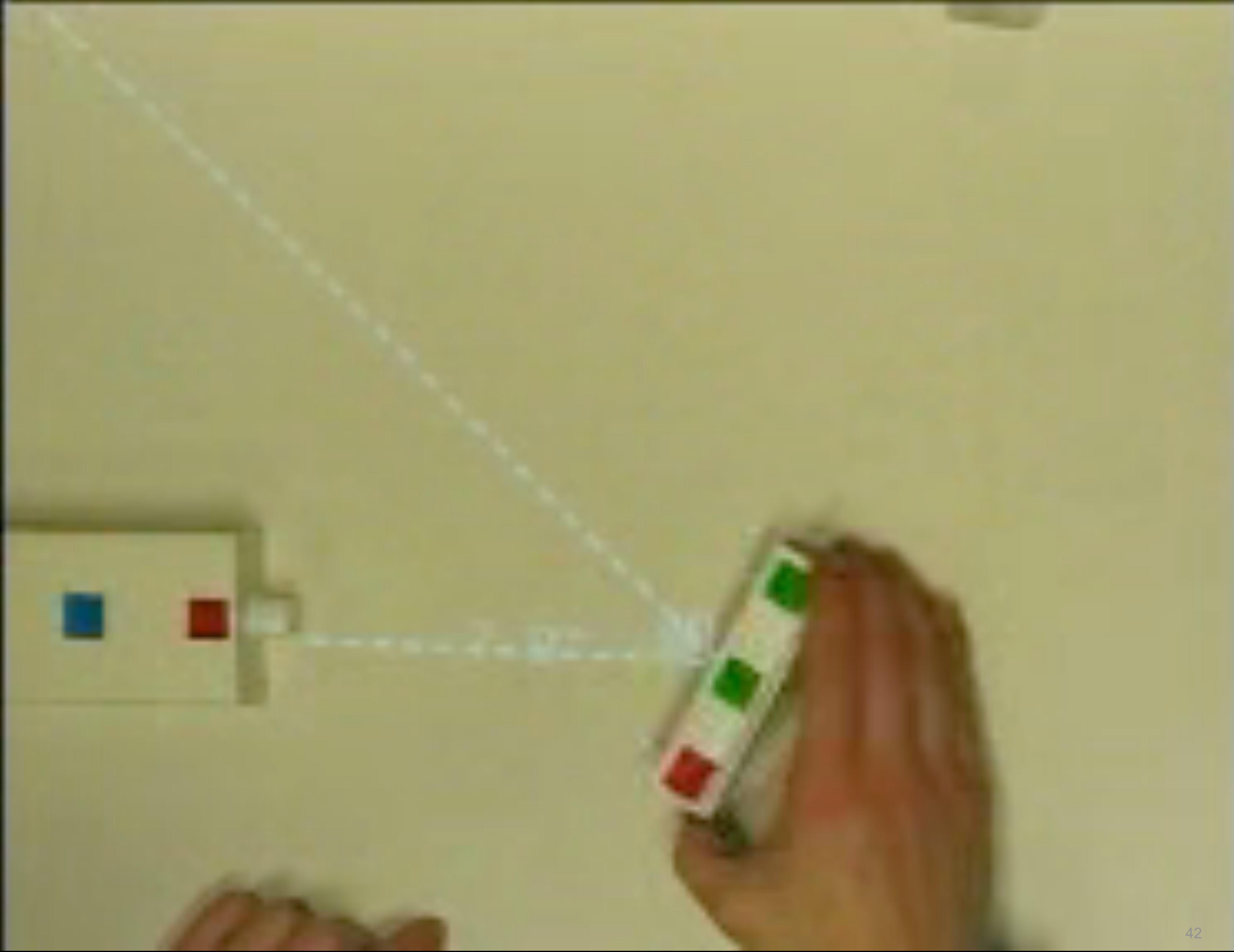
Luminous room: Illuminating Light

(John Underkoffler and Hiroshi Ishii, CHI 98)

- Simulation of optical/holographic setups
- Phys. objects represent optical elements
- Top projection of resulting laser beam



