Instrumental Interaction in Multisurface Environments

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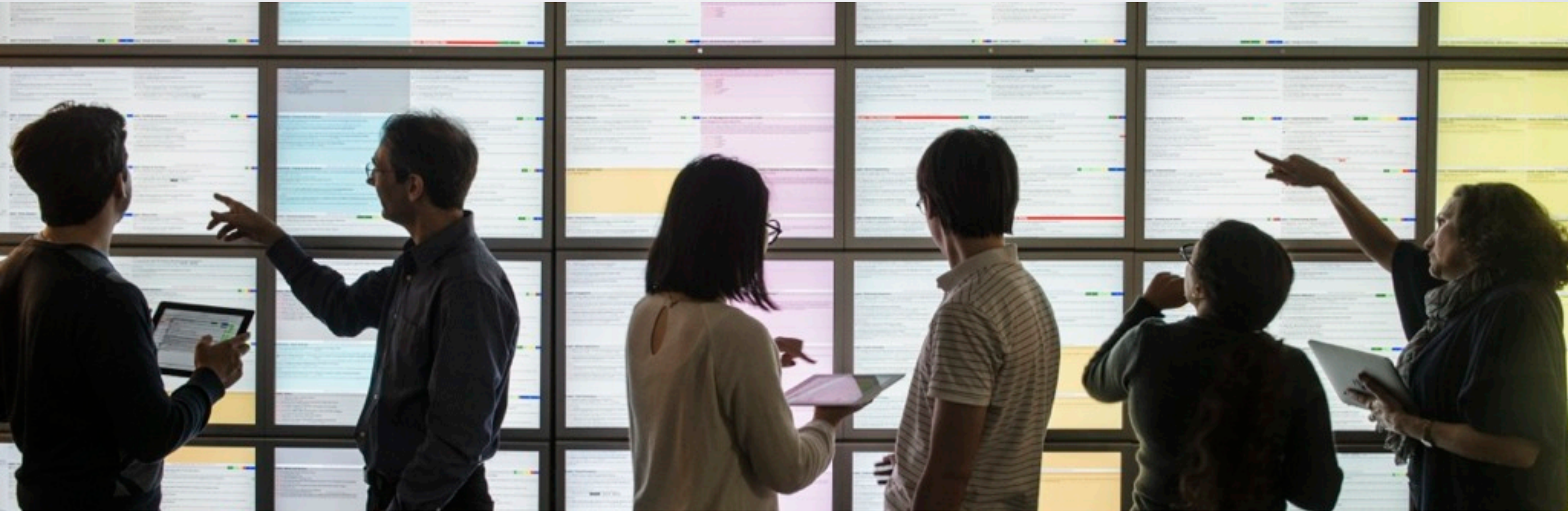
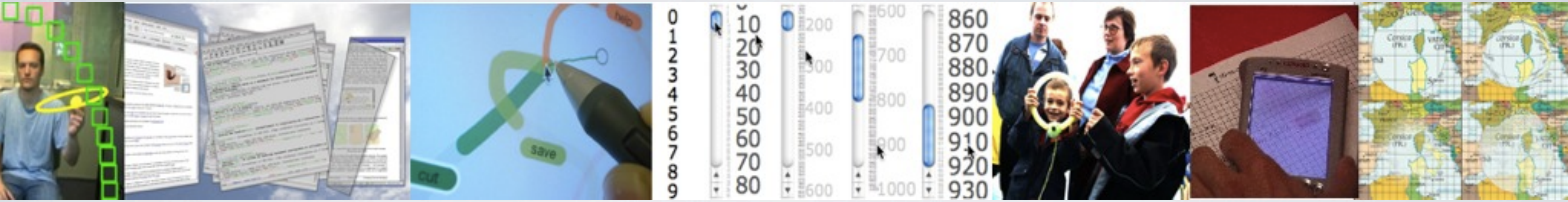
LMU München - 5 February 2014



In Situ - Situated Interaction

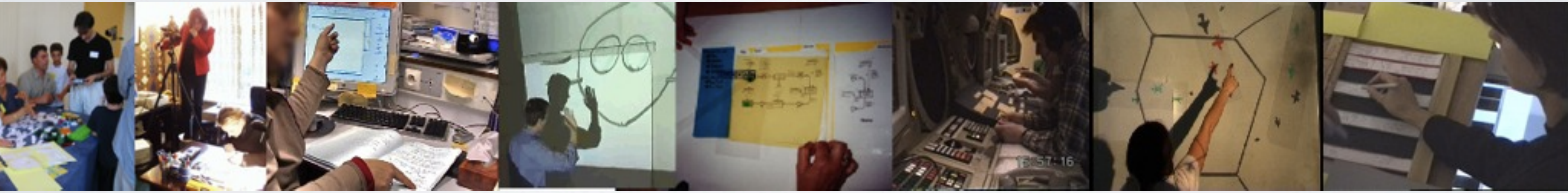
W. Mackay

Interaction and Visualization paradigms

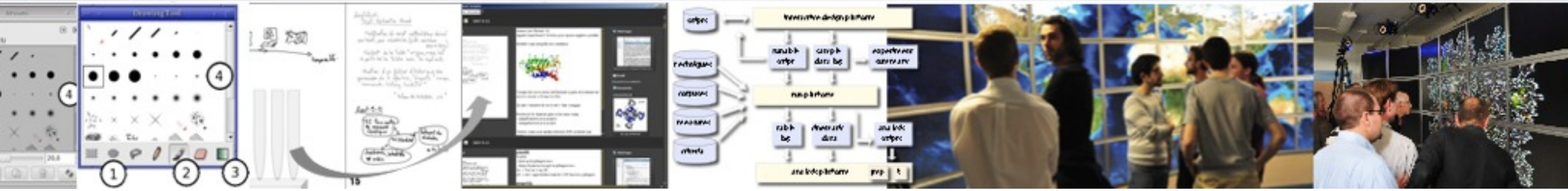


Mediated Communication

Participatory Design



Engineering of Interactive Systems



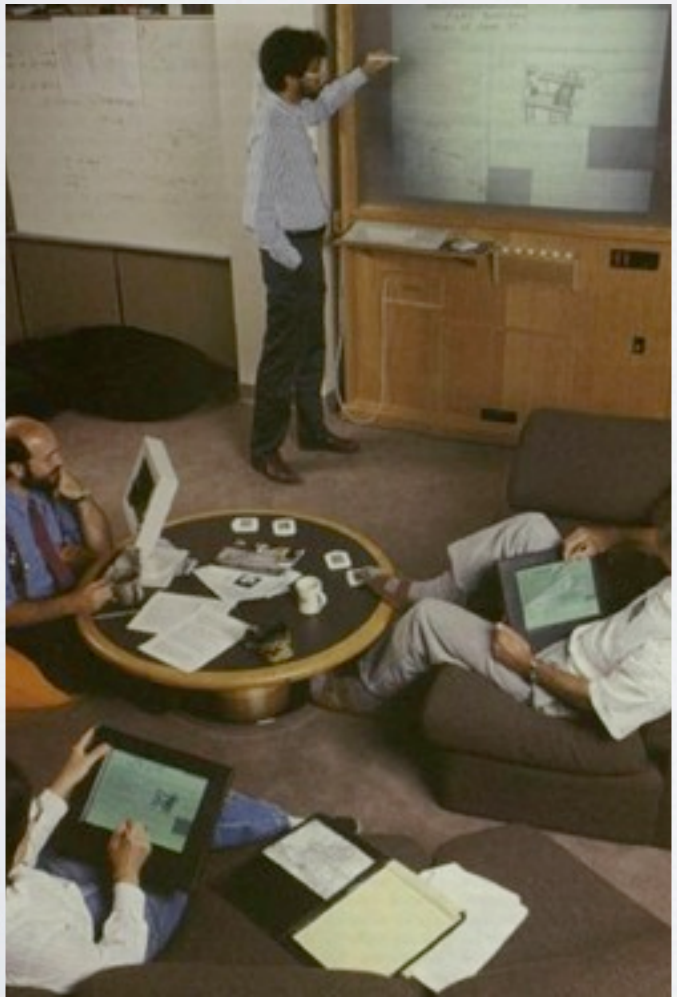
“The best way to predict the future is to invent it”
(attributed to Alan Kay)

NLS/Augment
1967

Xerox Alto
1973

What happened to the future promised by Ubicomp?

- “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are undistinguishable from it.” - Mark Weiser

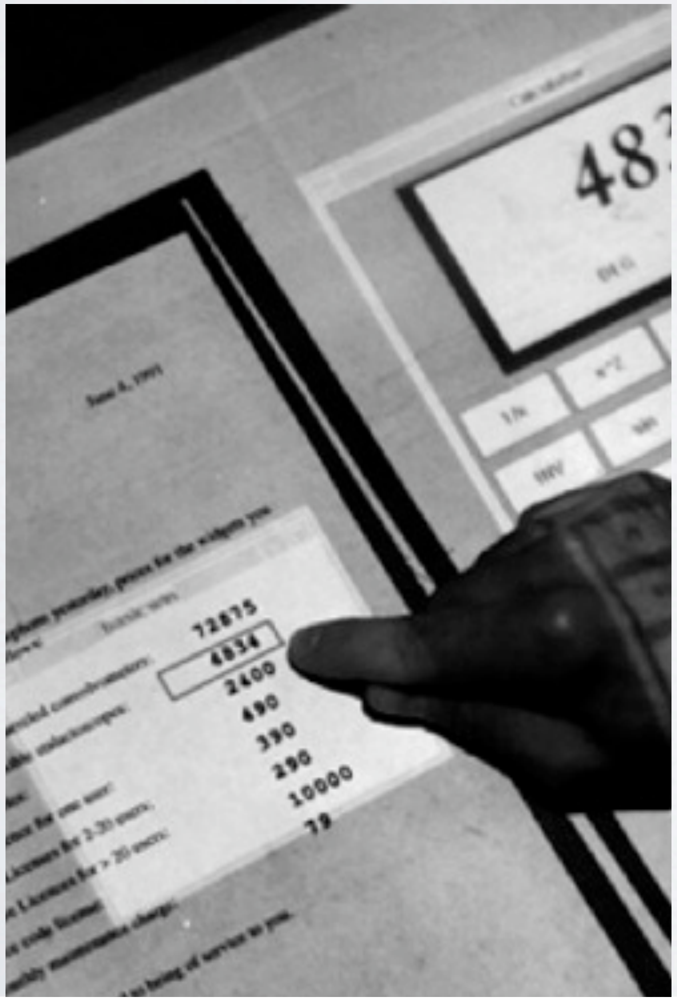


Weiser, 1991

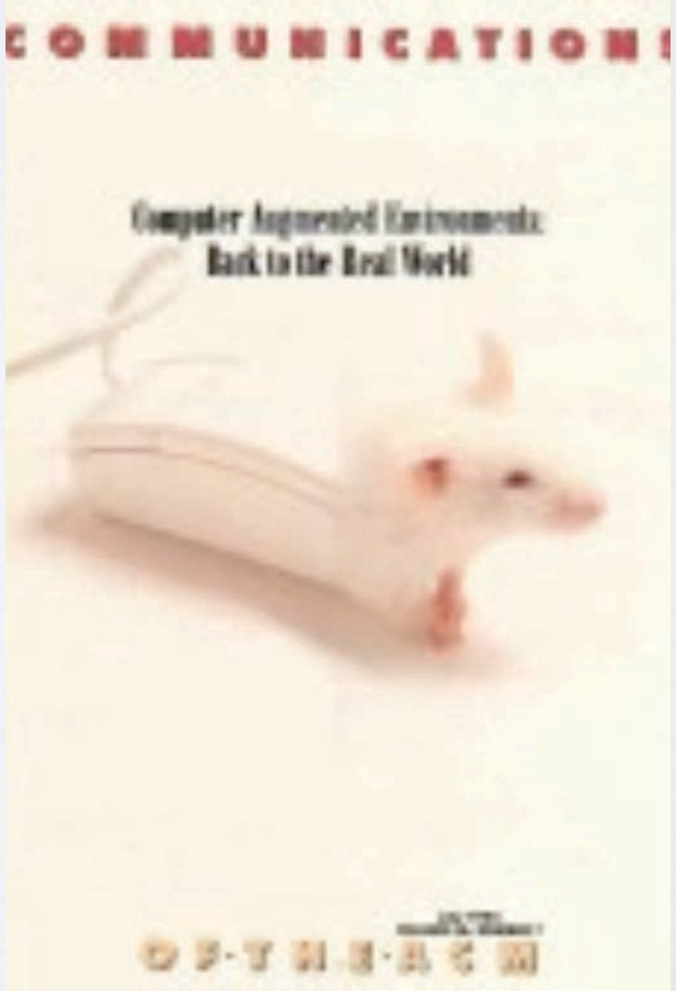
Rekimoto, 1997

What happened to the future promised by Augmented Reality?

- “From the isolation of our workstations we try to interact with our surrounding environment, but the two worlds have little in common. How can we escape from the computer screen and bring these two worlds together?” - Wellner, Mackay & Gold



Wellner, 1991



Wellner, Mackay & Gold, CACM’93

What happened to the future promised by Tangible Interfaces?

- “The term Graspable UI refers to both the ability to physically grasp an object (i.e., placing a hand on an object) as well as conceptual grasping (i.e., to take hold of intellectually or to comprehend)” - George Fitzmaurice

Fitzmaurice, 1995

Reactable, 2005

The missing link

- Between
  the interaction paradigm,
  illustrated by some prototypes,

  and

  the principled design
  of effective interfaces
  based on the paradigm

We need

new Interaction Models

and associated tools
to reinvent user interfaces
based on these paradigms

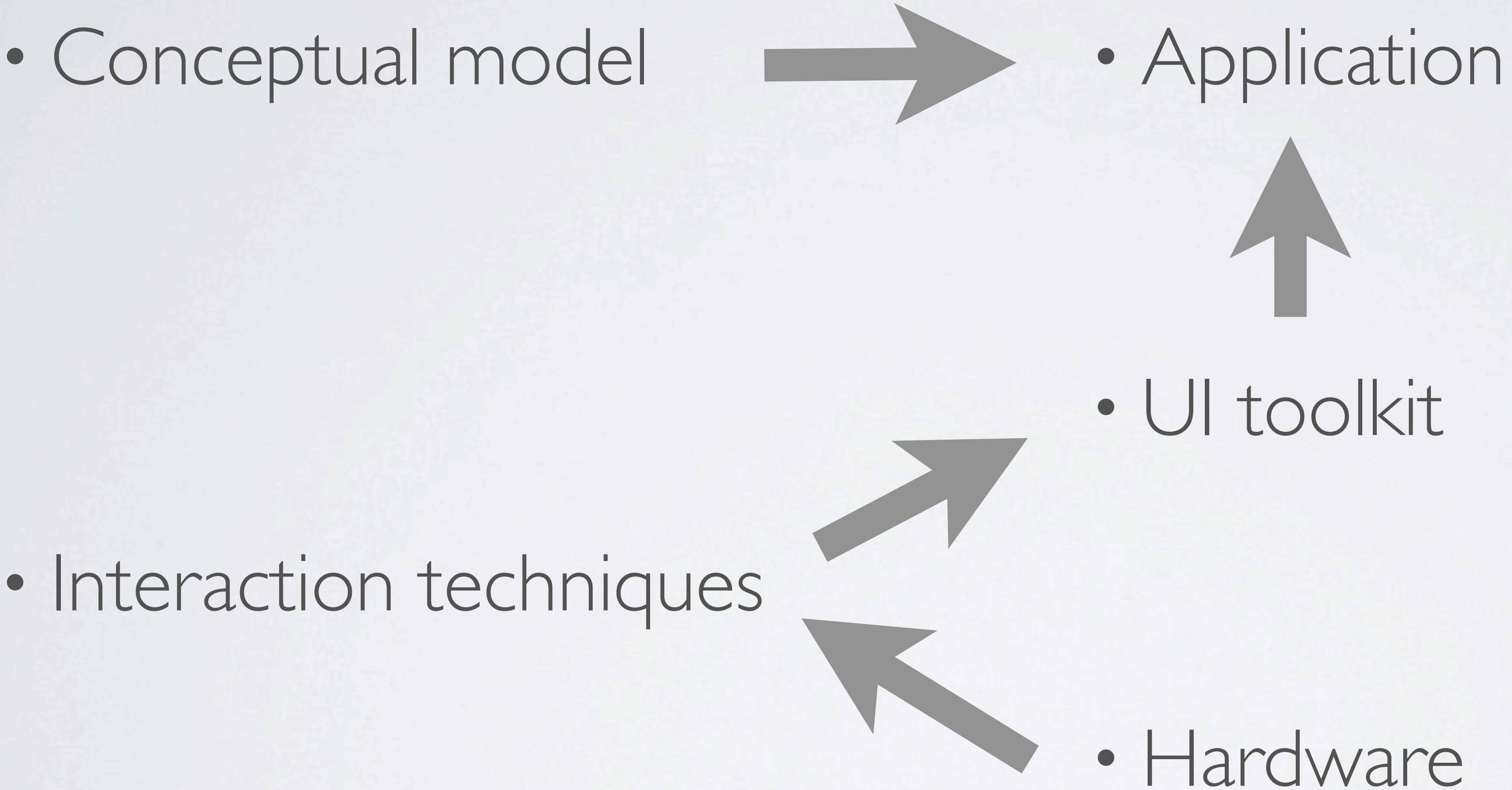
What is an Interaction Model?

