# Gesten, Blicke, Berührungen –

## Methoden und Konzepte natürlicher Mensch-Computer-Interaktion

Modul INF-D-910 Forschungslinie
Sommersemester 2019, 08.07.2019

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INTERACTIVE MEDIA LAB DRESDEN, Germany

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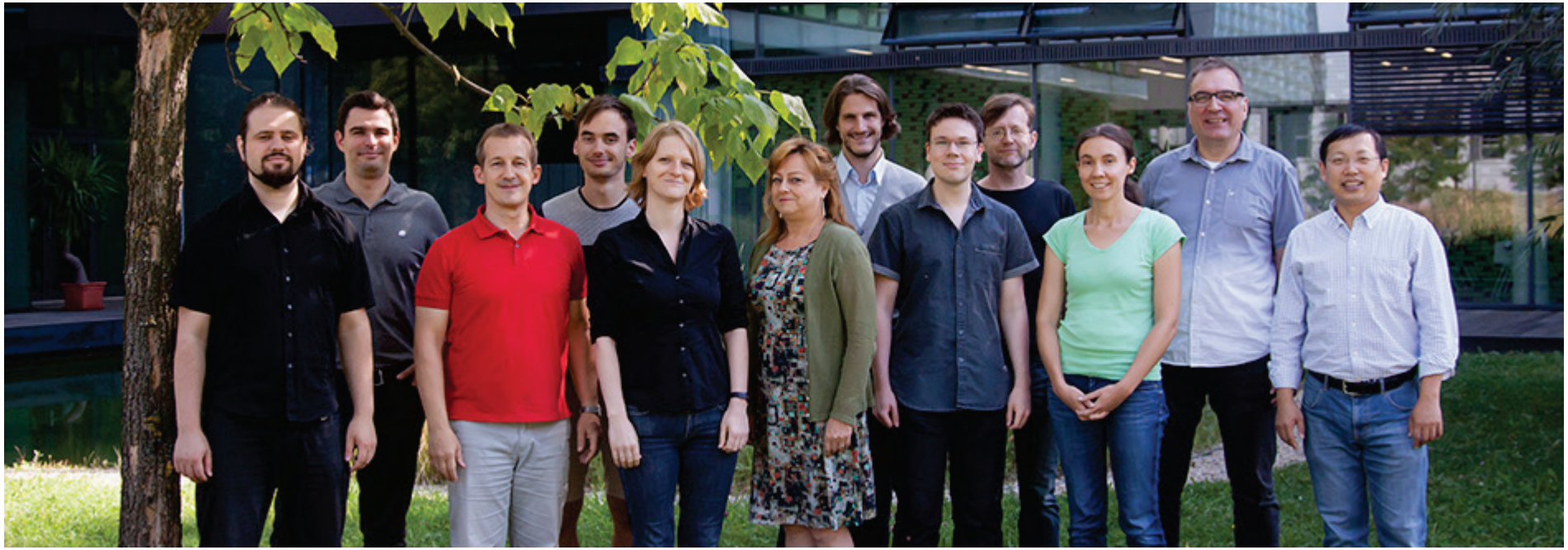
TECHNISCHE UNIVERSITÄT DRESDEN



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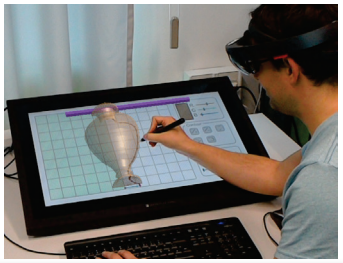
**http://www.imld.de/**



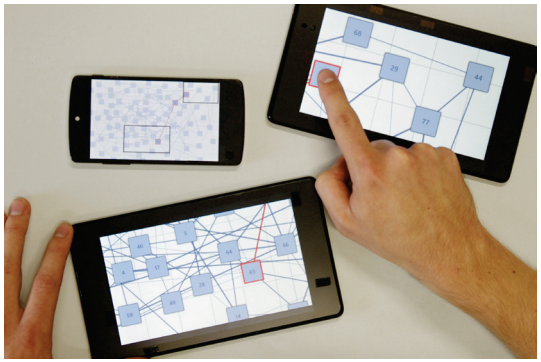

# Natural Human Computer Interaction

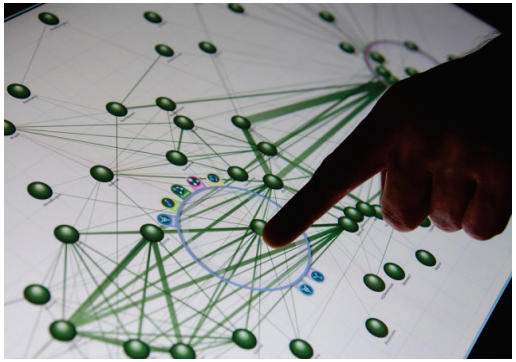
## Multimodal Interaction (with Multiple Interactive Surfaces)

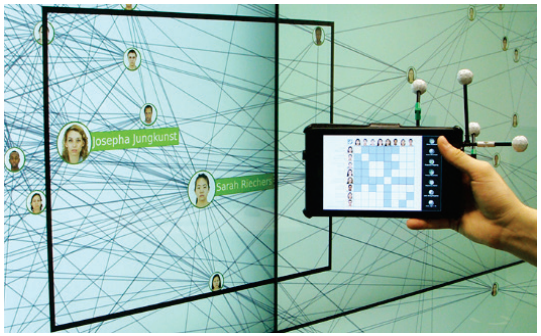
## Mixed Reality Interfaces + Mobile Interaction

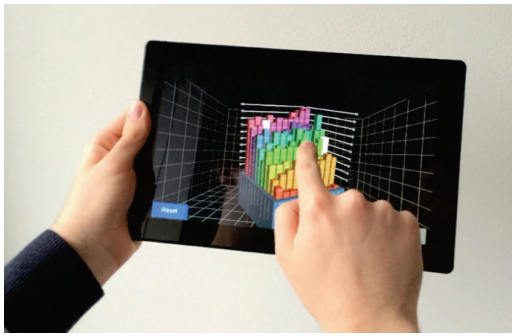
# Interactive Information Visualization

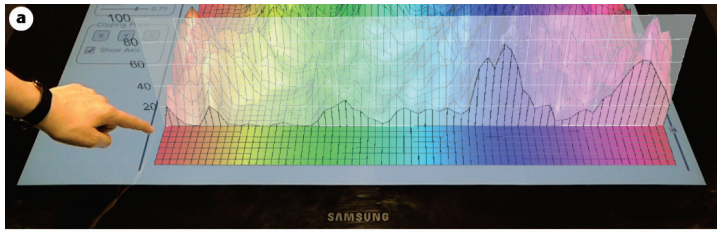
## Graph Visualization, Mobile Visualization, Immersive Analysis

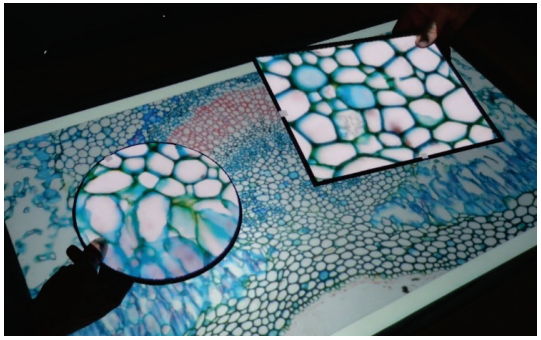


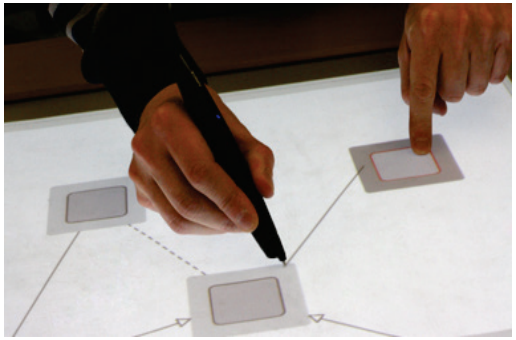


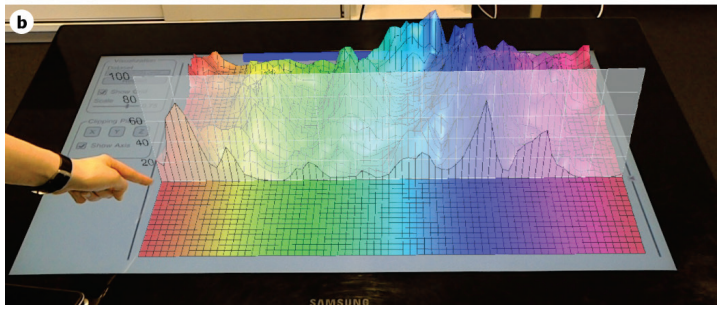






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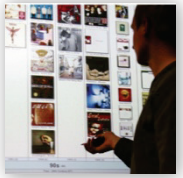
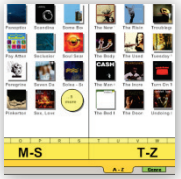
Metaphorical Gestures





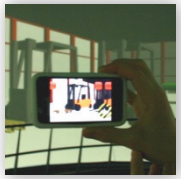

Zoomable UIs

Tilt gestures

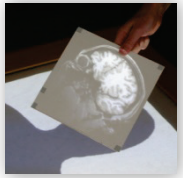
Tangibles


Multitouch

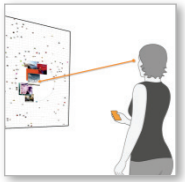
Tangible Windows



Foot Input



Magic Lenses



Gaze control

Freehand gestures

Pen Input

Images, Videos, Audio, Diagrams,...

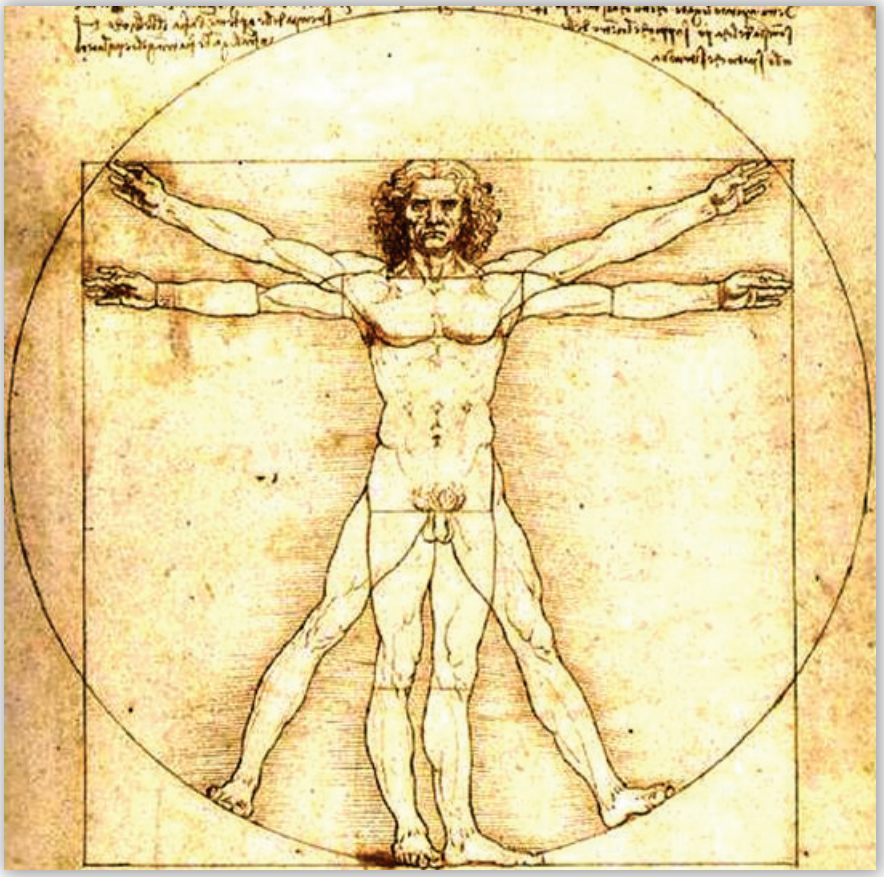
Exploration of and Interaction with Rich Media & Information Spaces

3D-Objects, Virtual Environments


**Course Book**

http://www.hci-buch.de/

# Mensch



# Computer - Interaktion

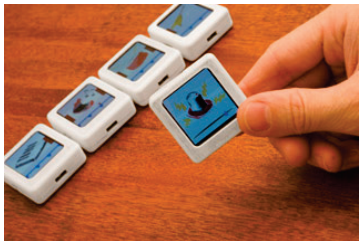
# Evolution

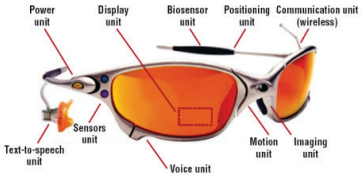

The New York Times
Obama Orders Improvements in Security Policies
Europe on a frugal budget

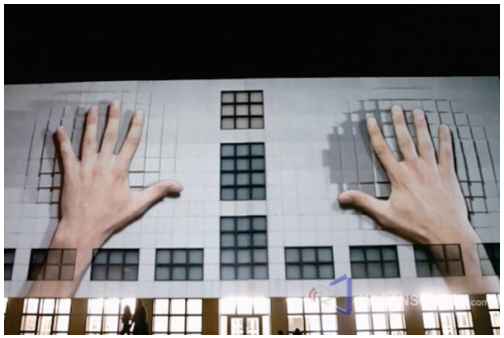
# Gerätevielfalt Ausgabe – Displays



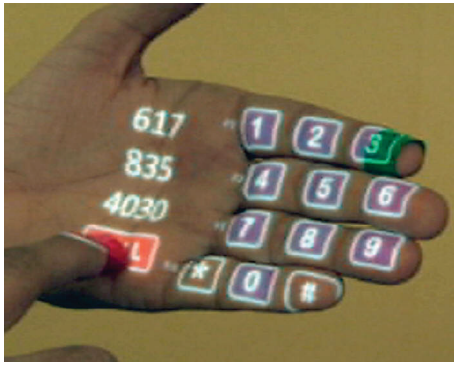

# Gerätevielfalt Ausgabe – Displays

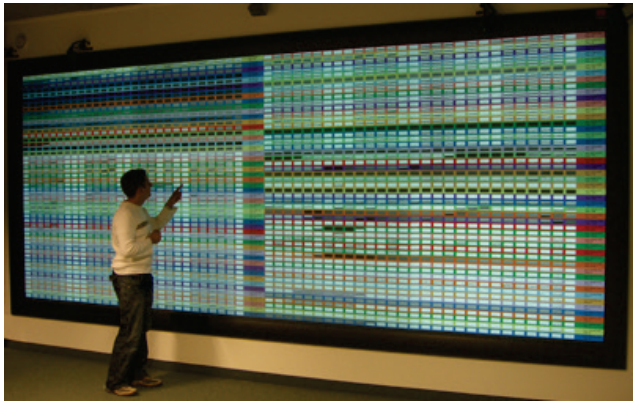





Kleine (mobile) Geräte → große (öffentliche) Displays
Displaylösungen *everywhere, every size*



# Gerätevielfalt Eingabe – Interaktionsgeräte und -stile

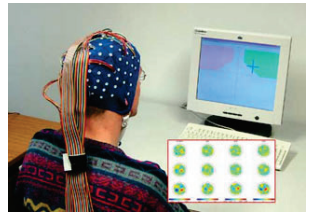
# Gerätevielfalt Eingabe – Interaktionsgeräte und -stile

- Interaktion mit/über
  - Tastatur, Maus, Joystick
  - Click-Wheel, Jog Dials, NaviPads…
  - Passive/Aktive Stifte und Zeigegeräte
  - Touch Pads, (Multi-)Touchscreens
  - 3D-Eingabegeräte
  - Bewegte oder beschleunigte Objekte (Wiimote…)
  - Vibrotaktile Interaktion, Haptik, Kraftrückkopplung
  - Gesten und Körperbewegung (Hände, Füße)
  - Muskeln, Tangibles
  - Sprache
  - Augensteuerung
  - Denken (Brain Computing)







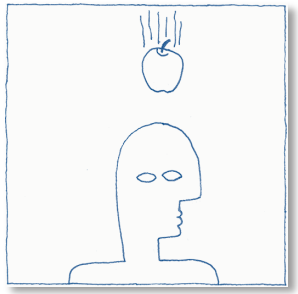
# Neue Generation von Interaktionsstilen

- Post-WIMP User Interfaces
  - Multimodale Benutzungsschnittstellen
  - 3D User Interfaces (Virtual, Augmented, Mixed Reality)
  - Wearable User Interfaces [Mann 1998]
  - Tangible User Interfaces
    [Fitzmaurice et al. 1995, Ishii & Ullmer 1997]
  - Natural User Interfaces
  - Organic User Interfaces [Vertegaal & Poupyrev 2008]
  - Reality-based Interaction [Jacob et al. CHI 08]
  - …

# Post-WIMP oder Reality-based Interaction [Jacob et al. CHI 08]

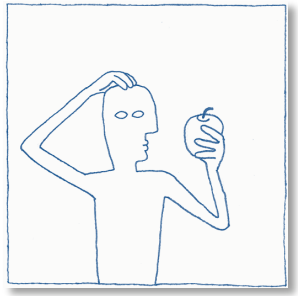
- Aspekte unserer realen Welt
  - Naïve Physics

    Menschen besitzen gutes Basiswissen über physikalische Welt



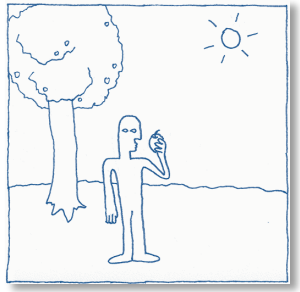
  - Body Awareness and Skills

    Menschen sind sich ihres Körpers bewusst und
    besitzen Fähigkeiten zu dessen Kontrolle und Koordination



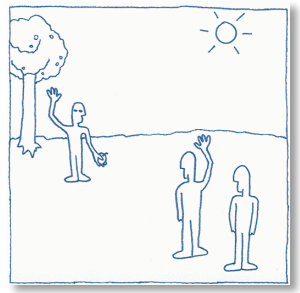
  - Environment Awareness and Skills

    Menschen nehmen ihre Umgebung wahr und besitzen
    Fähigkeiten zum Verhandeln, Manipulieren und Navigieren

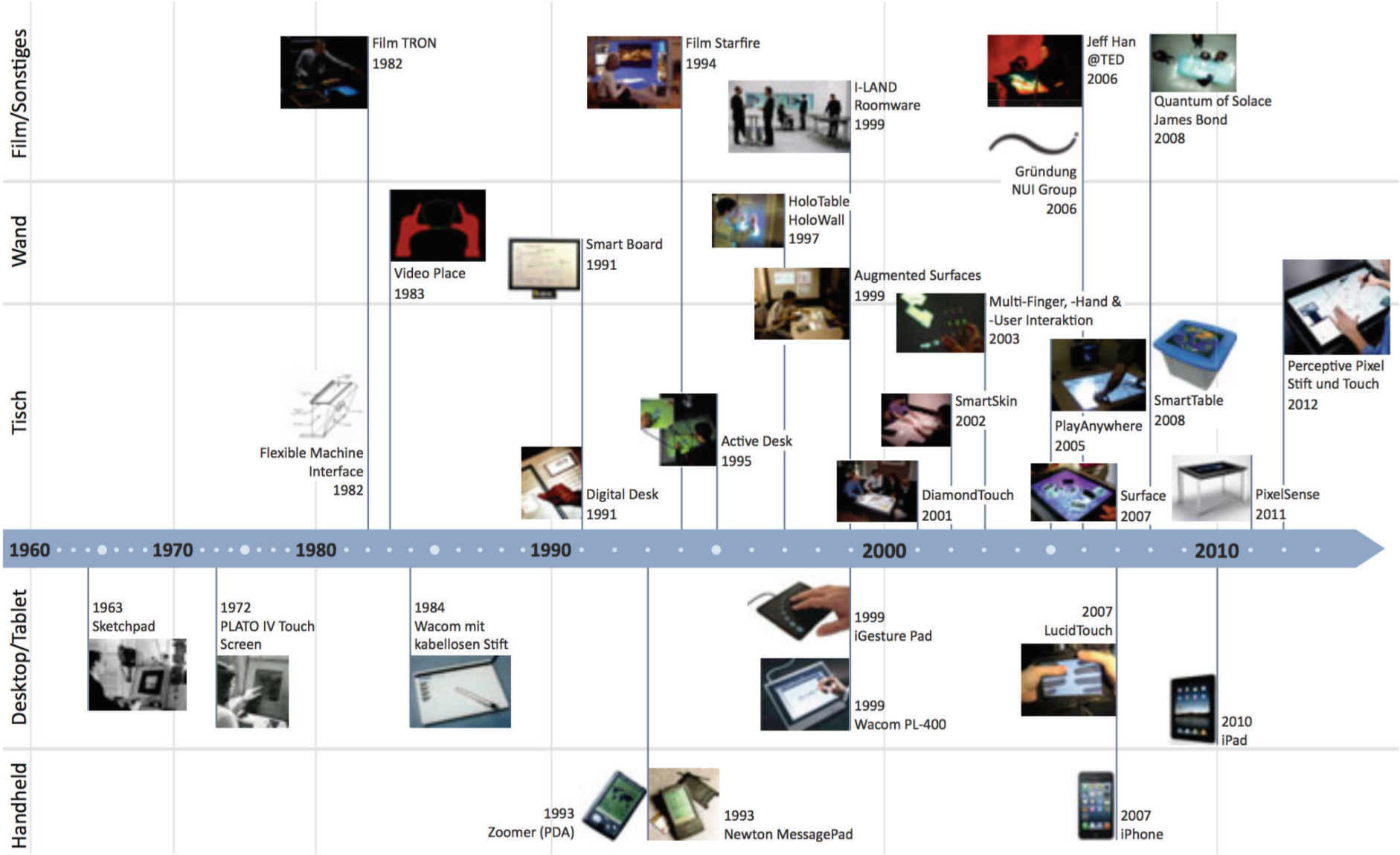


  - Social Awareness and Skills

    Menschen nehmen Mitmenschen in ihrer Umgebung wahr
    (meistens) und besitzen Fähigkeiten zur Interaktion mit ihnen



# Historie

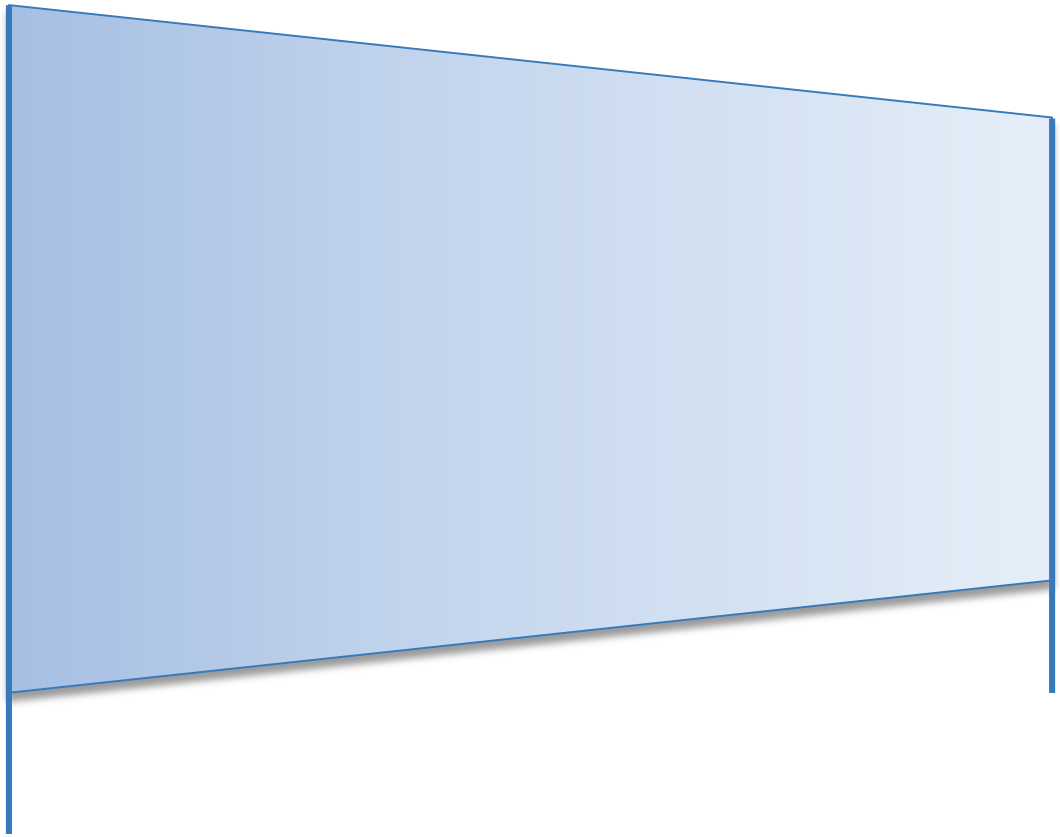

Film/Sonstiges
Wand
Tisch
Desktop/Tablet
Handheld
1960
1970
1980
1990
2000
2010
Film TRON
1982
Film Starfire
1994
I-LAND
Roomware
1999
Jeff Han
@TED
2006
Quantum of Solace
James Bond
2008
Gründung
NUI Group
2006
HoloTable
HoloWall
1997
Video Place
1983
Smart Board
1991
Augmented Surfaces
1999
Multi-Finger, -Hand &
-User Interaktion
2003
Perceptive Pixel
Stift und Touch
2012
SmartTable
2008
Flexible Machine
Interface
1982
Active Desk
1995
SmartSkin
2002
PlayAnywhere
2005
Digital Desk
1991
DiamondTouch
2001
Surface
2007
PixelSense
2011
1963
Sketchpad
1972
PLATO IV Touch
Screen
1984
Wacom mit
kabellosen Stift
1999
iGesture Pad
2007
LucidTouch
1999
Wacom PL-400
2010
iPad
1993
Zoomer (PDA)
1993
Newton MessagePad
2007
iPhone

Vorbetrachtung

# Interaktive Oberflächen: Output = Input

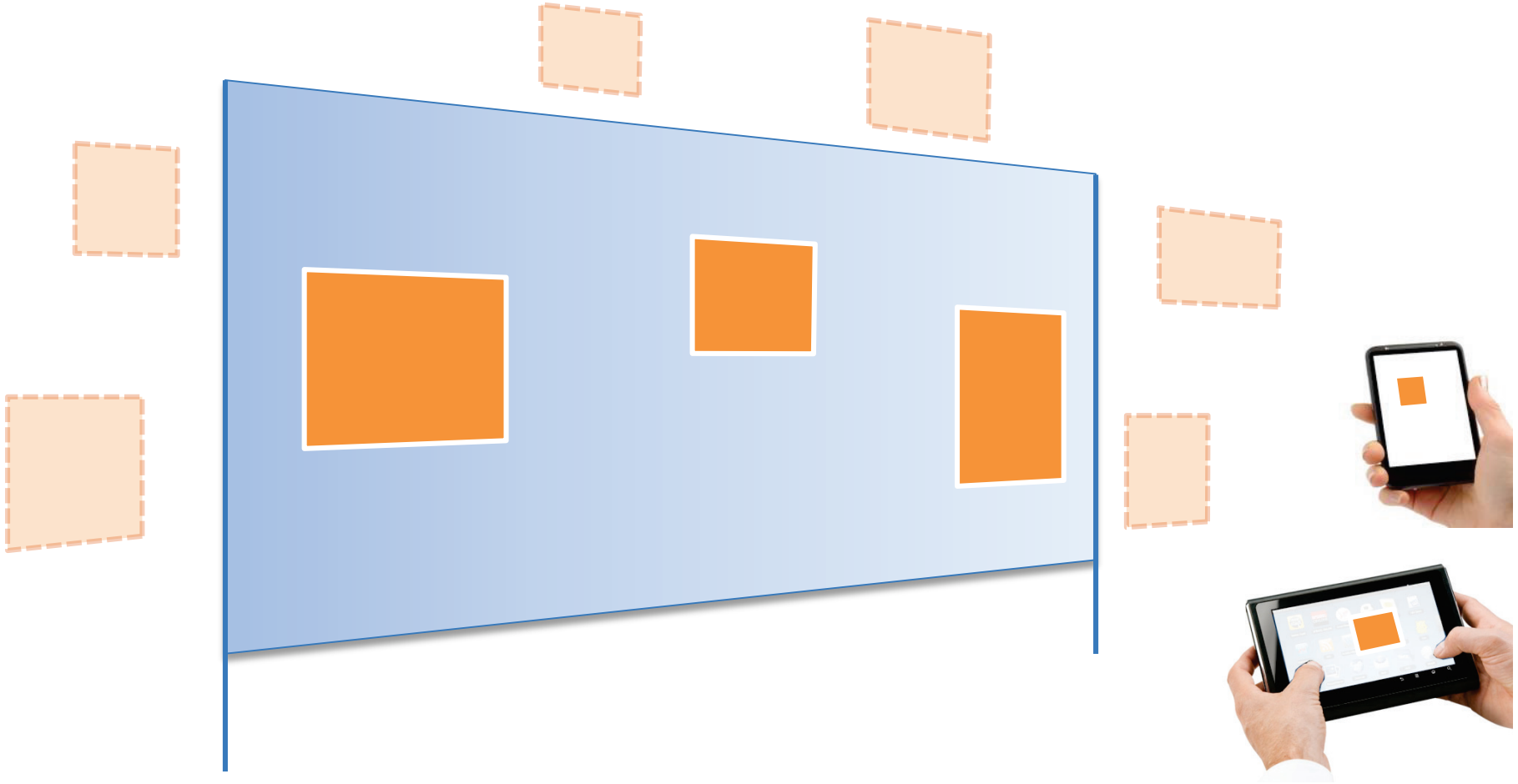
# Interesting Relation and Mapping between