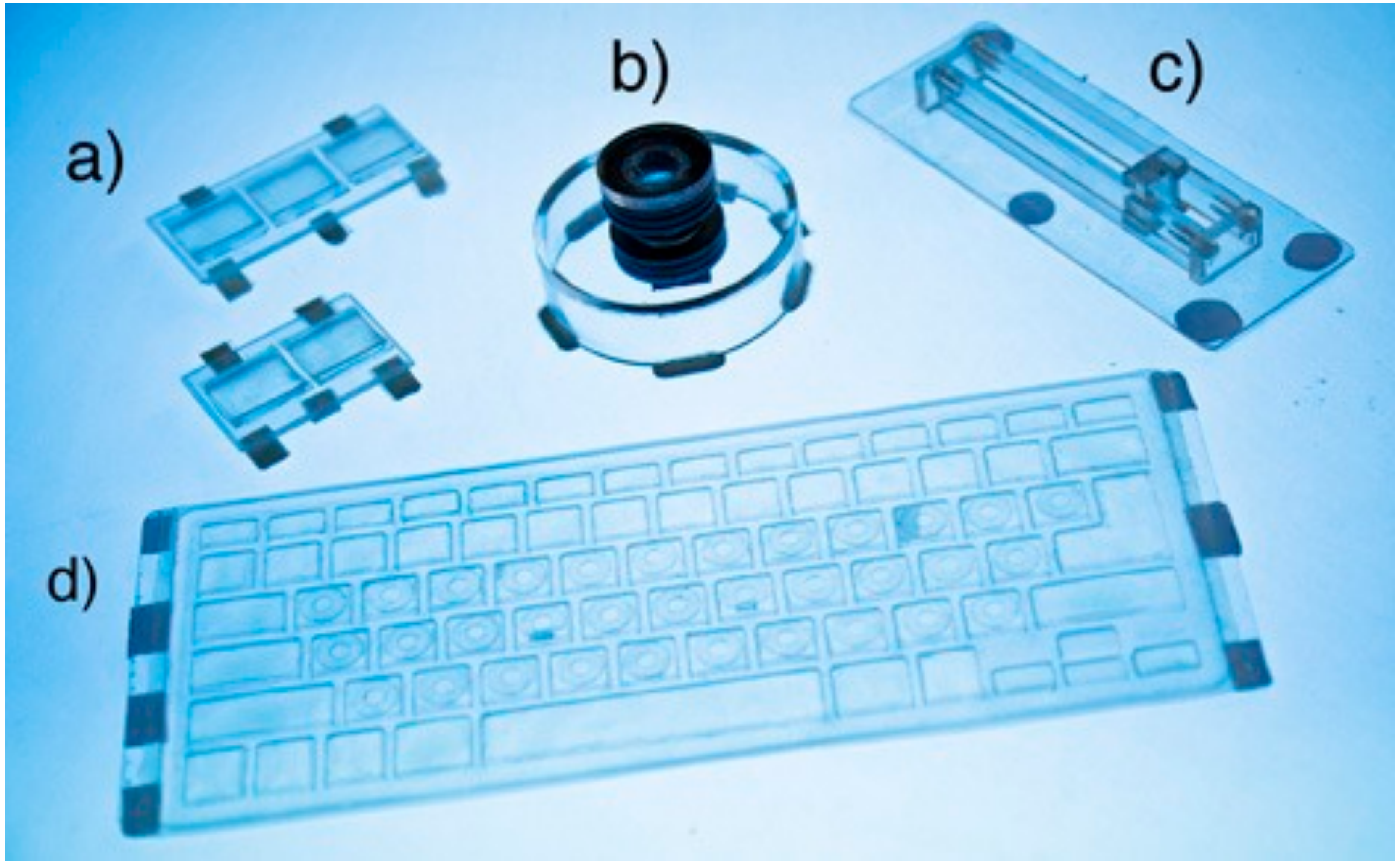




SLAP Widgets [Weiss et al. CHI 2009]

- Transparent Tangible objects for interactive surfaces
- Use optical sensing (FTIR + DI)
- Can be augmented with digital content
- Idea: flexible multi-purpose tangible widget set

- SLAP Widget set:
  - a) Keypads.
  - b) Knob.
  - c) Slider.
  - d) Keyboard.