- A set of rules and guidelines to help create consistent interactive systems according to a certain style
  - **Descriptive**: define the scope of the design space
  - **Prescriptive**: provide criteria to compare designs
  - **Generative**: support creativity and inspire new designs

Examples of Interaction Models

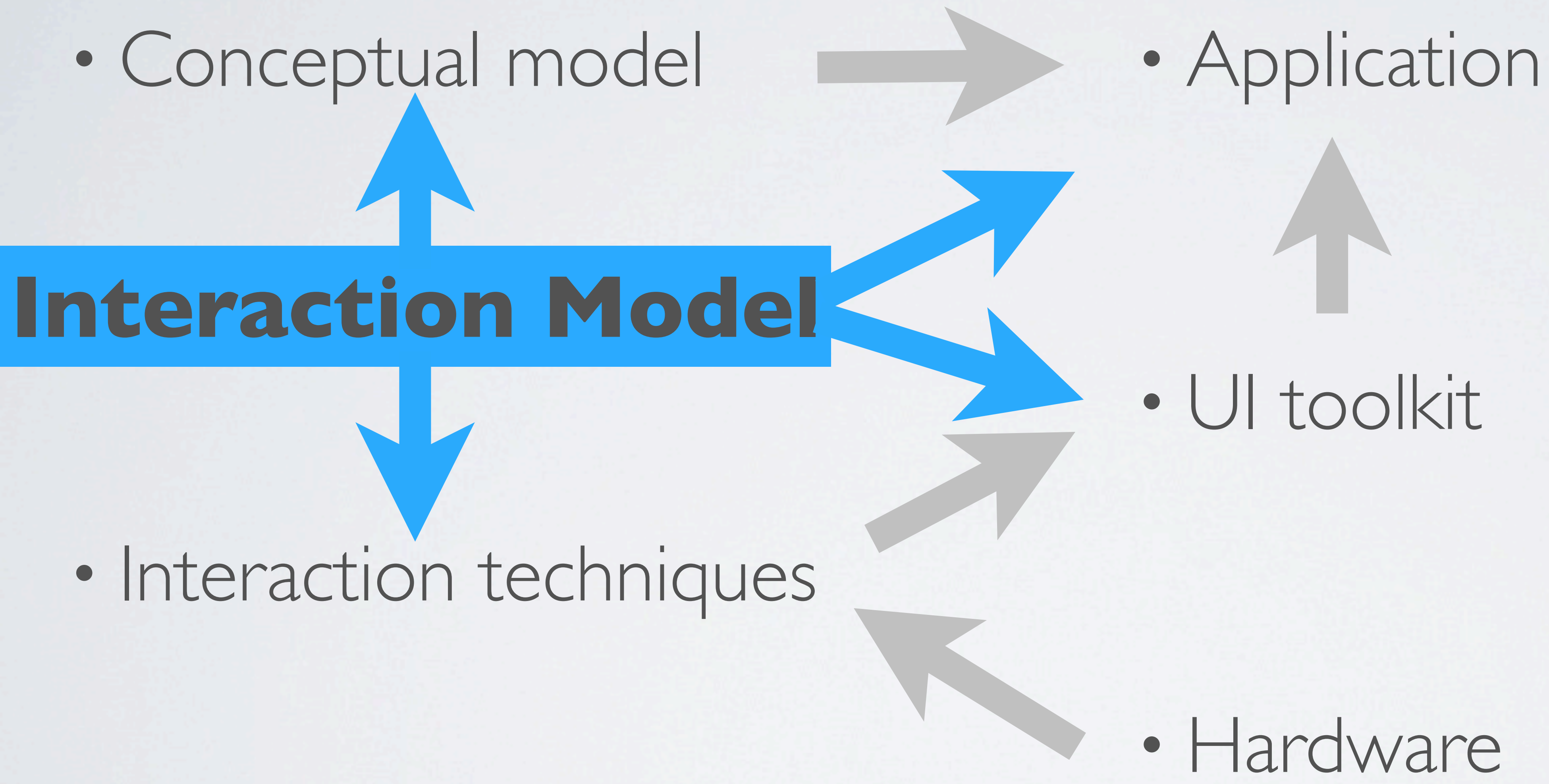
- CLI: dialogue - language - syntax
- GUI: direct manipulation - desktop metaphor
- Augmented Reality / Mixed Reality / Virtual Reality / Tangible interface / Ubiquitous Computing / Natural User Interfaces / Reality-Based Interfaces / ...

Interaction Model



- Conceptual model
- Application
- UI toolkit
- Interaction techniques
- Hardware

Interaction Model

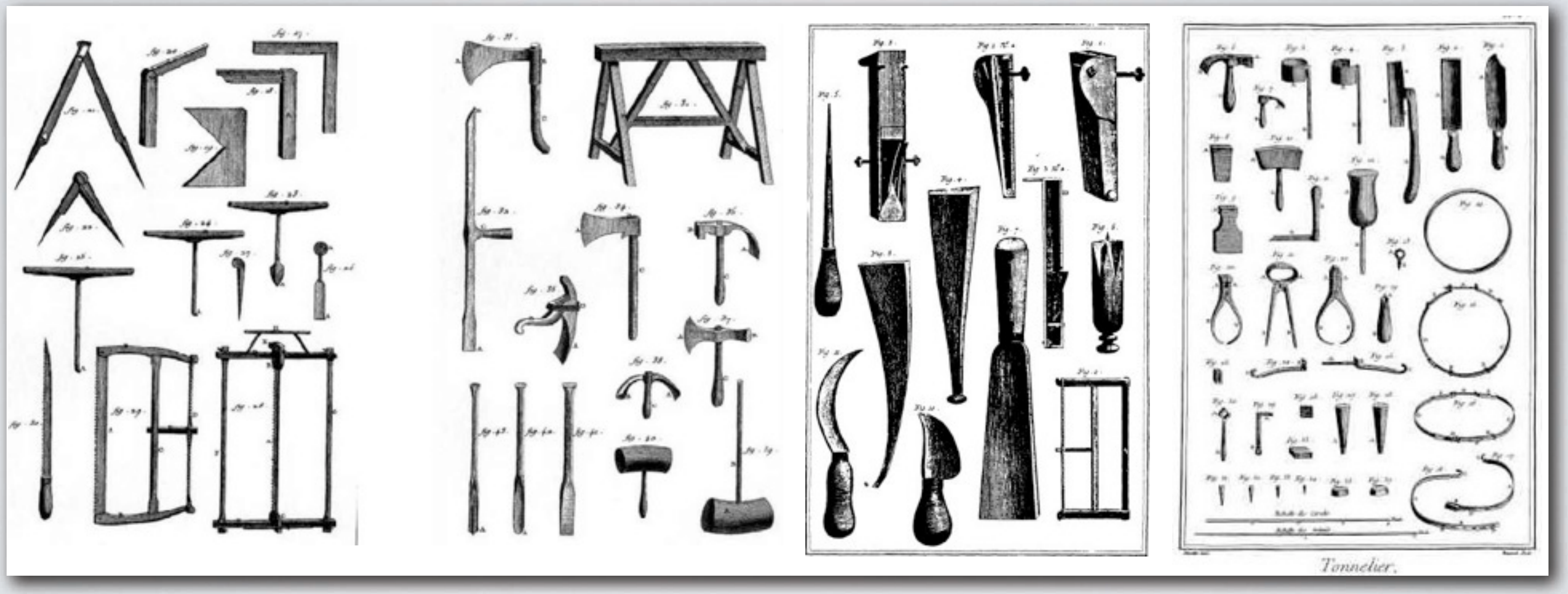


- Conceptual model
- Application

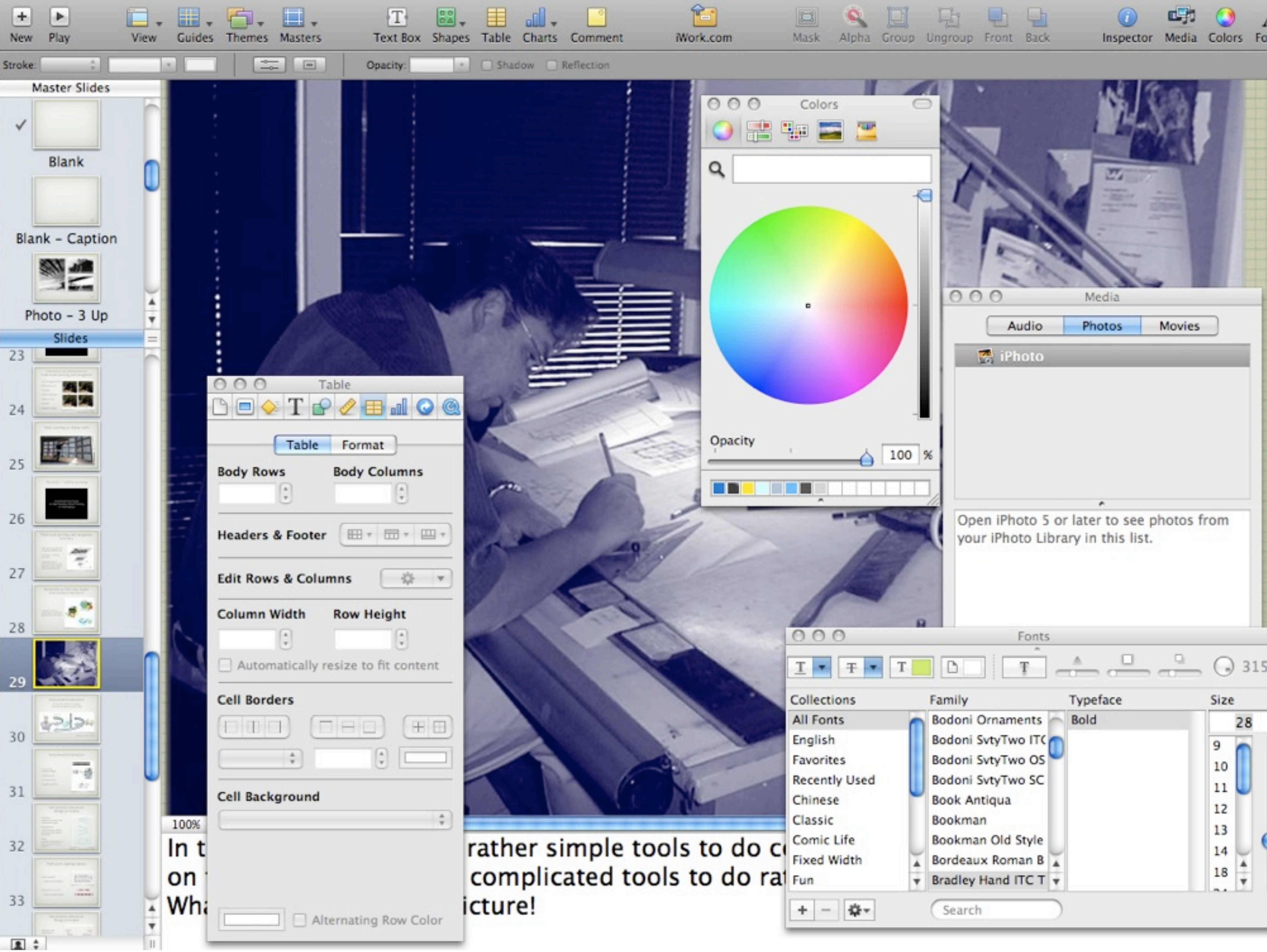
Interaction Model

- UI toolkit
- Interaction techniques
- Hardware

Tools and Instruments



L’encyclopédie - Diderot & d’Alembert, 1751-1772



Open iPhoto 5 or later to see photos from your iPhoto Library in this list.

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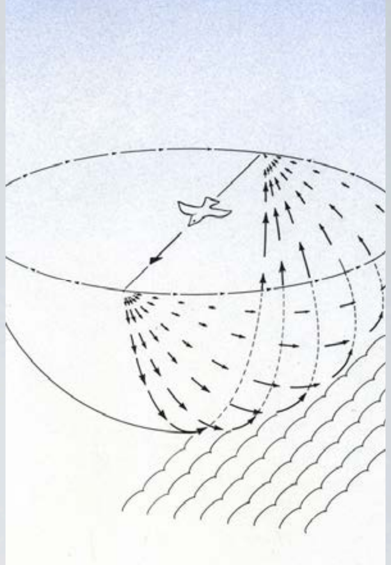
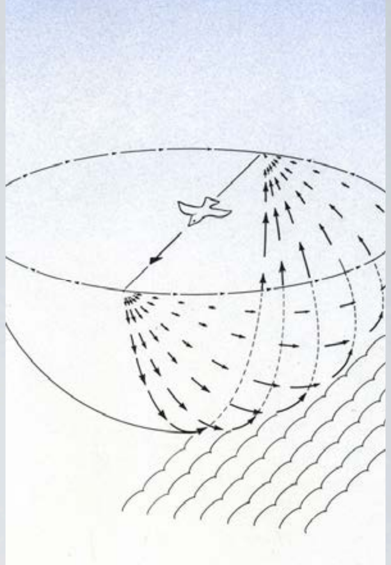
on complicated tools to do ra
Wha icture!

The power of tools



- Gibson's Ecological Theory:
  - Affordances = possibilities for action in the environment relative to the capabilities of the subject
- Tools redefine the affordances of the environment because they change the capabilities of the subject

Gibson on tools



- “When in use, a tool is a sort of extension of the hand, almost an attachment to it or a part of the user's own body, and thus is no longer a part of the environment of the user. […]
  This *capacity to attach something to the body* […] suggests that the absolute duality of "objective" and "subjective" is false.” *(Gibson, emphasis by the author)*

- Affordances of objects that afford manipulation (i.e., tools): a stick affords trace-making in the sand.