- **Display Space** | Information Space | Interaction Space



# Interesting Relation and Mapping between

- Display Space | **Information Space** | Interaction Space

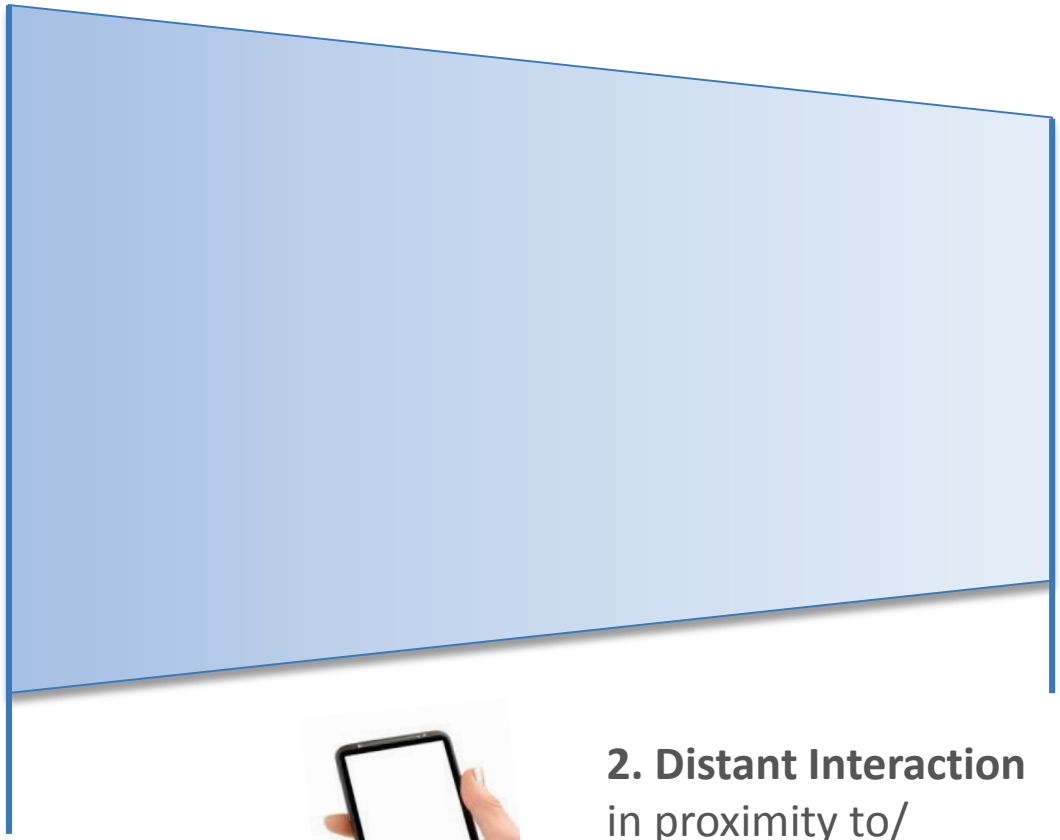


# Interesting Relation and Mapping between

- Display Space | Information Space | **Interaction Space I**

# Interesting Relation and Mapping between

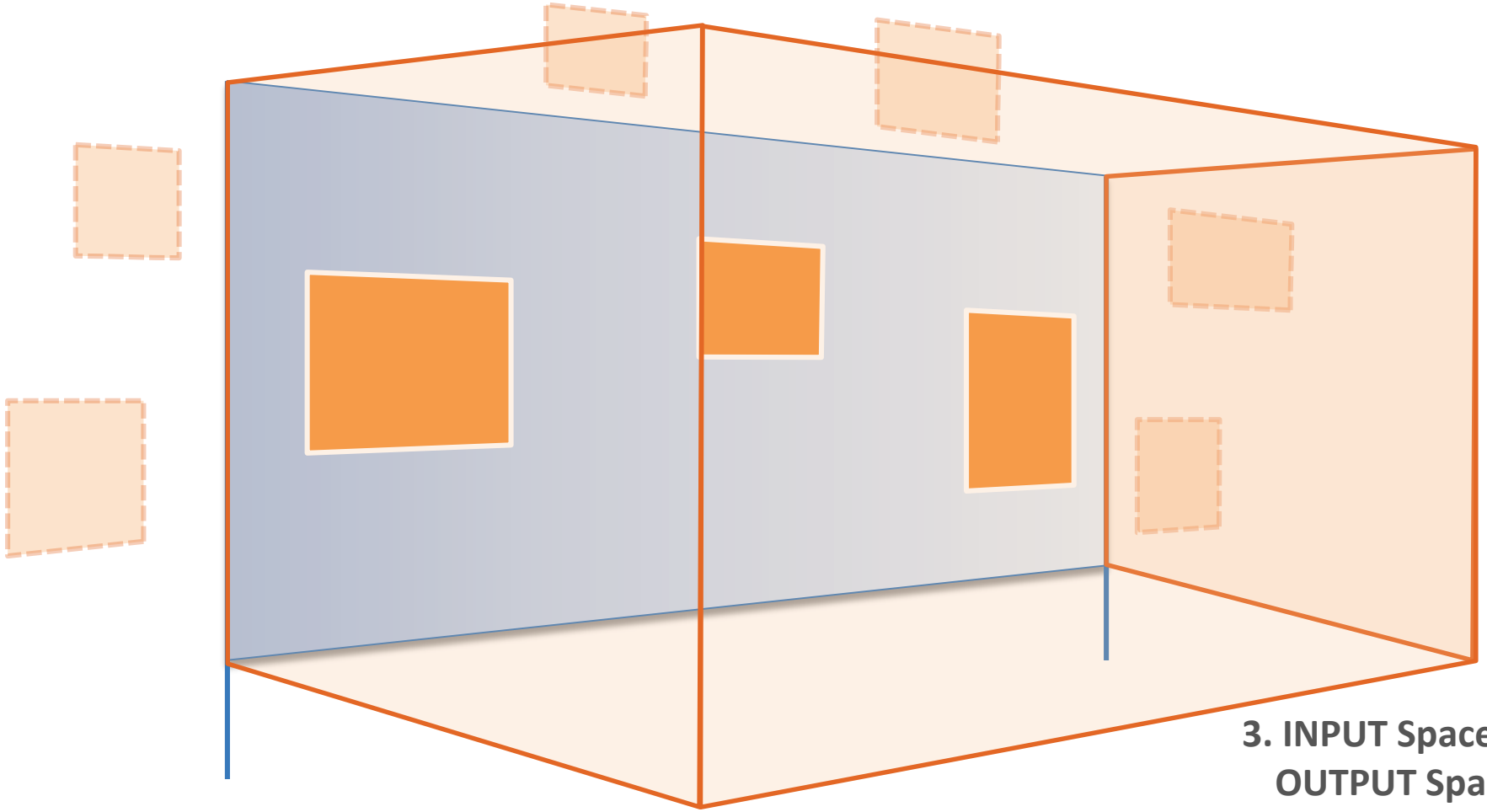
- Display Space | Information Space | **Interaction Space II**



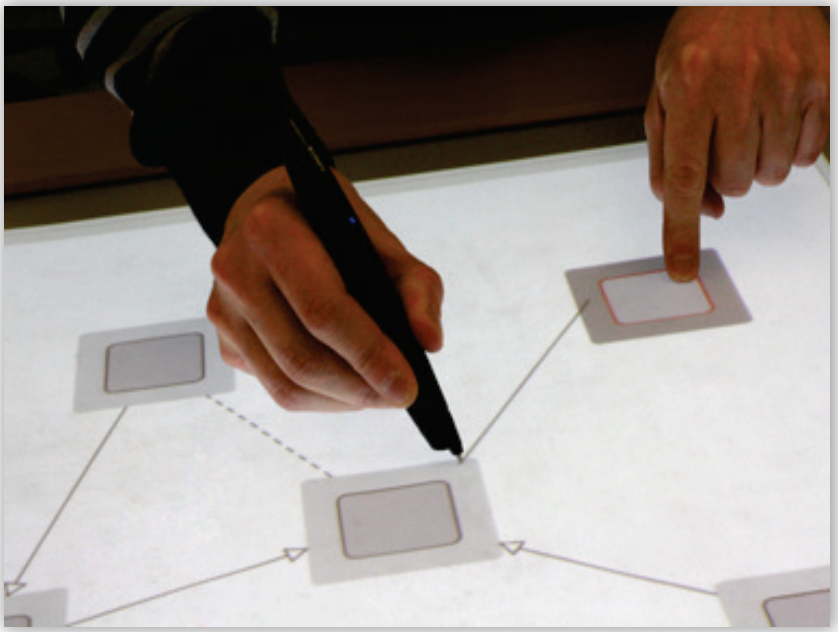
**2. Distant Interaction**
in proximity to/
in view of the surface

# Interesting Relation and Mapping between

- Display Space | **Information Space** | Interaction Space

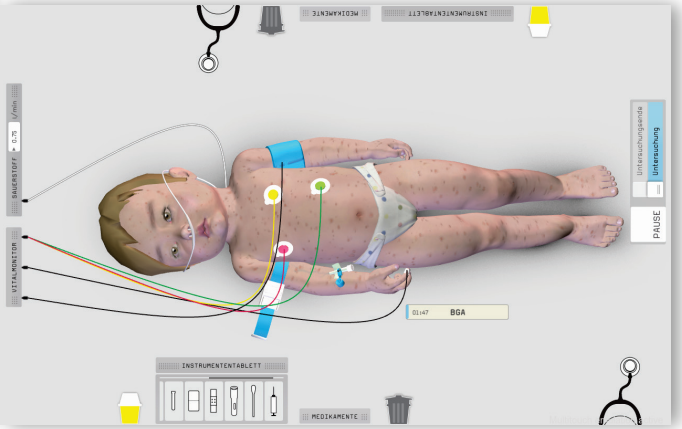


**3. INPUT Space = OUTPUT Space**
in entire volume attached to the surface



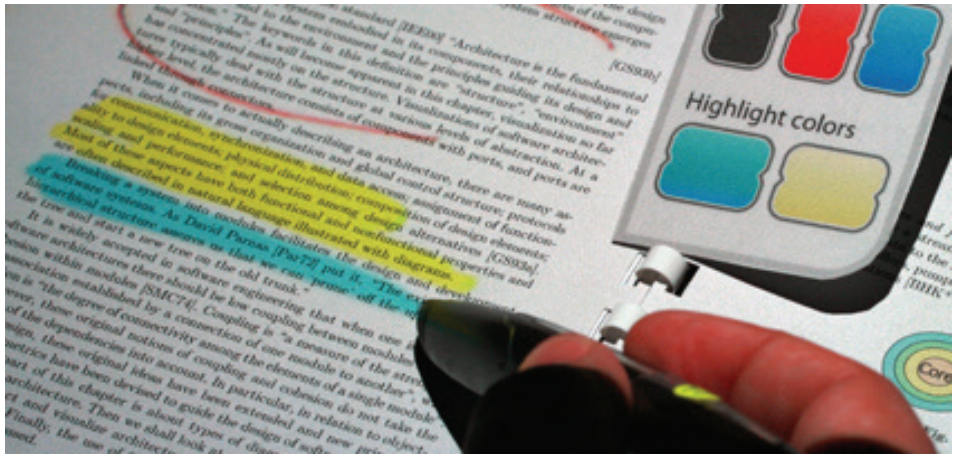
# 1. Working ON single Interactive Surfaces (Multitouch and bimanual Pen+Touch Interaction)

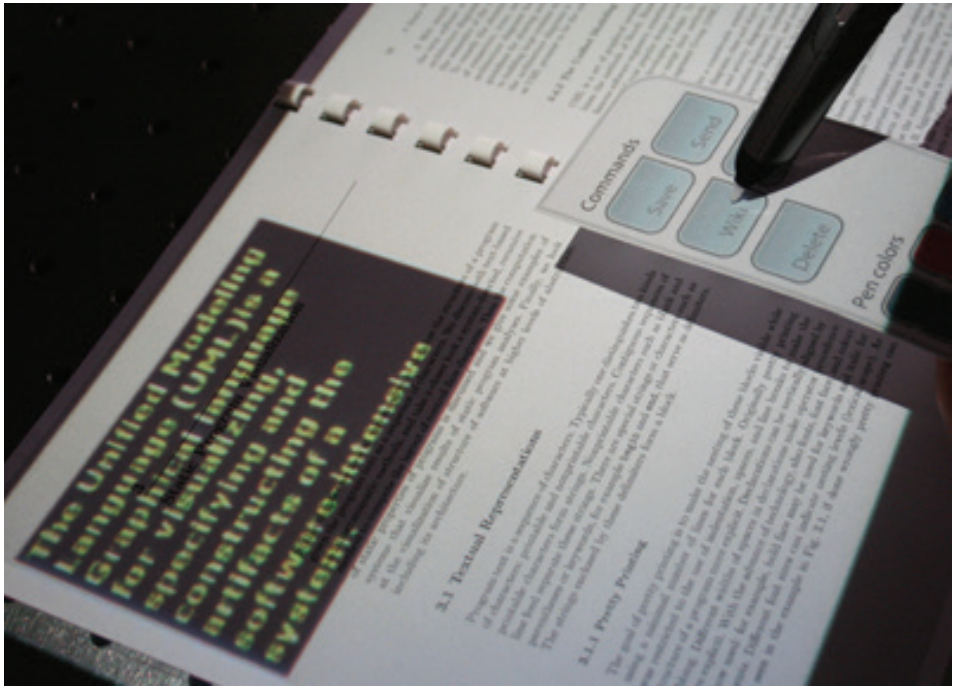
# SimMed [von Zadow et al. CHI 2013]

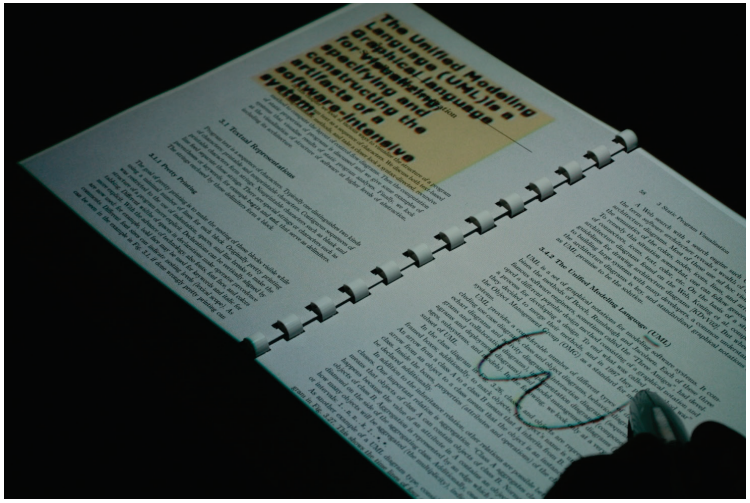




- SimMed addresses significant gap in medical education
- Hybrid 2D/VR system
- Study suggests significant learning effect
- Results support hypothesis: Full realism isn’t necessary

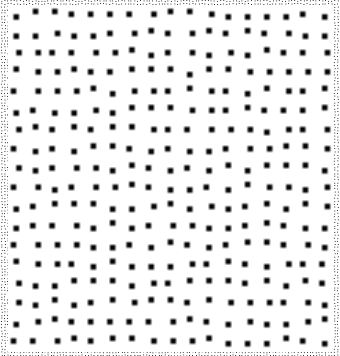
# Projected Augmented Book [Dachselt & AL-Saiegh 2011]



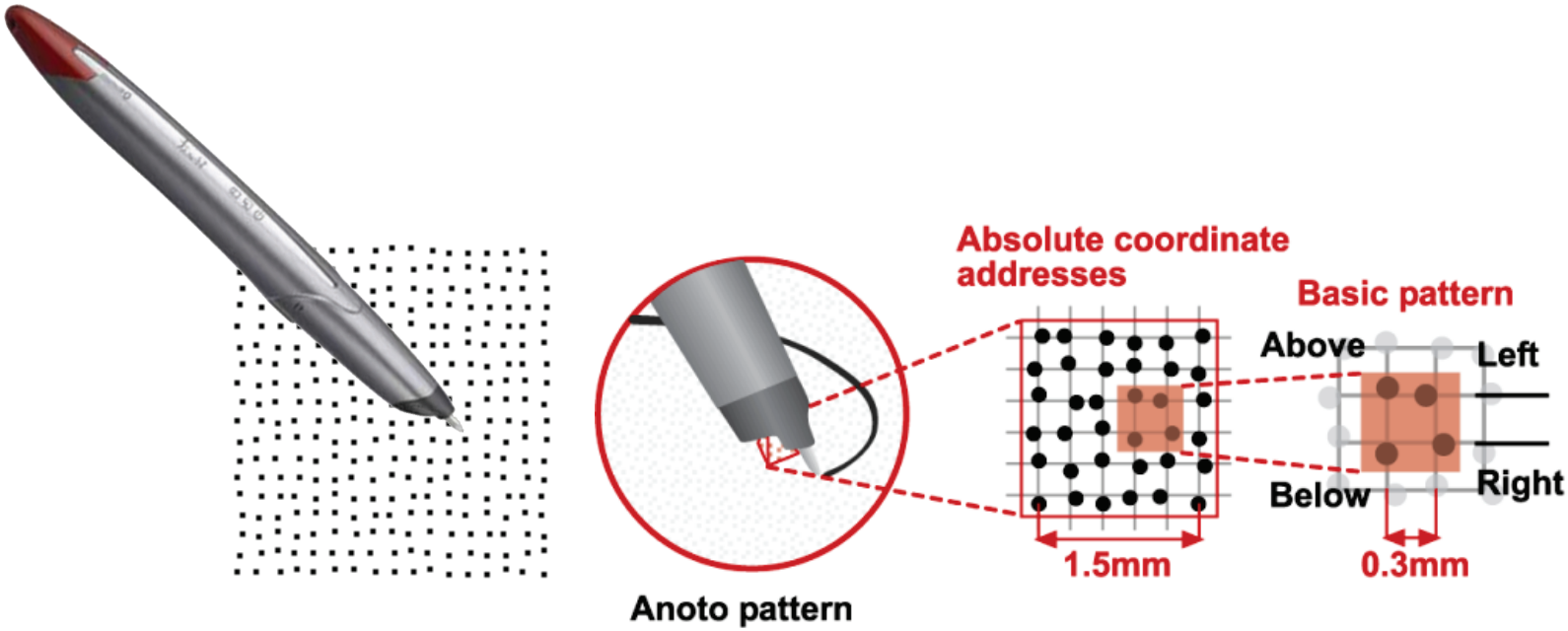



# Anoto Technologie

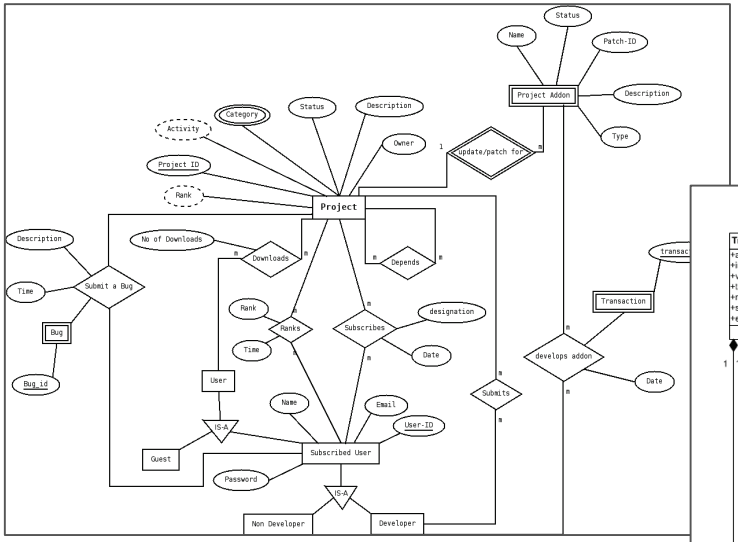


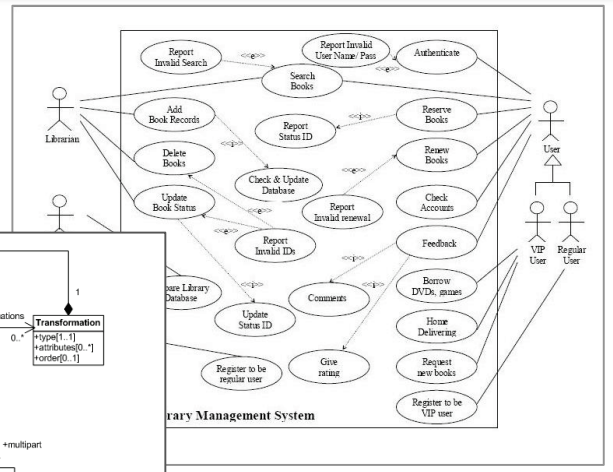
# Interaktion mit Digitalen Stiften & Papier

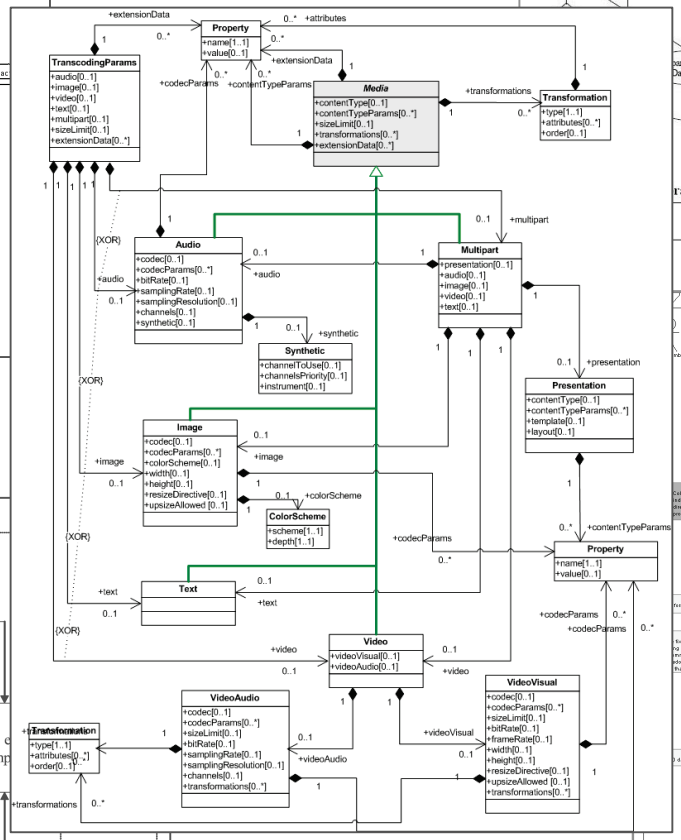
- Natürliche Interaktion mit ubiquitärem Stift & Papier
  - Malen, Zeichnen, Skizzieren, Schreiben…
  - Nutzung von digitalem Papier und digitalen Stiften (Anoto-Technologie)

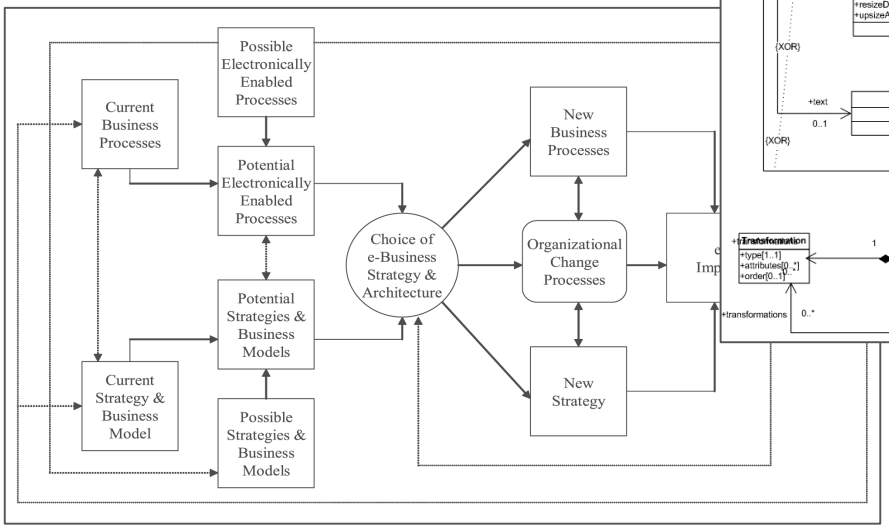


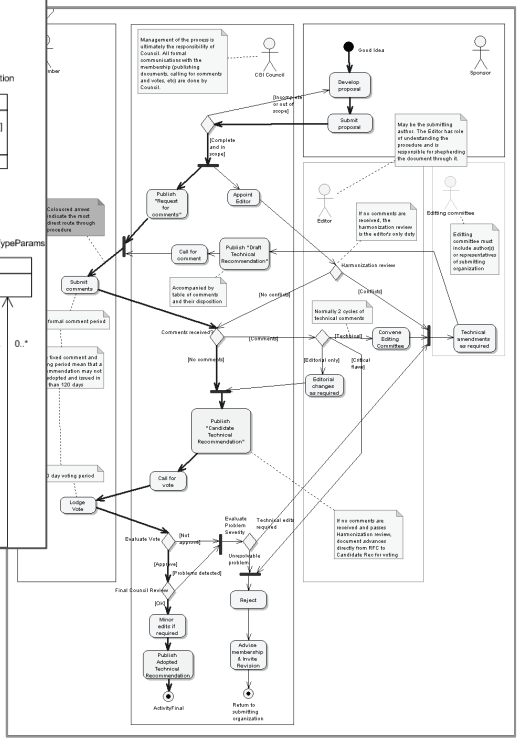
# Motivation Node-Link-Diagramme



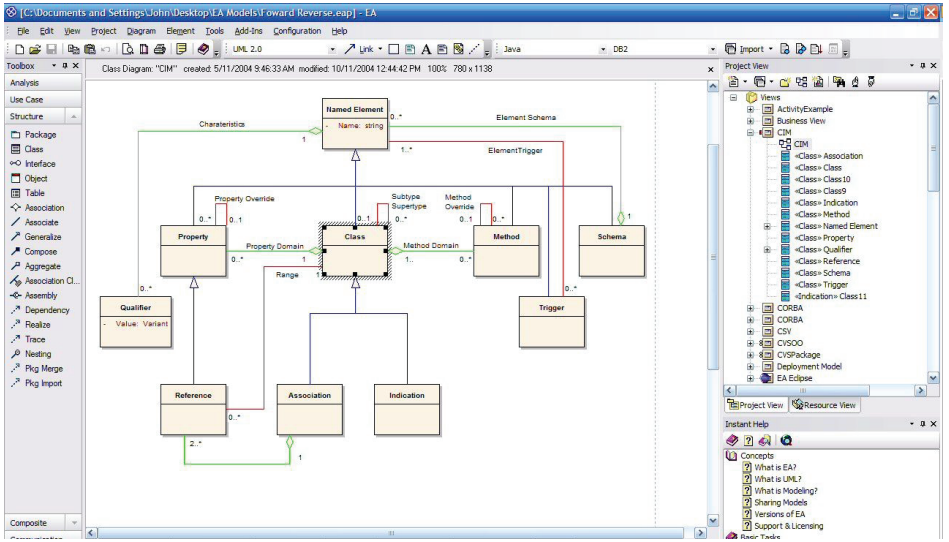



# Motivation Node-Link-Diagramme

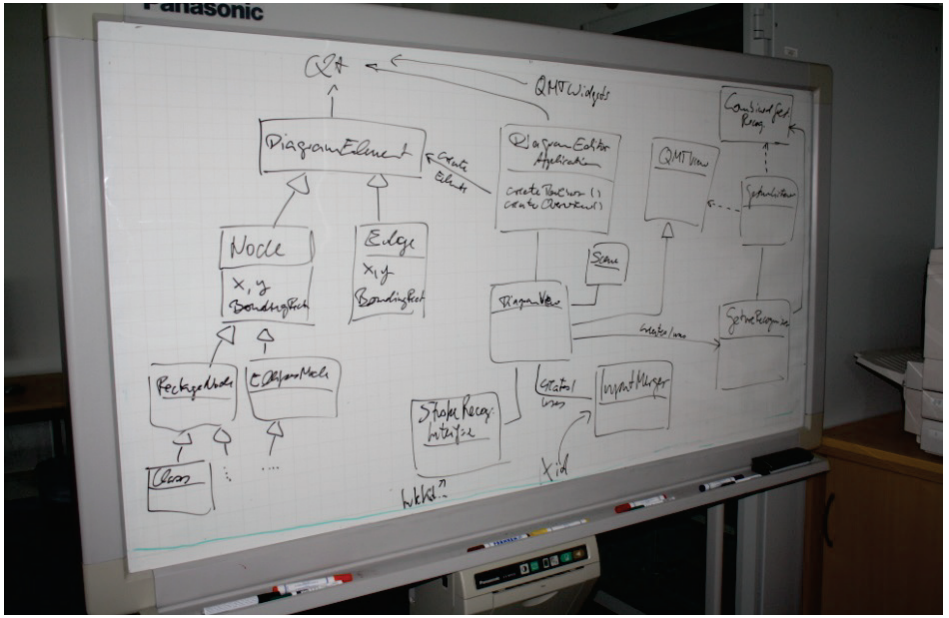
- Strukturelle Diagramm-Editoren

  Oft unflexibel und einschränkend [Damm et al. 2000], [Grundy et al. 2007]



