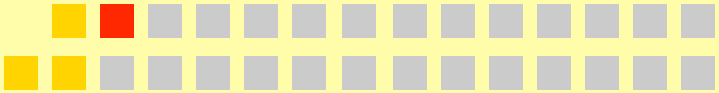
week
03



Tangible Bits

Implications for user interfaces

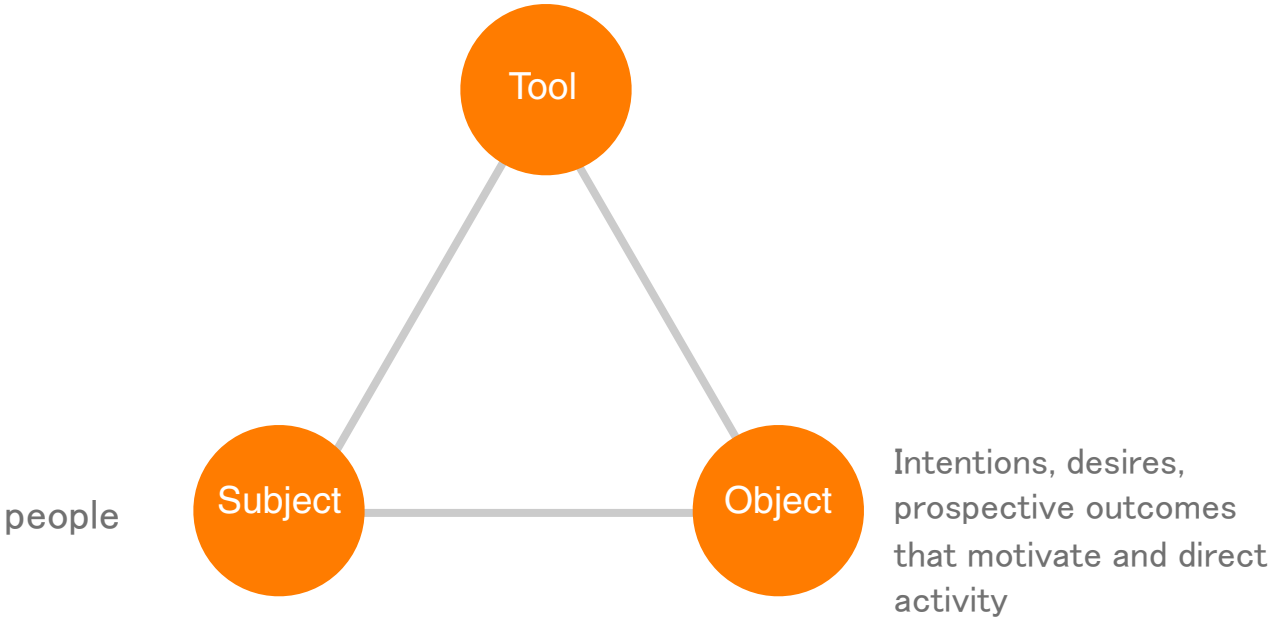
Lecture Outline

- Designing Interactions
- Tangible User Interfaces
- Midterm project and group forming exercise

Activity Theory

Unit of Analysis

Tools mediate between people and the world. Activity theory casts the relationship between people and tools as one of **mediation**.



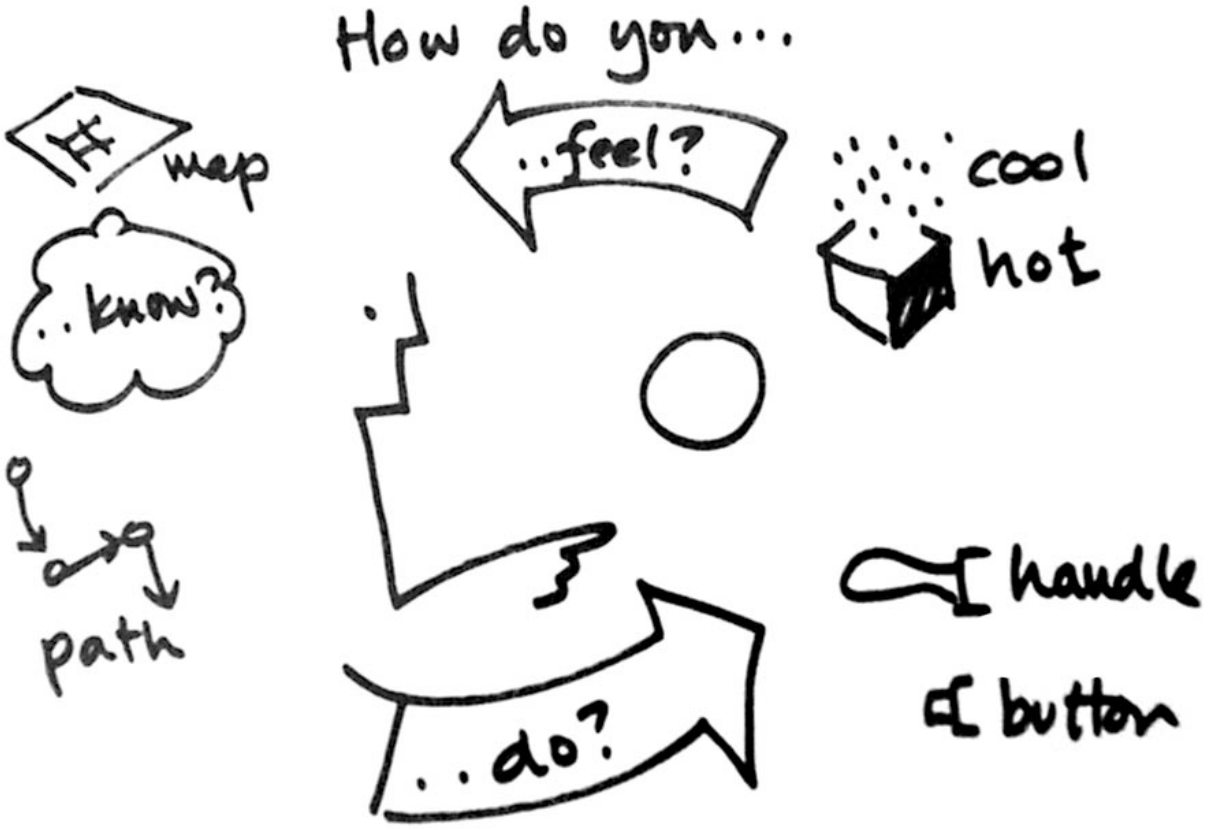
Designing Interactions

From designers' perspective

The term "interaction design" was coined by Moggridge in late 1980's. Until then, design was mostly design of physical things, but now it includes computer interface design.