The power of tools

- The user of a tool internalizes the tool as an extension of one's body

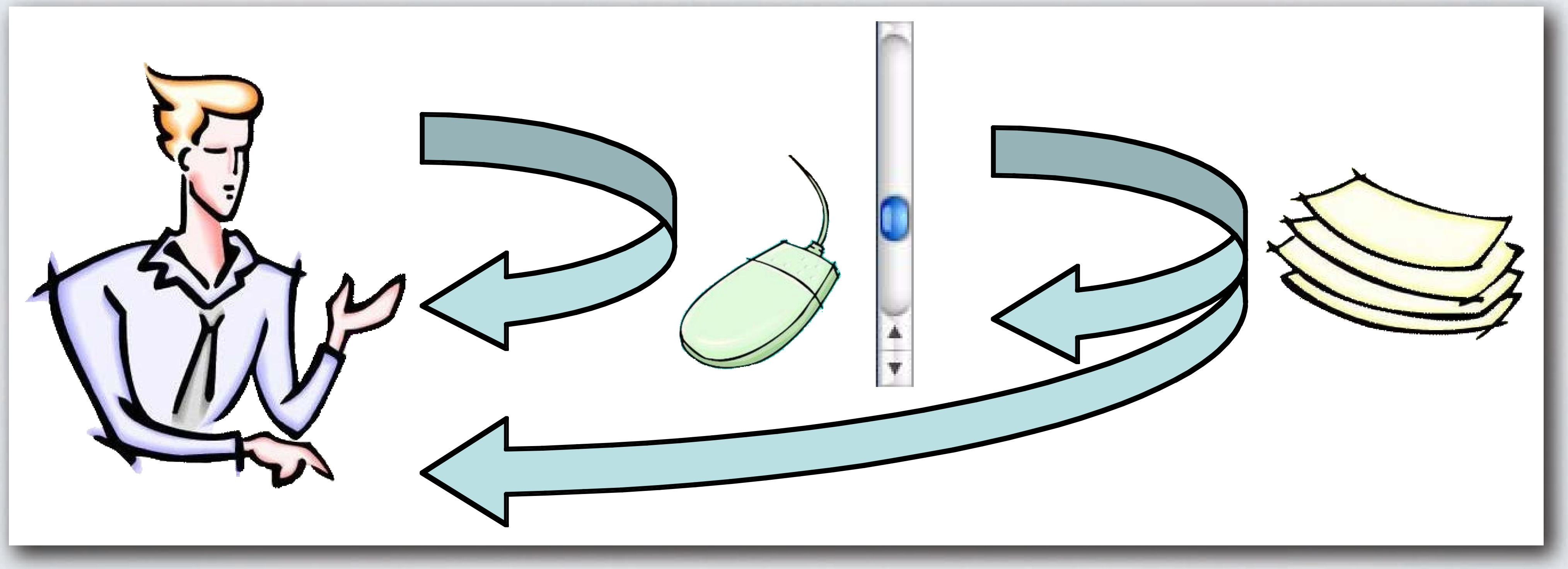
- A stick extends the reach of the arm

The power of tools

- Holding a pen raises awareness for the affordance for writability

Instrumental Interaction

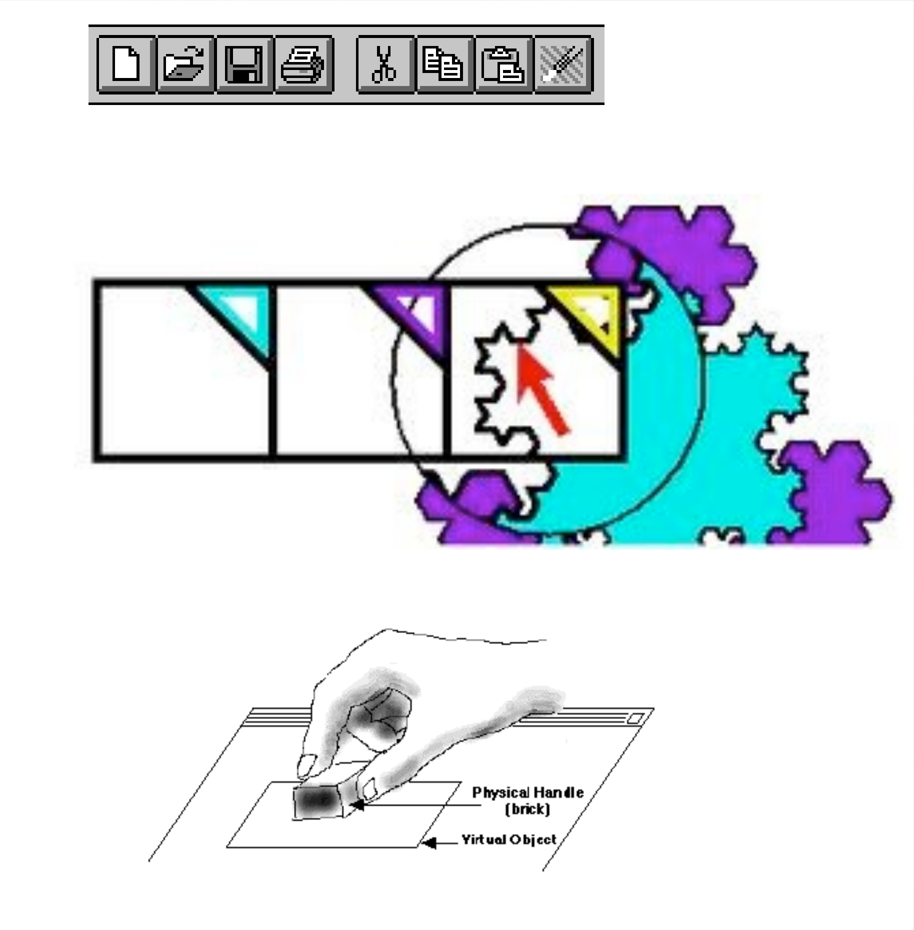
- Mediated interaction: user - instrument - object of interest
- An instrument **reifies** a command
- Use the same instrument with different objects (polymorphism)



Beaudouin-Lafon, CHI '00

Instrumental Interaction: descriptive

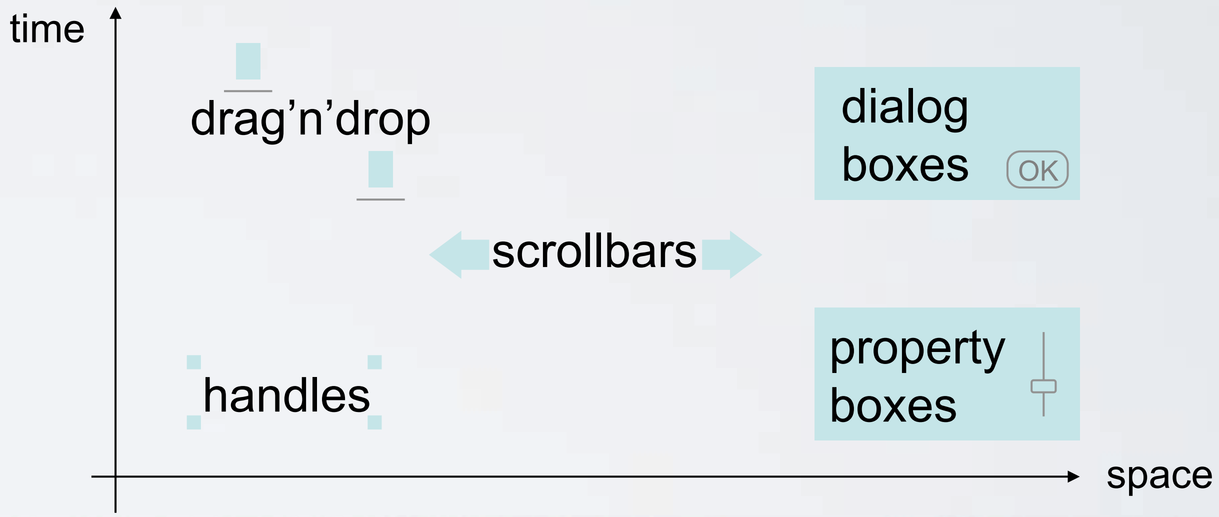
- Covers many interaction styles:
  - Traditional GUI
  - Novel techniques
  - Tangible interaction



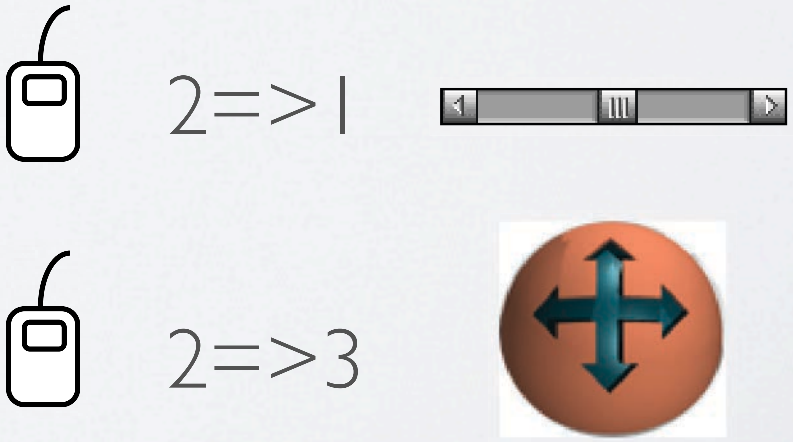
Instrumental Interaction: prescriptive

- Provides metrics to compare instruments, for example:

- Degree of indirection



- Degree of integration


2=>1

2=>3

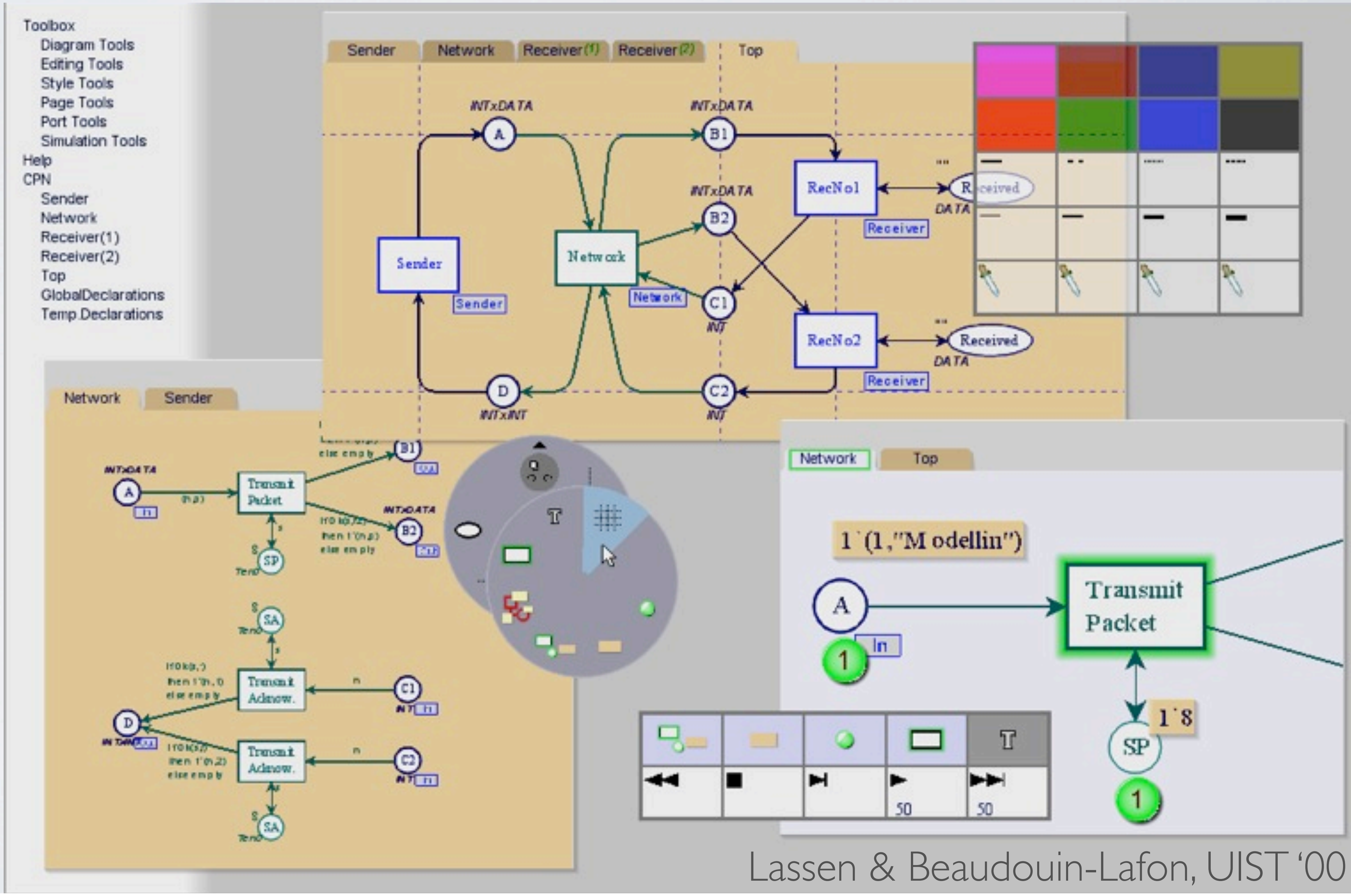
Instrumental Interaction: generative

- **3 design principles:**
- **Reification**: extends the notion of what constitutes an object
- **Polymorphism**: extends the power of instruments w.r.t. objects
- **Reuse**: provides a way of capturing and reusing interaction patterns

Beaudouin-Lafon & Mackay, AVI '00

Proof-of-concept: CPN2000

- Bi-manual interaction, Marking menus, Toolglasses
- Combines power and simplicity

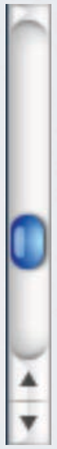


- 40 000+ downloads

Lassen & Beaudouin-Lafon, UIST '00

Reification

- Turns concepts into objects
- In particular, turns commands into instruments
- Interaction instrument
  - Example : scrolling a document => scrollbar
  - Reification of a command into an interface widget

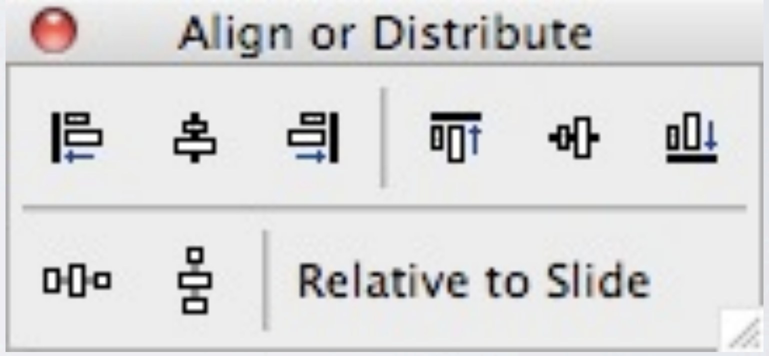


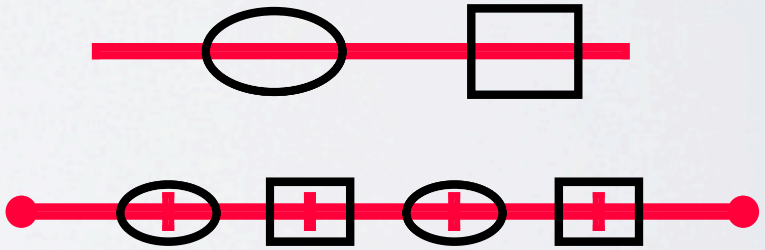
Example: aligning objects

- Align command:
  align now and forget it

  vs.

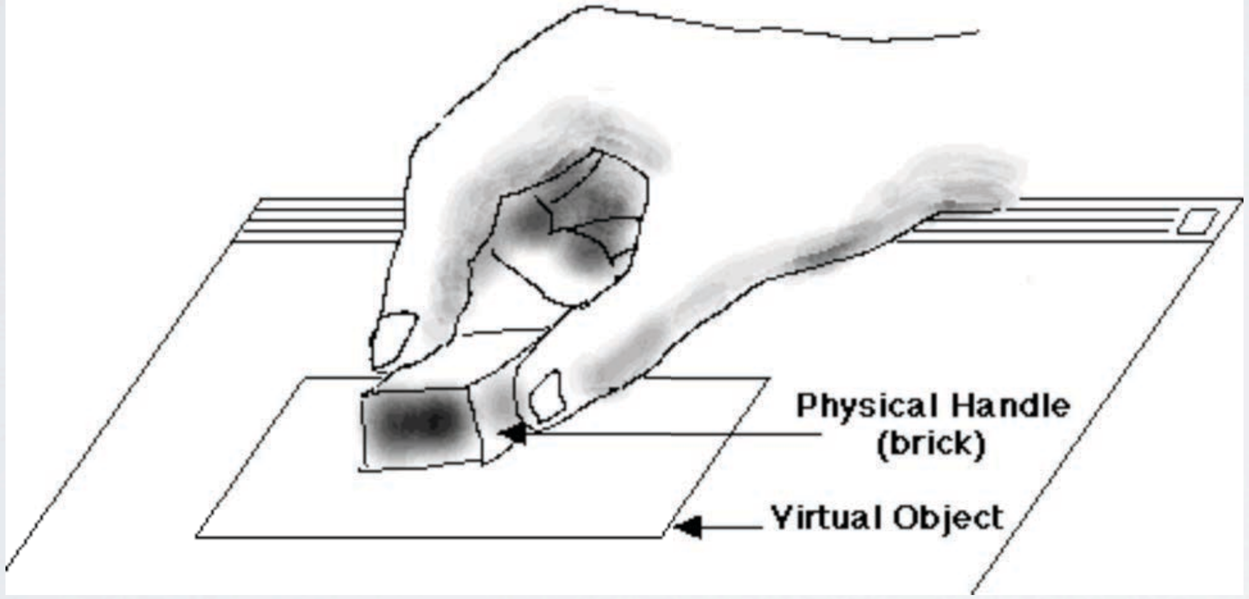
- Align instrument:
  align and keep aligned