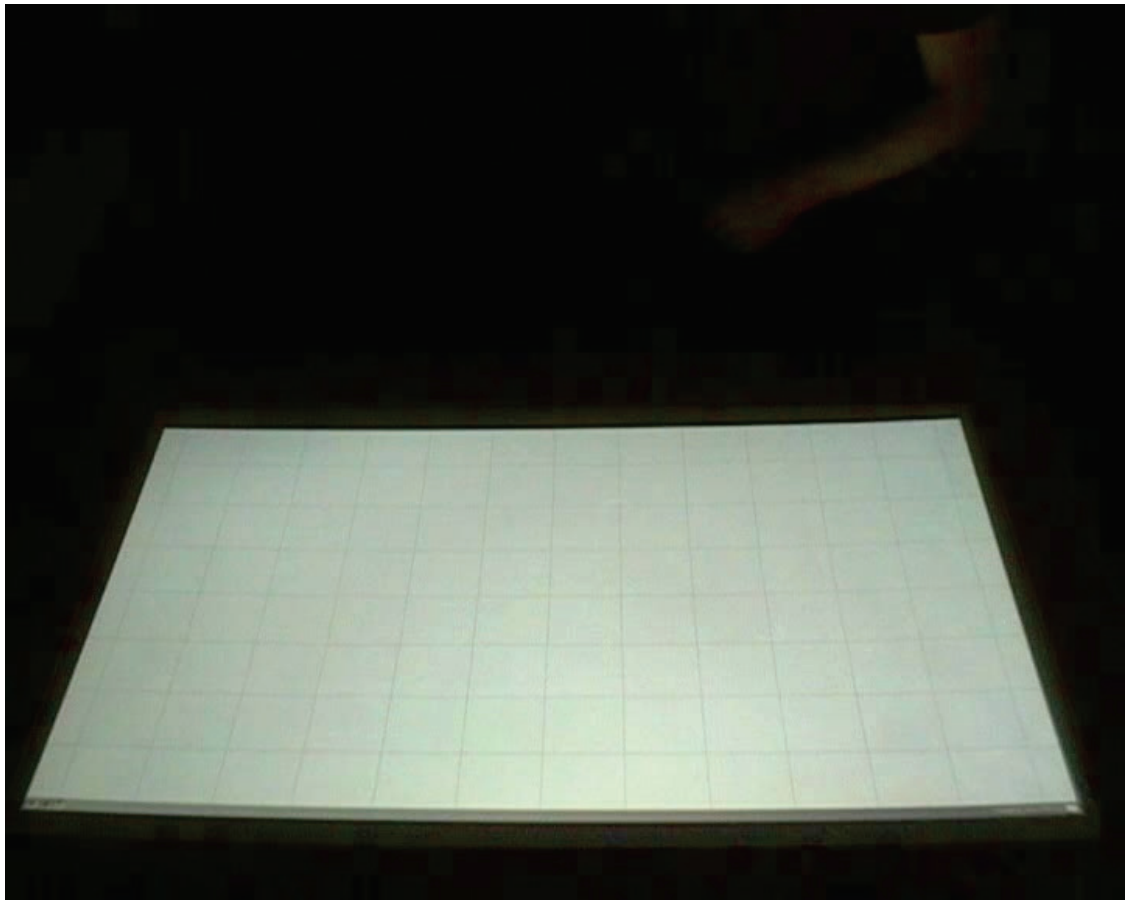

- Skizzieren von Diagrammen

  Digitale Remodellierung der Inhalte nötig [Chen et al. 2003]



# Editing of Node-Link Diagrams [Frisch et al. Diagrams 2010]

- Combination of multitouch and pen gestures on interactive surfaces for diagram editing



[Frisch et al. Diagrams 2010]

# Editieren von Node-Link-Diagrammen – Gesamtprozess

**1. Vorstudie**

- Nutzer schlagen Gesten vor [Epps et al. ’06, Wobbrock et al. ’09]
- Ziel: grundlegendes Gesten-Set *(user elicited gesture set)*
- [Frisch, Heydekorn & Dachselt ACM ITS ’09]

**2. Experten-analyse**

- Auswahl von Gesten und Beseitigung von Widersprüchen
- Designvarianten für konsistentes Gestenset

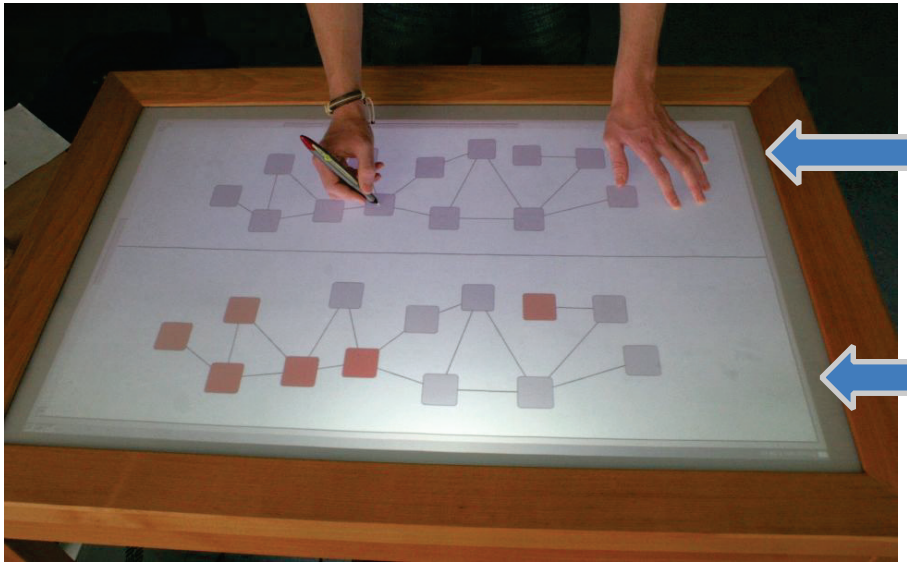
**3. Implemen-tierung**

- Zuverlässige Gestenerkennung, Frameworkentwicklung
- [Frisch, Heydekorn & Dachselt Diagrams ’10]

**4. Evaluation**

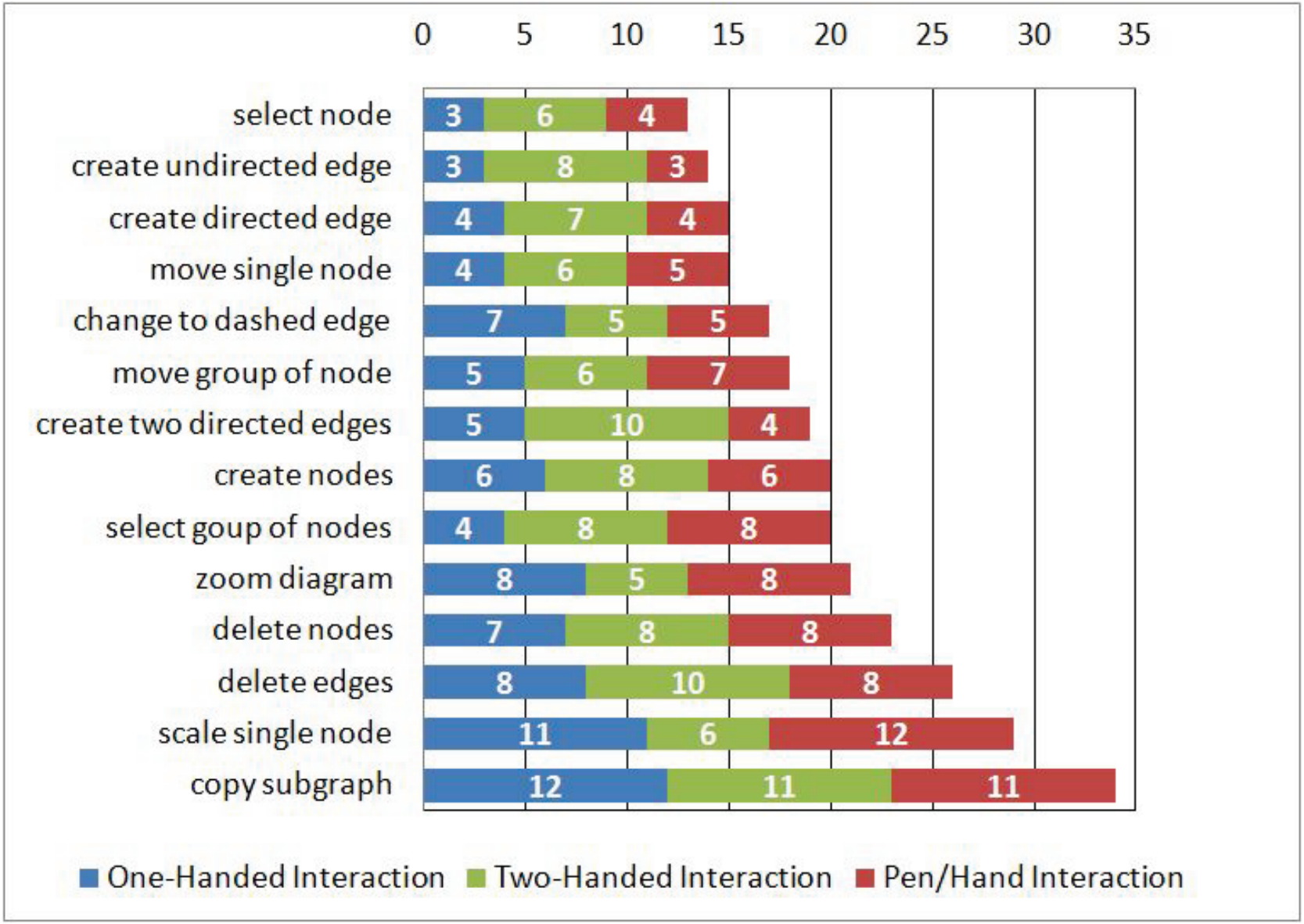
- Gründliche Nutzerstudie mit komplexen „echten“ Aufgaben
- Im Gegensatz zu 1: *Art* der Ausführung, Einbettung in Workflow
- [Heydekorn, Frisch & Dachselt M&C ’11]

# 1. Vorstudie: Von Nutzern vorgeschlagene Gesten [Wobbrock et al. 09]



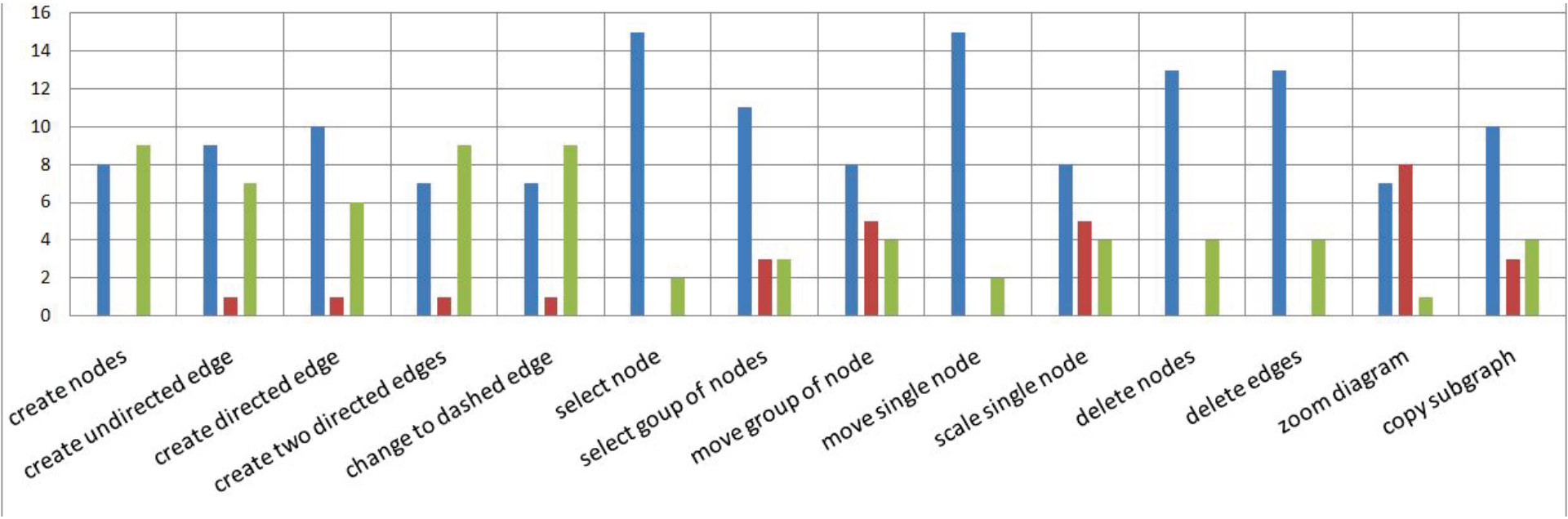

- Studienteilnehmer (17) führten Gesten aus
  - Unabhängige Variable:
    - Einhändig | Zweihändig | Stift (Handunterstützung optional)
  - Am Anfang freie Wahl der Interaktionstechnik
  - 14 Diagramm-Editieraufgaben
  - Fragebögen, Videobeobachtung, Logging

# Resultate – Analyse der 658 Gesten [Frisch et al. ITS 2009]



# Resultate – Erste Wahl bei der Interaktionsmodalität

- Einhändige Interaktion: 141 Fälle (59%)
- Stift/Hand-Interaktion: 68 Fälle (29%)
- Bimanuale Interaktion: 28 Fälle (12%)



# Resultate

- Vorrangig einhändige und Stiftbedienung
- Bimanuale Interaktion für Zoomen, Skalieren, Kopieren

- Skizzieren und strukturelles Editieren gleichermaßen
- Ungewöhnliche Gesten (nicht erkennbar)
- Dominanz der Desktop-Metaphor
  - Teilnehmer fragten nach Buttons und Menüs
  - Hand auf Hintergrund gelegt zum Moduswechsel (Taste Strg)

# Resultate – Analyse der 658 Gesten [Frisch et al. ITS 2009]

- Vorrangig einhändige (59%) und Stift-Bedienung (29%)
- Bimanuale Interaktion für Zoomen, Skalieren, Kopieren
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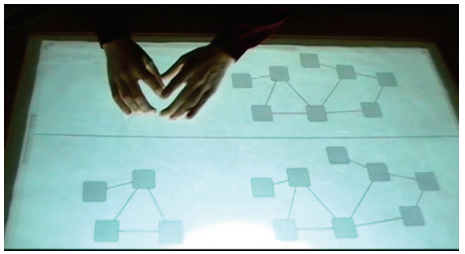
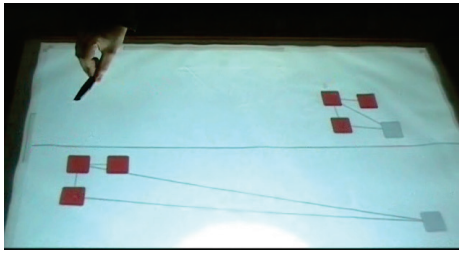
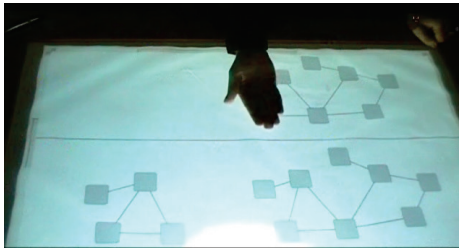
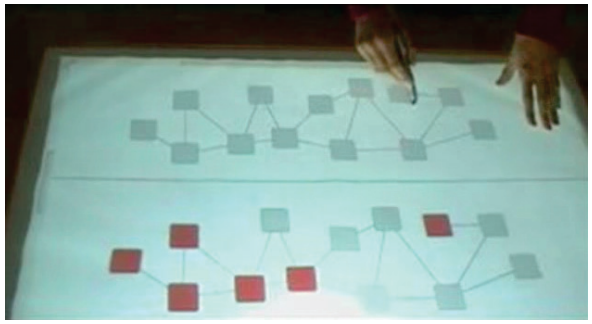
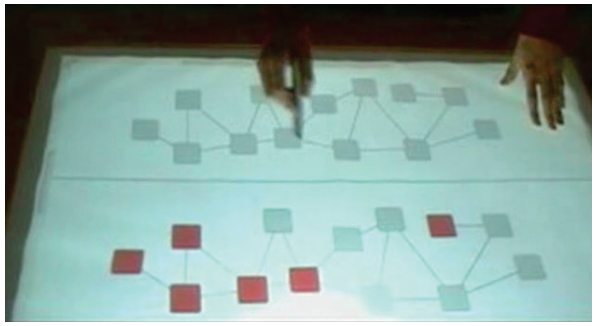


- Dominanz der Desktop-Metaphor
  - Teilnehmer fragten nach Buttons und Menüs
  - Hand auf Hintergrund f. Moduswechsel ≙ Strg

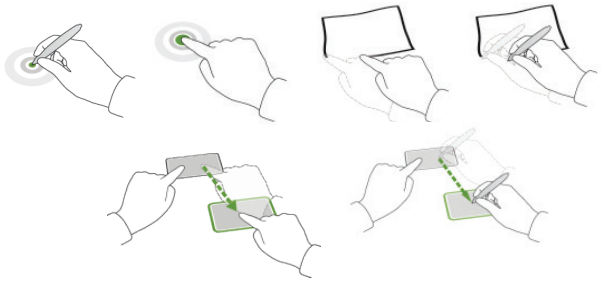




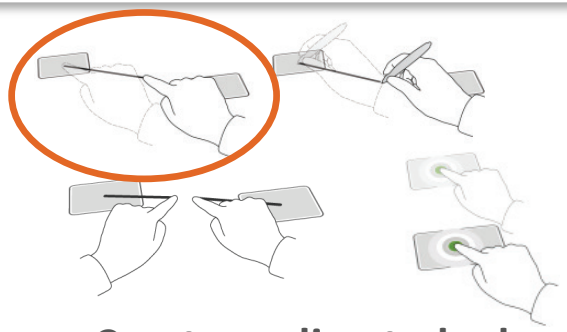




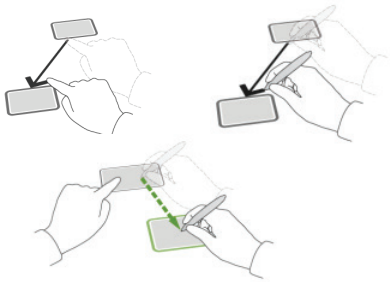
# 2. Expertenanalyse der Gestensammlung (46 Gesten / 658)



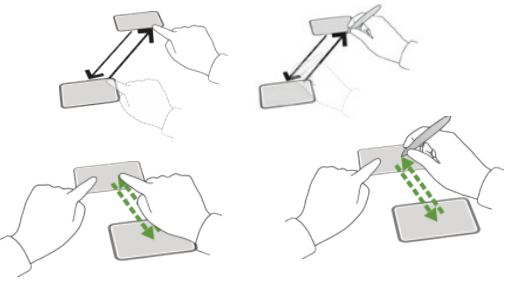
Create node



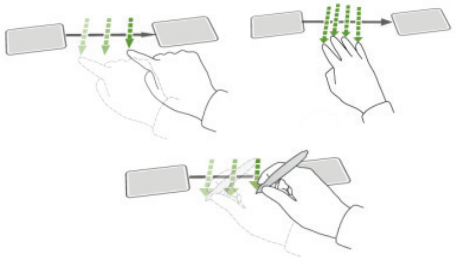
Create undirected edge



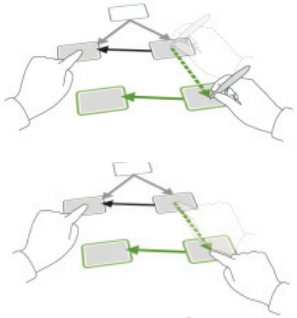
Create directed edge



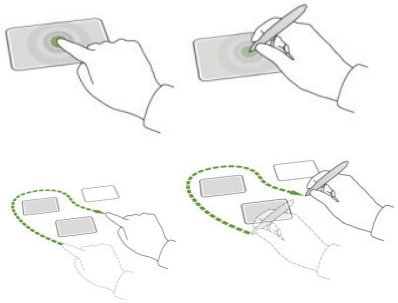
Create two directed edges



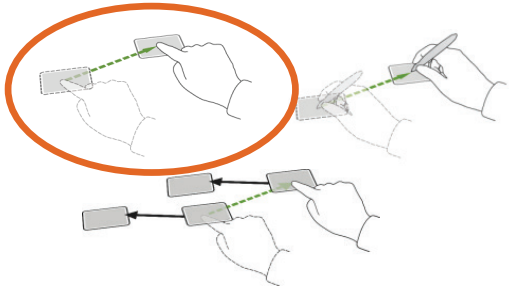
Change type of edge



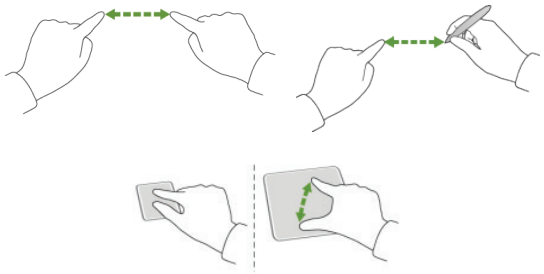
Copy sub-graph



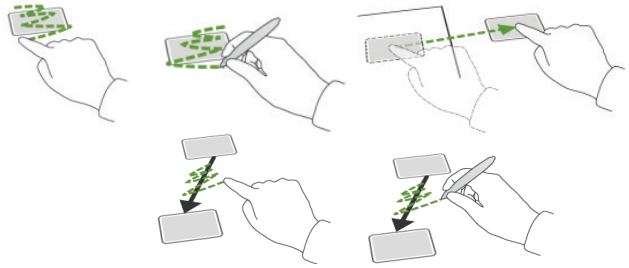
Select node(s)



Move node(s)



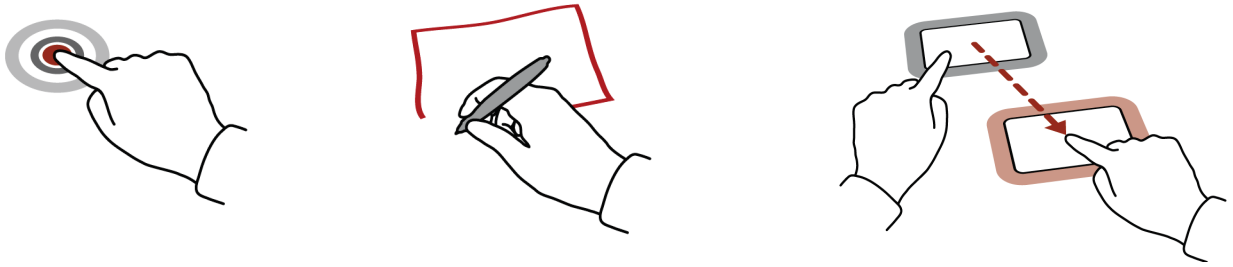
Scaling & Zooming



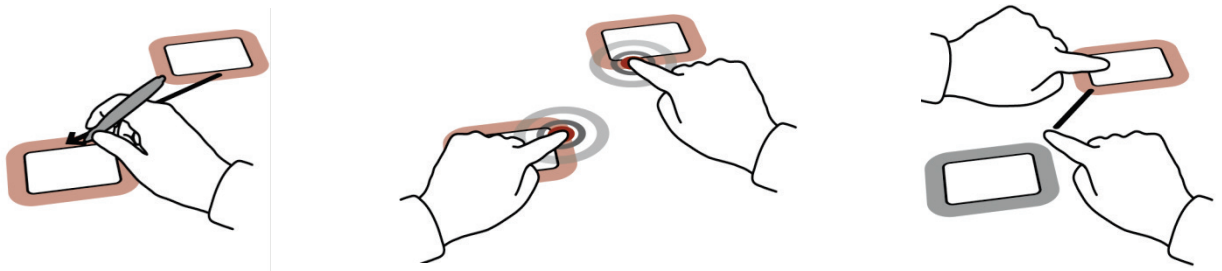
Delete nodes & edges

# 3. Das final implementierte Gestenset

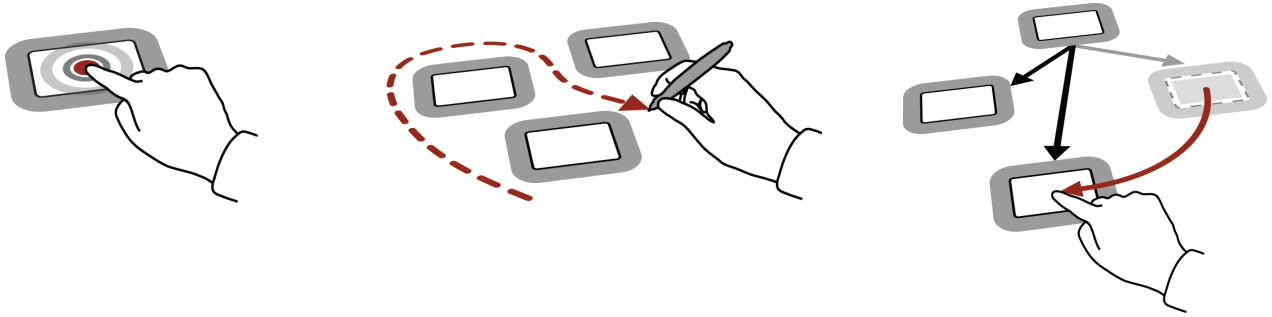
Creating nodes: **Tapping , Sketching and Copying**