Bill Moggridge, co-founder of IDEO

Interaction Loop



Bill Verplank from Moggridge (2006)

Design as Communication

Design is a conversation between designer and user, even though the designer is no longer present once the user enters the scene.

Norman (2004)

Design as Communication

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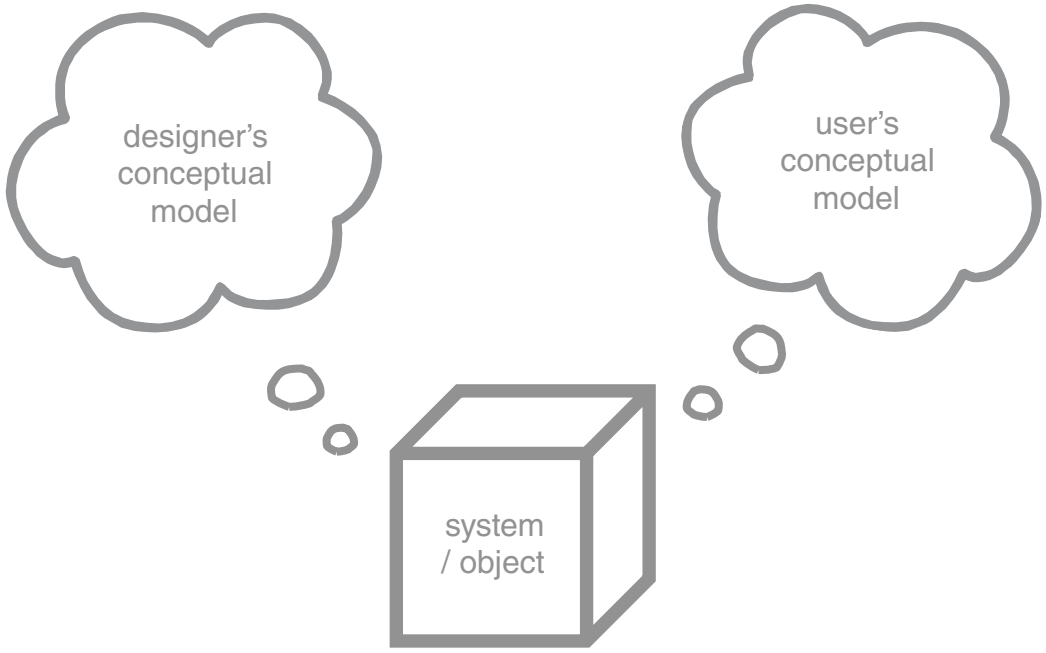
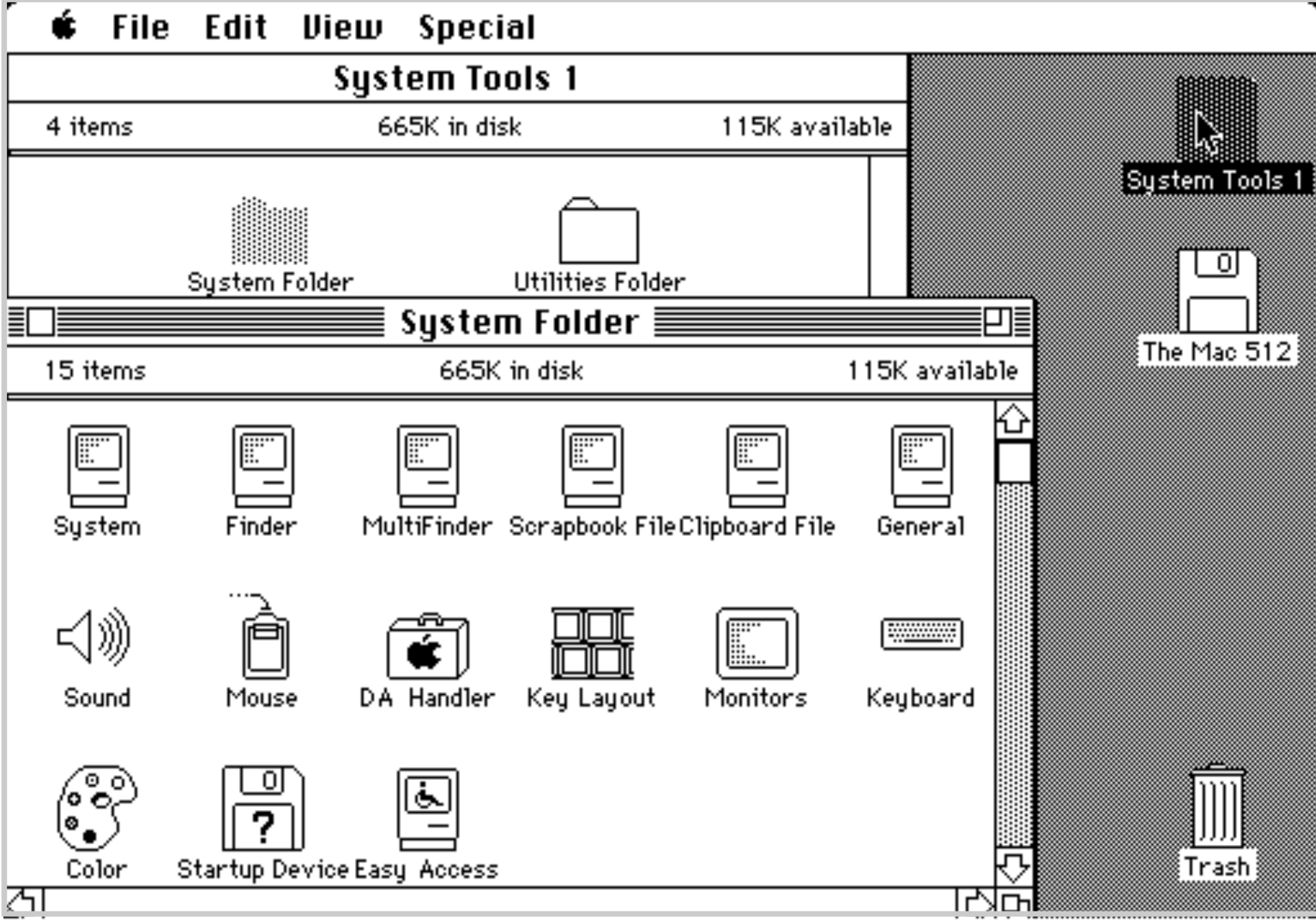
Norman (2004)