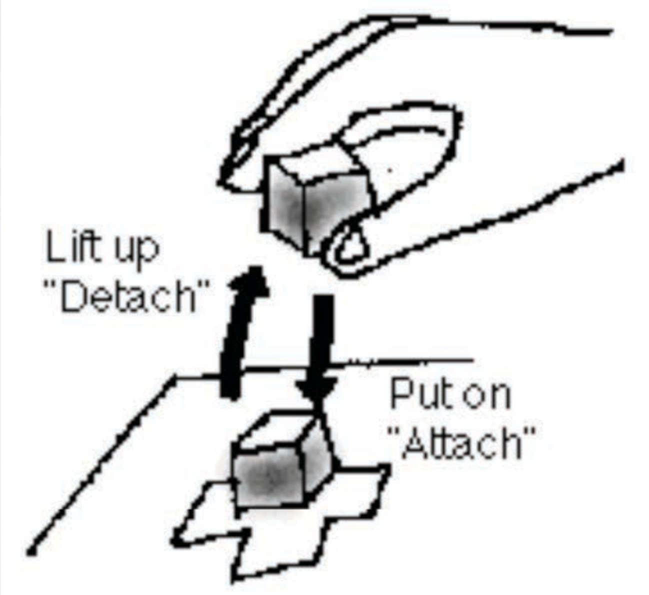


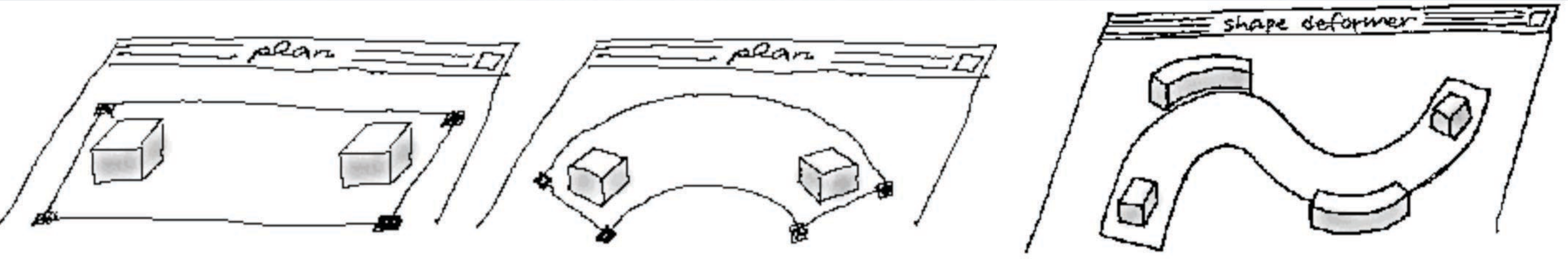


Example: Graspables

Fitzmaurice, 1995





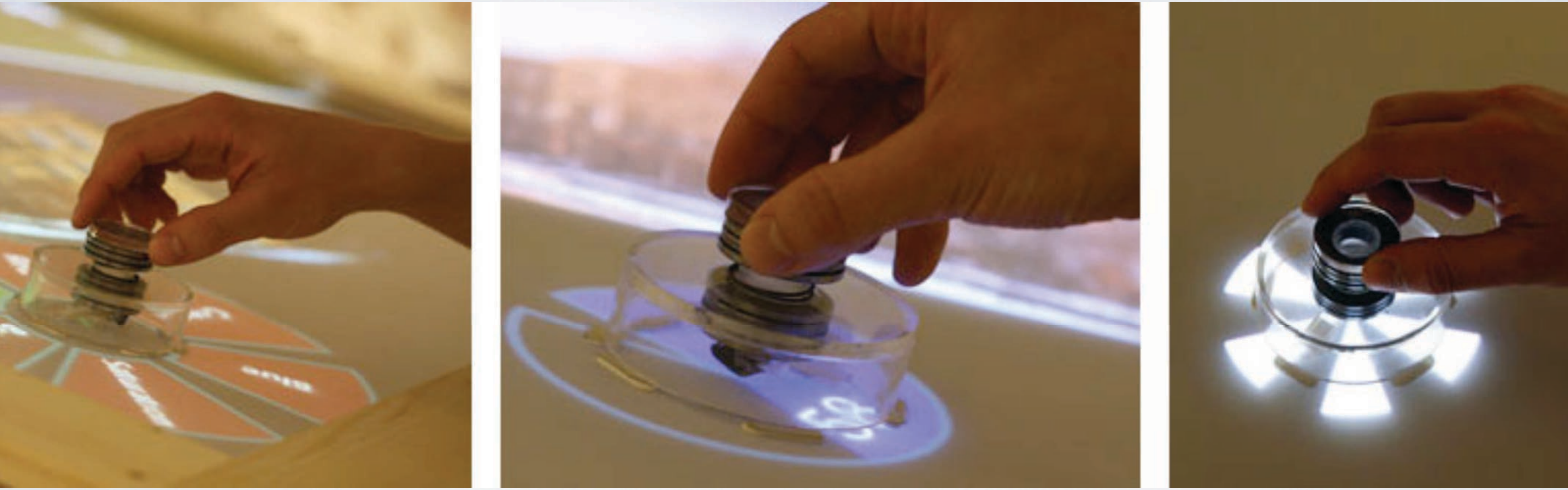


Polymorphism

- Extends commands to multiple object types
  - Common examples: Cut, paste, delete, move
- Instruments can be applied to many different objects
- Groups take advantage of polymorphism:
  Applying a command to a group applies it to each object

Example: Slap Widgets

Weiss, Wagner, Jansen & Borchers, 2009



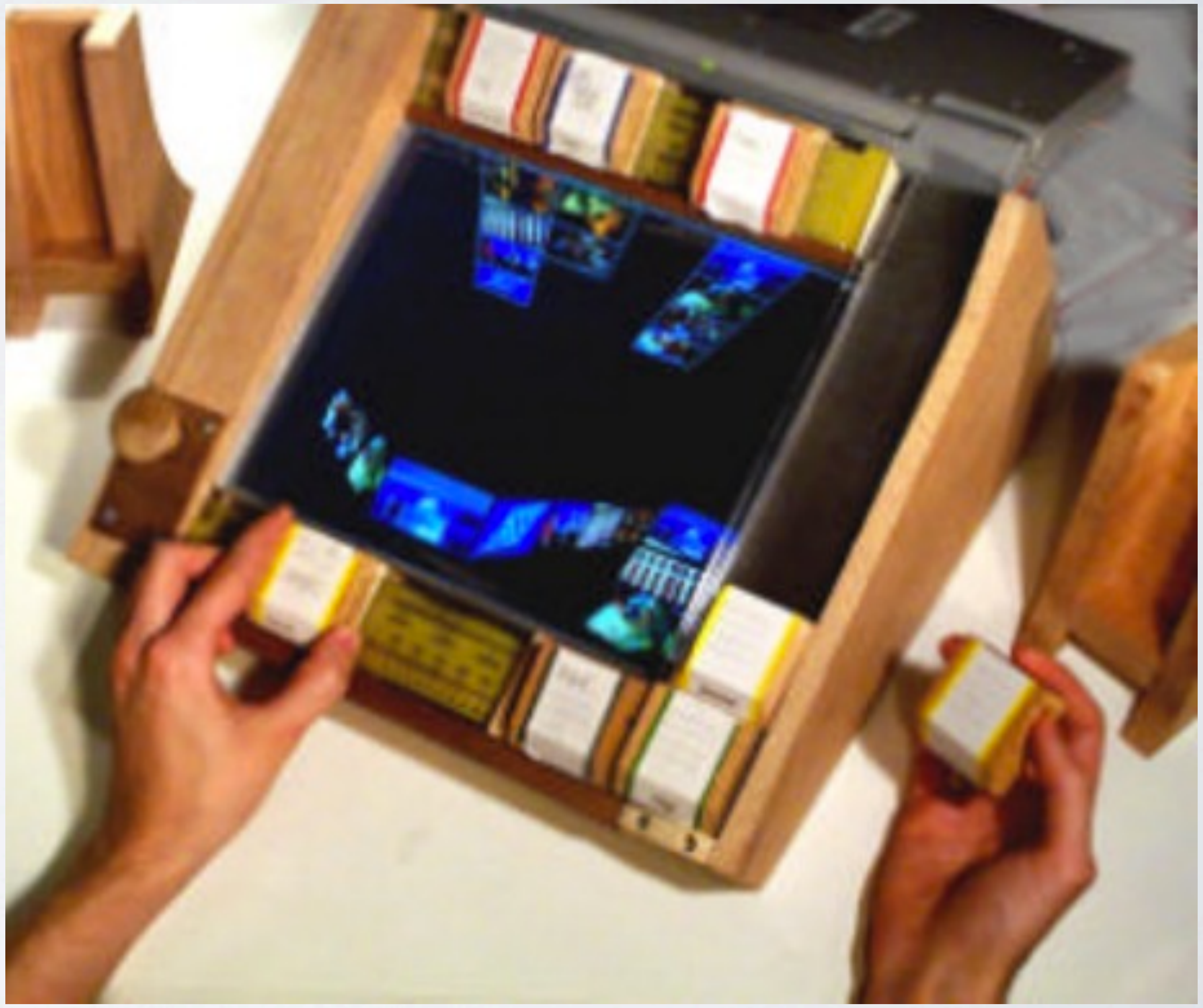
Reuse

- Captures interaction patterns for later reuse
- Output reuse
  - Reuse previously created objects
  - Example: duplicate, copy/paste
- Input reuse
  - Reuse previous commands
  - Example: redo, history, macros

Example: Media Blocks

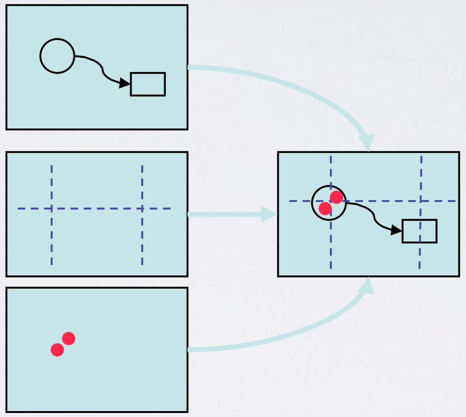
Ullmer, Glas & Ishii, 1998

- Limited form of output reuse: a block can change content
- Limited form of input reuse: replacing a block or changing its location

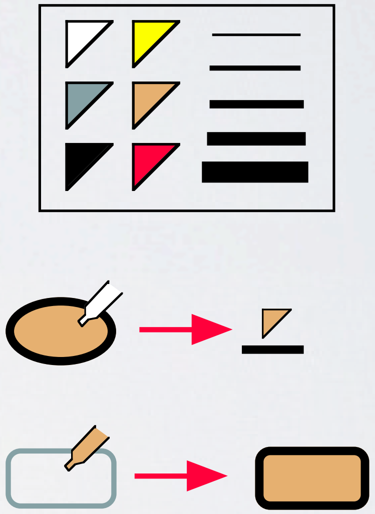


Combining the principles

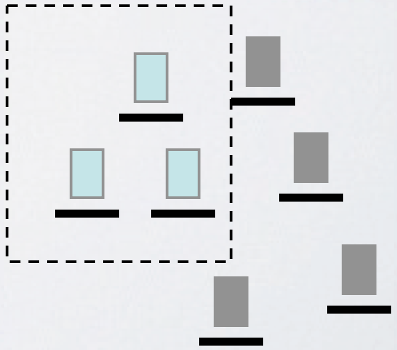
- **Layers**: Reify modes
  - Control visual complexity



- **Styles**: Reify collections of attributes
  - Support polymorphism, encourage reuse



- **Groups**: Reify selection
  - Support polymorphism



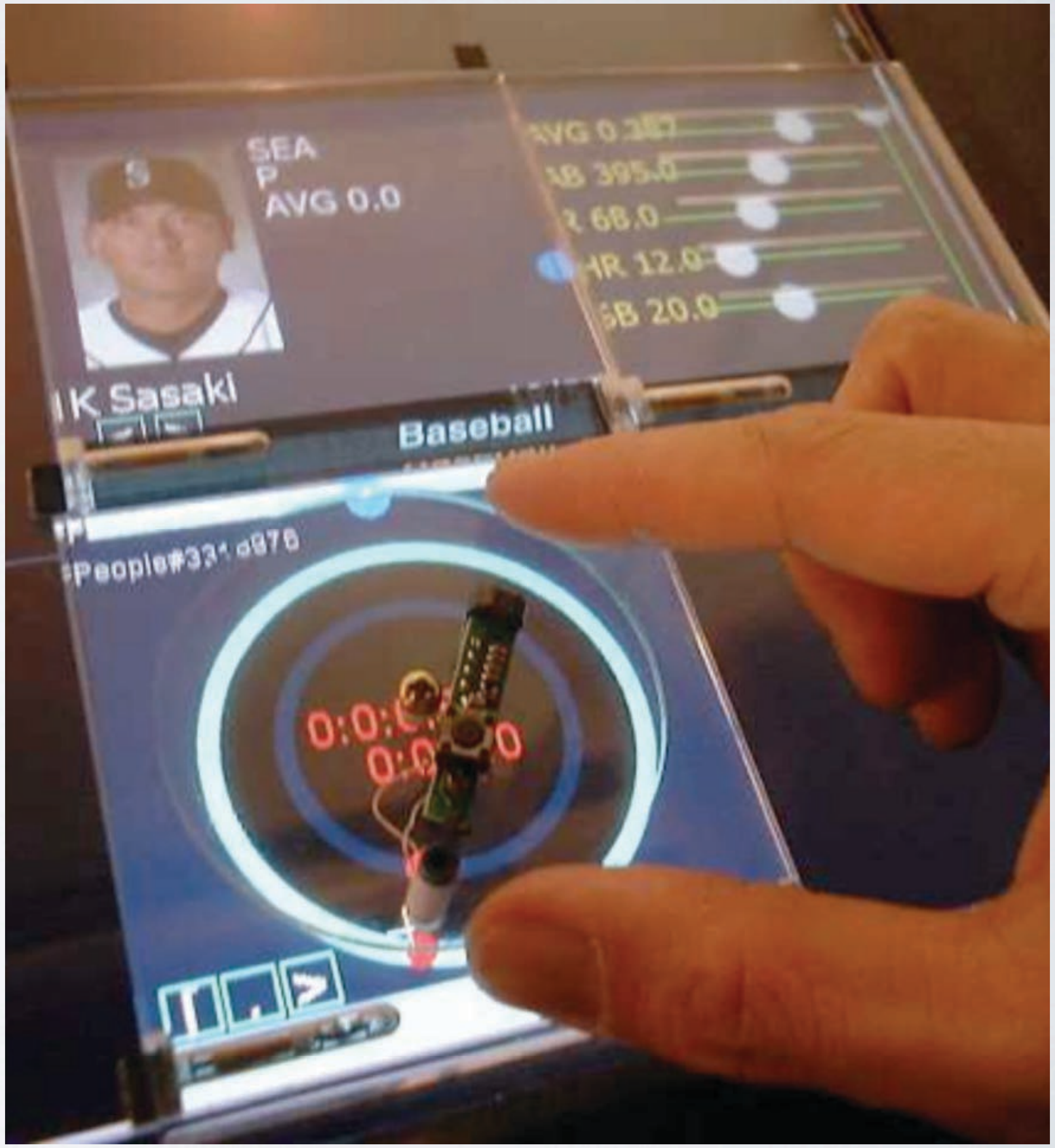
Example: DataTiles

Rekimoto, Ullmer & Oba, 2001

- Some tiles represent content, others are instruments: reification

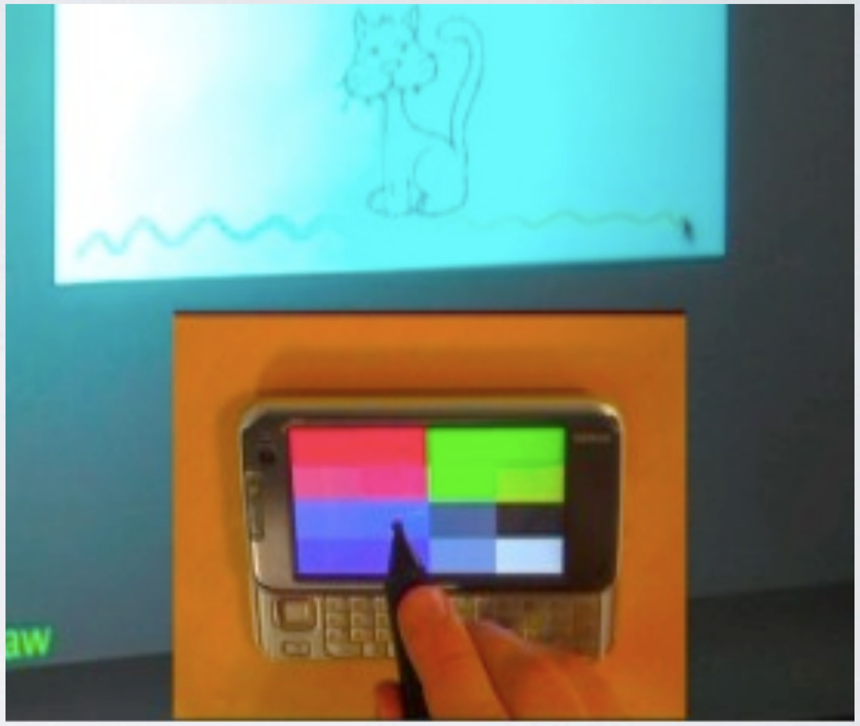
- Spatial combinations specify chains of computation: polymorphism of the tiles

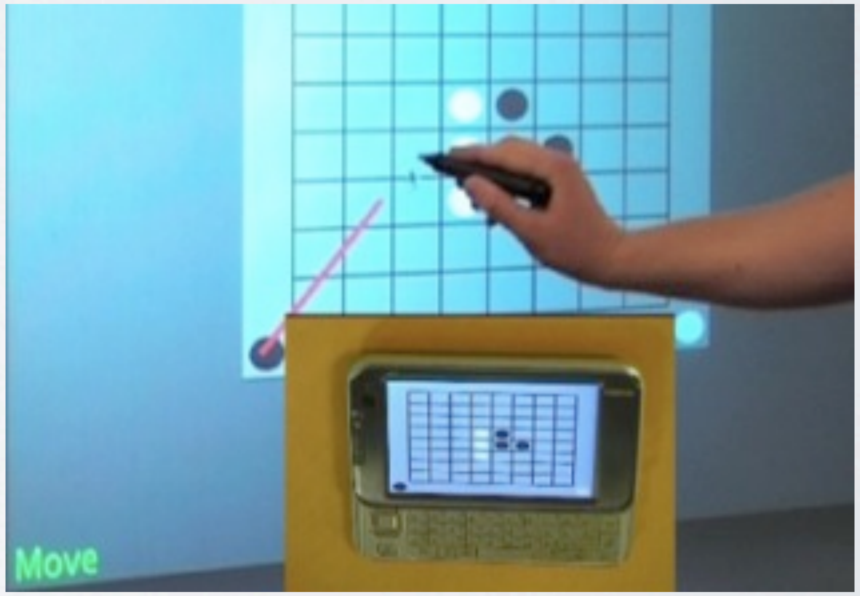
- Changing a tile in the chain reuses the chain: reuse



Ubiquitous Instrumental Interaction

- Detaching instruments from the objects of interest
  ... and from applications
- Instruments spanning multiple interaction surfaces
- **Multisurface interaction**