Creating edges: **Sketching, Tapping and Dragging**

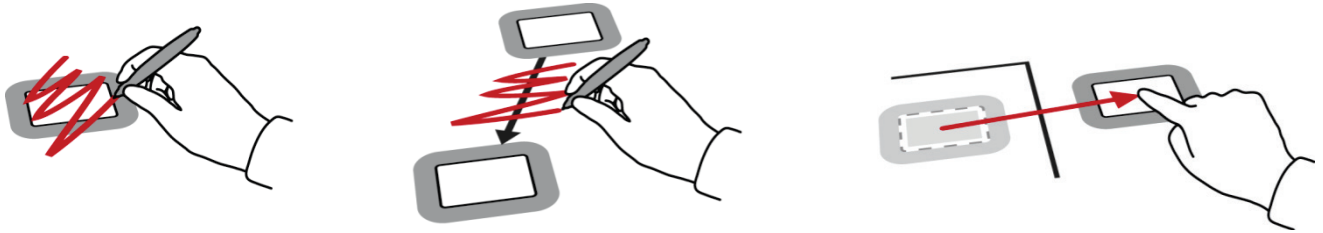


Selecting & moving nodes: **Tapping, encircling, dragging**

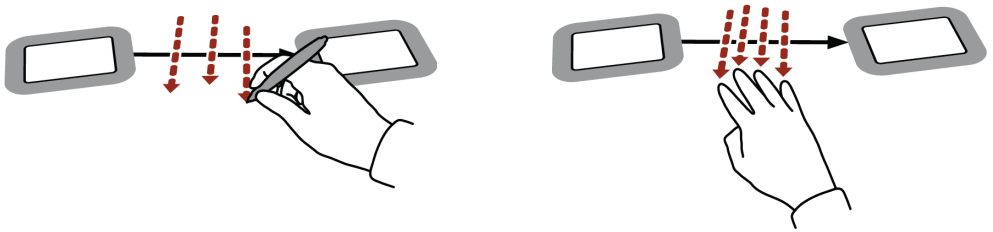


# 3. Das final implementierte Gestenset

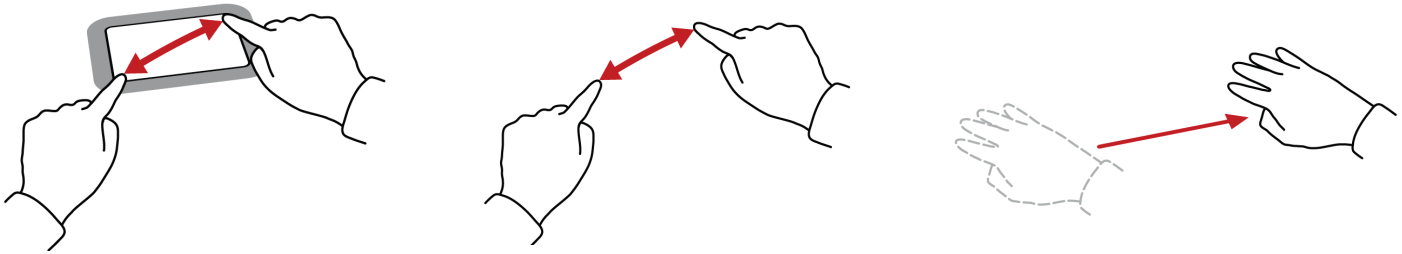
Deleting diagram elements: **Wiping, dragging to off-screen**



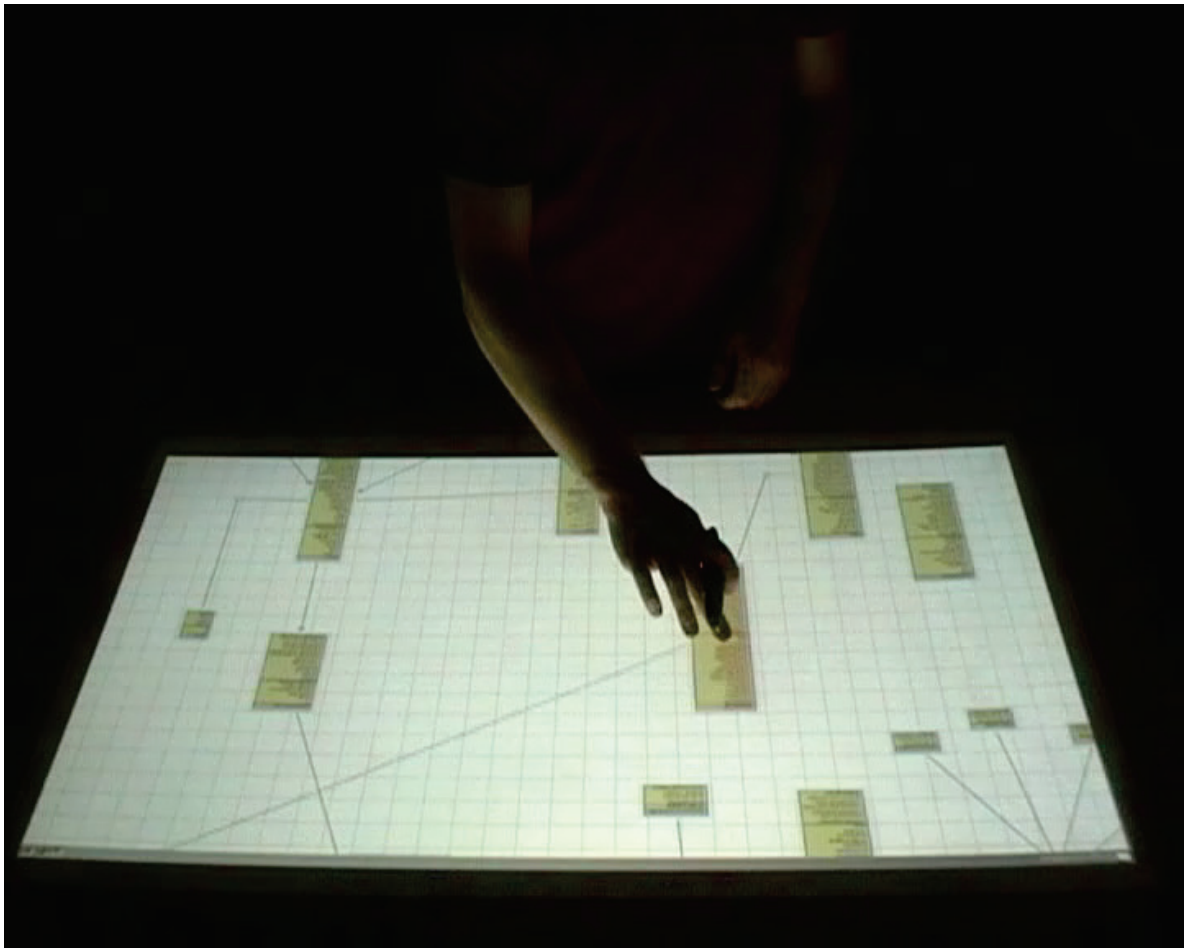
Changing the type of an edge: **“Rake” gesture, sequential crossing**



Scaling, zooming and panning : **Pinching, multi-finger dragging**



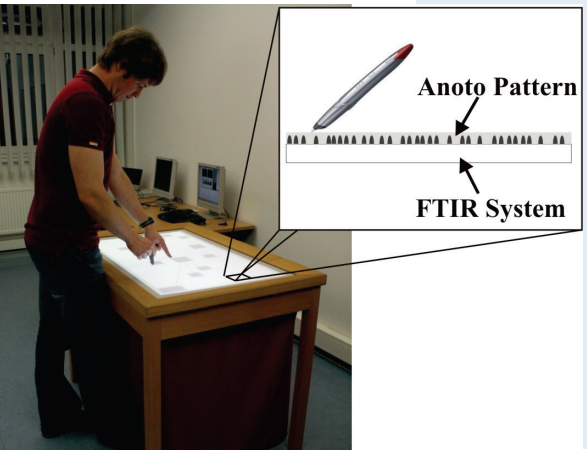
# Sample Application Software Diagrams (UML)



[Frisch et al. ITS 2009] [Frisch et al. Diagrams 2010] [Heydekorn et al. CHI WS 2010]

# 3. Architektur zur Gestenerkennung (Multitouch, Stifte, Gesten)

[Heydekorn et al. M&C 2010]




Selektion eines Gestensets

Applikation

Geste

High Level

Gestensets

Gesten-Bibliothek

Kontinuierliche Symbole

Diskrete Symbole

Low Level

Multi-Touch Recognizer

Sketch Recognizer

...

Vorlagen

Signale

Hardware Abstraction Layer

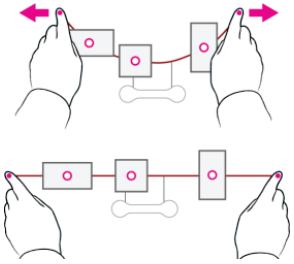
Touchscreen

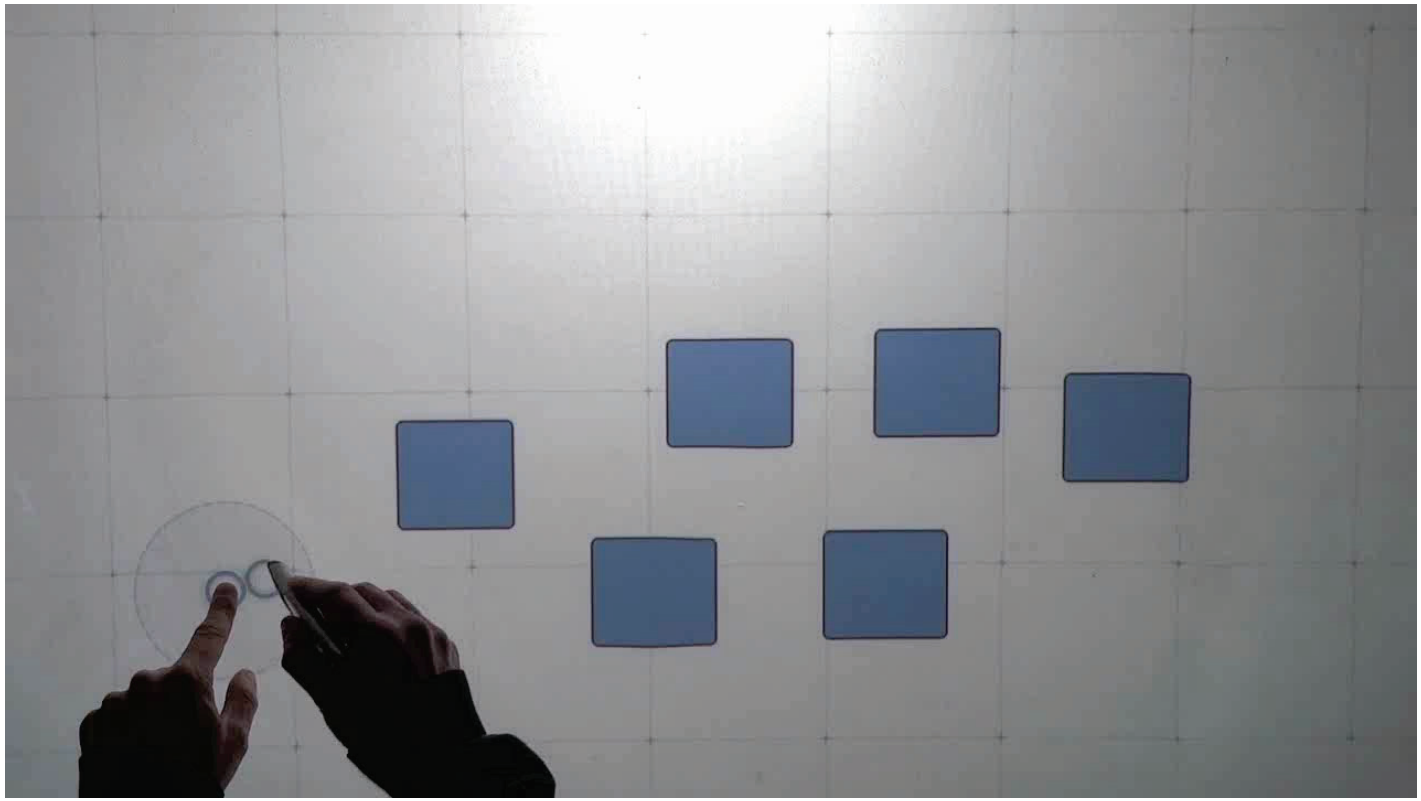
Digital Pen

...

# NEAT – Multitouch Alignment Guides [Frisch et al. ITS 2010, CHI 2010]

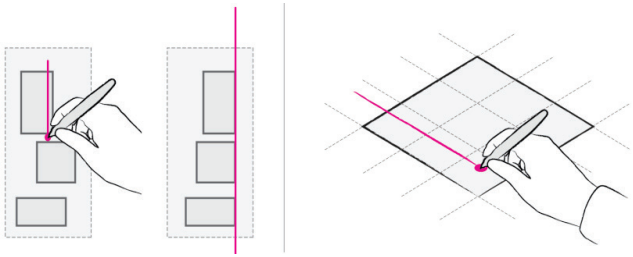
– Changing the layout:
  Necklace metaphor

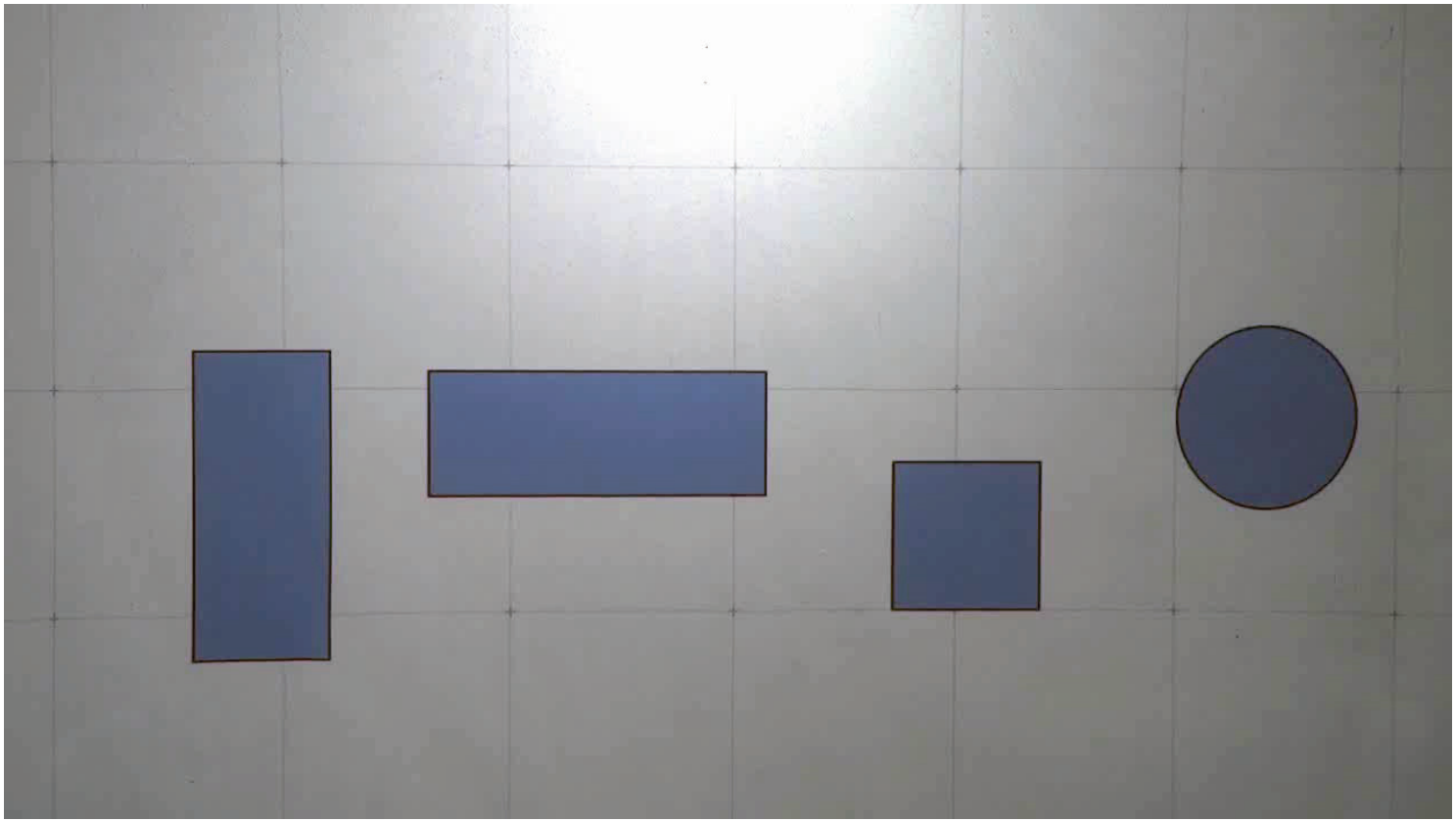




# Layout Gestures

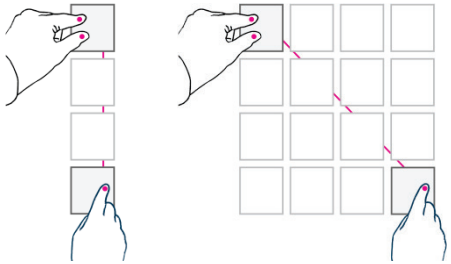
- Alignment of multiple objects
  - **Align-by-Crossing** (grouped):

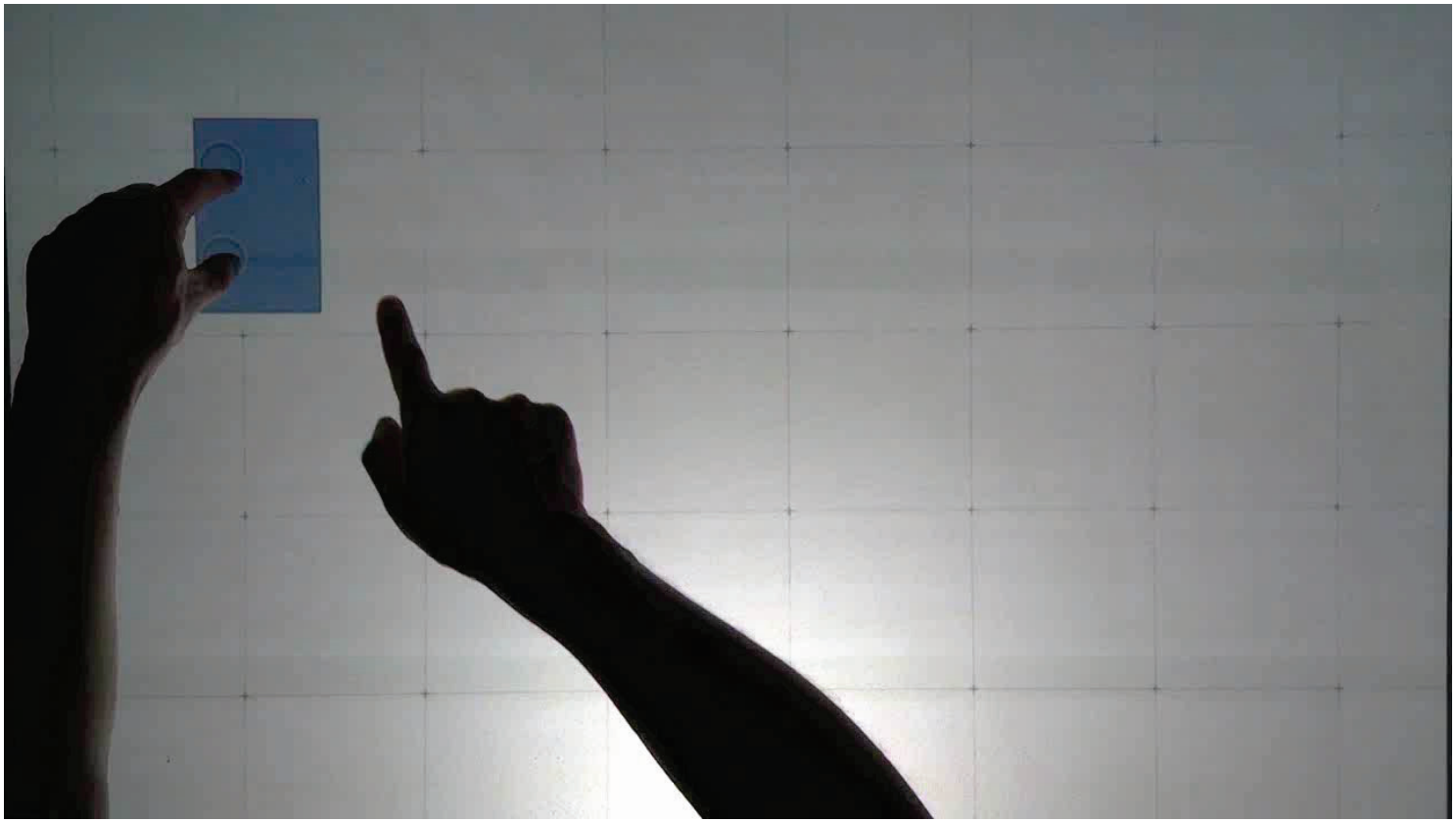




# Layout Gestures

- Multiplying objects
  - Along lines or as grids
    [Zaman et al. 10]





# A Research Perspective on Multiple (Interactive) Displays

2. **Remote Interaction:** Multimodal Interfaces
   - Throw & Tilt
   - Gestures | Pen & Paper | Stackables: Tangible Queries
   - Gaze-supported Interaction

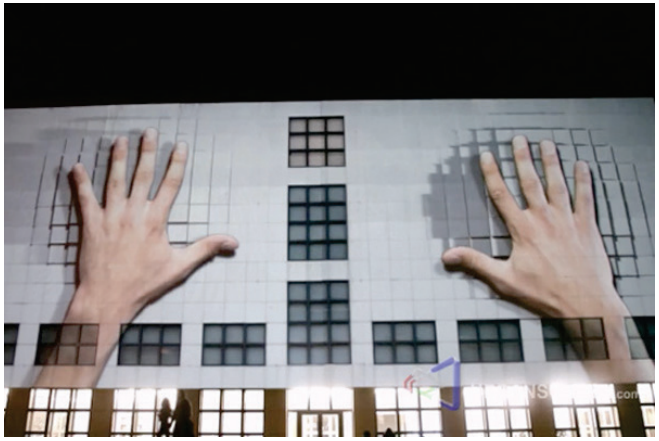
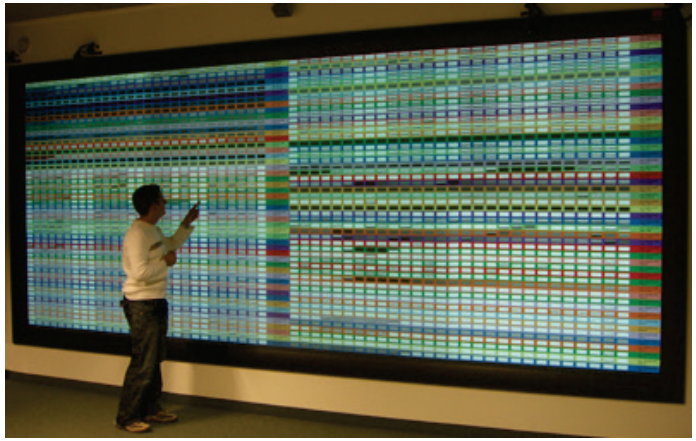
3. **Output = Input Space:** Tangible Magic Lenses
   - Information Spaces & Interaction Vocabulary
   - InfoVis + Exploration of 3D Data (Tangible Windows)


# 2. Multimodal Interaction with Distant Displays

# Motivation

- Increasing number of (large) displays
- Direct interaction often neither feasible nor desired

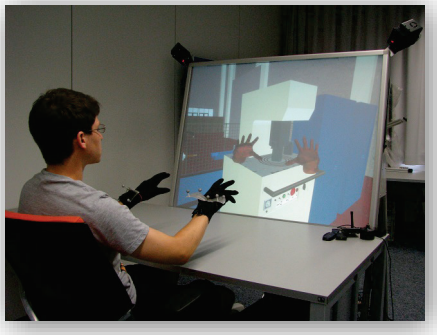


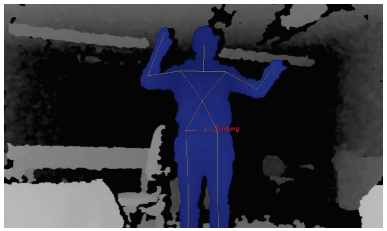




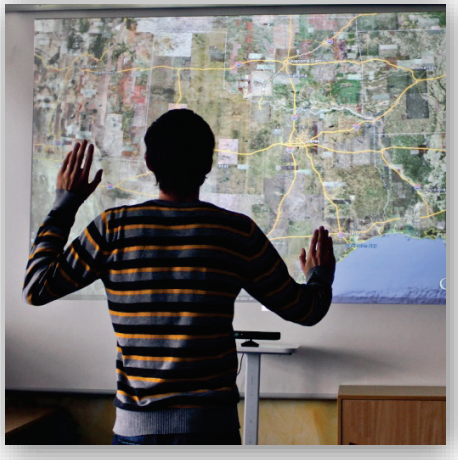

# Solutions for interacting with distant displays (I)

## 1. Bimanual interaction with freehand gestures

- [Franke et al. VR/AR'10, Stellmach et al. M&C'12]
- Using optically tracked gloves or bare hands

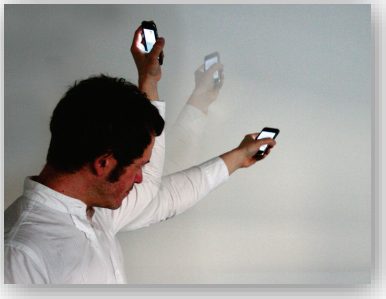




## 2. Throw & Tilt: Phones gestures

- [Dachselt & Buchholz MEIS 2008, CHI 2009]
- Combining several gestures using handhelds with multitouch input



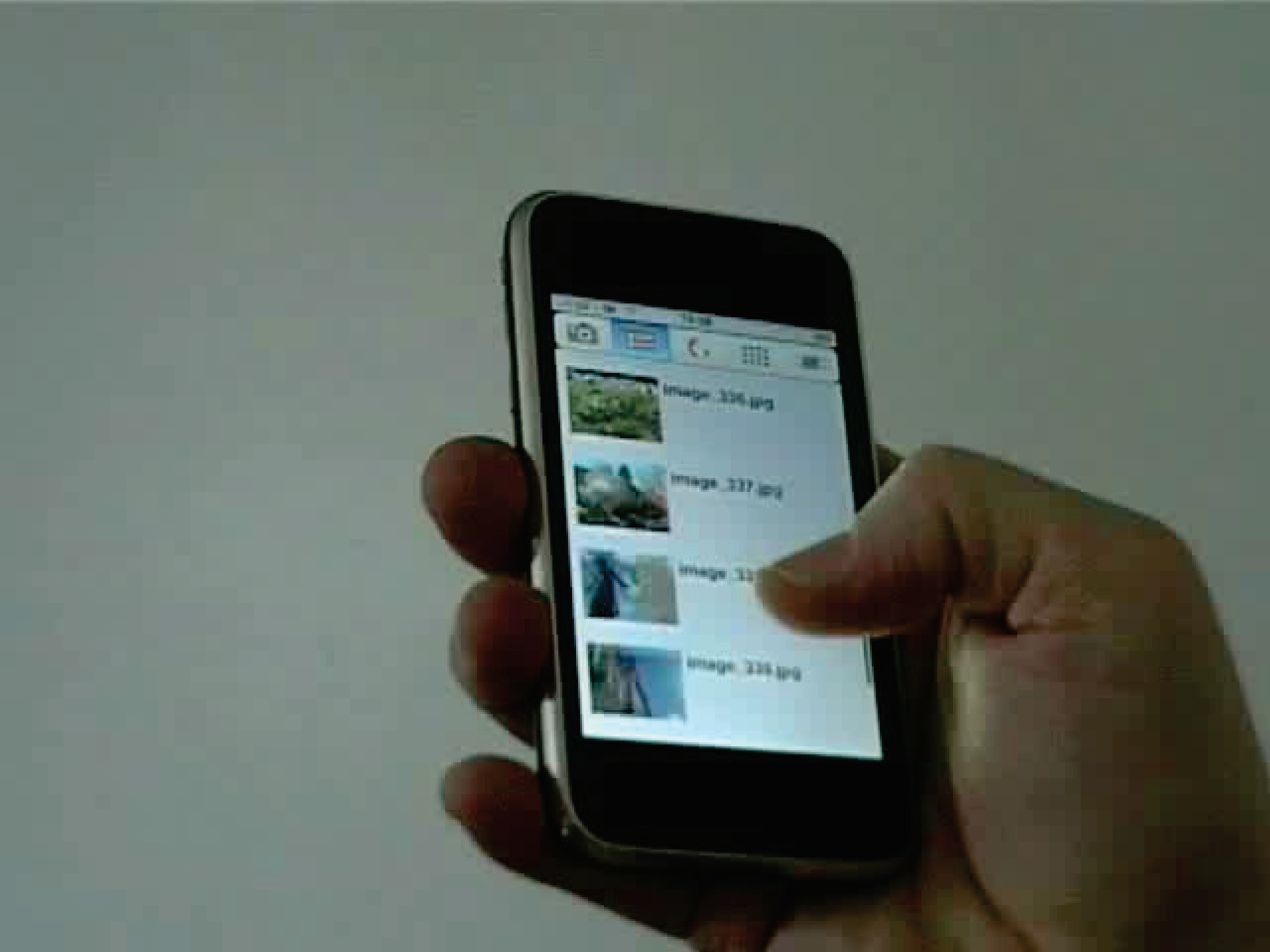
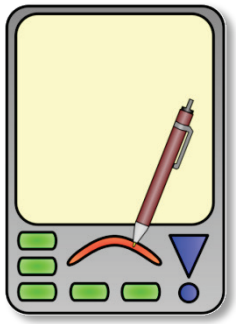


image_336.jpg
image_337.jpg

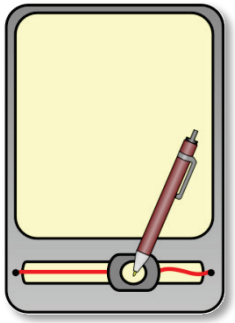
# Solutions for interacting with distant displays (II)