Conceptual models [Norman, 2004]

Design as a Form of Mediated Communication

Human-computer interaction can be thought of as a form of mediated communication between the end user and the system designer, who must structure the system so that it can be understood by the user, and so that the user can be led through a sequence of actions to achieve some end result. (Dourish, 2004)


File Edit View Special
System Tools 1
4 items
665K in disk
115K available
System Folder
Utilities Folder
System Folder
15 items
665K in disk
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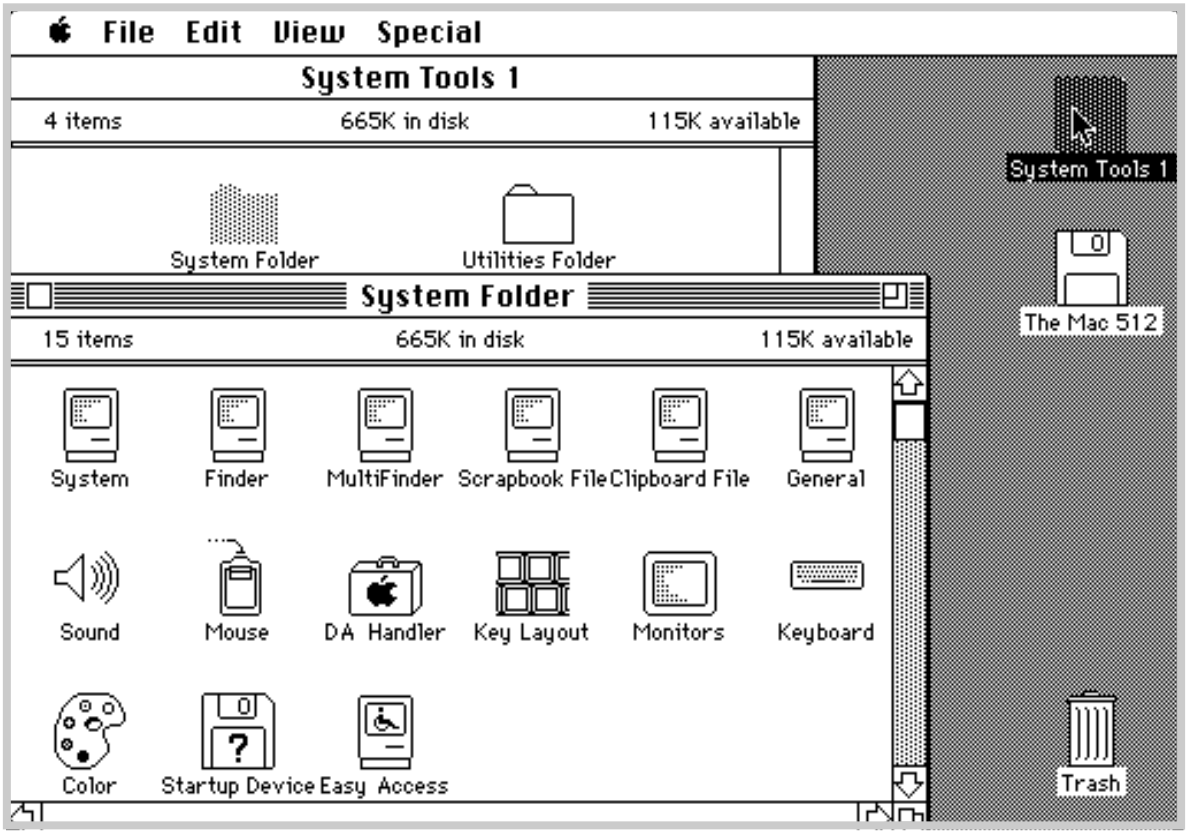
MultiFinder
Scrapbook File
Clipboard File
General
Sound
Mouse
DA Handler
Key Layout
Monitors
Keyboard
Color
Startup Device
Easy Access
System Tools 1
The Mac 512
Trash

Designed affordances

Messages from designer to user, attracting attention to the set of desired possible actions. (Norman, 2004)