Klokmose & Beaudouin-Lafon, CHI ‘09

Multisurface Interaction in the WILD room

Video supplement

IEEE Computer, April 2012

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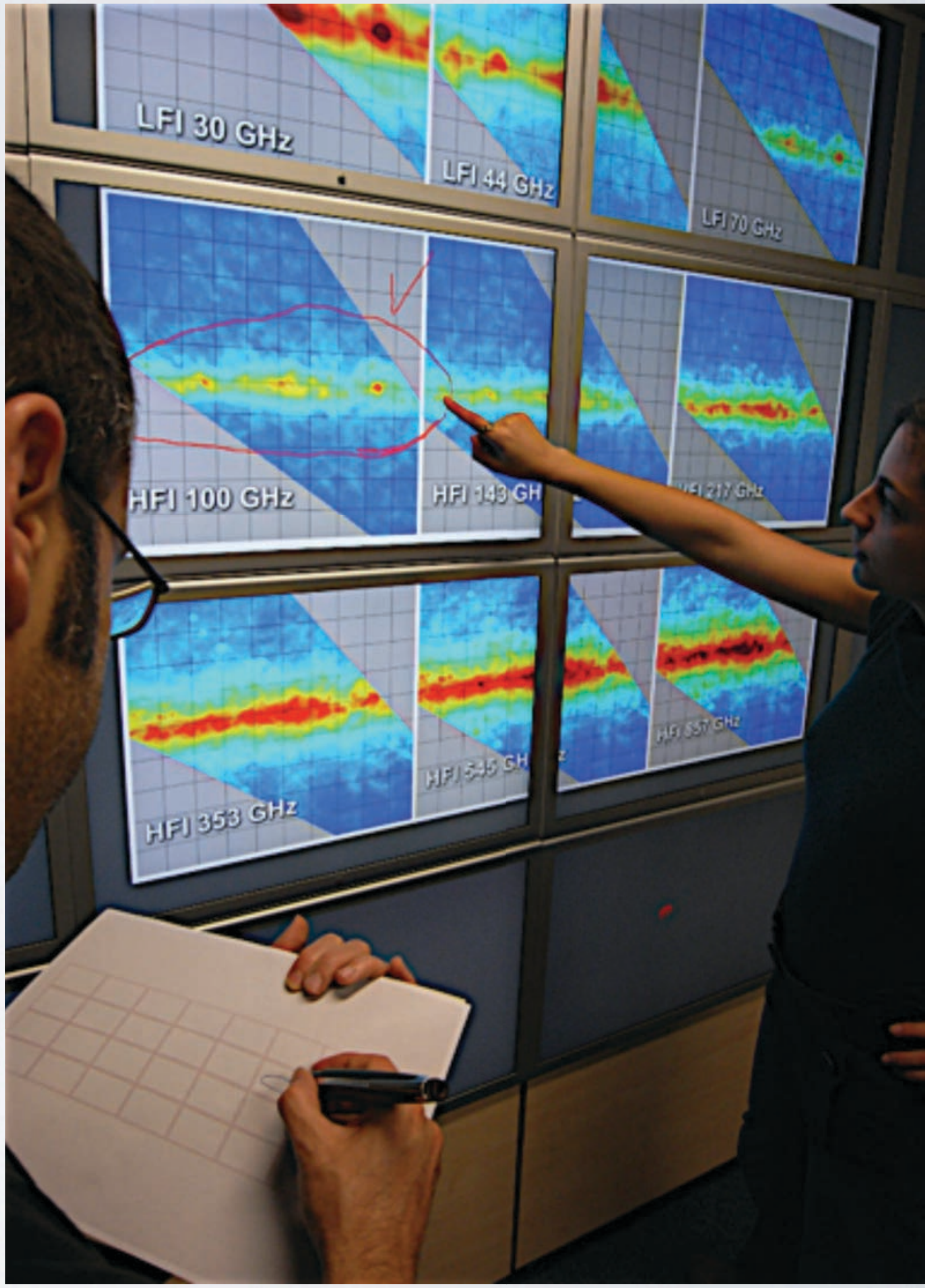
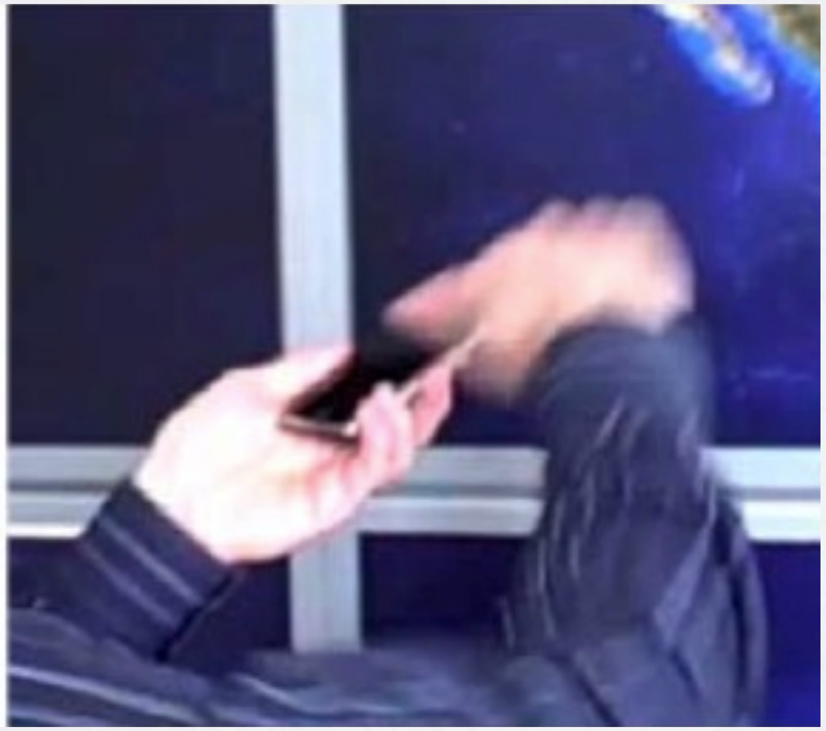
Exploring instruments for Multisurface Interaction

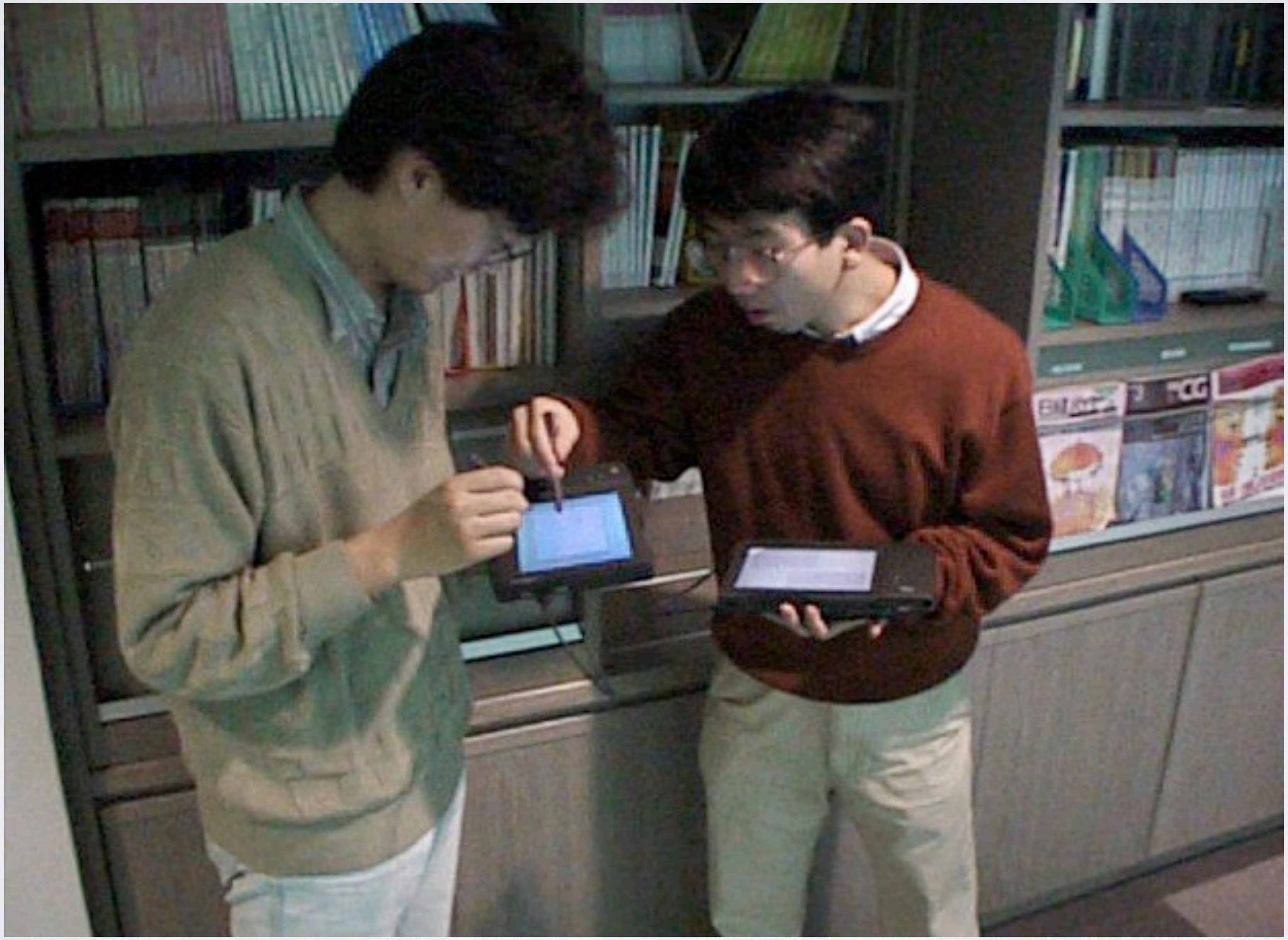




Participatory Design

- Create new ways to interact with complex data
- Transport objects with the "shovel"