## 3. Digital Pen + Paper Interaction in Virtual Environments

- [Stellmach et al. M&C ’10]
- Navigation and interaction in 3D worlds, GUI on paper sheets



Constraints

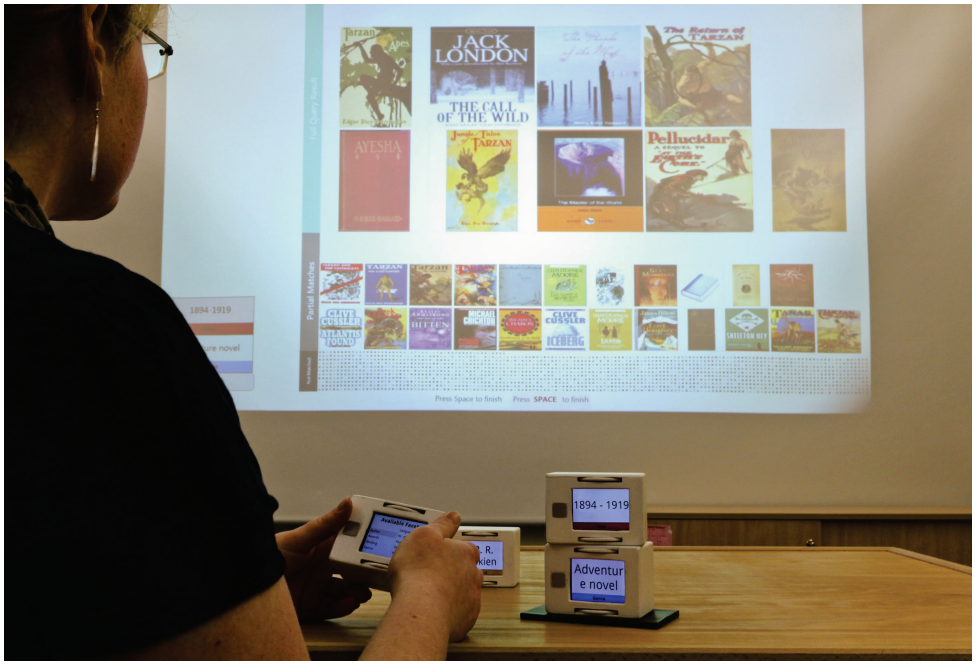


Elastic Feedback

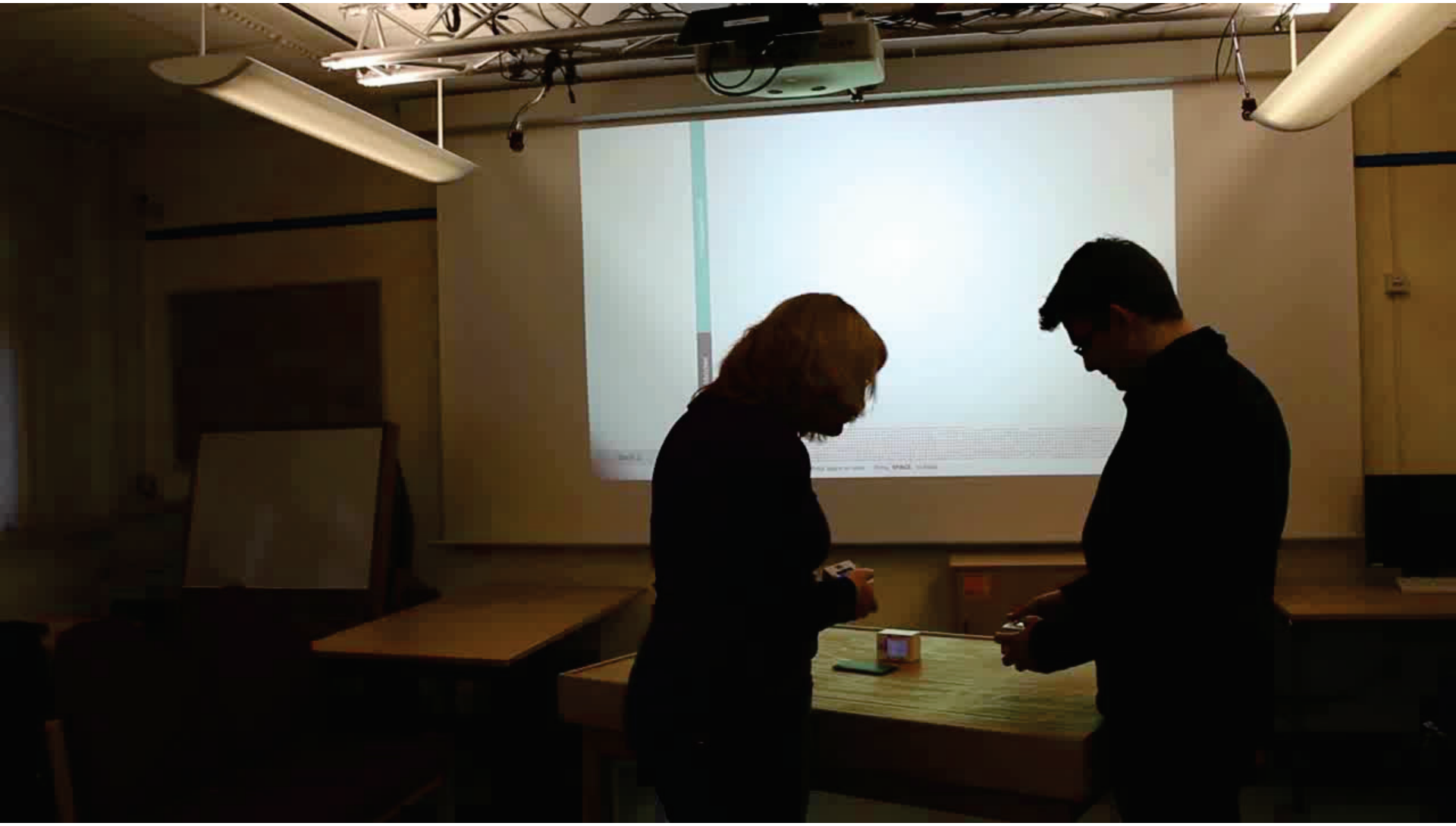
# Solutions for interacting with distant displays (III)

## 4. STACKABLES

- [Klum et al. AVI ’12, Isenberg et al. CHI ‘12]
- Physical widgets (tangibles) with controls for faceted browsing
- Stacking metaphor: build queries, proximity




# Stackables



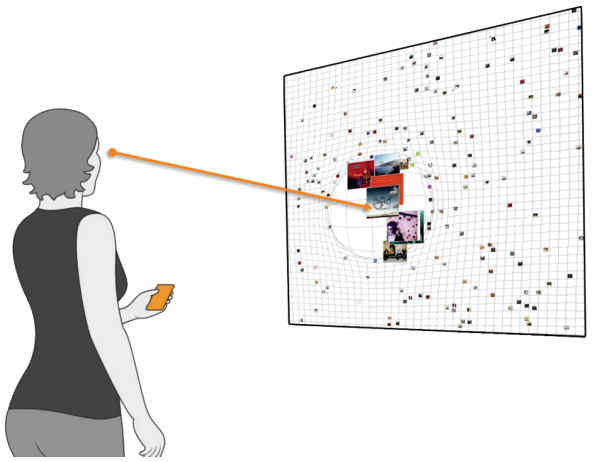
# Solutions for interacting with distant displays (IV)

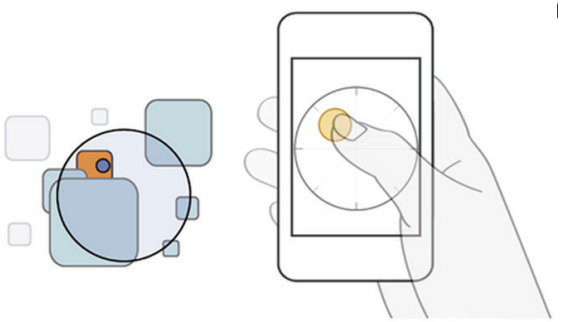
## 5. Gaze-supported Interaction: Touch, Tilt gestures, Feet

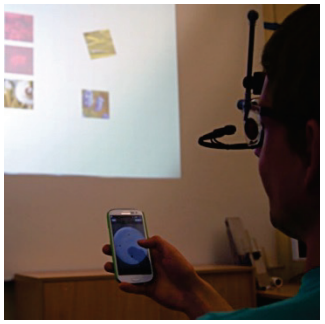
– [Stellmach et al. ACM NGCA ’11], [Stellmach & Dachselt ETRA ’12], [Stellmach & Dachselt CHI ‘12, CHI ‘13]

– Gaze + additional input to support
  - Navigation (e.g., zoom and pan),
  - Selection and manipulation

- Gaze suggests: rough cursor position
- Touch (or other modality) confirms: fine positioning, triggering actions







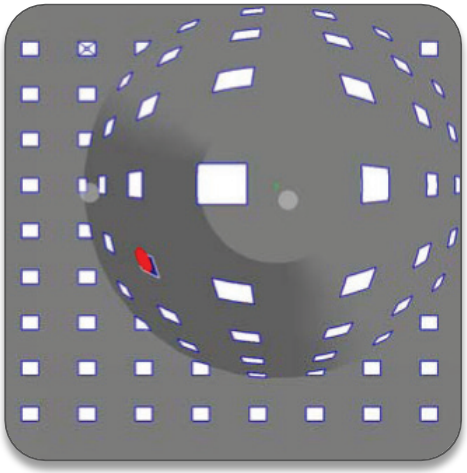
# Why not use eye gaze? Well, there are some Challenges…

1. Midas Touch
   - Involuntary triggering an action
2. Inaccuracies
   - Physiological and technical
   - Need to handle: Jitter and offsets
3. Reliability
   - Changing lighting conditions
   - Physiological adaptations (e.g., pupil size)
4. Eyes are rather made for perception than control
   - Adapted techniques required instead of mouse replacement

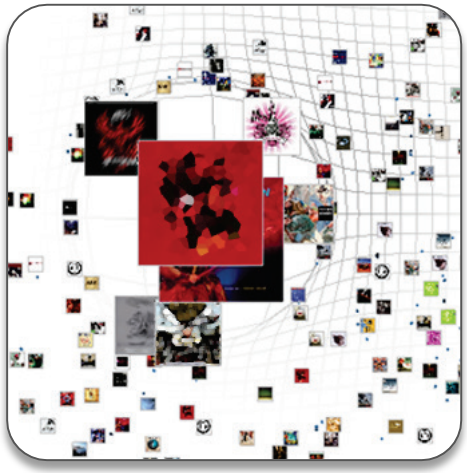
→ Our approach: **Gaze-supported Interaction**

# Related Work: Target Expansions

- Visibly extend targets in motor space
  - Facilitate quick and precise selections
  - Compensate inaccuracies (offsets)



Gaze-based fisheye lenses
[Ashmore et al., 2005]

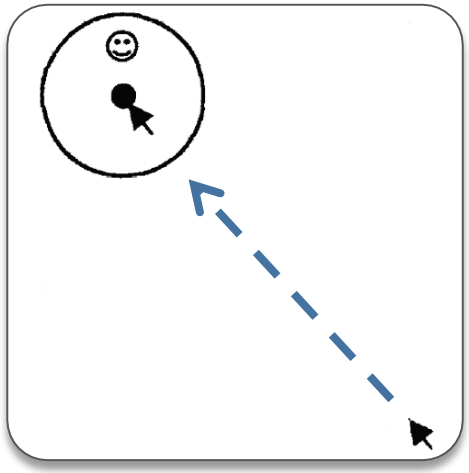


Gaze-directed spring lens for browsing images
[Stellmach et al., 2011]


Gaze + keyboard for pointing and selection
[Kumar et al., 2007]

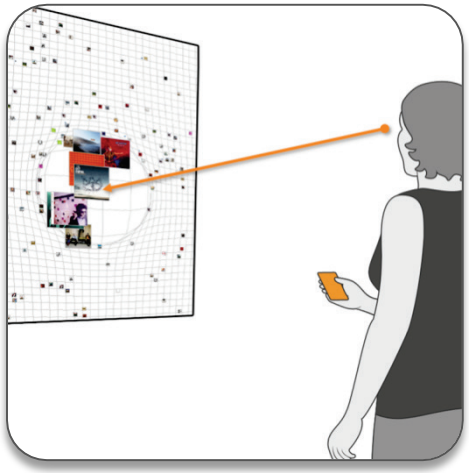
# Related Work: Gaze & Manual Input

- Gaze + manual input to support selection tasks
  - Gaze: Rough cursor position
  - Additional device for confirmation and/or fine positioning



**MAGIC Pointing**: Mouse cursor is placed in the vicinity of the fixated target [Zhai et al., 1999]

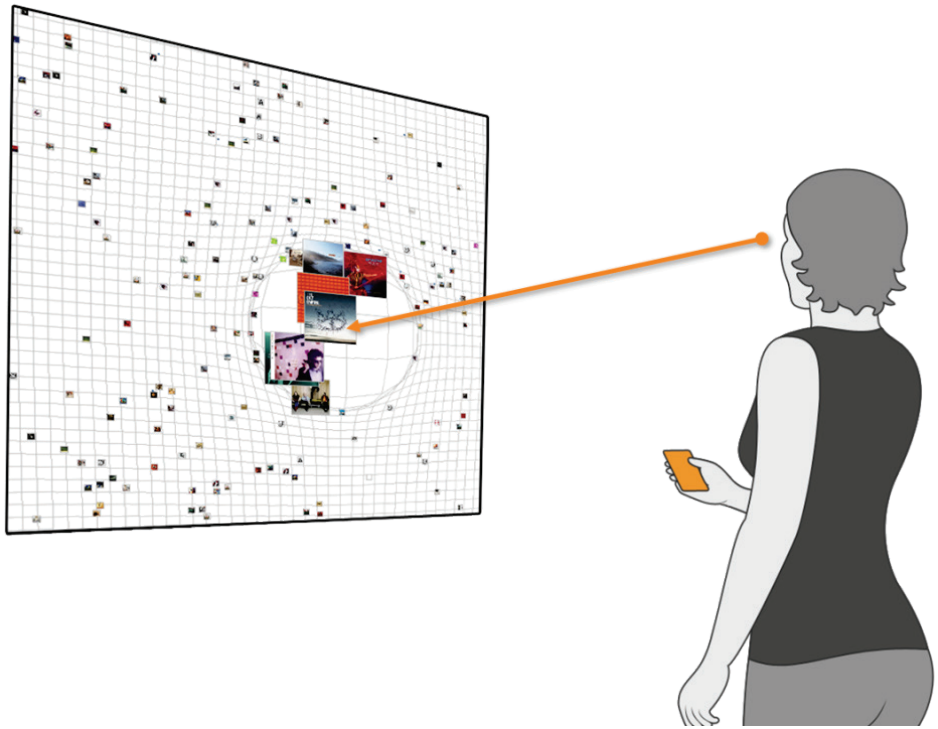

MAGIC Pointing with a touch-sensitive mouse [Drewes and Schmidt, 2009]

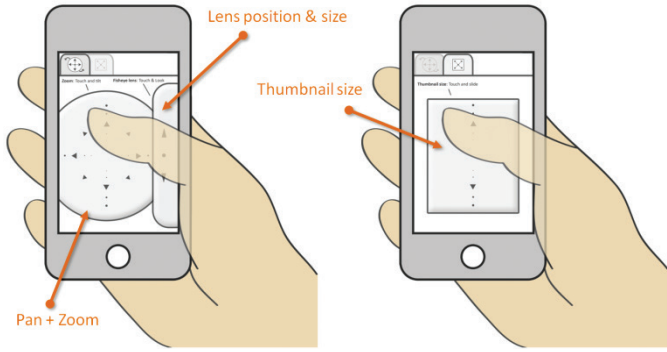


Gaze + mobile *touch-and-tilt* device for image selections [Stellmach et al., 2011]

# Gaze-supported Interaction: Exploring Media

- Gaze Galaxy [Stellmach et al. ACM NGCA ’11]
- Exploration of media collections
  - Gaze-supported Interaction = Gaze + Touch + Tilt-Gestures
  - Multi-faceted browsing of media objects



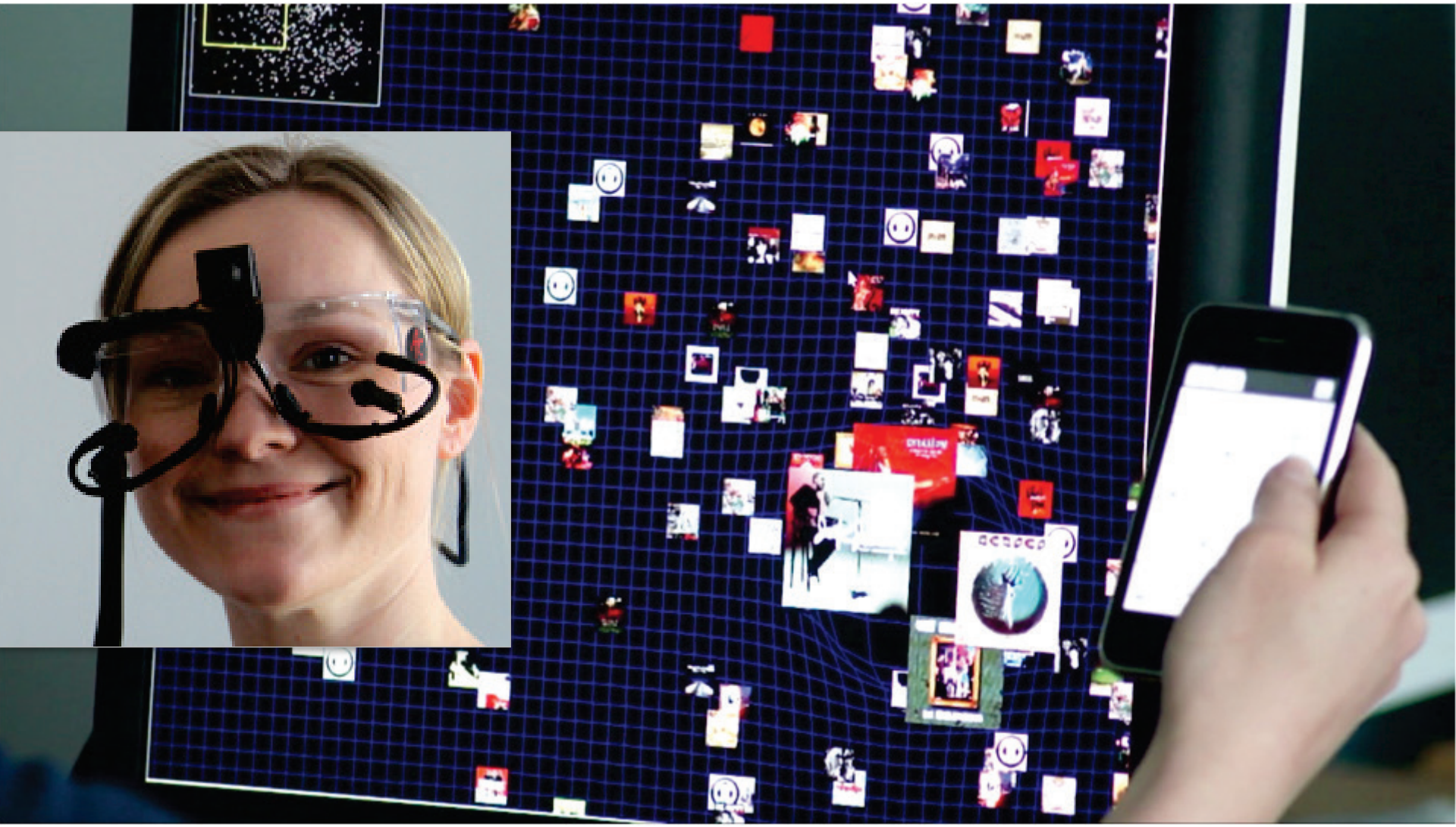


# Interaction Techniques

- Design a conflict-free gesture set
- Basic considerations:

| | |
|---|---|
| No gaze dwell activations | *Multimodal interaction* |
| Reduce Midas Touch problem<br>*(unintentional tilt and gaze events)* | *Explicit activation*<br>*→ Touch in a designated area*<br>*→ No issued tasks without a touch* |
| Thumb-only interaction | *Single touch gestures* |
| Minimal attention shifts / “Blind interaction“ | *Large touch areas*<br>*Relative touch gestures* |

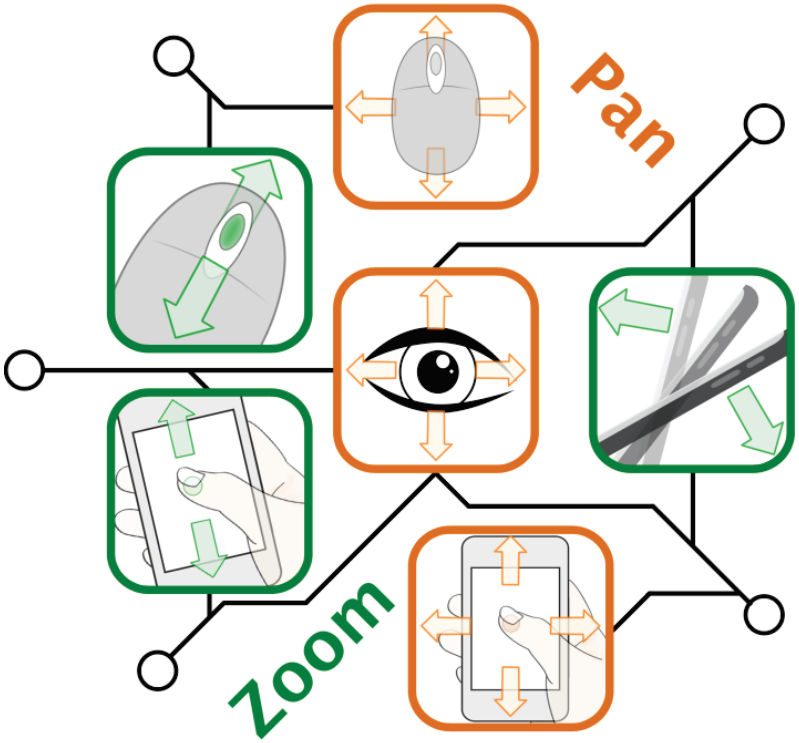
# Realization



# Gaze-supported Interaction: Navigation

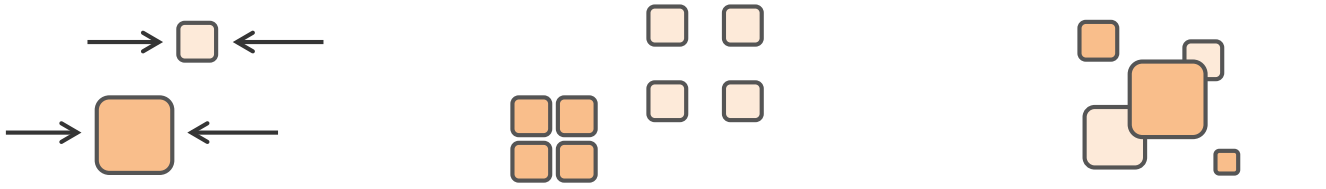
- Pan & Zoom with smartphone and gaze control

[Stellmach & Dachselt ETRA'12]




# Gaze-supported Selection: Design Considerations

- Flexible gaze-supported interaction
  - Combination of gaze + mobile touch device
- Support convenient selection of varying targets:



Size | Distances | Overlapping

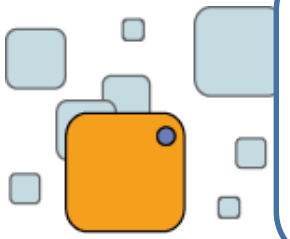
- Eyes-free and thumb-only interaction with handheld

*Gaze suggests, touch confirms*

[Stellmach & Dachselt CHI'12]

# Our Solution: Gaze-supported Selection Techniques

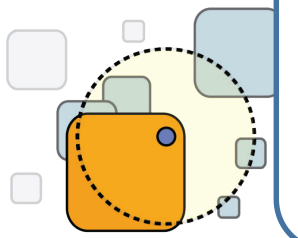
[Gaze] + [Mobile **touch** device]



Enhanced gaze-directed cursor

Gaze-directed zoom lenses

- Eye-slaved
- Semi-fixed

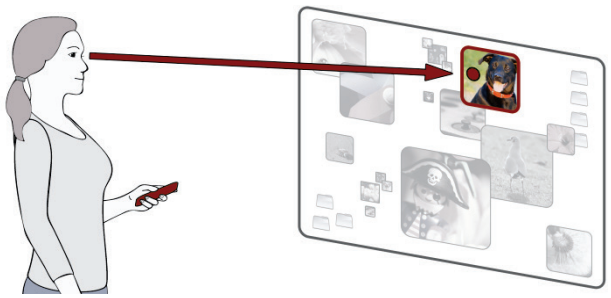


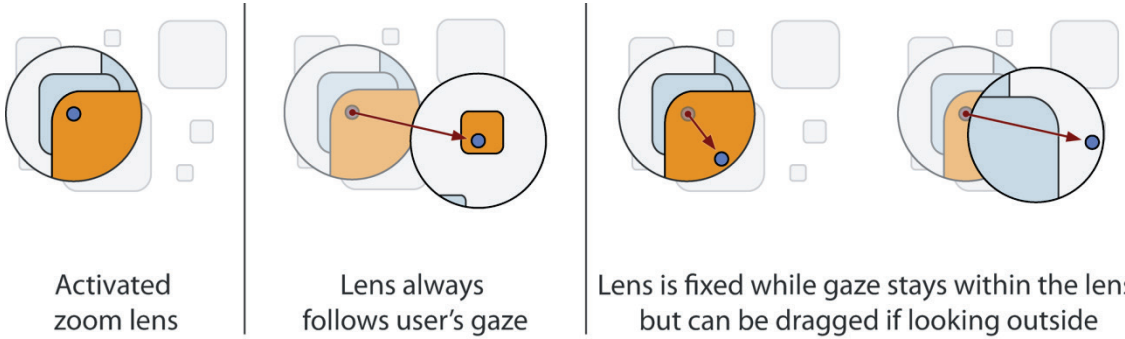
Manual fine positioning

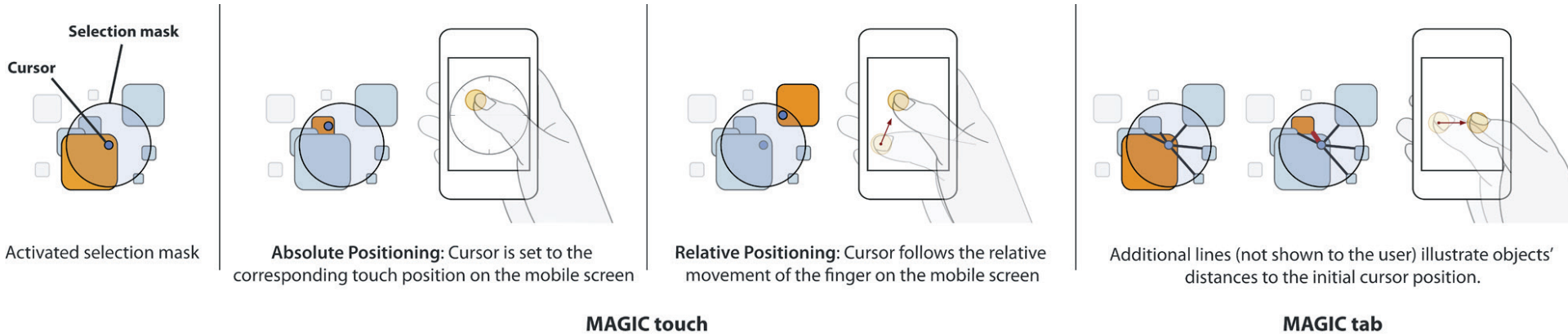
- MAGIC touch
- MAGIC tab

# Look & Touch: Gaze-supported Target Acquisition (Selection)

[Stellmach & Dachselt CHI'12]