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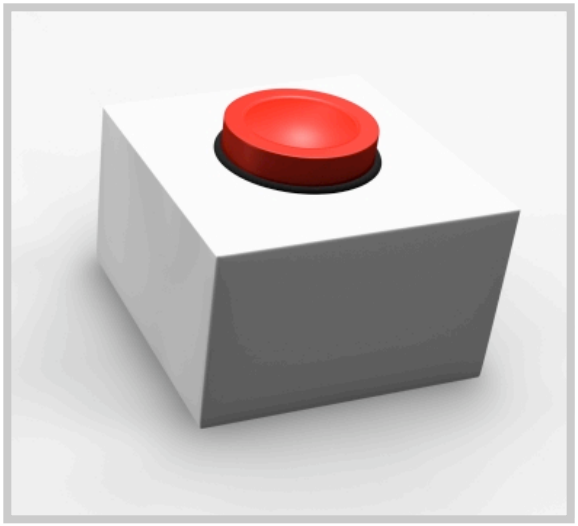
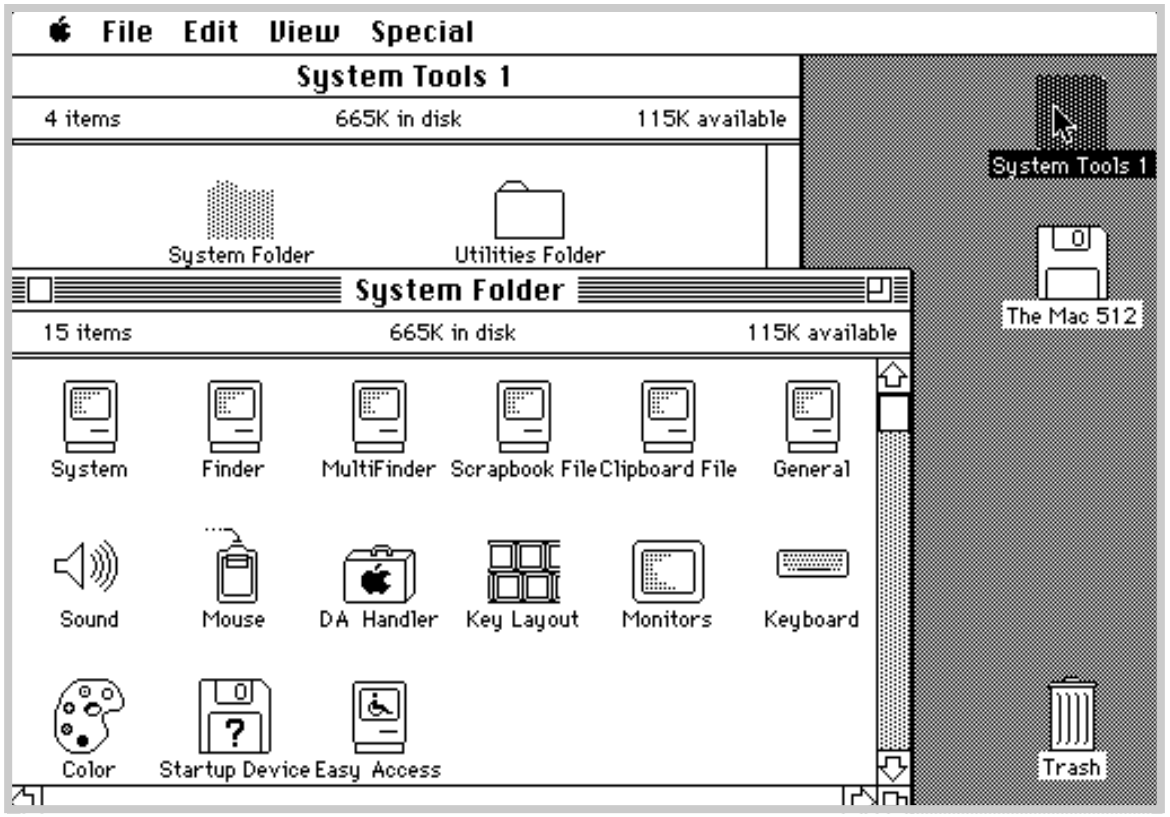


Historical Development of HCI

Graphical



Macintosh System 4.2, 1987

- **Peripheral Attention**
  Primary space, secondary space (e.g., windows and dashboards)
- **Pattern recognition and spatial reasoning**
  Opportunities to arrange data spatially
- **Information density**
  A picture really can be worth a thousand words (e.g., diagrams)
- **Visual metaphors**
  File cabinets, trashcans, desktop tools

User Interfaces: The Current State of Affairs

Hands, eyes, tools, and interactions

"The computer is inherently a tool for the mind—not the hands."
From *Abstracting Crafts* (McCullough, 1996)

Eyes are in charge and hands are underemployed

McCullough (1996)

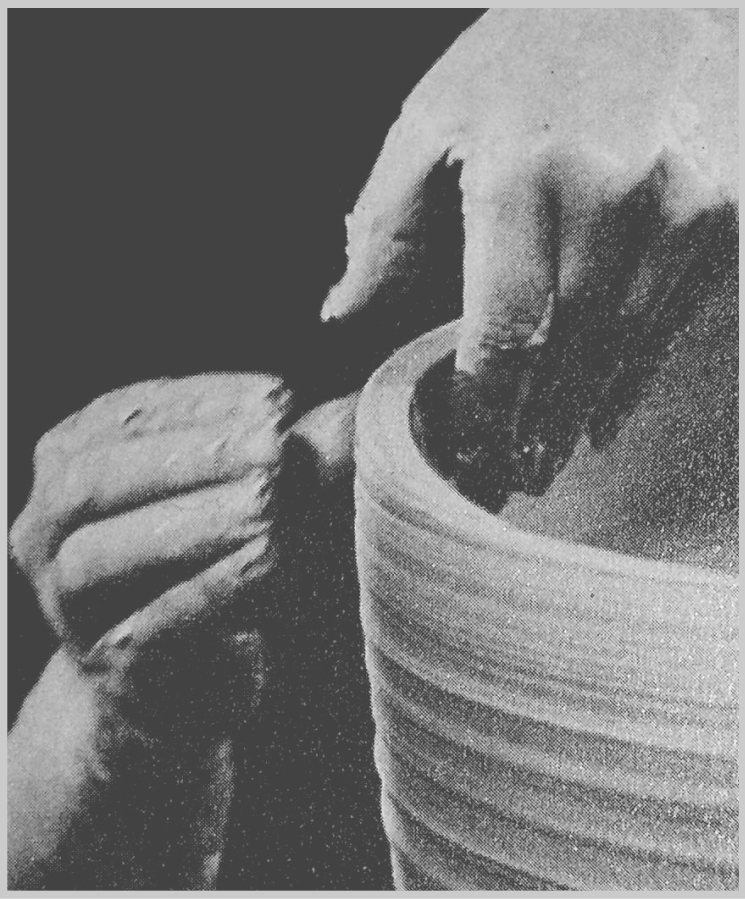
Eyes are in charge

Seeing objectifies the world. Eyes guide tools, read notations, appraise designs. Eyes see wholes, and compare many objects simultaneously. Eyes are the great monopolists of the senses. McCullough (1996)