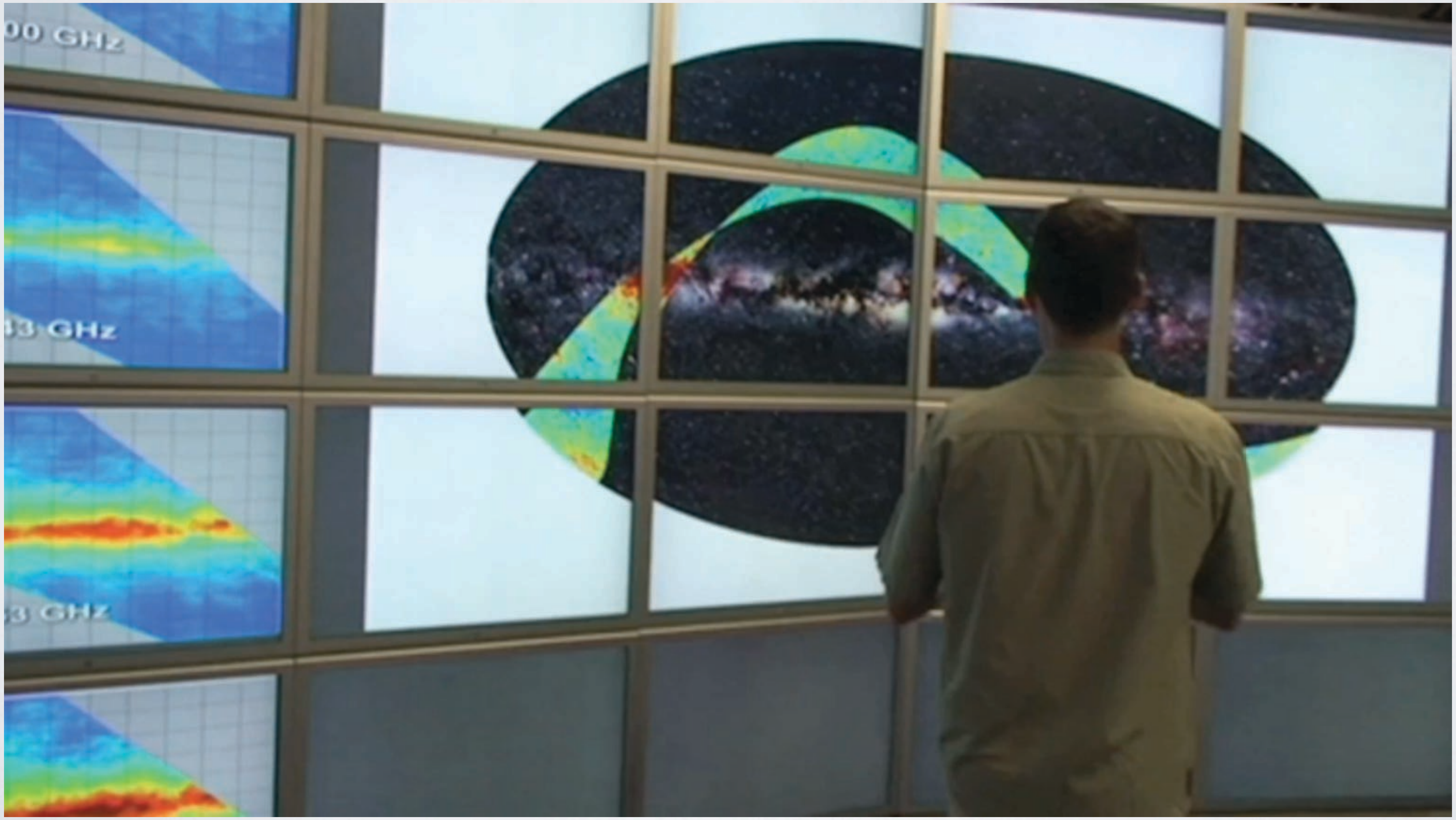
Reminiscent of Rekimoto's pick and drop



Rekimoto, 1997

Participatory Design

- Create new ways to interact with complex data
- Use a tablet as a magic lens

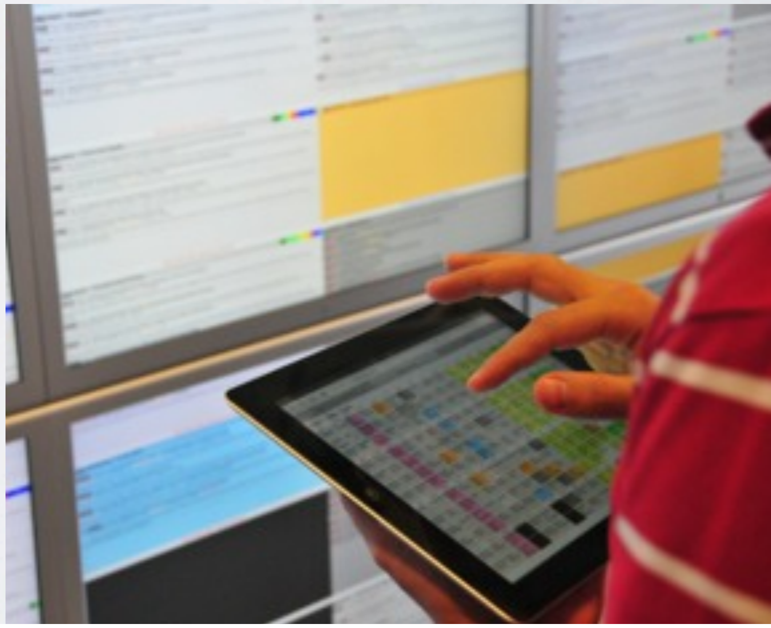


CHI 2013

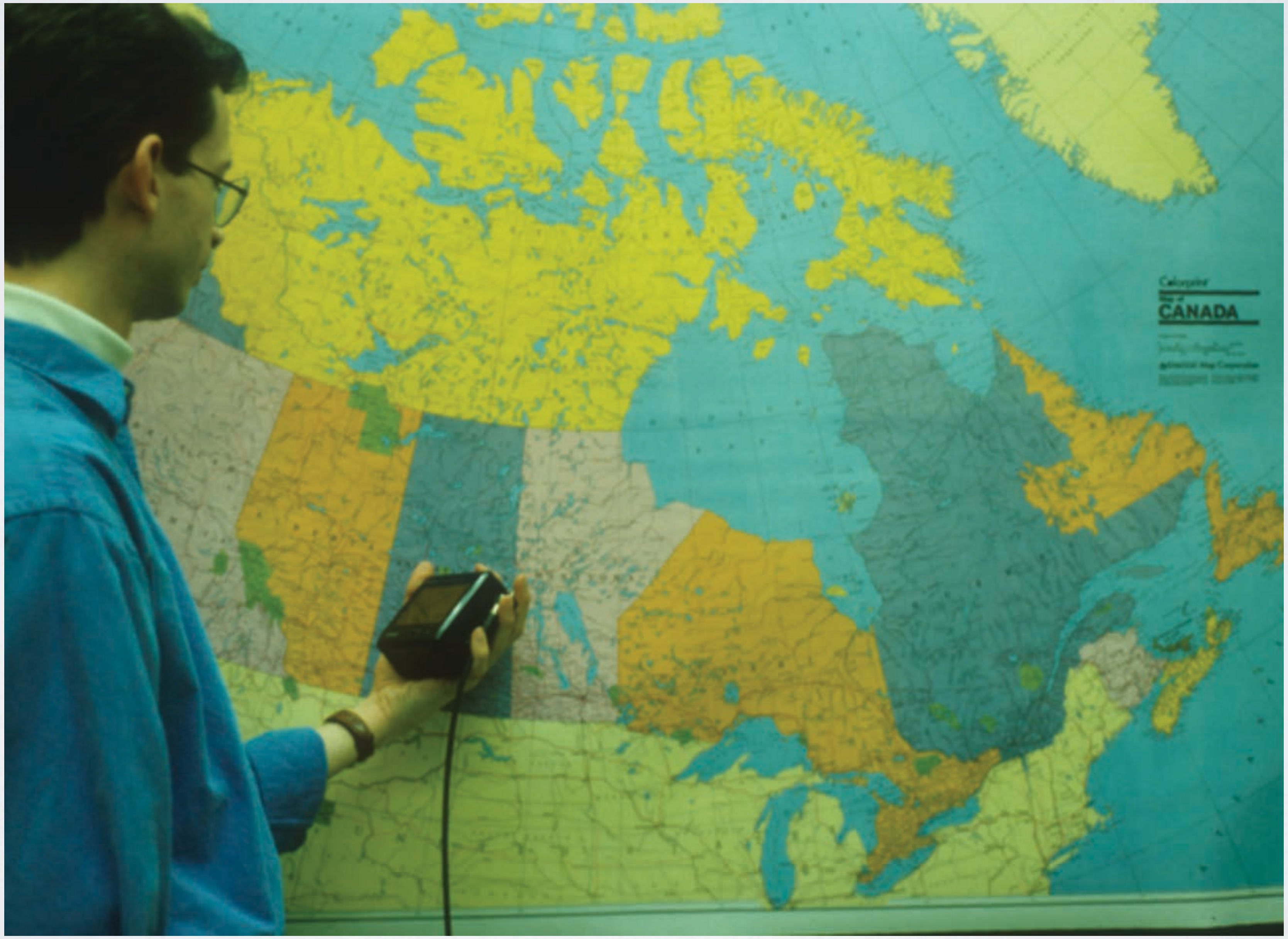
200 sessions
400 papers

16 parallel sessions over 4 days

no conflicts



Reminiscent of Fitzmaurice's Chameleon



Fitzmaurice, CACM'93

Participatory Design

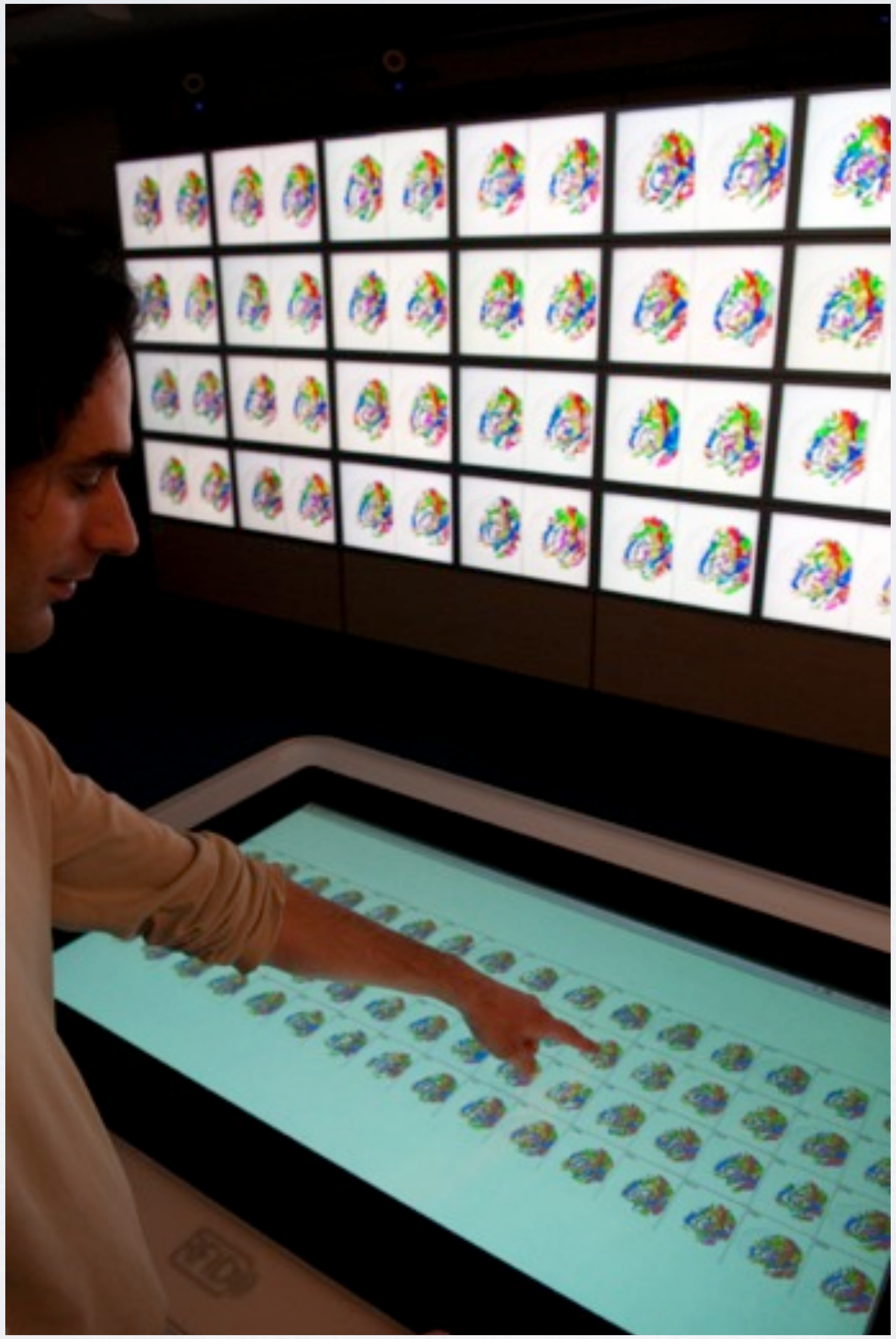
- Create new ways to interact with complex data
- Use a prop to control online objects