Video

# User Feedback – Gaze-directed Cursor

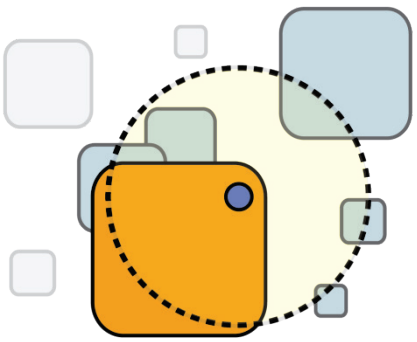
- ✓ Very easy to learn
- ✓ Easy and fast for selecting large targets
- ■ No compensation for offsets
- ■ Impractical and wearisome for small targets

# User Feedback – Gaze-directed Zoom Lenses

- ✓ Easy to learn and use also for smaller targets (not tiny though)
- *Limited* compensation for offsets
- Not enough customization options

| Eye-slaved Zoom Lens | Semi-fixed Zoom Lens |
| --- | --- |
| Wearisome for tiny targets | ✓ More stability |
| Partly distracting and imprecise | Unusual gaze-based dragging |

# User Feedback – Manual Gaze-supported Techniques



- ✓ Easy, fast and precise selections
- ✓ Robust against inaccurate gaze data
- ✓ More relaxing for the eyes
- ✓ Higher feeling of control

## MAGIC touch

- ■ Imprecise touch input

**Relative positioning:**

- ■ Cursor overshooting

**Absolute positioning:**

- ✓ Quick selections of large targets

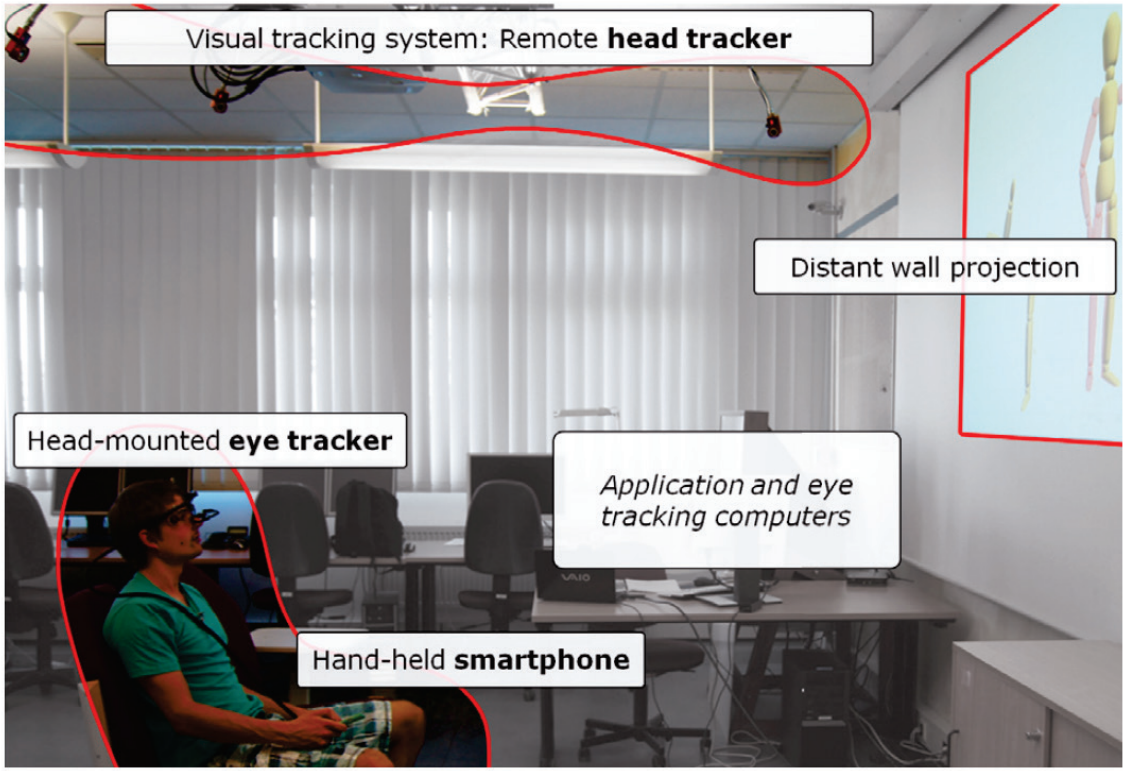
## MAGIC tab

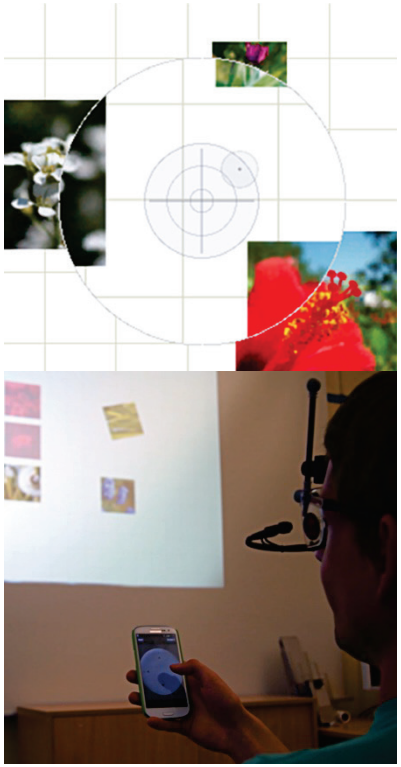
- ✓ Appropriate even for tiny targets
- ■ Unclear order in target list
- ■ Impractical for large amount of targets

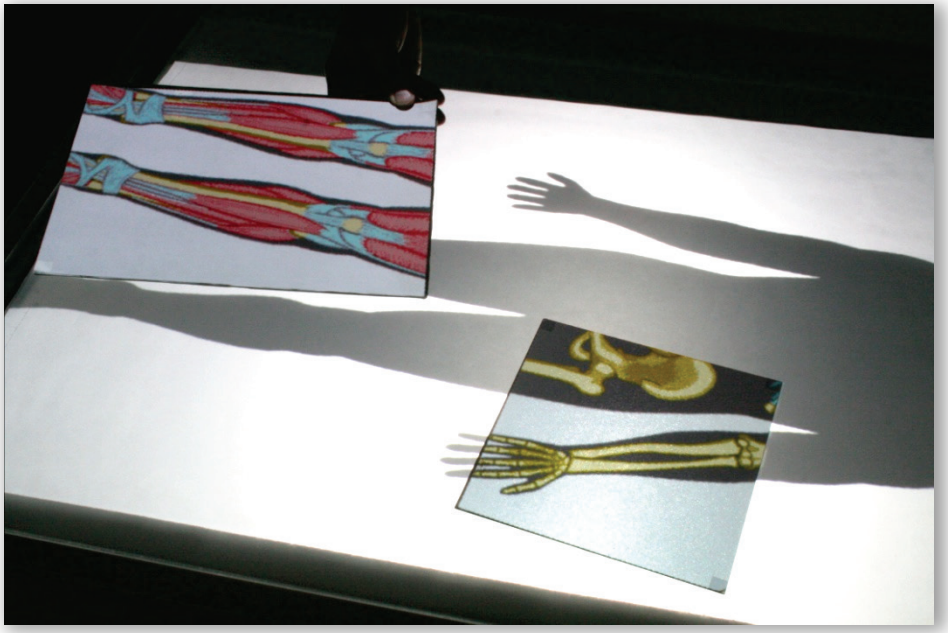
# Seamless Selection, Positioning, and Manipulation

- Still Looking:
  Investigating Seamless Gaze-supported Selection, Positioning, and Manipulation of Distant Targets

  [Stellmach & Dachselt CHI'13]

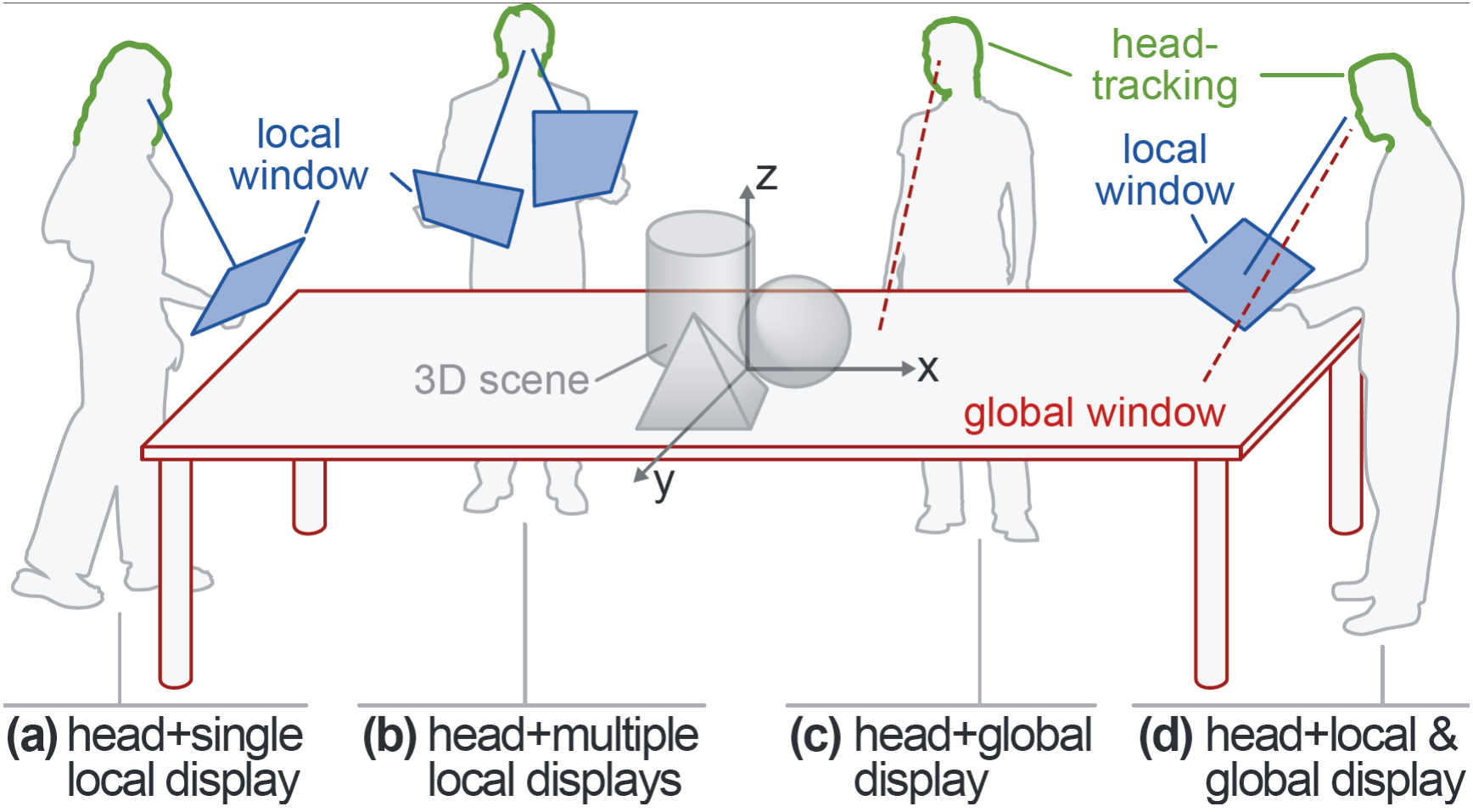


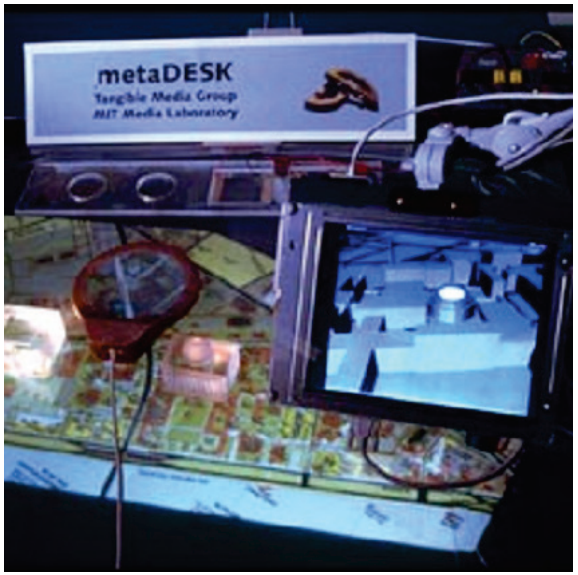


# 3. OUTPUT = INPUT Space
# Interacting  WITH and ON location-aware displays

# Concept of Tangible Lenses/Views/Windows



# Related Work: Spatially Aware Tangible Displays

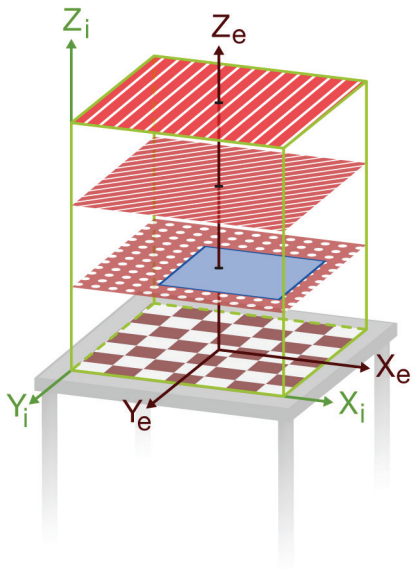



**metaDESK**
[Ullmer & Ishii UIST1997]

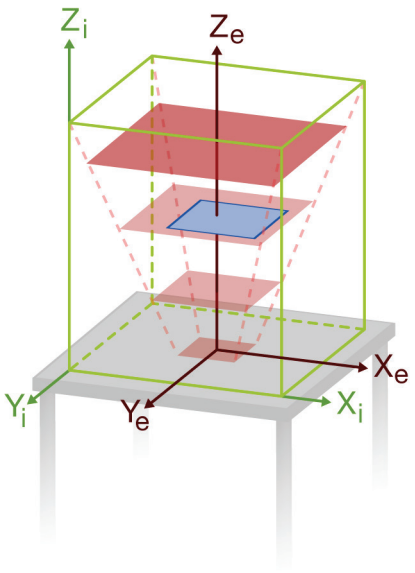

**Paper Windows**
[Holman et al. CHI2005]

**SecondLight**
[Izadi et al. UIST2008]

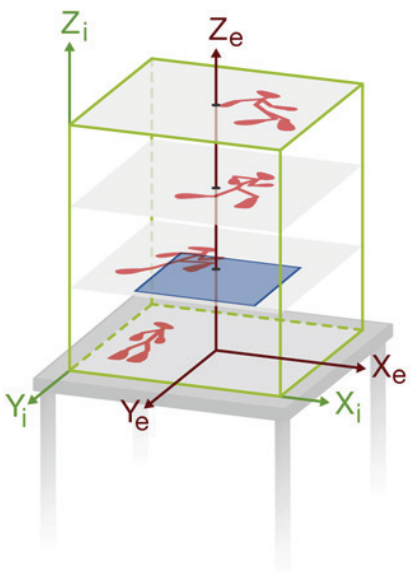
# Classification of Information Spaces [Spindler et al. M&C '09]



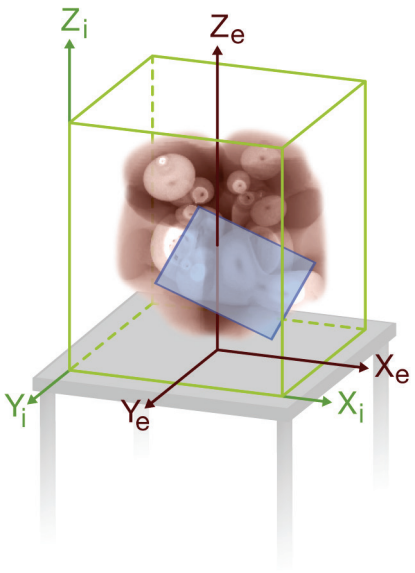

Layered




Zoomable

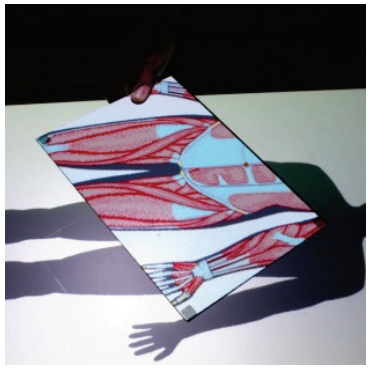


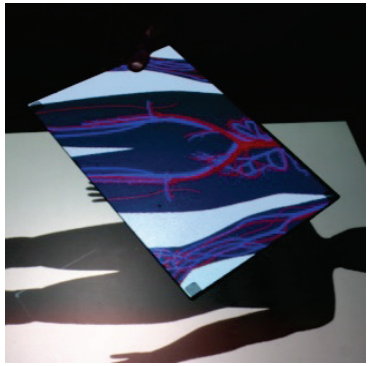

Temporal

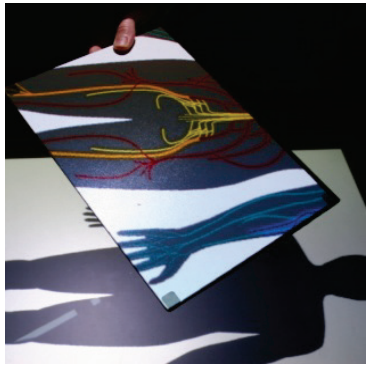


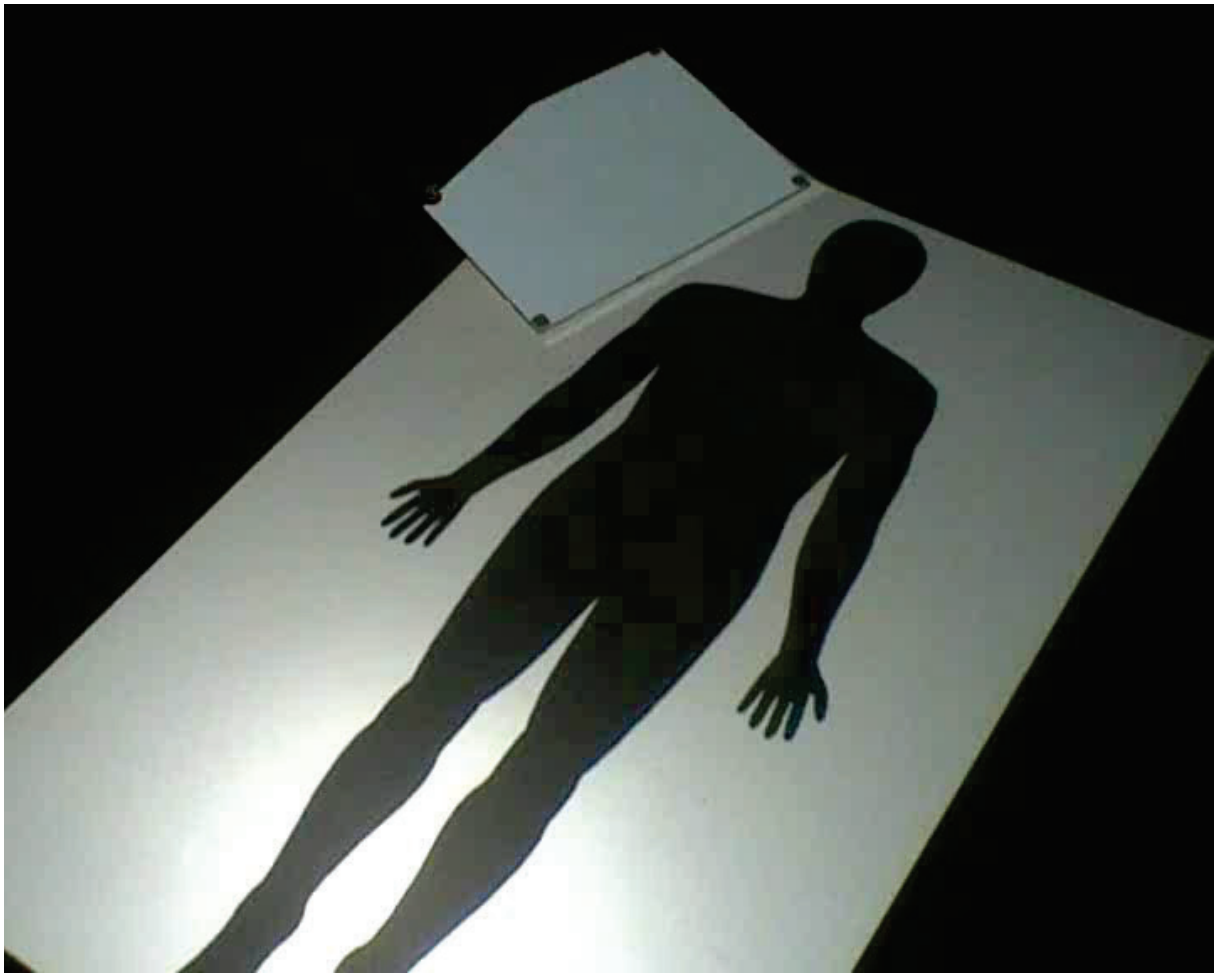

Volumetric

# Layered Information Space







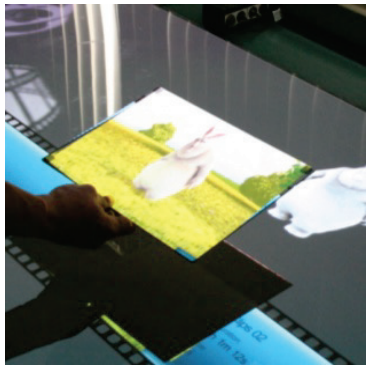


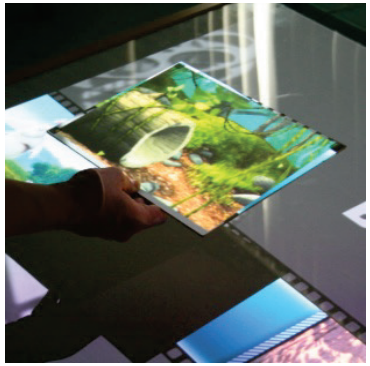
[Spindler et al. ITS'09], [Spindler & Dachselt CHI'10]

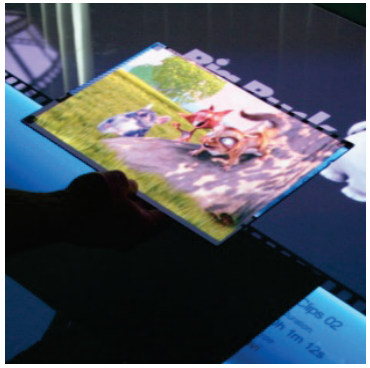
# Zoomable Information Space

[Spindler et al. ITS'09], [Spindler & Dachselt CHI'10]

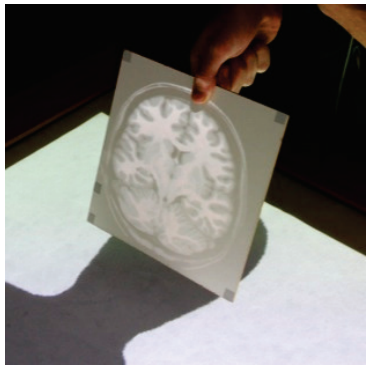
# Temporal Information Space

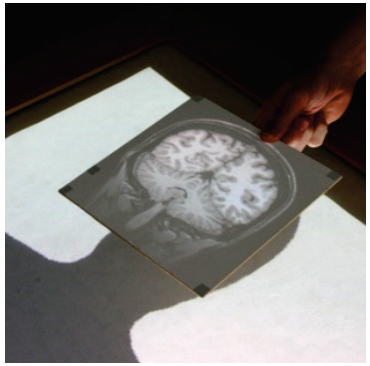


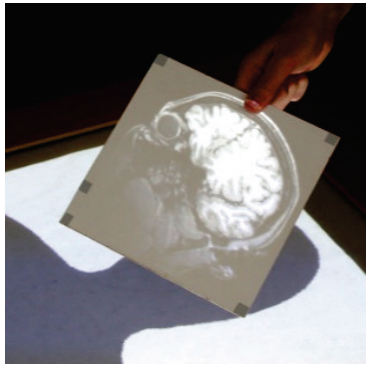




# Volumetric Information Space

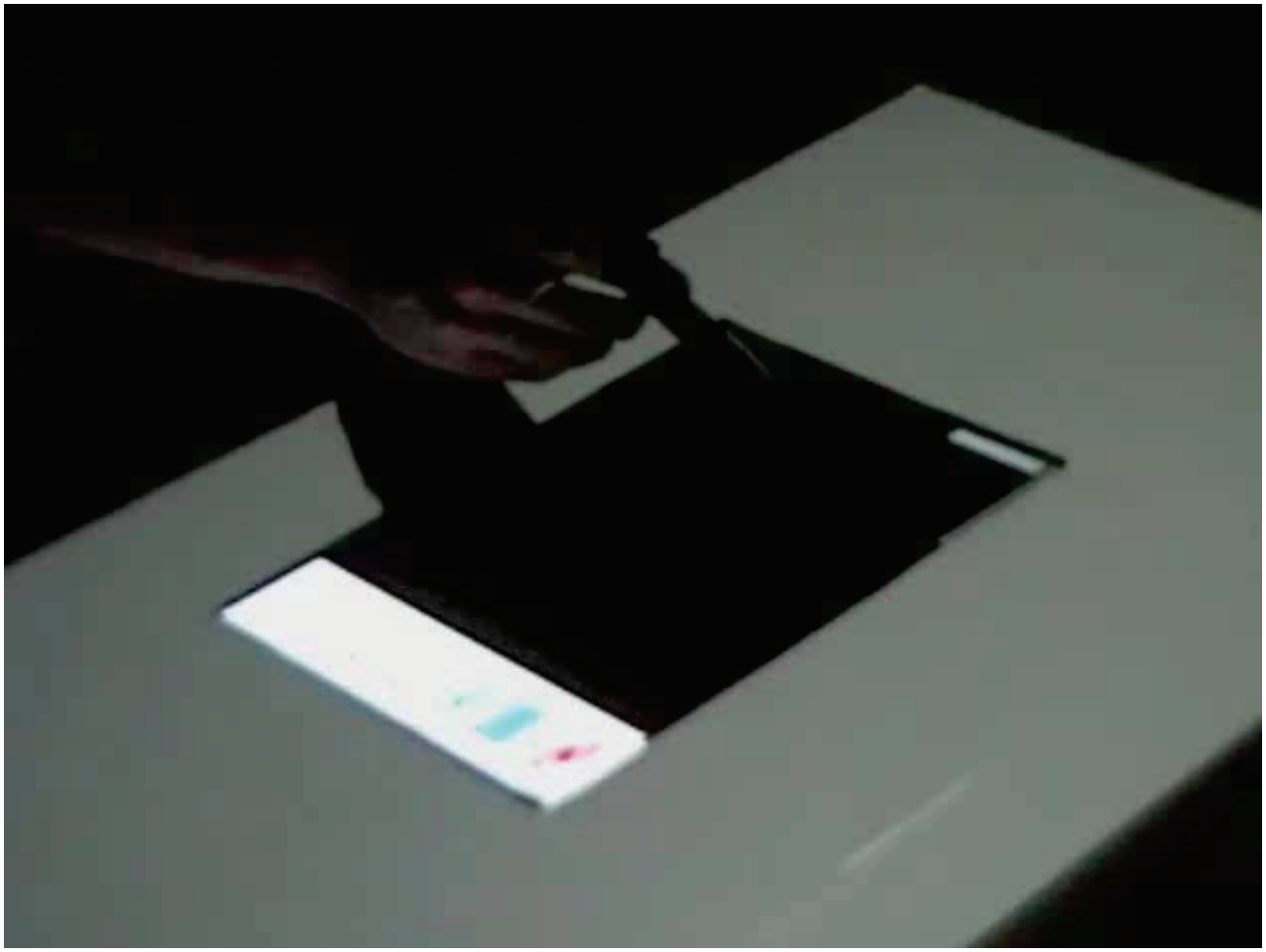






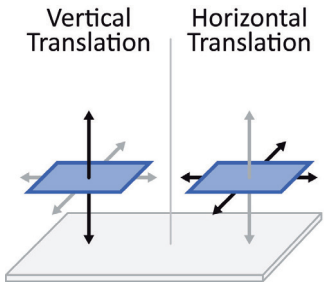
[Spindler et al. ITS'09], [Spindler & Dachselt CHI'10]