Blue
Brightness
Green
Contrast
Red

eLabBench [Tabard et al., ITS 2011 best paper]

- Idea: make a Biology lab bench interactive
- Use the same lab instruments as before
- Augment them with digital information


First-year-Nano

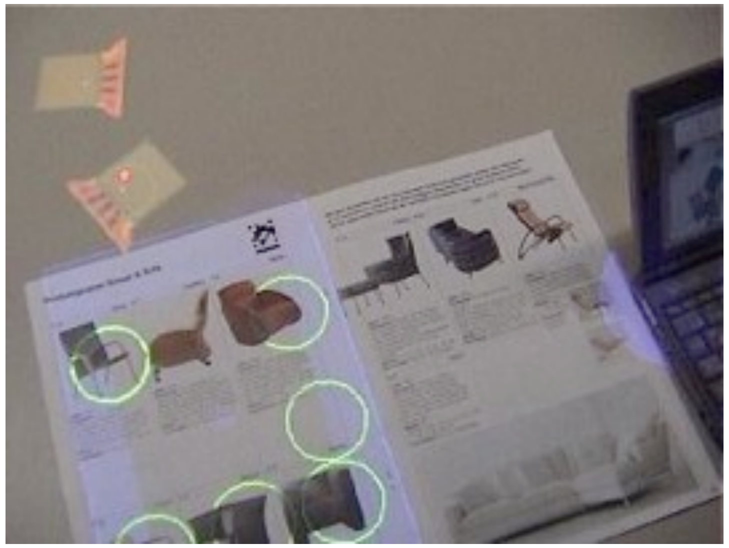
Multi Display Interaction

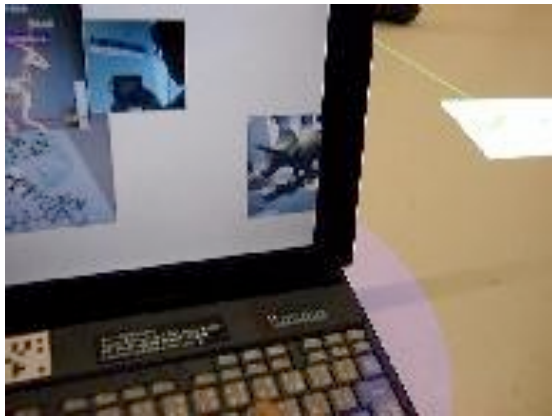
- Historic: Augmented Surfaces, Pick&drop
- newer: bump, stitch
- recent example: Touch projector

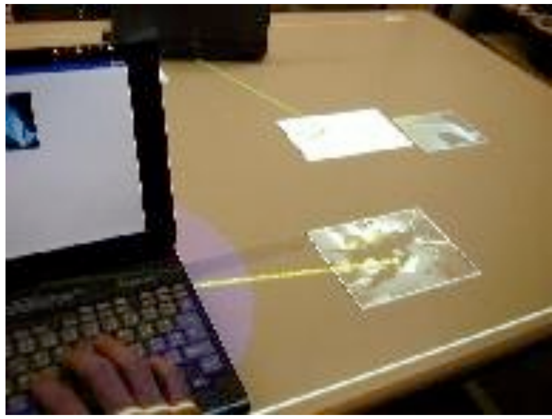
Augmented Surfaces

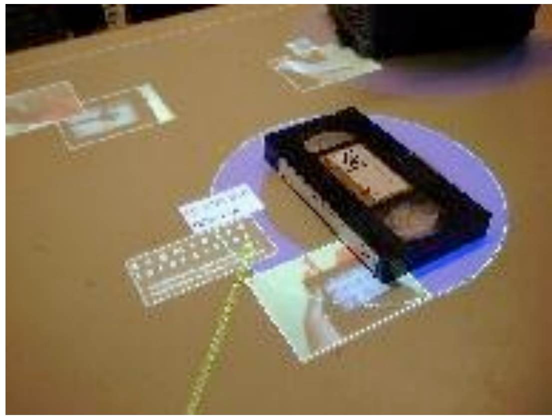
Jun Rekimoto and Masanori Saitoh, CHI'99