Hands bring us knowledge of the world

They are the most subtle, sensitive, probing, differentiated, and the most closely connected to the mind. They deserve to be admired.
McCullough (1996)

Hands are underrated



By pointing, by pushing and pulling, by picking up tools, hands act as conduits through which we extend our will to the world.
McCullough (1996)

Eyes activate the hands and hands direct the eyes

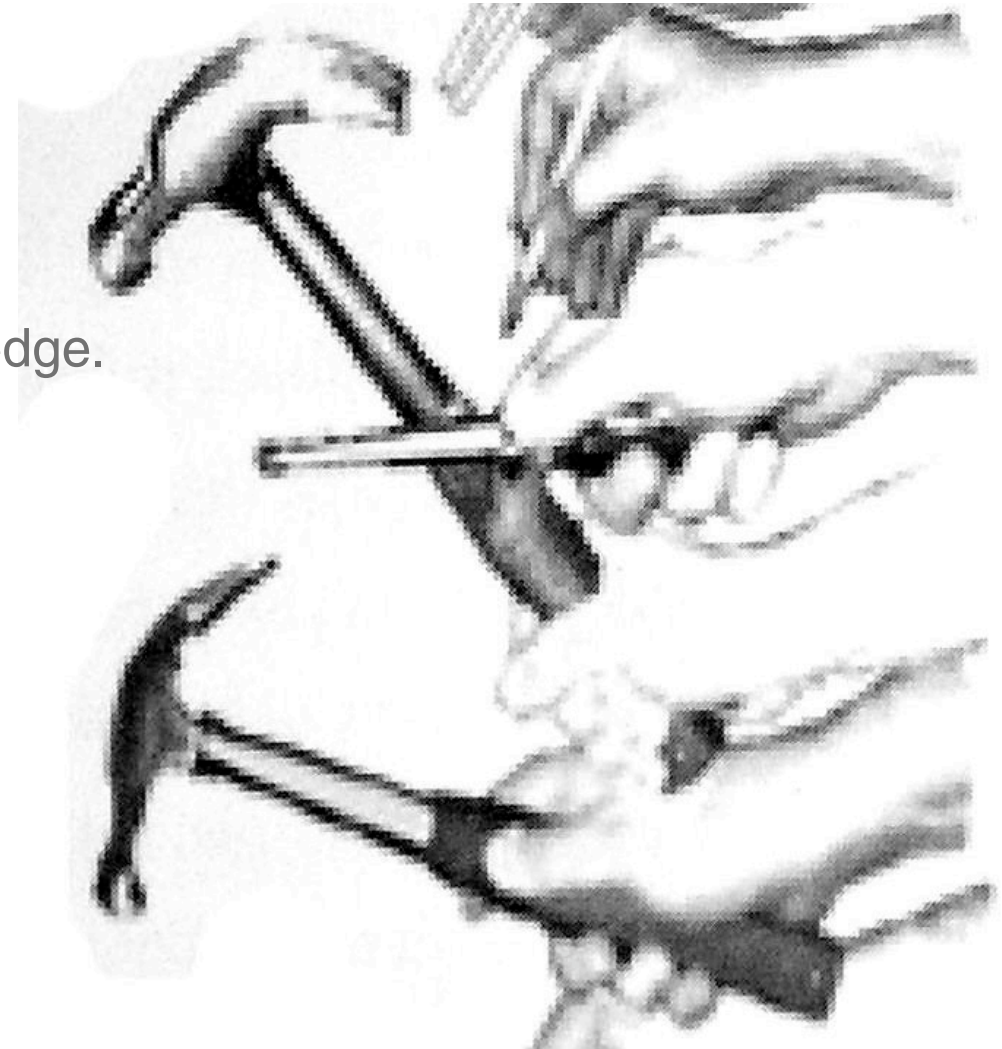
Hand-eye coordination distinguishes humanity as the maker of things: *homo faber*. McCullough (1996)