# Direct Pointing – Drawing with a Pen

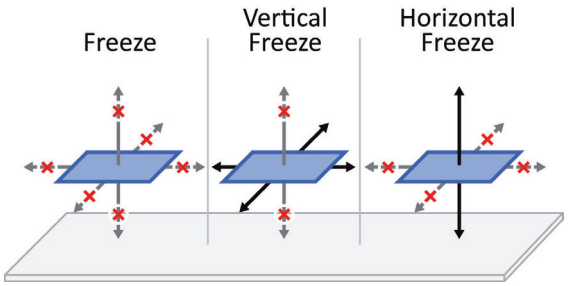


Digital Pen Input

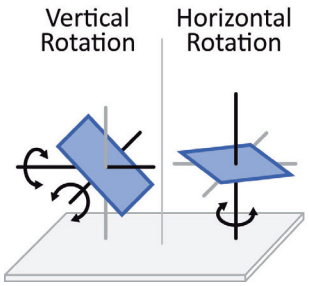
# Interaction Vocabulary [Spindler et al. ITS '10]




**Translation**

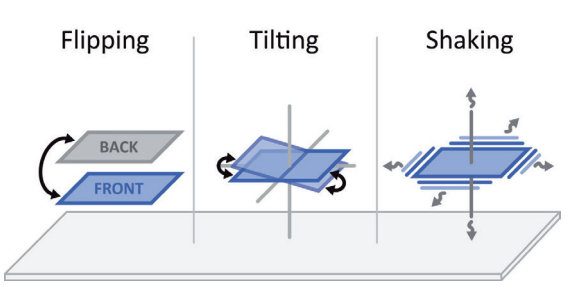



**Freeze**



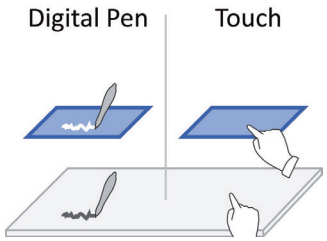

**Rotation**

[Lee et al. UIST2008]
[Lee et al. ITS2009]

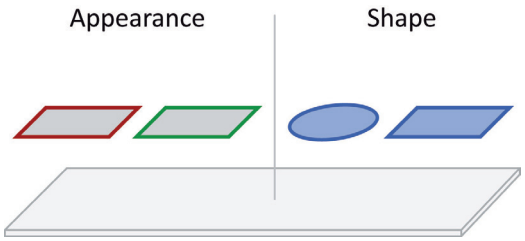



**Gestures**

[Holman et al. CHI2005]
[Rekimoto UIST1996]
[White et al. ISMAR2009]

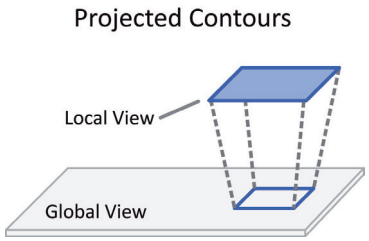



**Direct Pointing**

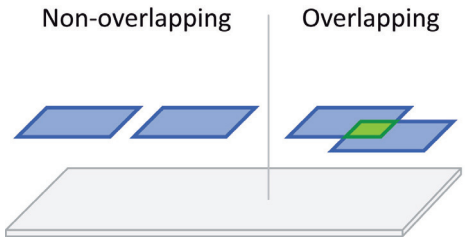



**Toolbox Metaphor**

[Fitzmaurice PhD1996]
[Ullmer & Ishii INTERACT2003]



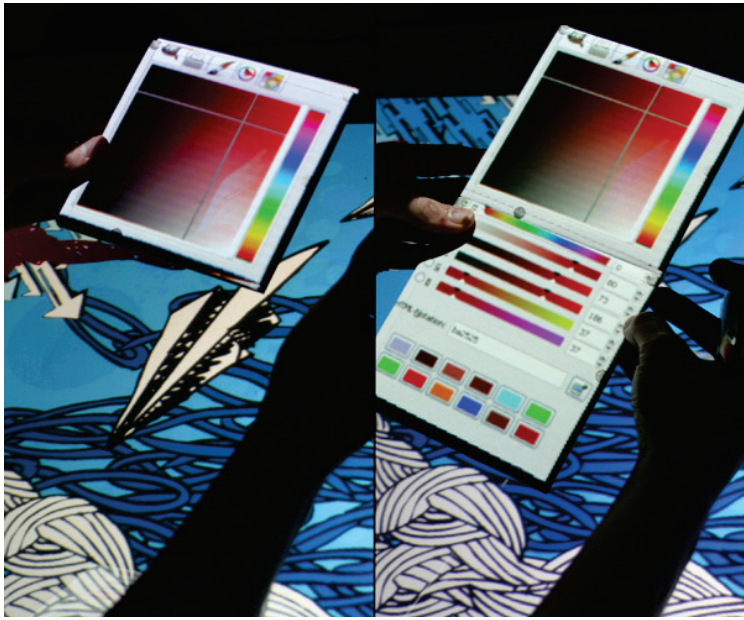

**Visual Feedback**

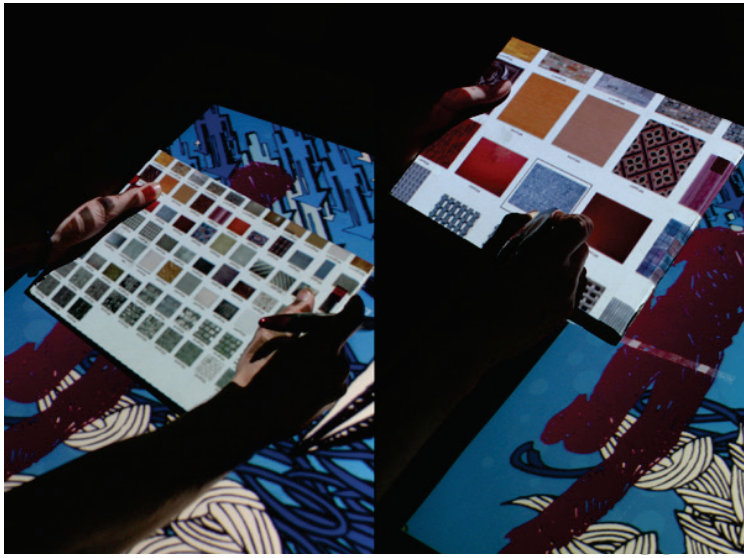



**Multiple Views**

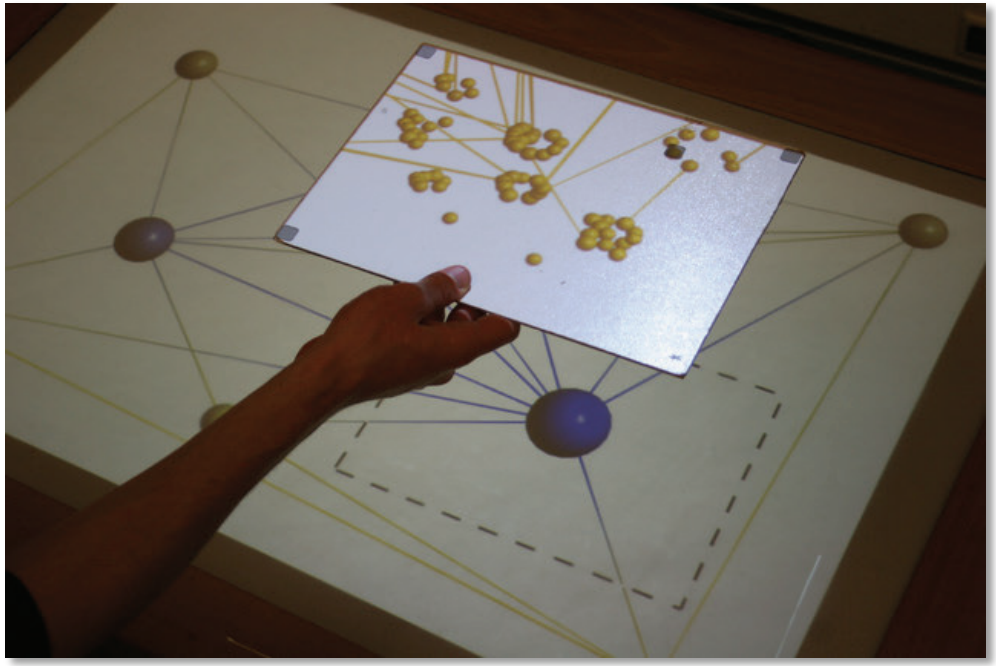
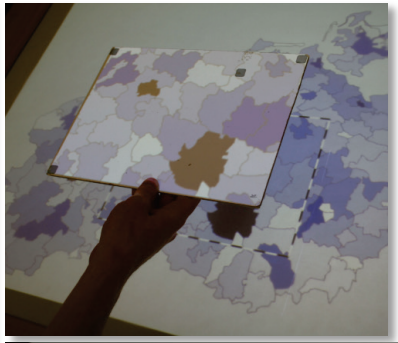
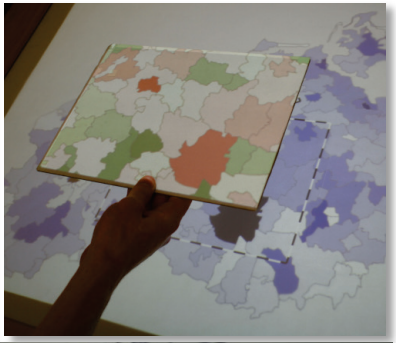
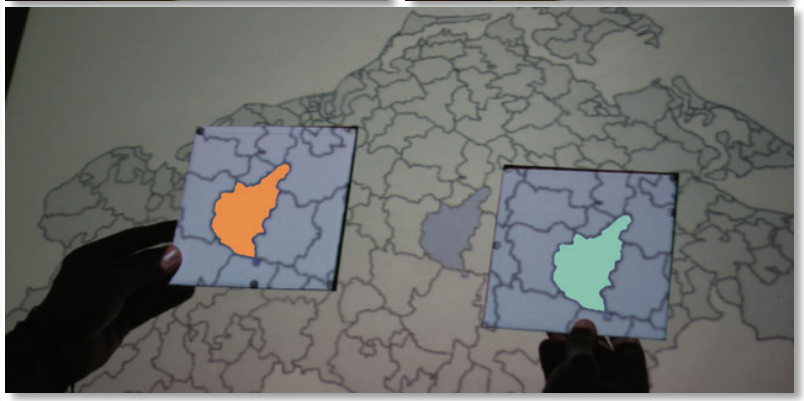
# Tangible User Interface Palettes

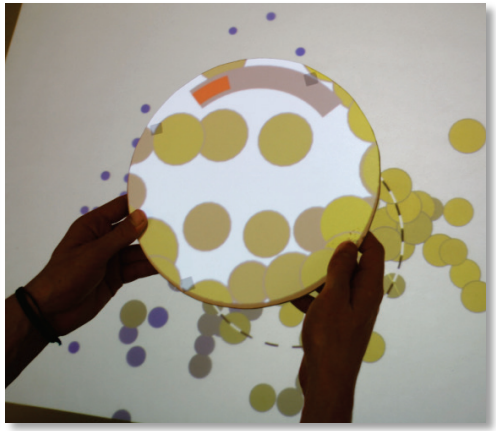
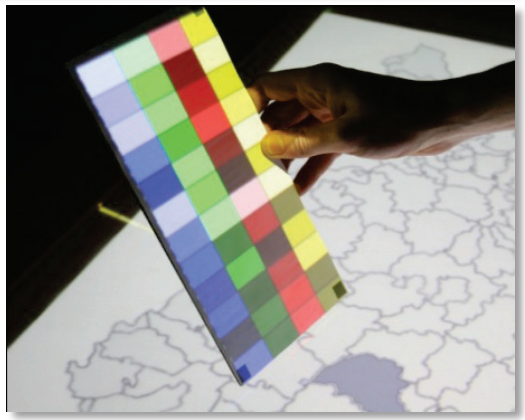
[Spindler, Hauschild & Dachselt ITS '10]





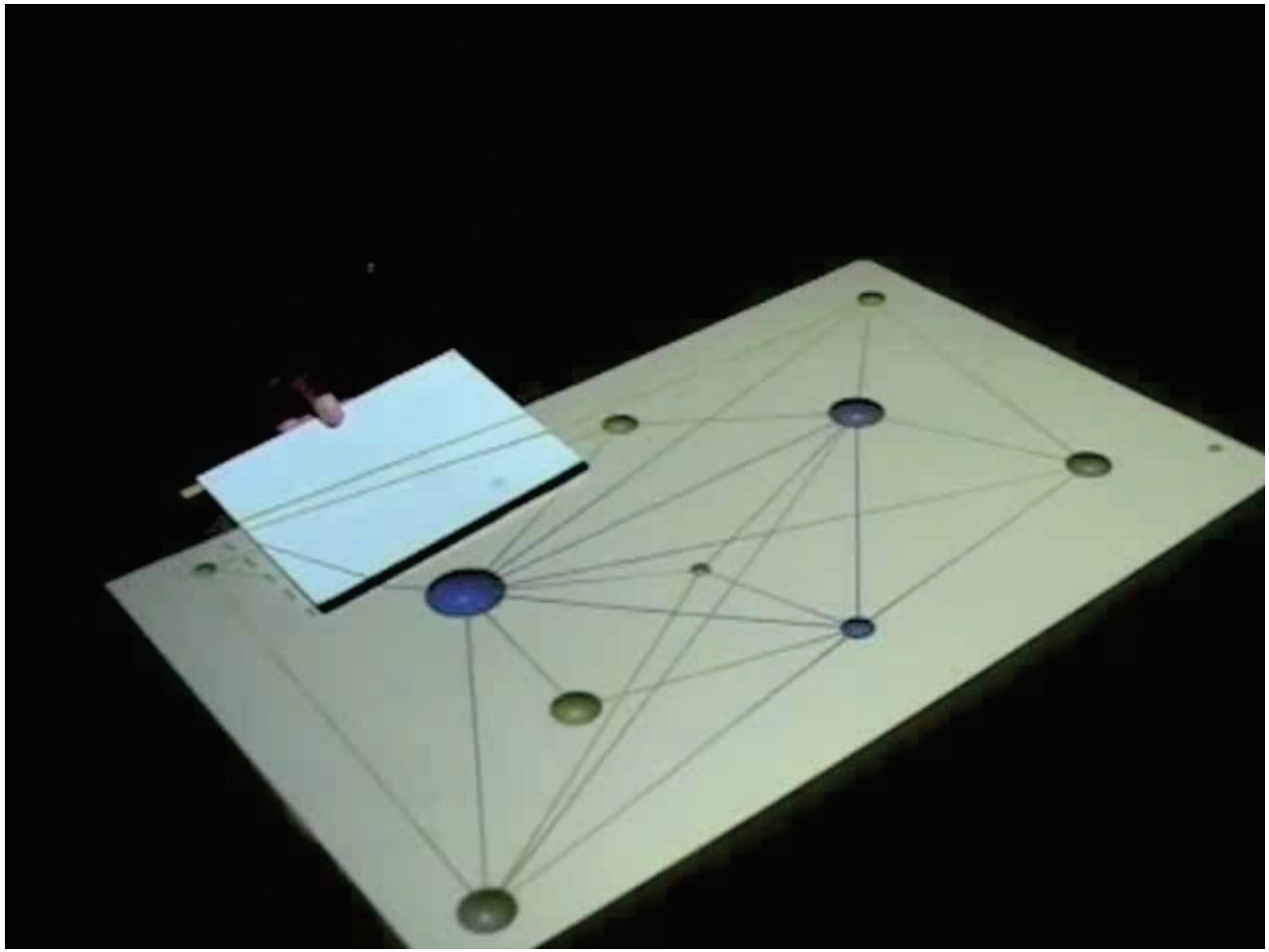
# Application Example: Information Visualization

[Spindler et al. IEEE InfoVis ’10] [Spindler et al. ACM ITS ’10]

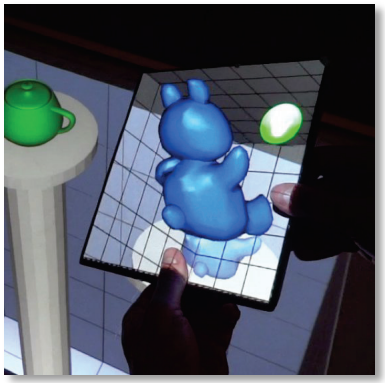
# Graph Exploration – Semantic Zooming

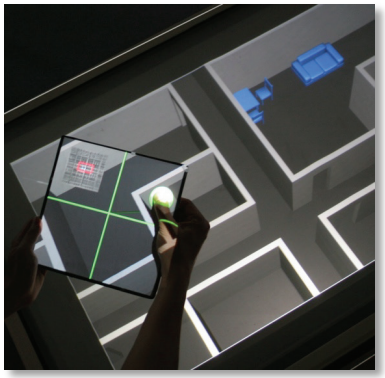


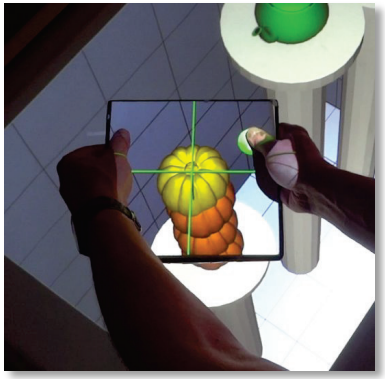
# Space-Time-Cube Visualization


**Slicing the Space-Time Cube Horizontally**

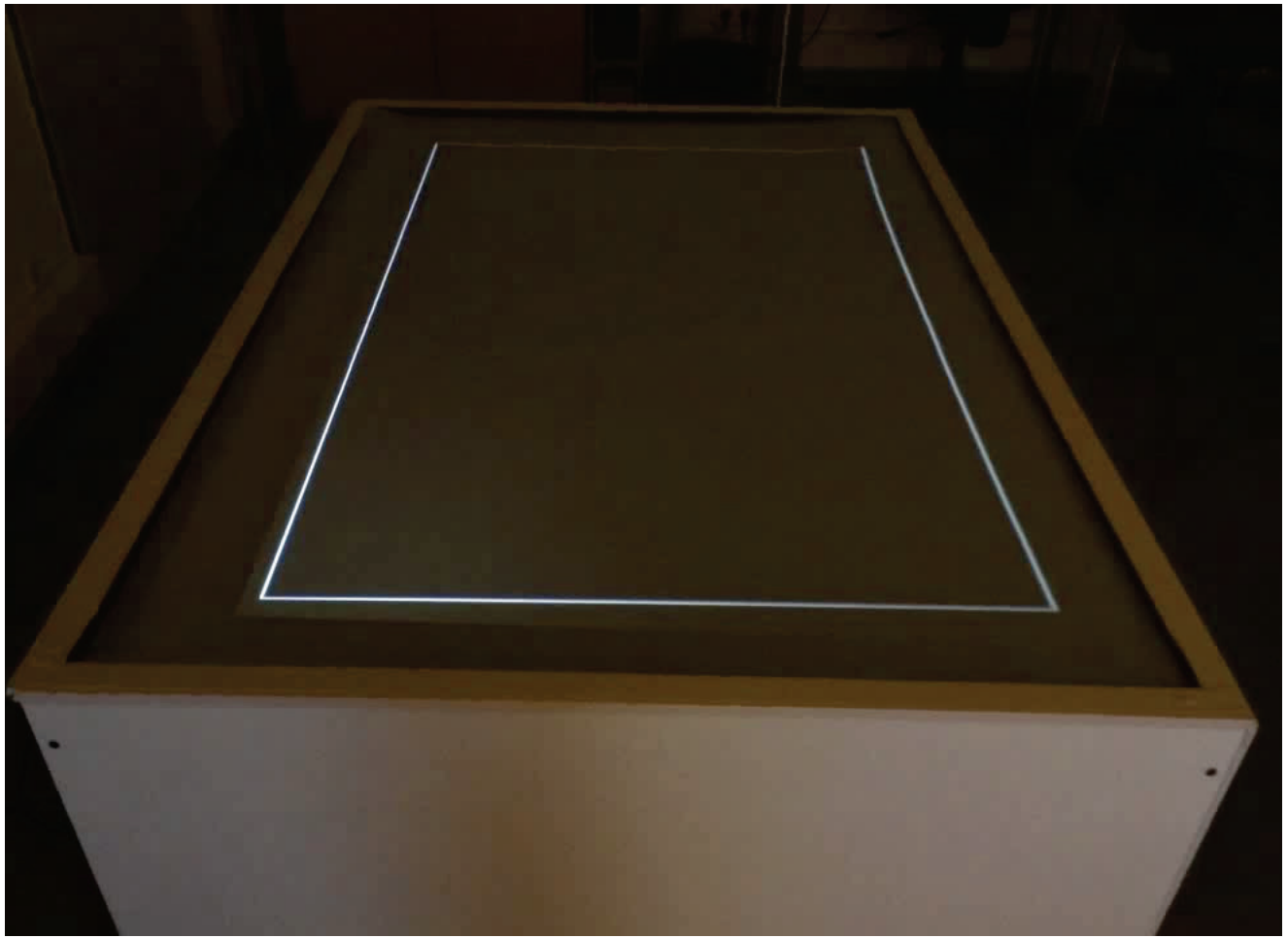
# Application for 3D Interaction [Spindler et al. ITS 2012]



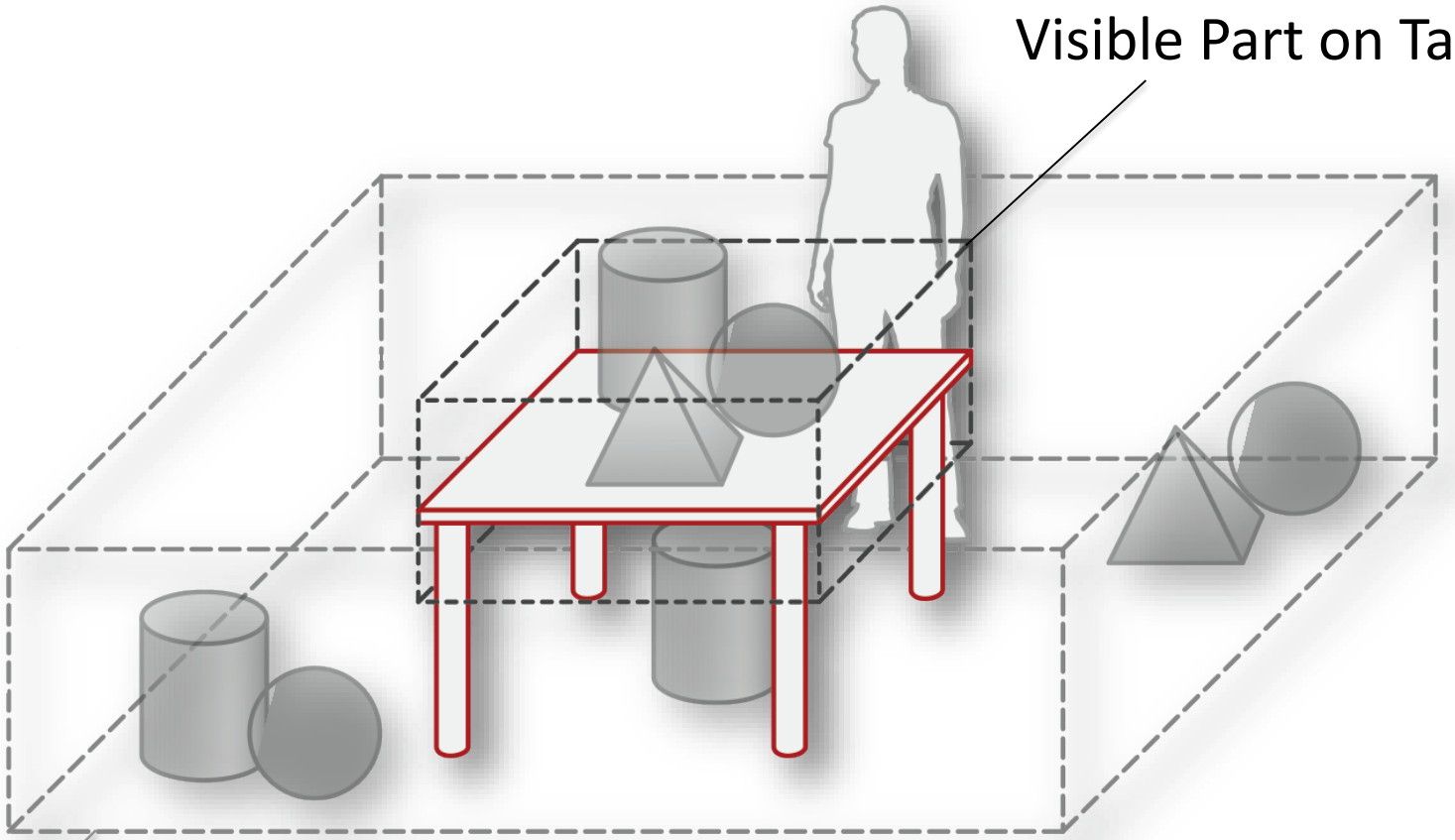




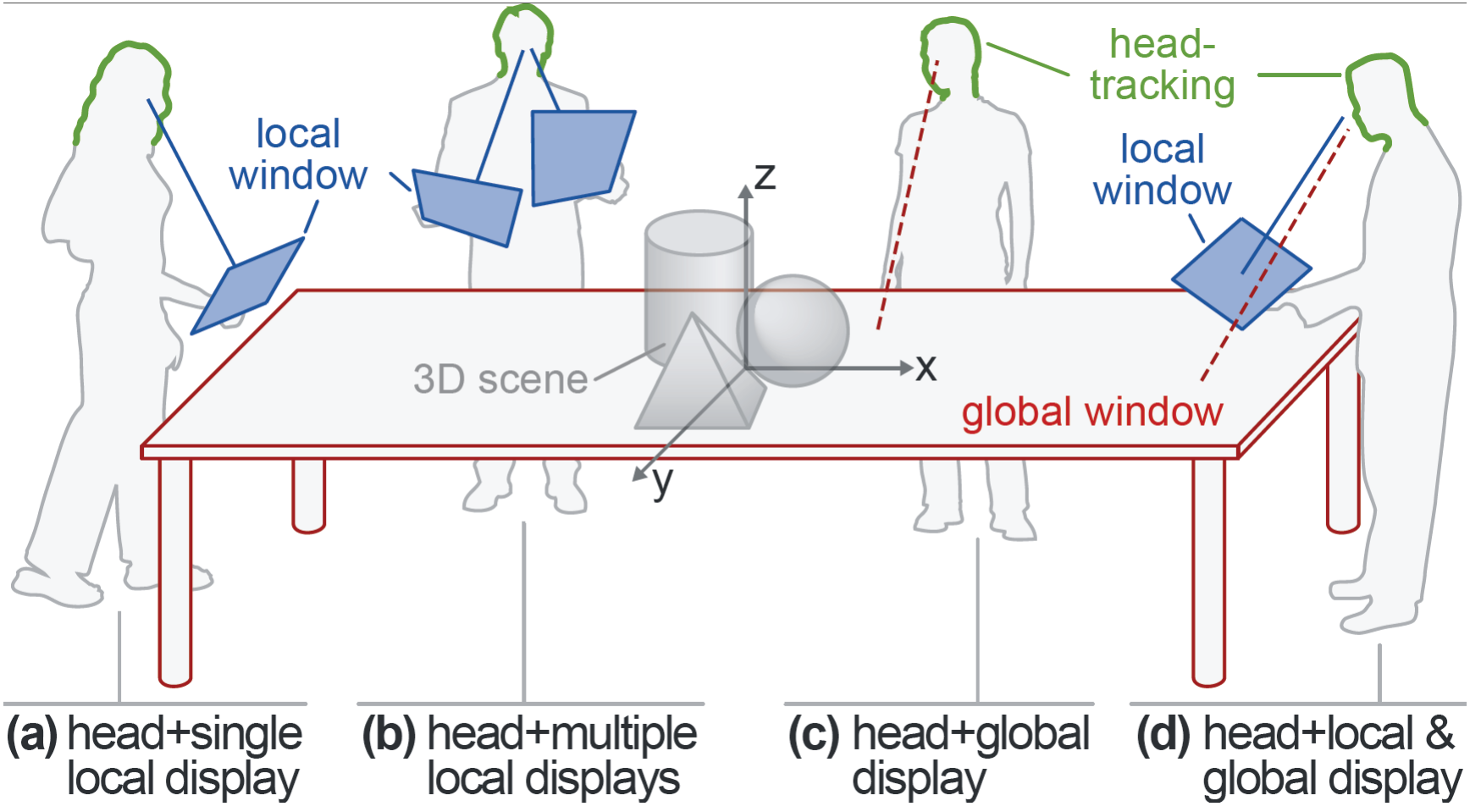
How can 3D interaction benefit from **tangible displays with head input**?