- Combination of mobile devices and projection surfaces
- Interaction techniques:
  - hyperdragging
  - pick-and-drop
  - pick-and-beam
  - digital attachment
    - interaction objects for tangible interaction
    - Camera-based acquisition of images
    - Selection from physical catalogues









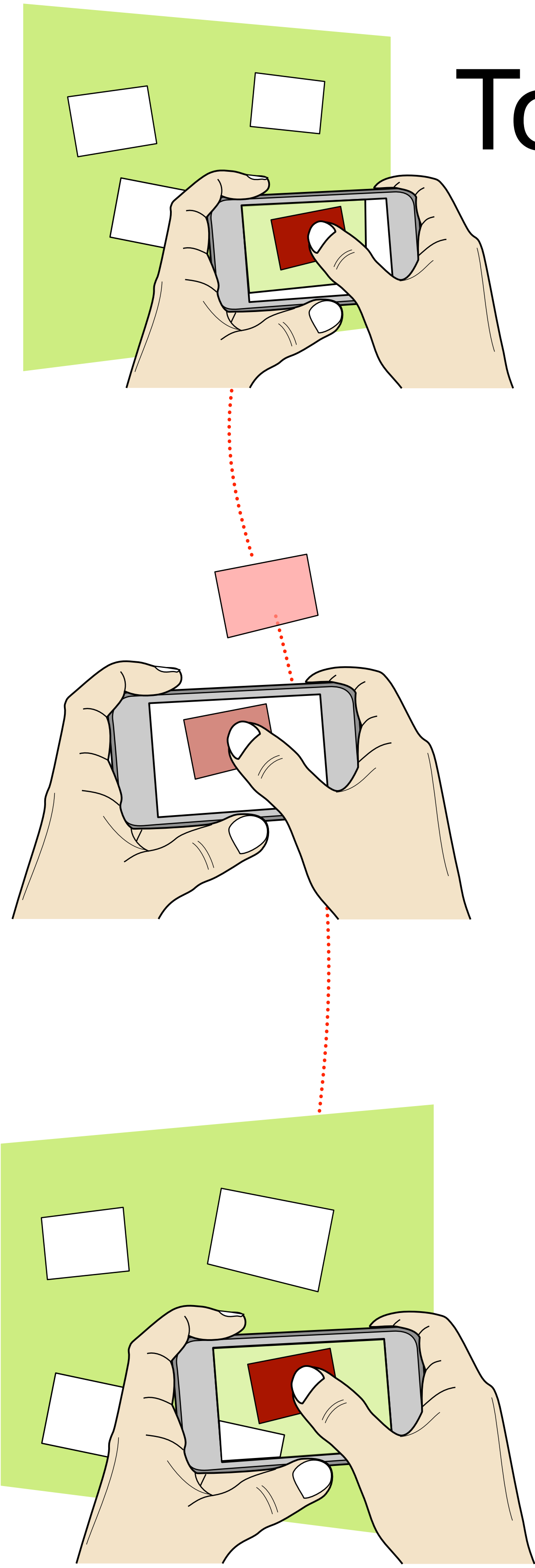
Video

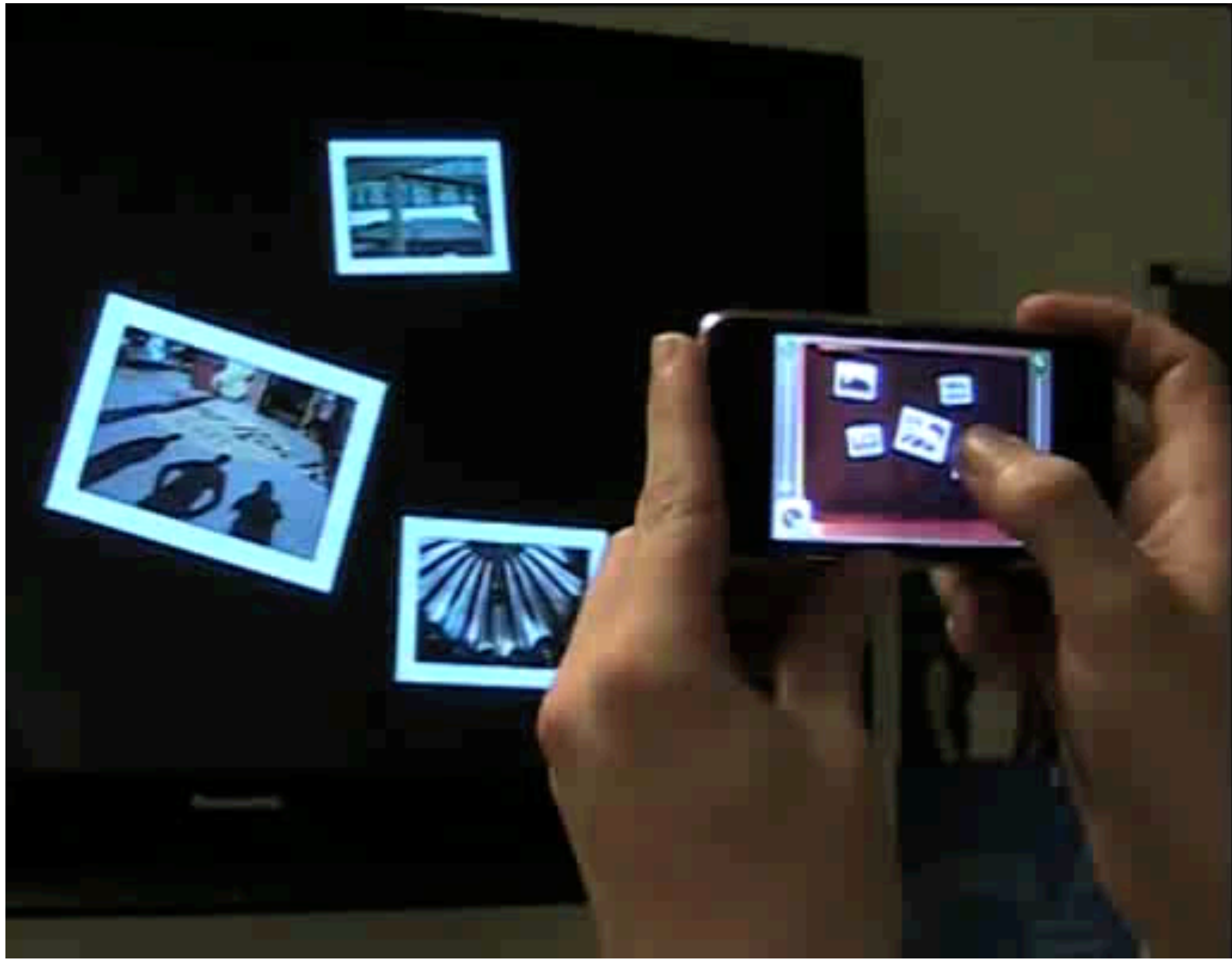
Augmented Surfaces: A Spatially Continuous Workspace for Hybrid Computing Environments