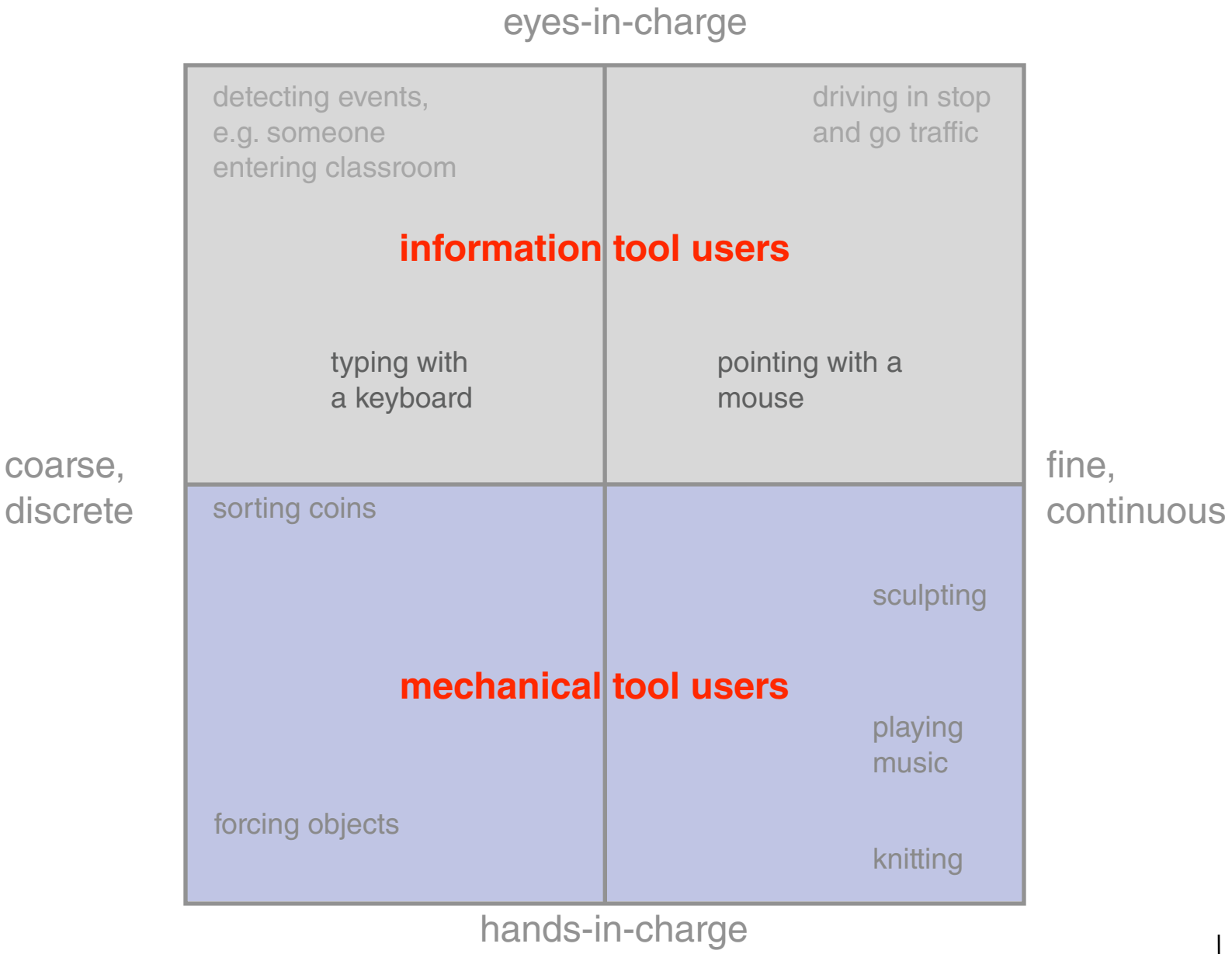
Activity Theory

Tools and Mediation

Tools direct our attention and its function becomes our focus.

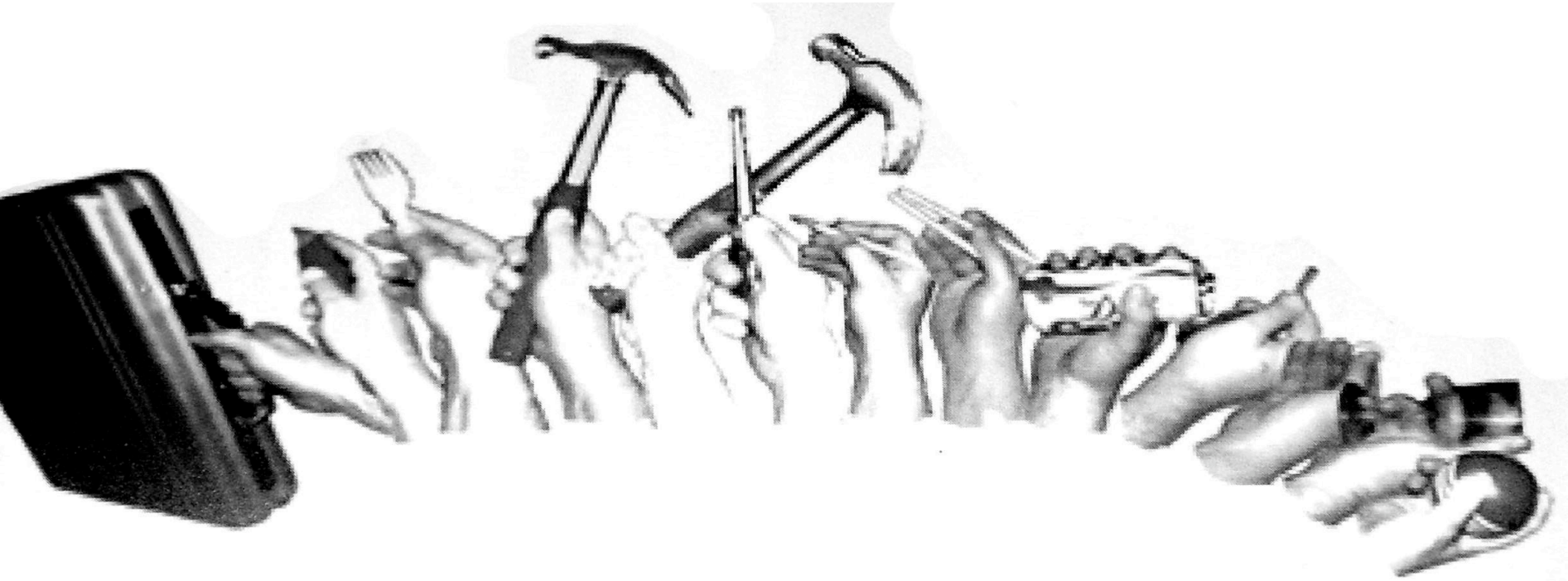
Use of tools is an accumulation and transmission of social knowledge.




eyes-in-charge
detecting events, e.g. someone entering classroom
driving in stop and go traffic
information tool users
typing with a keyboard
pointing with a mouse
coarse, discrete
fine, continuous
sorting coins
sculpting
mechanical tool users
playing music
forcing objects
knitting
hands-in-charge