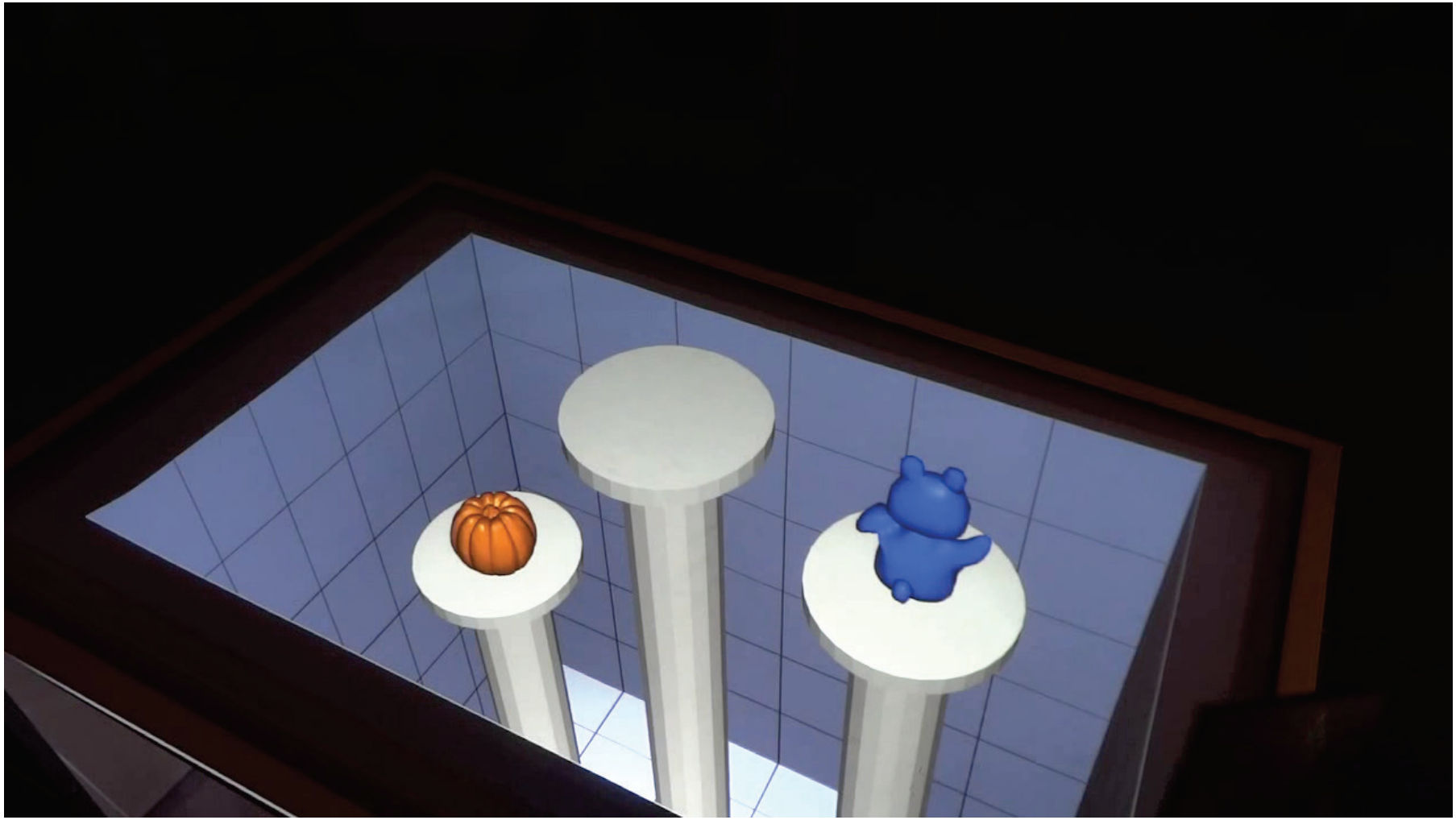
# Design Space: 3D Scene



# Concept of Tangible Windows

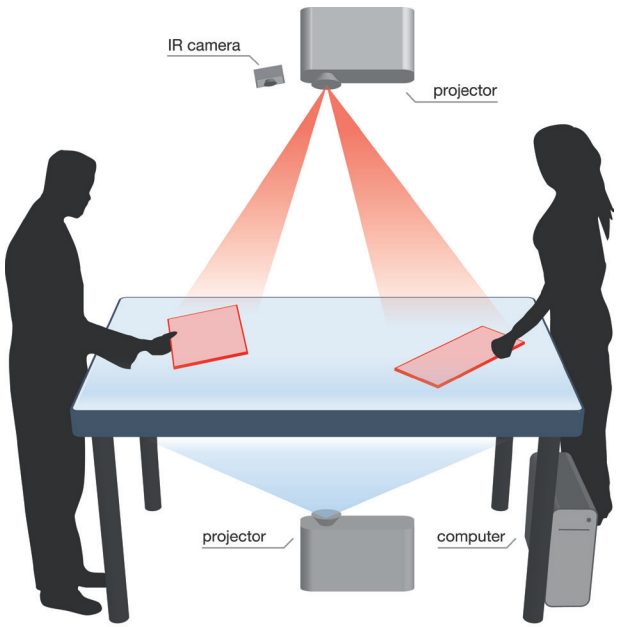


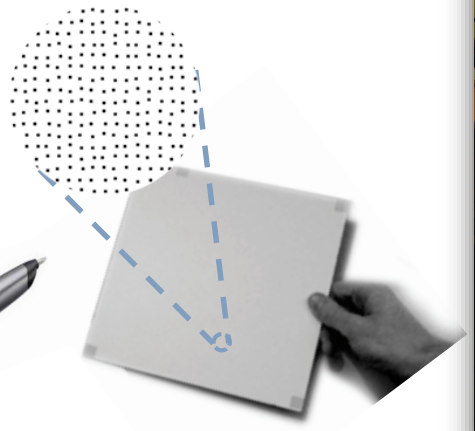
# Tangible Windows [Spindler et al. ITS 2012]



# **Tangible Windows** [Spindler et al. ITS 2012]

# Technical Setup

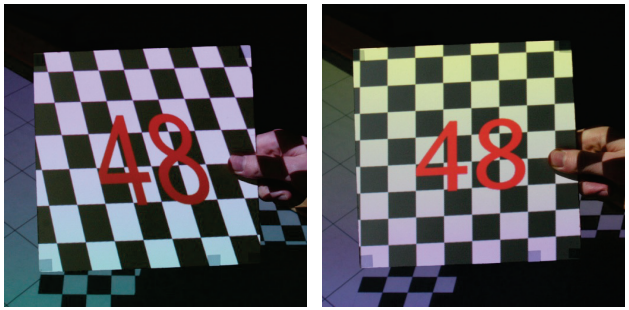


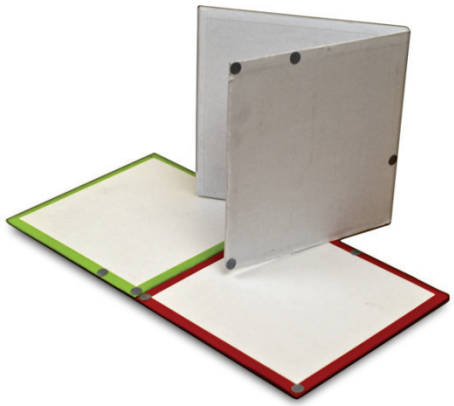



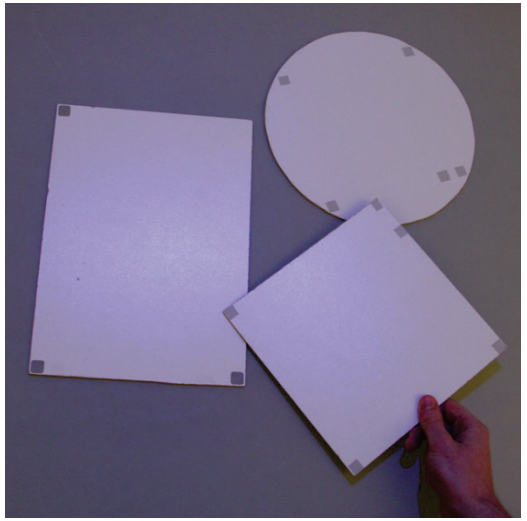
# Technische Umsetzung

- Tracking Tools 2.0: Rigid Body Tracking System
  - Position/Orientierung in hoher Präzision
  - Linsen IDs → Multiple Linsen (Views)


- Linsen Design
  - Papier, Pressspanplatte oder Plexiglas (günstig und leicht)
  - Beliebige Formen: Rechteck, Kreis, Quadrat, …
  - IR-reflektierende Marker
- Perspektivkorrektur

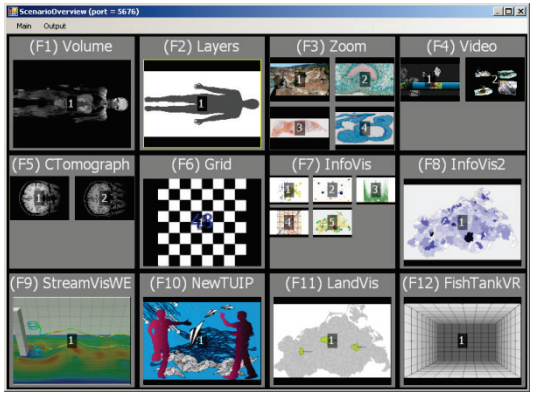


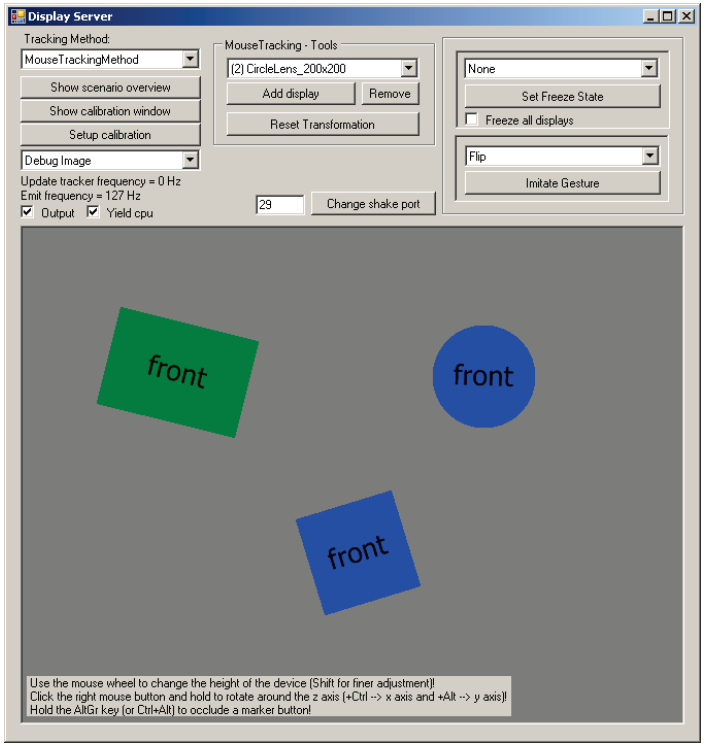



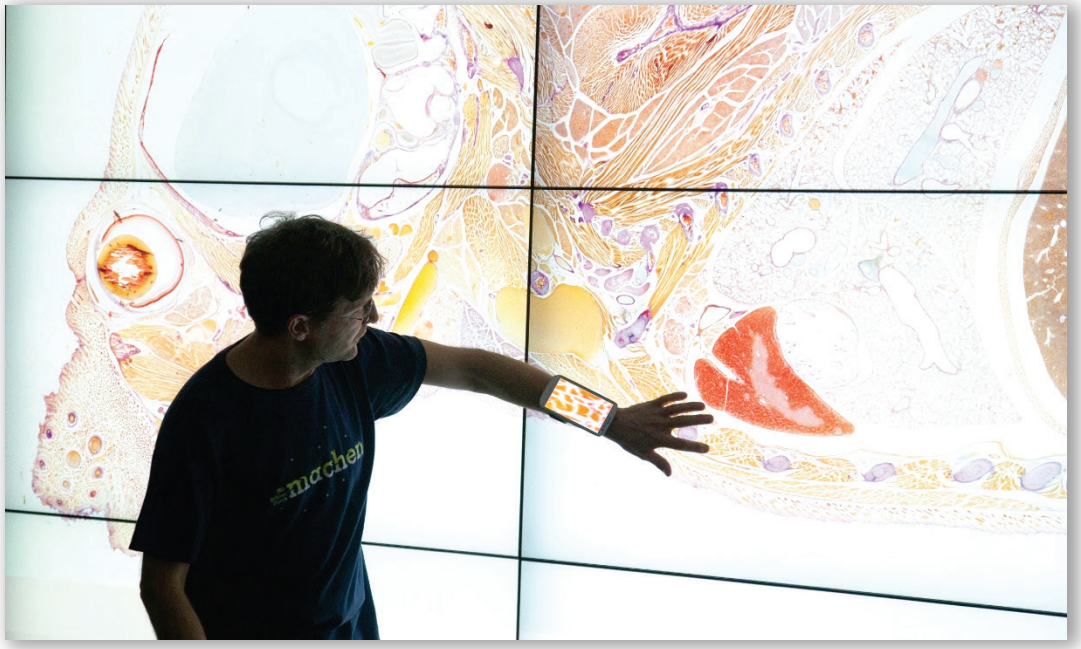


# Technische Umsetzung

- Client-/ Server-Modell
  - VRPN (Lage/Orientierung von Linsen)
  - XML-RPC (Remote Procedure Calls)
- Eigener Lens-Server
  - Tracking von Multiplen Linsen
  - Gesten-Erkennung
  - Stift-Interaktion mit Anoto
  - Offline-Unterstützung (Mausemulation)
- Client:
  - C#, C++
  - OpenGL (Texturen, FBO)
  - Qt für GUIs



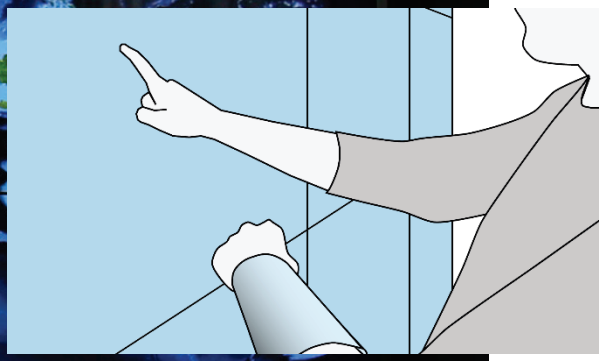


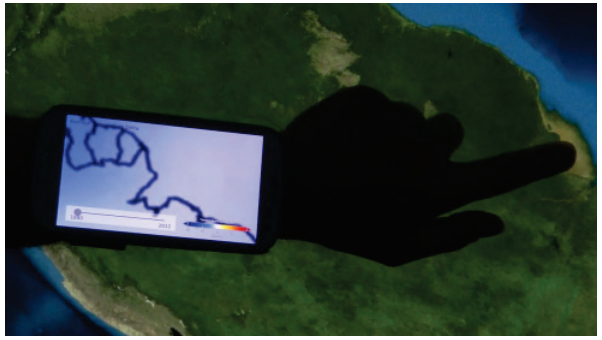
# 4. Lenses in Multi-Display Environments

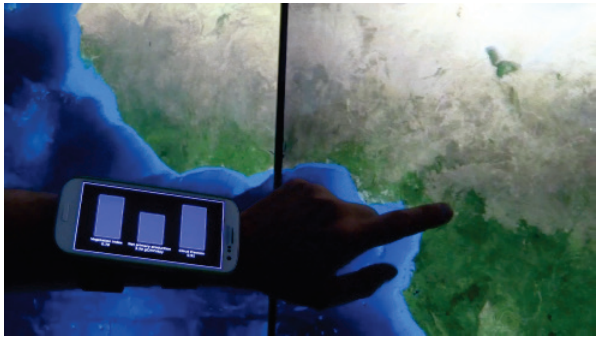
# Sleed: Using a Sleeve Display for Distant Data Exploration

[von Zadow et al. ITS'14]

# SleeD Example: Explorative Map Lenses [von Zadow et al. ITS'14]



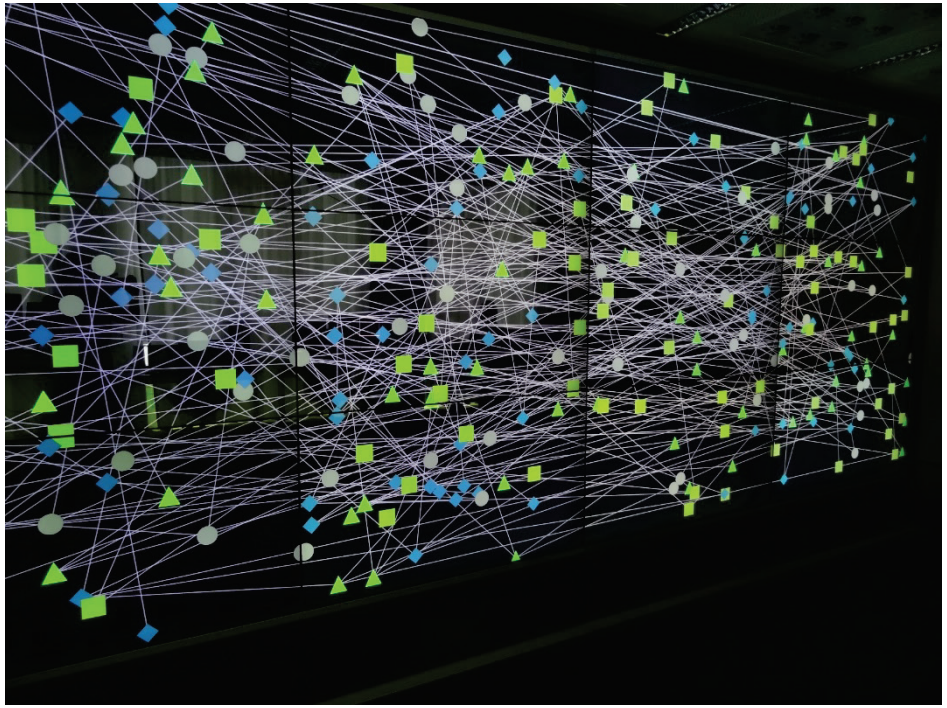




# 5. Full Body Interaction (BodyLenses)

# Motivation (among others): Supporting Large Graph Analysis

- Interaction at large display walls
  - Contact-based, direct interactions: multitouch, pen, tangible



  - Physical Navigation in front of the display
  - Proxemic Dimensions:
    - Distance
    - Orientation
    - Movement
    - Identity
    - Location

[Greenberg et al. 2011]

# Transforming Magic Lenses to Embodied, Personal Territories

- BodyLenses [Kister et al. ITS'15]
  - Personal, body-controlled magic lenses on vertical displays

# Transforming Magic Lenses to Embodied, Personal Territories

- BodyLenses
  - Design Space
    - Appearance & Shapes
    - Mapping User – Lens
    - Lens Function
    - Multi-User Aspects
  - Various Application Cases

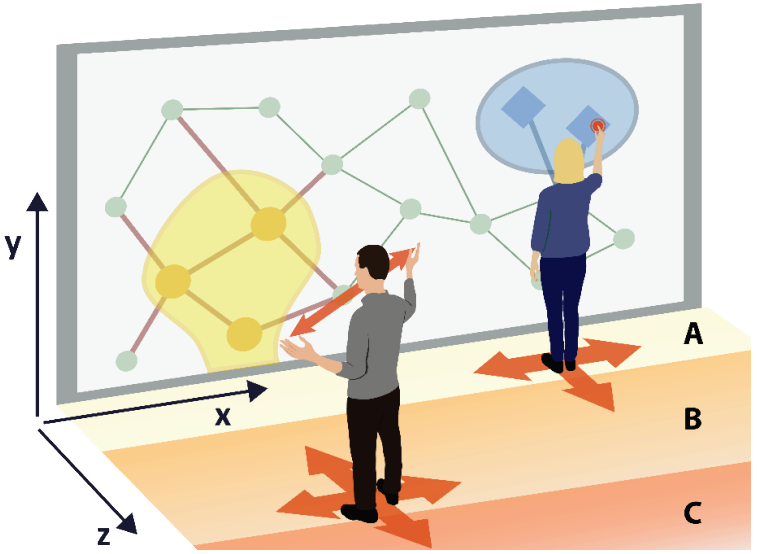



Image Analysis

Graph Explorer

Mind-Mapping

[Kister, U., Reipschläger, P., Matulic, P., and Dachselt, R. 2015.
*BodyLenses – Embodied Magic Lenses and Personal Territories.* In Proc. ITS '15. ACM]

# Herausforderungen

- Grand Challenges
  - Tracking of input in environments rich of sensoric stimuli
  - Gesture recognition
  - Gesture disambiguation (from each other)
  - What IS an input? (start, end, meaningless gestures, Midas)
  - Recognition vs. recall
  - Combination of modalities (alternatively, adaption, synergy)
  - Efficiency of “natural” interaction → care for magic AND efficiency
  - How to evaluate ubiquitous user interfaces
  - Appropriateness in particular situations
  - Social acceptance and implications
  - …

# A Research Perspective on Multiple (Interactive) Displays

## 1. Working on interactive surfaces

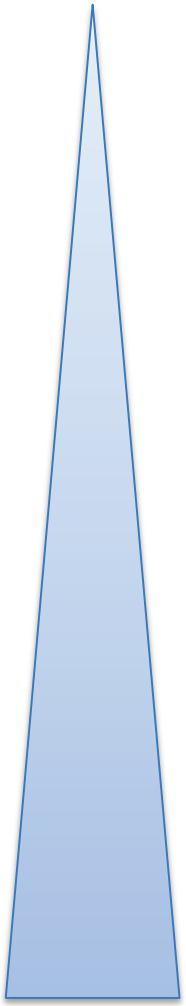
- Gestures, bimanual interaction, pen+touch, tangibles
- *Narrow interaction space for multiple people*

## 2. Interaction space in front/above large surfaces

- **Output = Input Space,** multiple private displays
- Tangible Magic Lenses/Views/Windows, gestures, pen+touch, head-coupled perspective
- *Good collaborative interaction for multiple people*

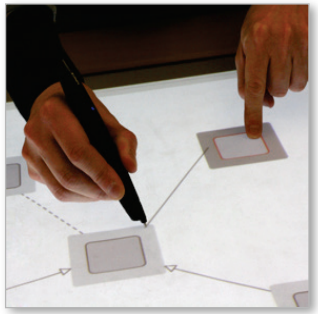
## 3. Interaction with distant displays

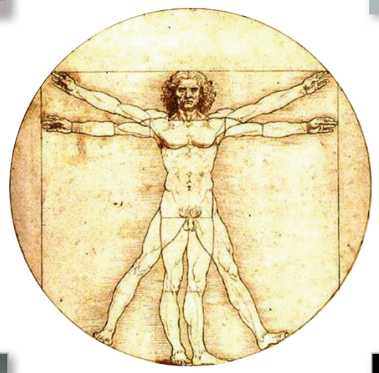
- Free hand gestures, phone gestures, pen & paper, Gaze-supported Interaction, tangibles
- *Need better understanding about collaborative work*

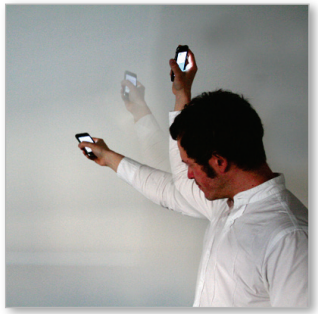


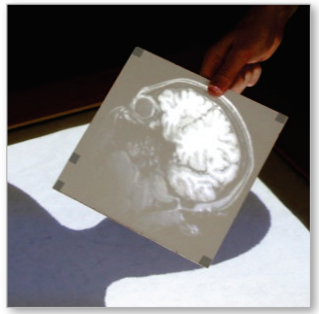
→ Rich multi-display, multimodal interface continuum

# Contact Raimund Dachselt: dachselt@acm.org









TECHNISCHE UNIVERSITÄT DRESDEN

# Important Publications

- M. Spindler, W. Büschel, R. Dachselt. Use Your Head: Tangible Windows for 3D Information Spaces in a Tabletop Environment. In Proc. of the ACM Conference on Interactive Tabletops and Surfaces, 2012.
- S. Stellmach and R. Dachselt. 2012. Look & touch: gaze-supported target acquisition. In Proc. of ACM CHI '12. ACM, New York, NY, USA, 2981-2990 (Best Paper Honorable Mention).
- B. Preim und R. Dachselt. Book „Interaktive Systeme - Band 1: Grundlagen, Graphical User Interfaces, Informationsvisualisierung“. Springer Verlag, 628 pages, 2010.


- M. Frisch und R. Dachselt. Off-Screen Visualization Techniques for Class Diagrams. In Proc. of ACM Software Visualization, pp. 163–172, 2010 (ACM Distinguished Paper Award).
- M. Spindler, C. Tominski, H. Schumann, and R. Dachselt. 2010. Tangible views for information visualization. In ACM Intern. Conference on Interactive Tabletops and Surfaces (ITS '10). ACM, New York, NY, USA, 157-166.
- M. Spindler, S. Stellmach, und R. Dachselt. PaperLens: Advanced Magic Lens Interaction Above the Tabletop. In Proc. of the ACM Intern. Conference on Interactive Tabletops and Surfaces, S. 77–84. 2009.
- M. Frisch, J. Heydekorn, und R. Dachselt. Investigating Multi-Touch and Pen Gestures for Diagram Editing on Interactive Surfaces. In Proc. of the ACM Conference on Interactive Tabletops and Surfaces, S. 167–174. 2009.
- R. Dachselt and R. Buchholz. 2009. Natural throw and tilt interaction between mobile phones and distant displays. In Proc. ACM CHI EA '09. ACM, New York, NY, USA, 3253-3258.
- R. Dachselt, M. Frisch, and M. Weiland. 2008. FacetZoom: A Continuous Multi-scale Widget for Navigating Hierarchical Metadata. In Proc. ACM CHI '08. ACM, New York, NY, USA, 1353-1356.
- R. Dachselt und A. Hübner. Three-dimensional Menus: A Survey and Taxonomy. Computers & Graphics, 31(1): S. 53 – 65, 2007.
- R. Dachselt, M. Hinz, and K. Meißner. 2002. Contigra: an XML-based architecture for component-oriented 3D applications. In Proc. ACM Web3D '02. ACM, New York, NY, USA, 155-163.

More: http://www.imld.de/Forschung/Publikationen/