Jun Rekimoto

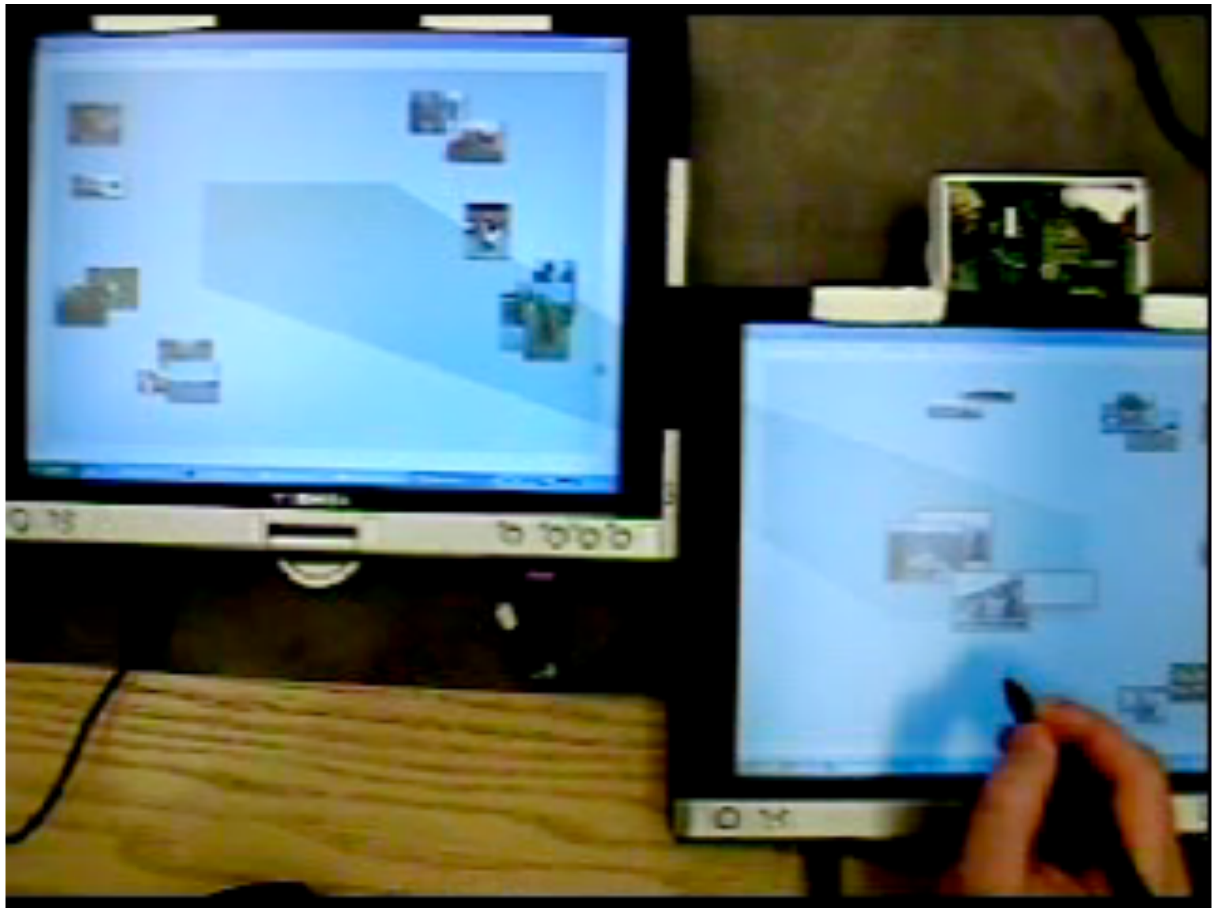
Sony Computer Science Laboratory

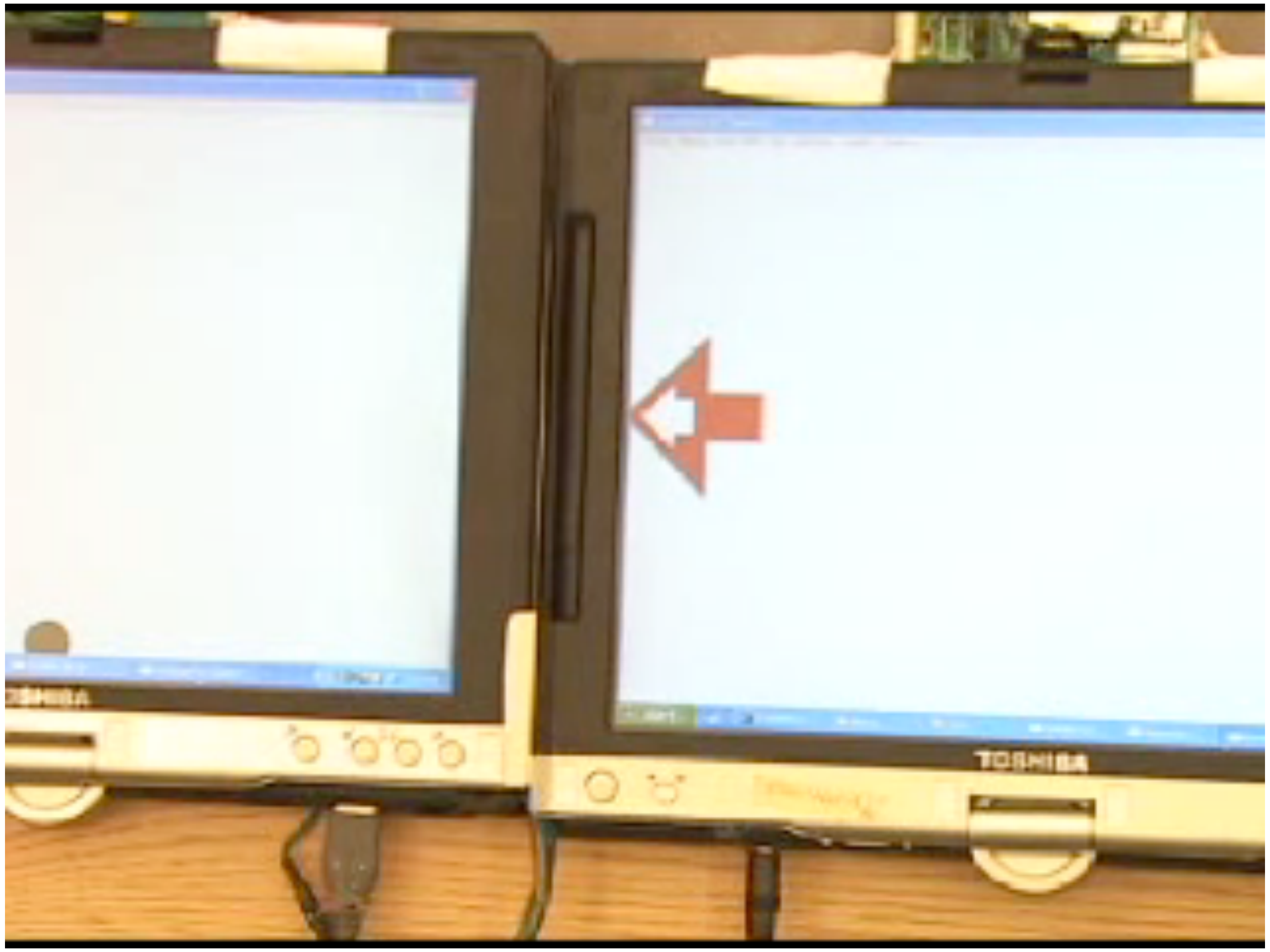
TouchProjector [Boring et al., CHI `11]





Stitching & Bumping [Hinckley et al.]





Take-away Message

- many visual output technologies
  - displays
  - tabletops
  - (steerable) projection
- instrumented environment = many displays
  - think about coordination
  - interaction techniques need to be invented
- No clear interaction concept yet
  - every device works differently
  - think about rules that can be applied to all
  - field of ongoing research!!

Additional Literature

- Rotation and translation mechanisms for tabletop interaction. Mark S. Hancock, Frédéric Vernier, Daniel Wigdor and Sheelagh Carpendale, and Chia Shen. In Proc. Tabletop, pp. 79-86, 2006.
  - (also the source of the image on slide 25)
- A. D. Wilson, S. Izadi, O. Hilliges, A. Garcia-Mendoza, D. Kirk: „Bringing Physics to the Surface“, ACM UIST 2008 - Best Paper Award
- Malte Weiss, Julie Wagner, Yvonne Jansen, Roger Jennings, Ramsin Khoshabeh, James D. Hollan, and Jan Borchers. SLAP Widgets: Bridging the Gap Between Virtual and Physical Controls on Tabletops. In CHI '09:
- A. Tabard, J.D. Hincapié-Ramos, M. Esbensen, and J.E. Bardram: „The eLabBench: An Interactive Tabletop System for the Biology Laboratory“. ACM ITS 2011 - Best Paper Award

Michel Beaudouin-Lafon: Instrumental Interaction in Multisurface Environments

February 5th, 2014
10:15 - 11:45
here in this room