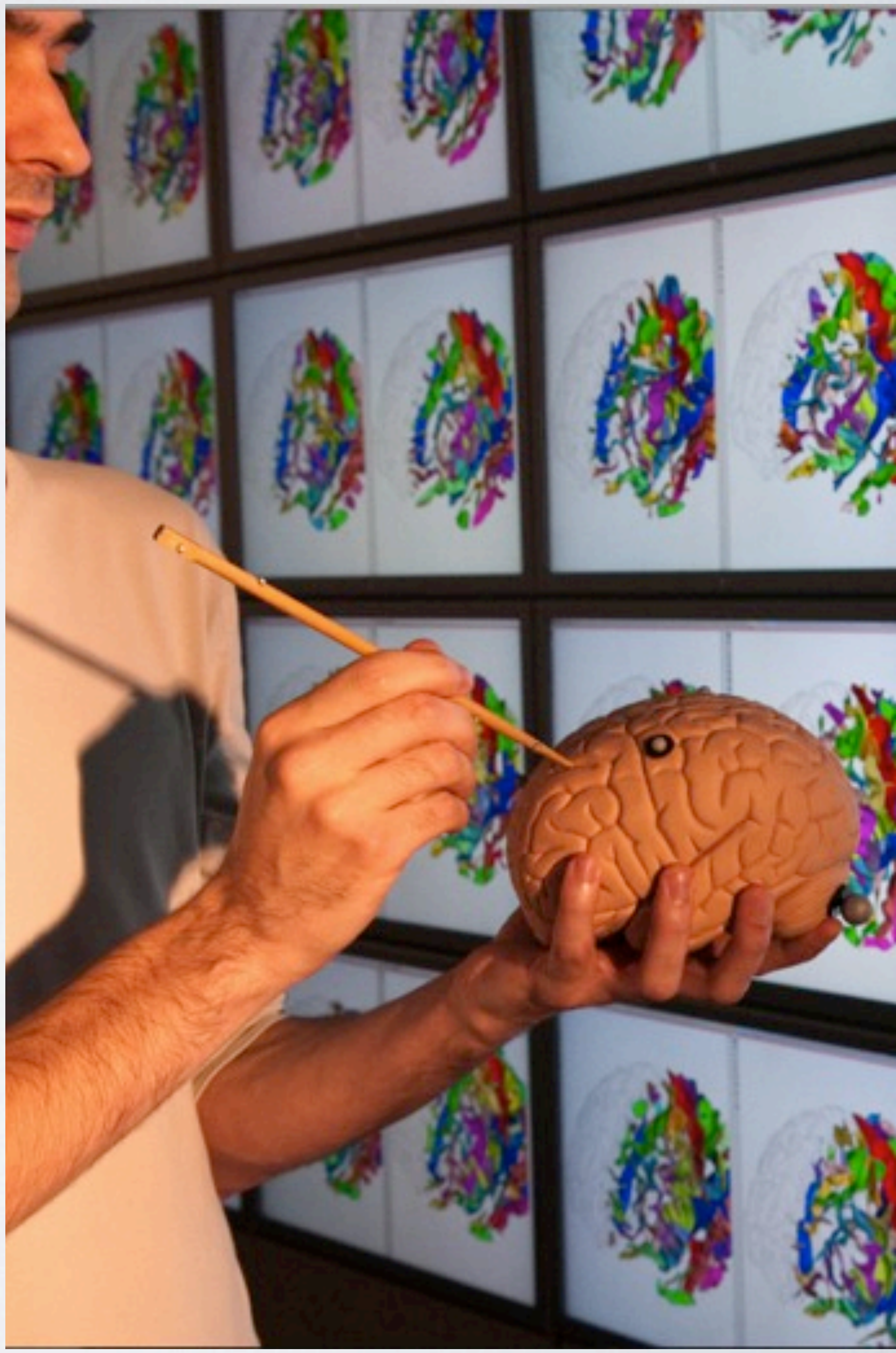
Software: Substance Grise

- Display 64 3D brain scans with VISA/Anatomist

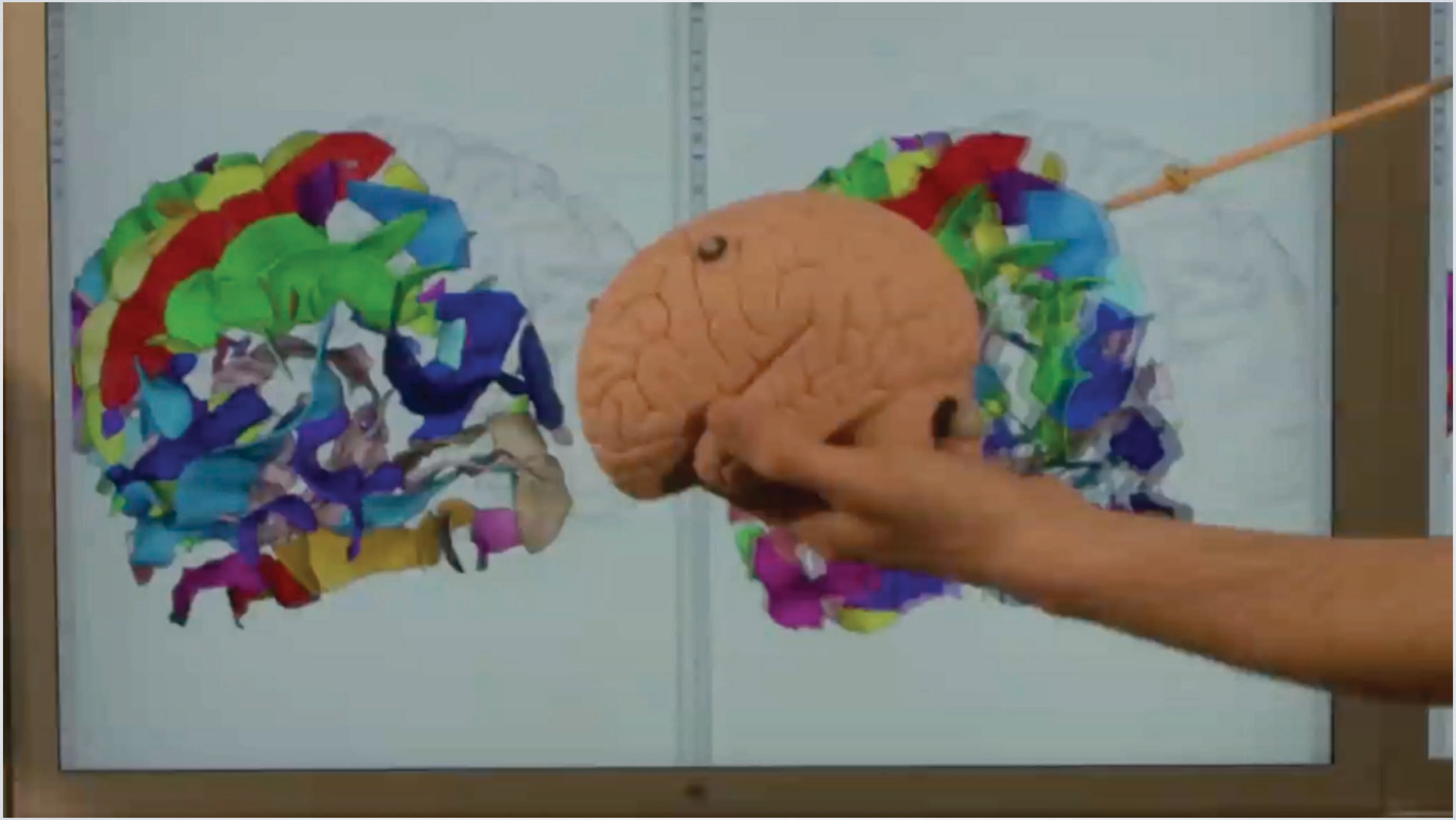
- Organize them on the table

- Control their orientation in real time through a prop

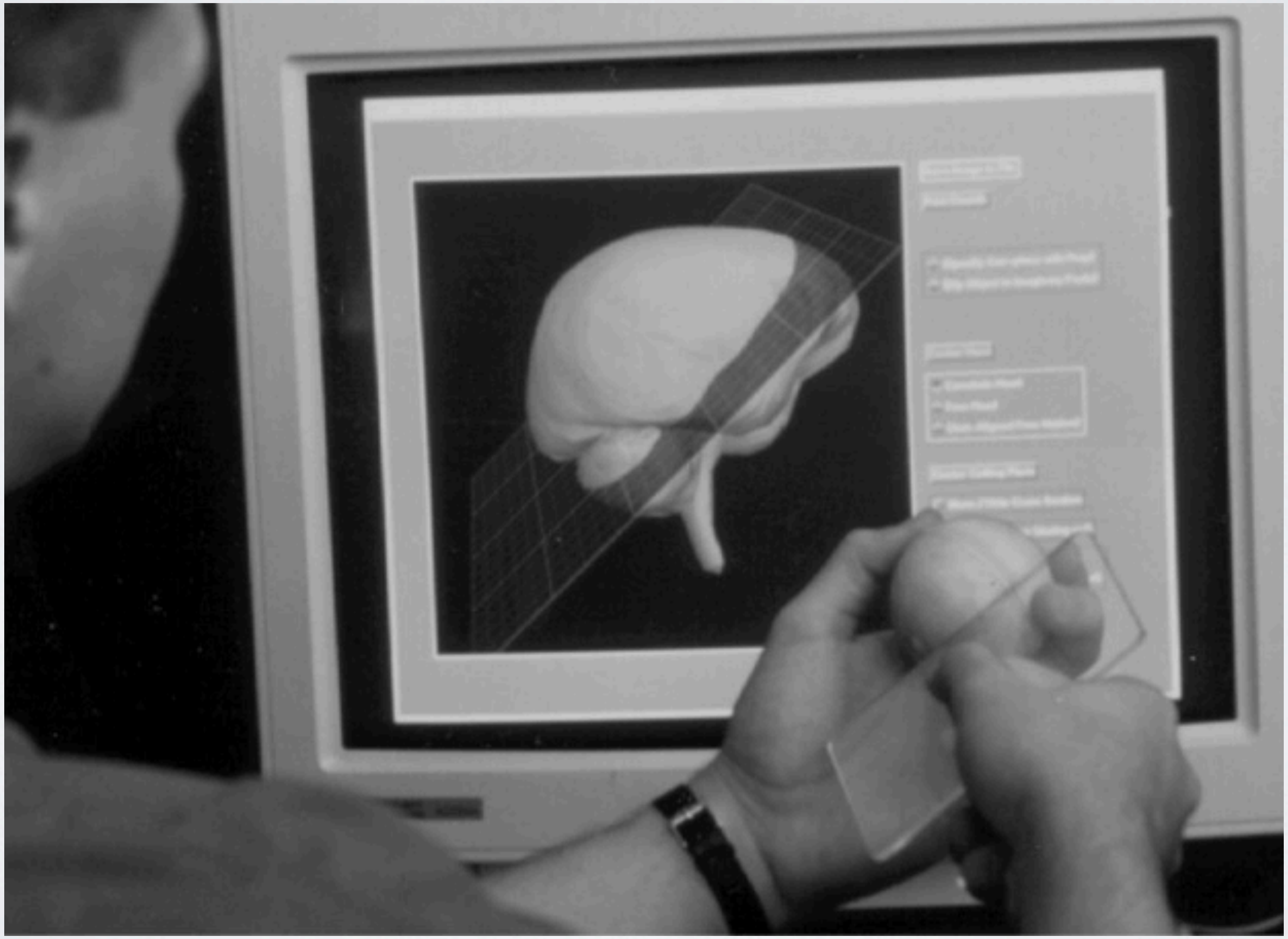




Substance Grise

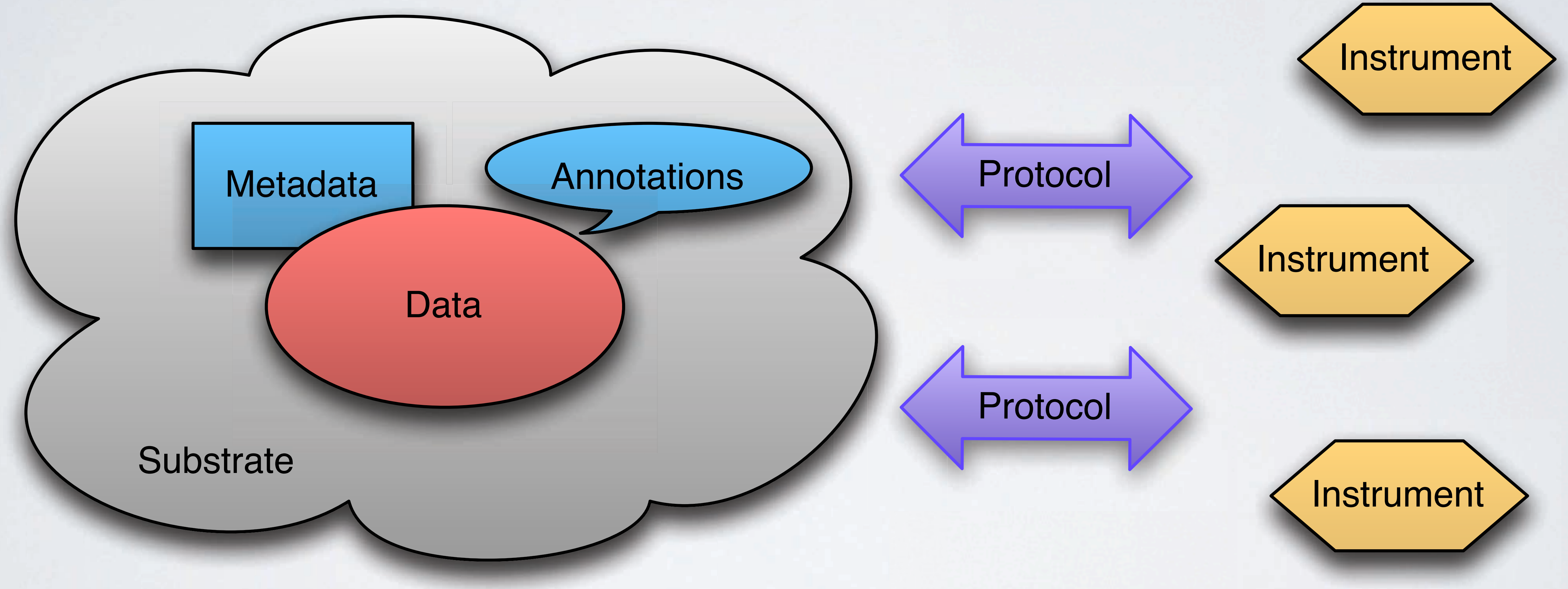


Reminiscent of Hinckley's neurosurgical props



Hinckley et al, CHI 94

A meta-model for instrumental interaction



Information substrates

- Data does not exist in a vacuum
- Substrates provide context for interpreting data and constraints for presenting and interacting with it
- Examples: table, page-based layout, graph, musical score

Substrates

- Not just a view (in the sense of MVC)
- Representation and physical organization of data

CULTURE CLUB

Bibendum quis dapibus ut lorem

Etiam sit amet est

- Affordances for certain operations:
  layout and spatial organization,
  data flow (a graph linked to a table), ...

Workout Tracker

- Can embed instruments, e.g. magnetic guidelines.
  Similar to scaffolding when creating a building

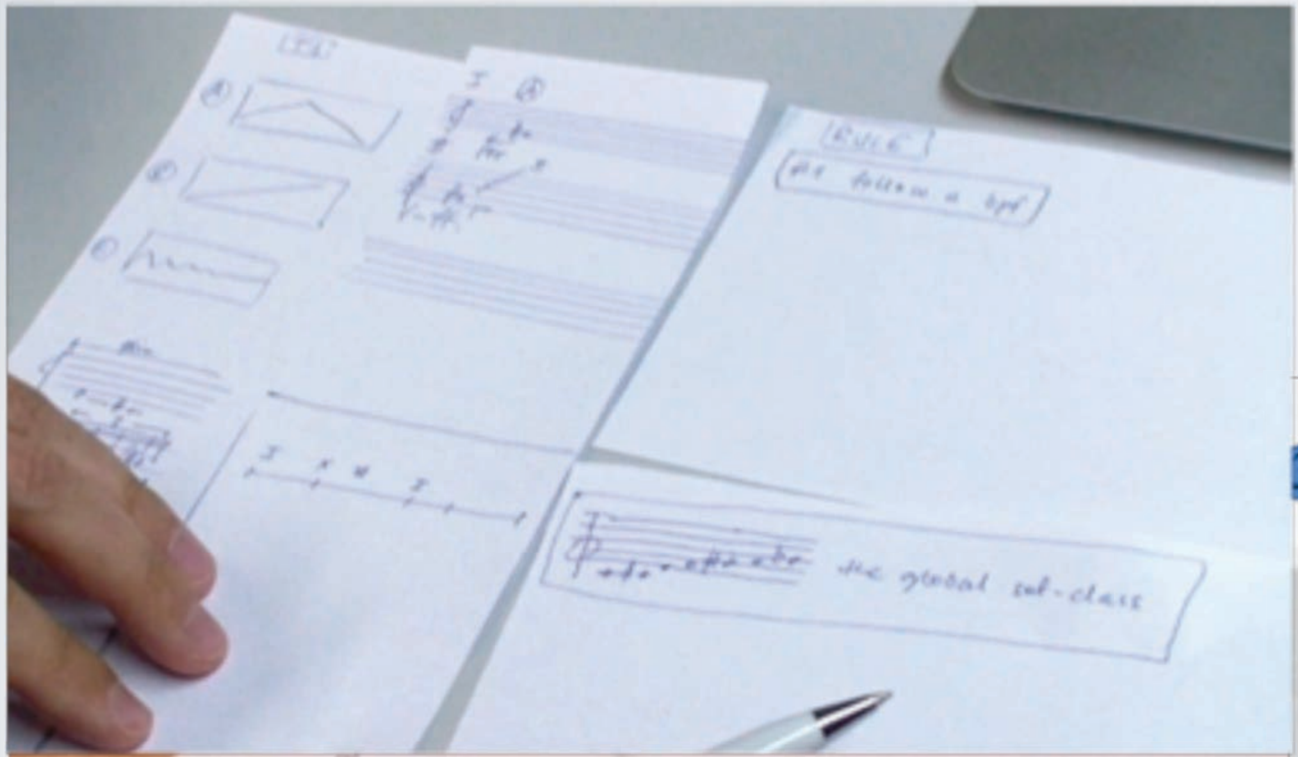
Paper substrates: Video Mosaic

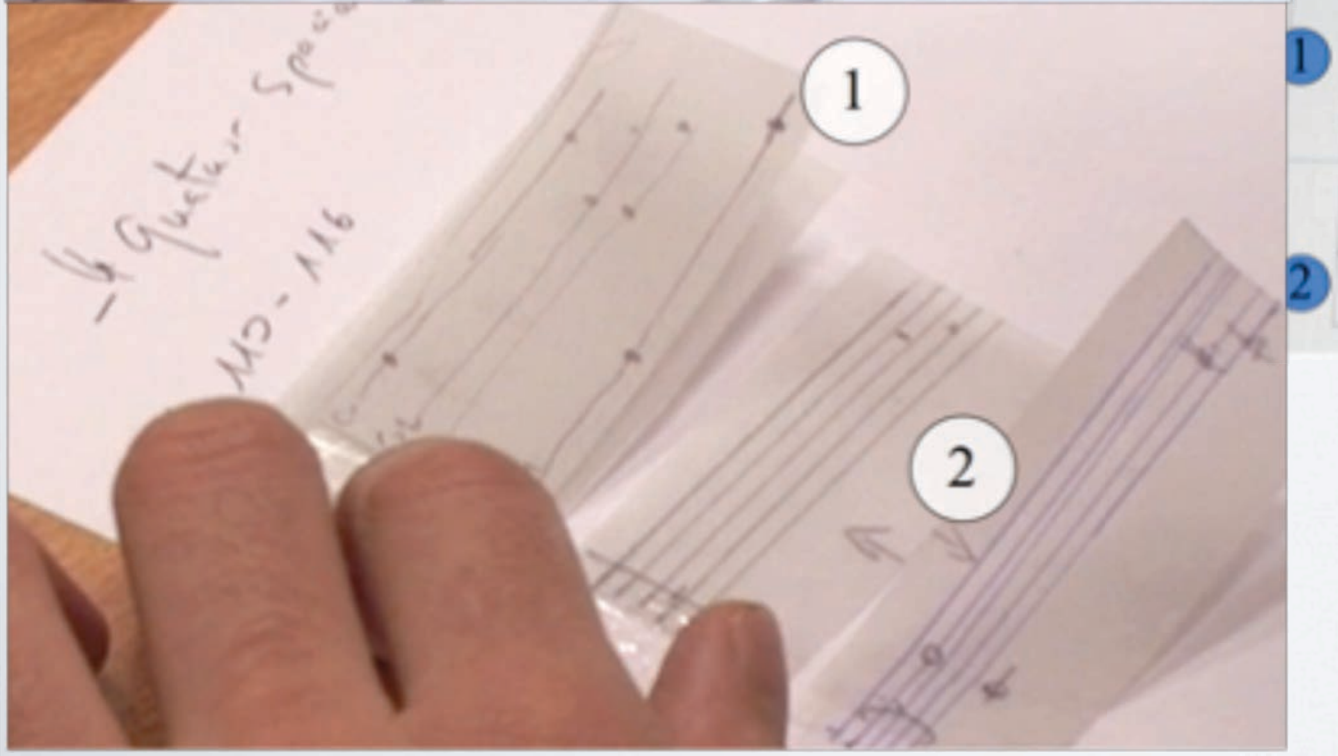
Mackay & Pagani, 1994

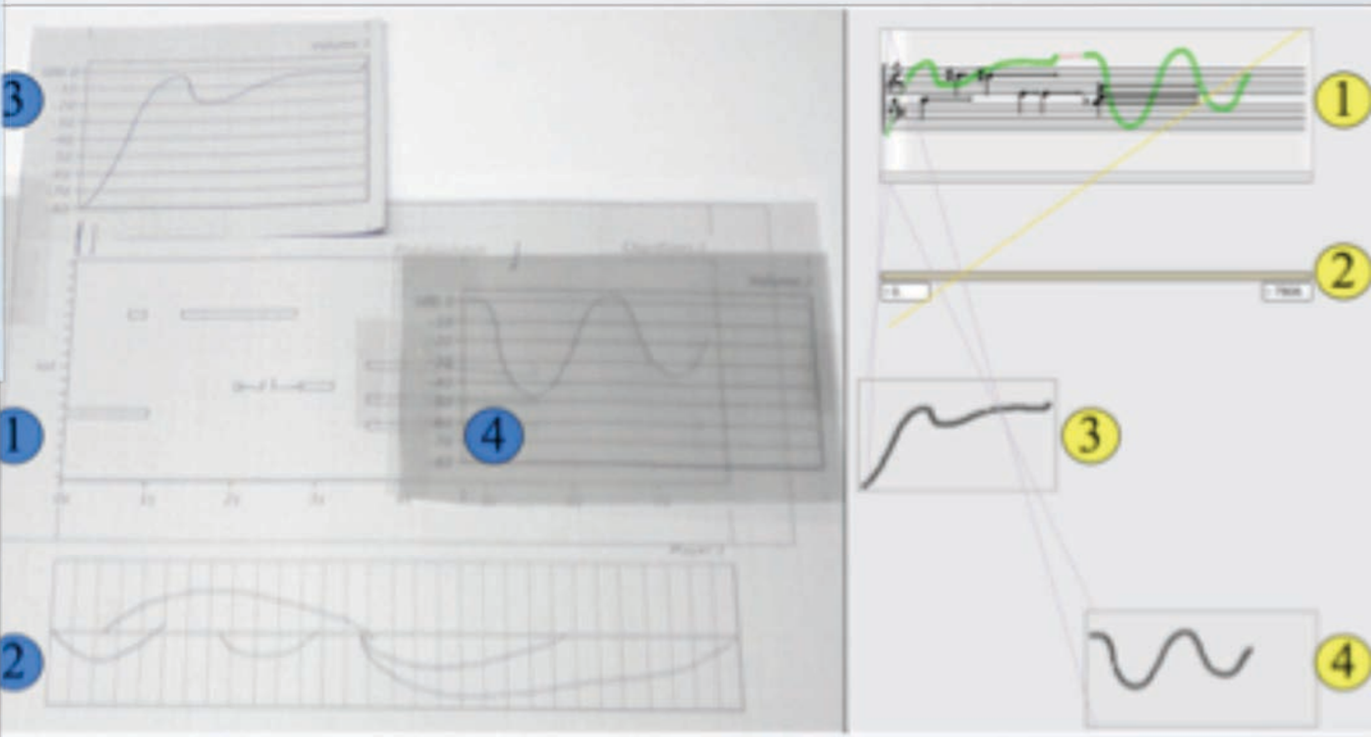
- Storyboard elements printed on paper
- Laying out time in space to organize a sequence of clips
- Paper buttons

Paper substrates for music composition

Garcia, Tsandilas, Agon & Mackay, 2012



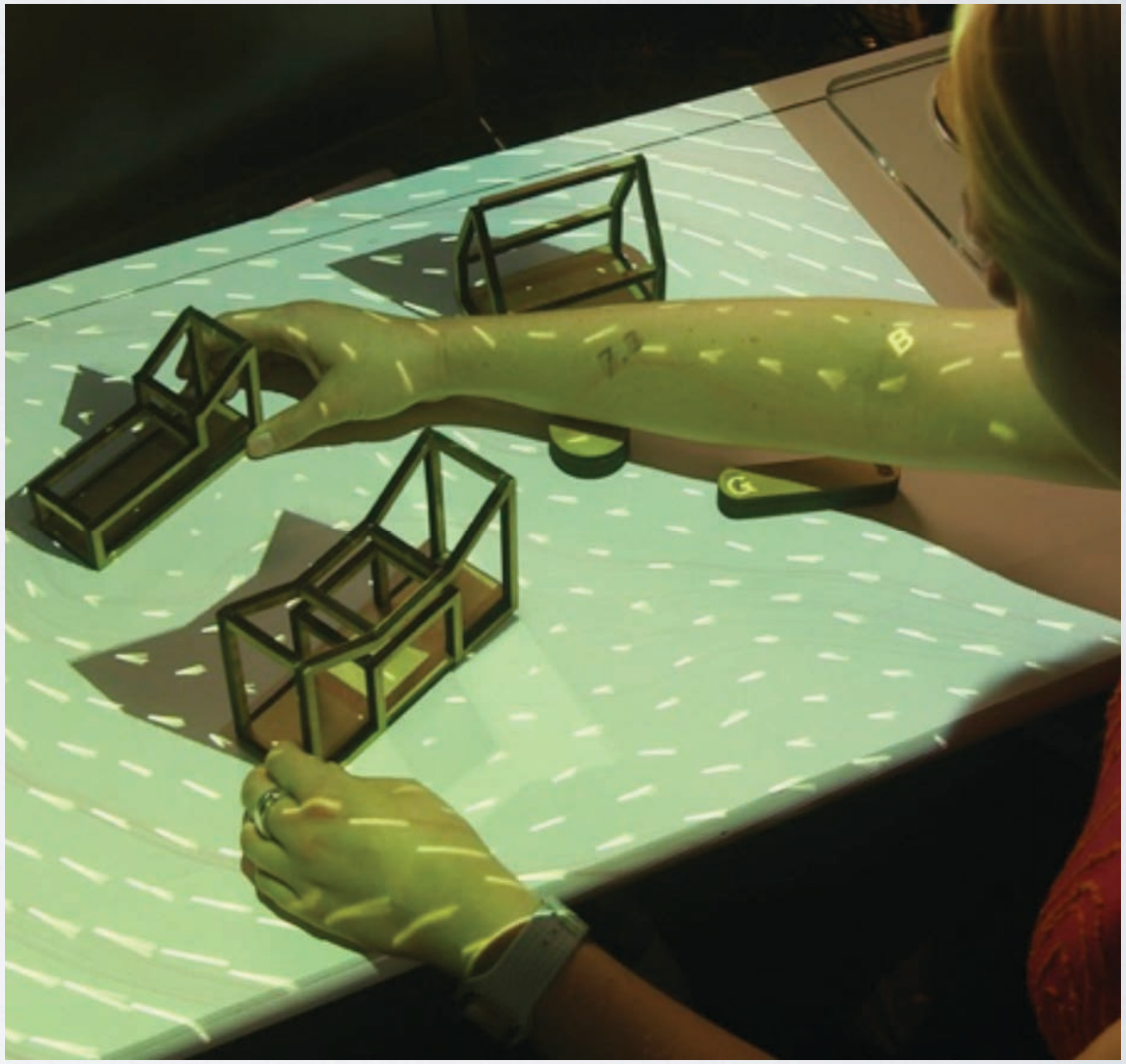




Tangible substrates: URP

Underkoffler & Ishii, 1999

- Tangible representation of buildings
- Real-time display of simulation data (wind, lighting, ...)
- Tangible tools to control the simulation