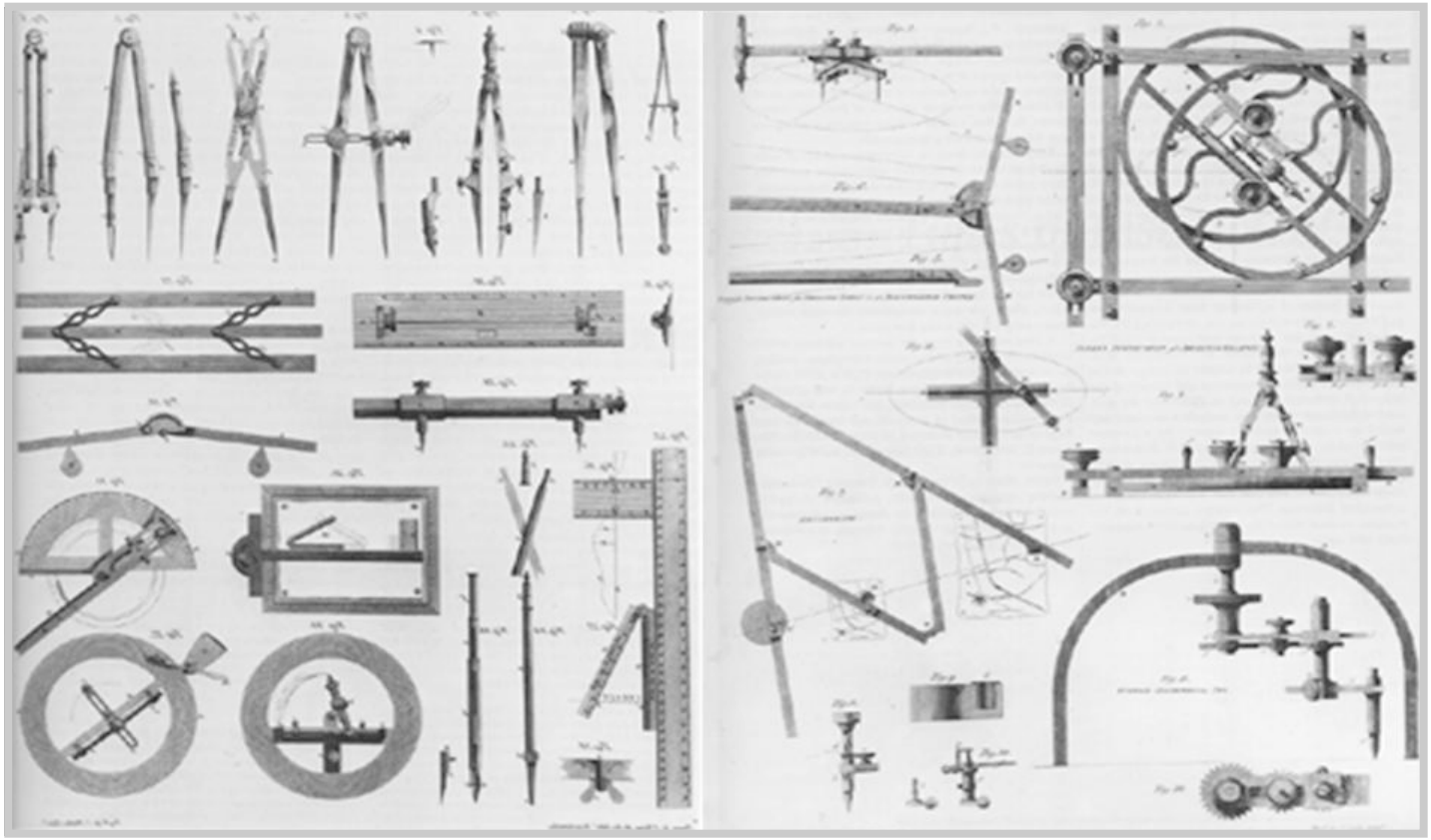
Tools

Deep in our nature, we are tool users as well as symbol users.



Tools

Aesthetics of the tools lost in the flood of PCs?

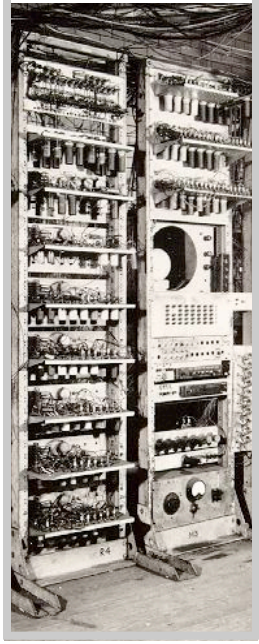


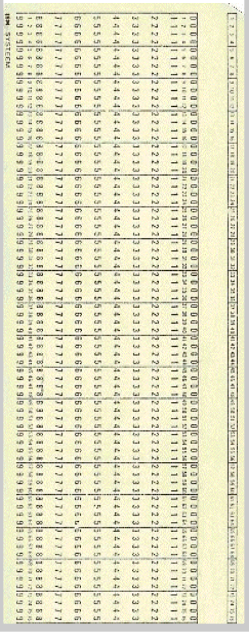
Combining the skillful hand with the reasoning mind

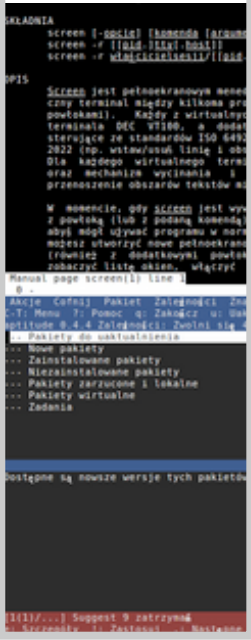
Computers let us turn the table — to apply something we know about using tools to achieve richer symbolic processing.