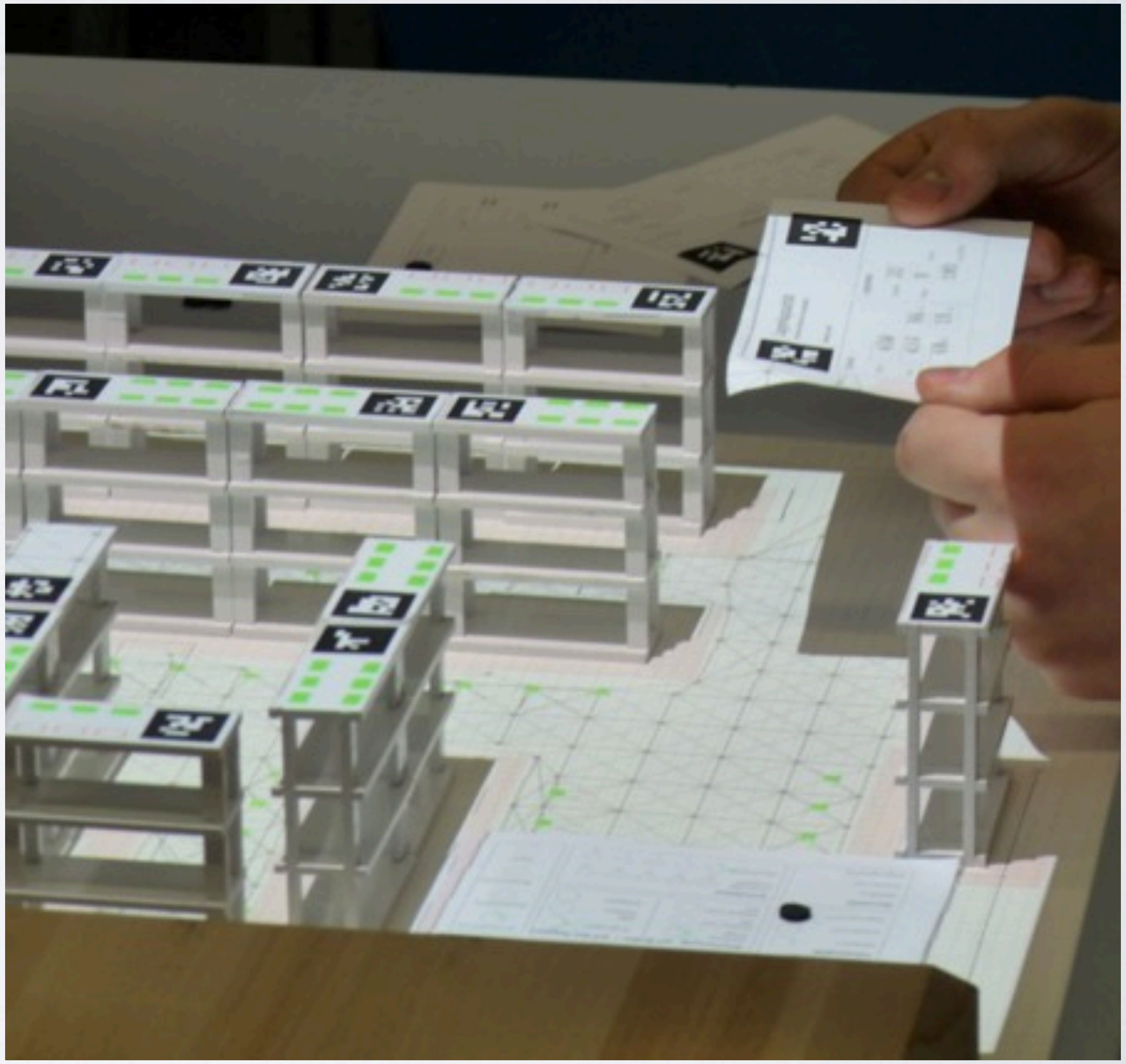
Tangible substrates: TinkerLamp

Zuffery, 2010

- Tangible representation of a warehouse to train students

- Also uses interactive paper to control the simulation

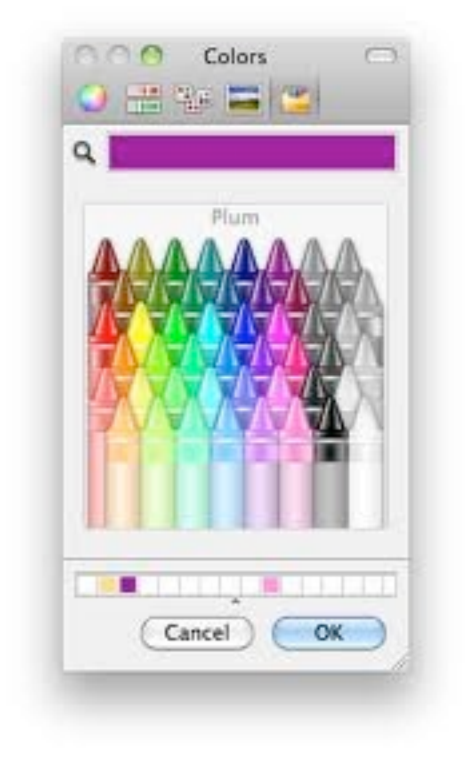
- Used for teaching at a vocational school in Switzerland

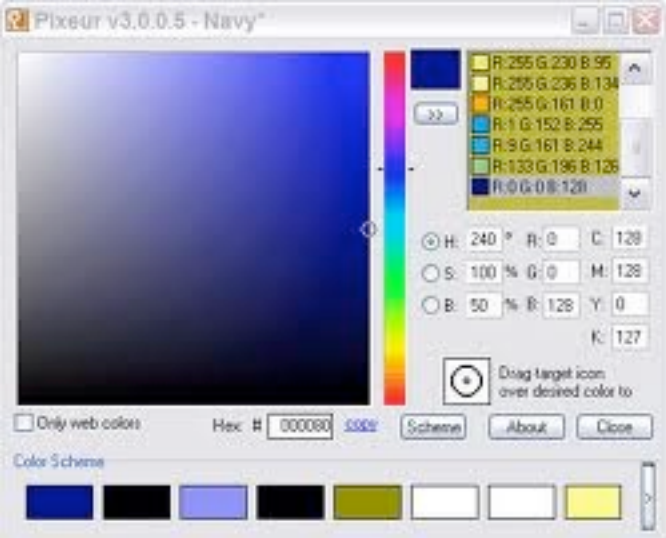


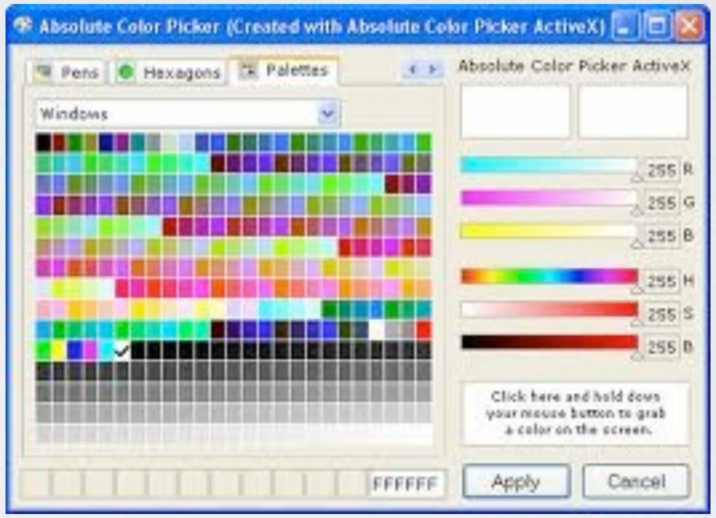
Interaction protocols

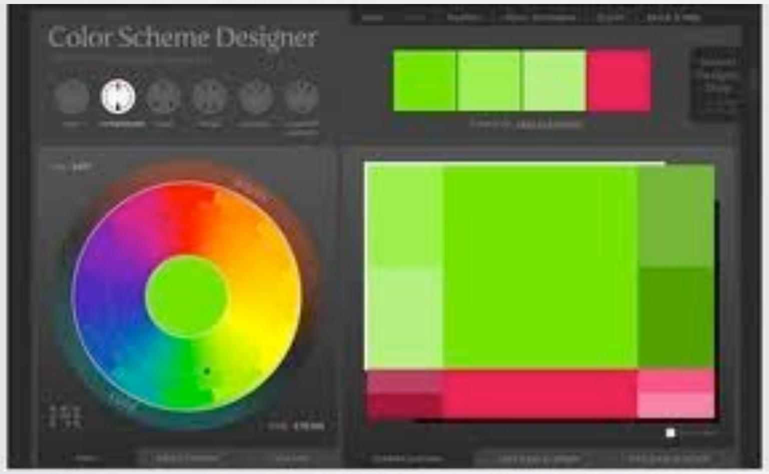
- Describe which instruments can operate on which objects
- Support exploration and appropriation (including breaking things)
- Explicit compatibility: object advertises its capabilities
- Implicit compatibility: instrument discovers objects' properties

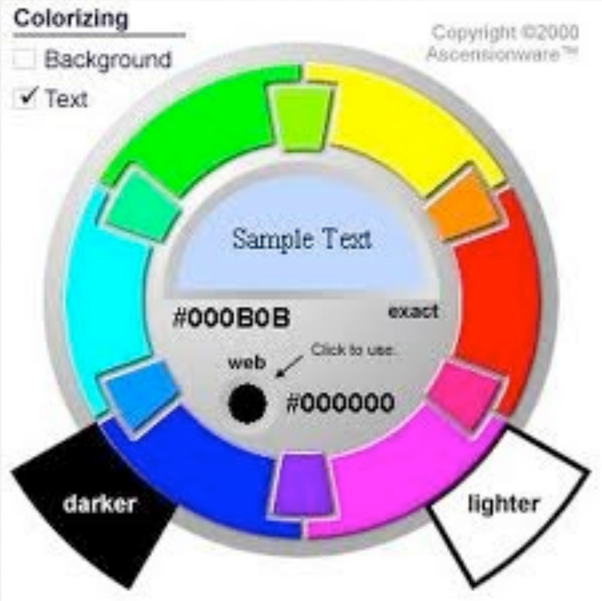
Example: color pickers





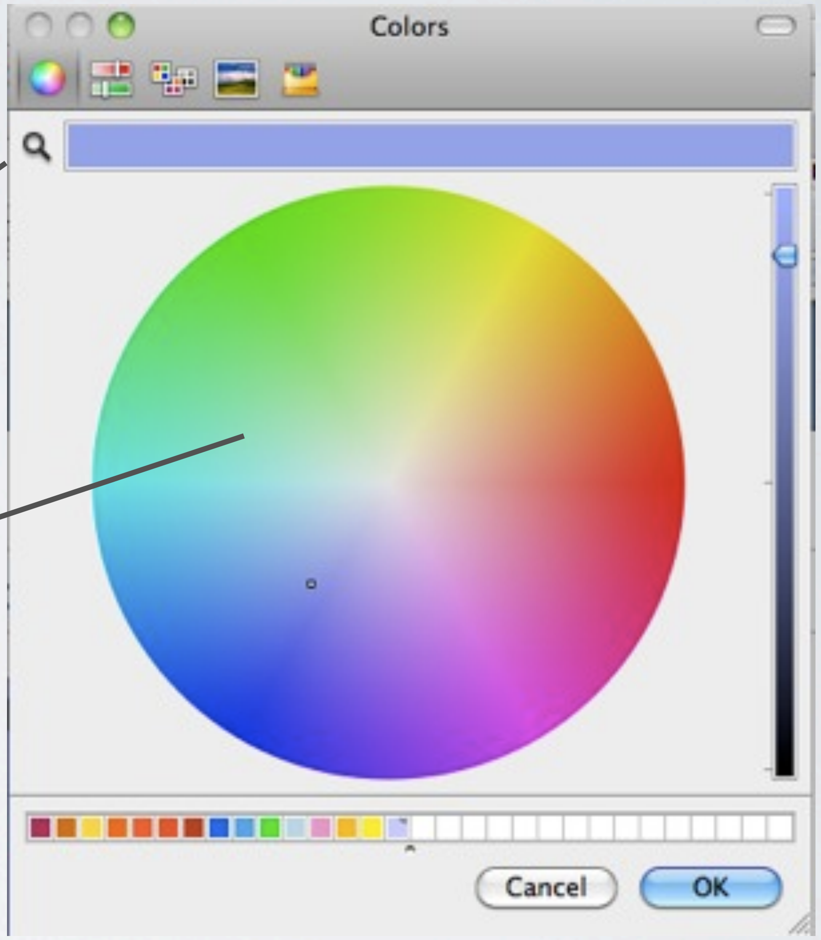

Absolute Color Picker (Created with Absolute Color Picker ActiveX)
Pens
Hexagons
Palettes
Windows
Absolute Color Picker ActiveX
255 R
255 G
255 B
255 H
255 S
255 B
Click here and hold down your mouse button to grab a color on the screen.
FFFFFF
Apply
Cancel





Example: color pickers

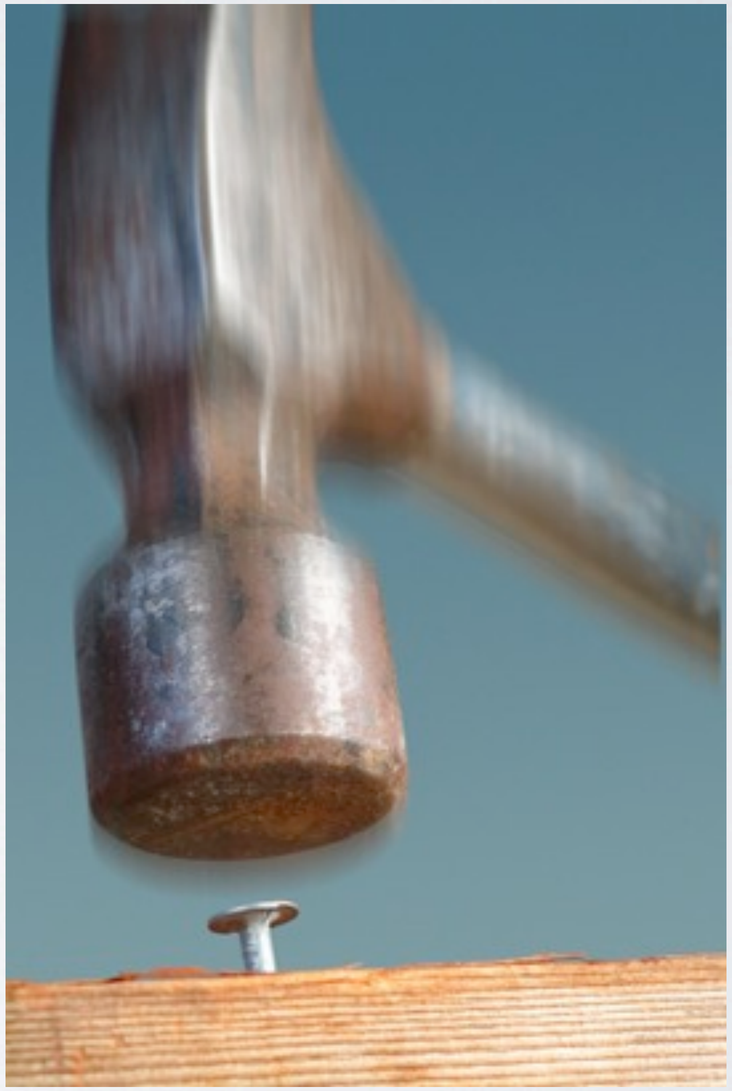
- Select a color:
  - From an external object
  - From a color space
  - From a color palette



- Explicit compatibility: SetColor/GetColor methods
  Implicit compatibility: a property of the object is a color

Benefits of instruments

- Decouple data/information from the tools used to view/edit it
- Provide a natural way to support user customization / appropriation
- Foster a different business model for software, based on components and interoperability



Next steps

- Refine the conceptual model
  - Information substrates
    + interaction protocols
    + instruments
  - Explore the use of instruments
    with objects they were not designed for
- Build a robust and scalable software infrastructure
- Test in various settings

Thank you!

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