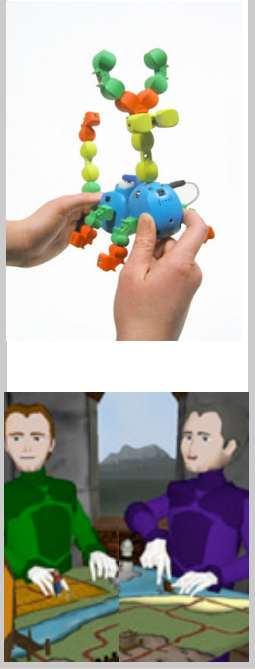
Embodied Interaction

Electrical → Symbolic → Textual → Graphical → Embodied







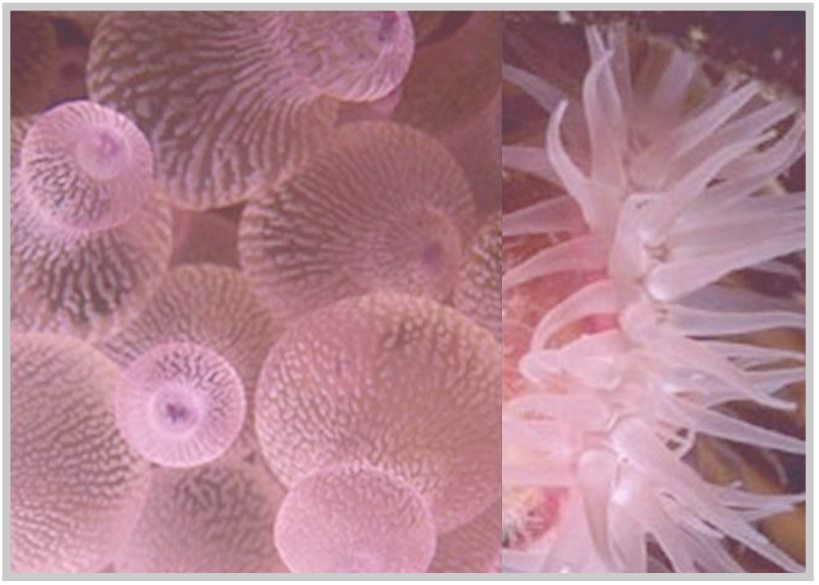


Tangible Bits

Seamless couplings between physicality and virtuality

“We live between two worlds: our physical environment and digital space.” (Ishii, 2007)

At the border between elements



At the border

We live on the border where bits meet atoms. In the flood of pixels from the ubiquitous GUI screens, we are losing our sense of body and places. [Ishii, 1997]

Tangible User Interfaces

Coincidence of input and output spaces

Curlybot

[Frei, Su, & Ishii, 2000]

Topobo

[Raffle, Parkes, & Ishii, 2004]

Coincidence of input and output spaces

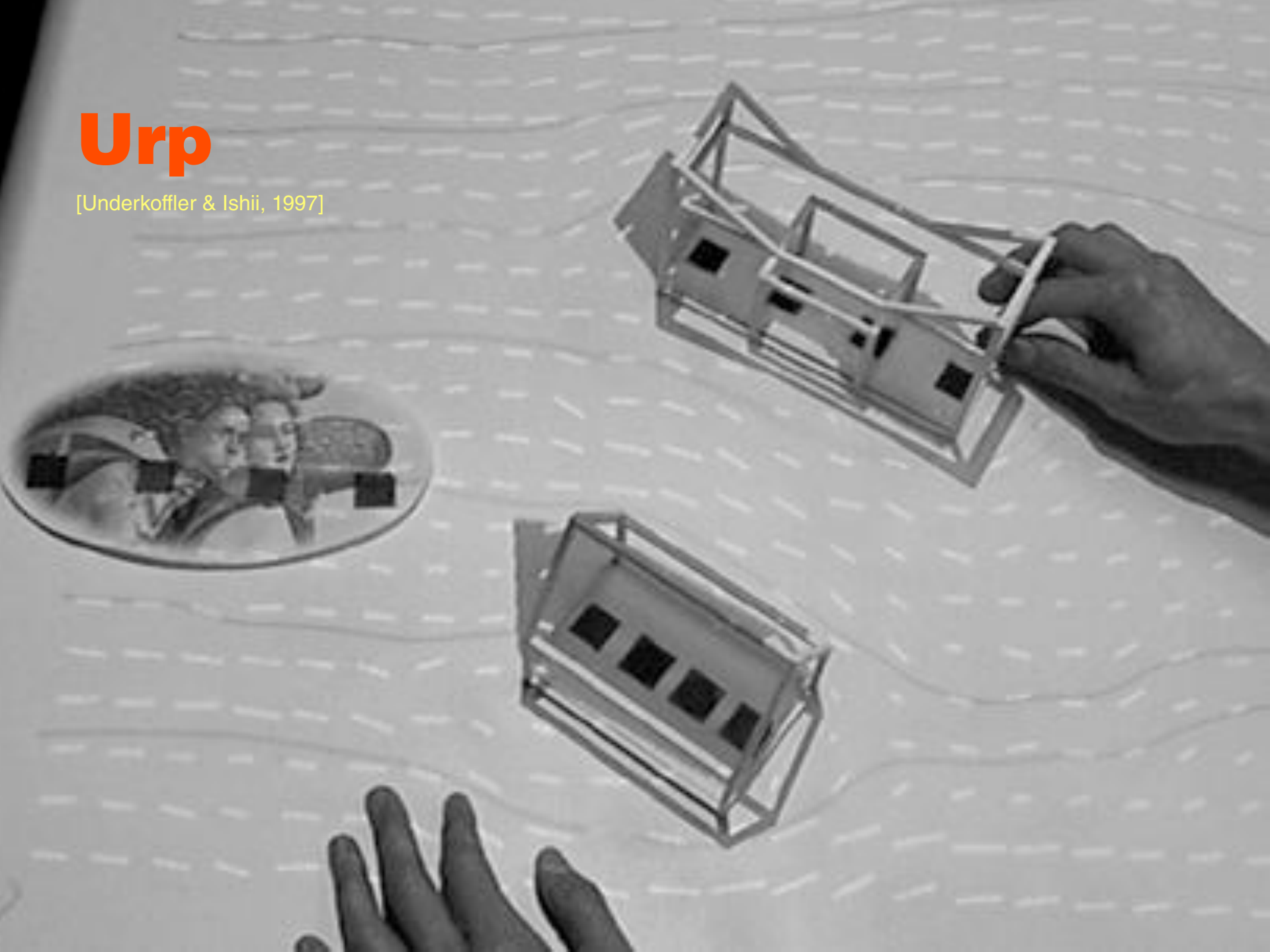
Tangible User Interfaces

Tabletop TUIs

Coupling tangible representations to digital information and computation

Urp

[Underkoffler & Ishii, 1997]



Illuminating Clay

[Piper, Ratti, & Ishii, 1999]

AudioPad

[Patten, Recht, & Ishii, 2004]

Bubblegum Sequencer

Making Music With Candy

What is the Bubblegum Sequencer?

The Bubblegum Sequencer is a physical step sequencer that lets you create drumloops by arranging colored balls on a tangible surface. It generates MIDI events and can be used as an input device to control audio hardware and software. Finally, people can't claim anymore that electronic music isn't handmade.

Here's how it works: A grid of holes, consisting of several rows with 16 holes each is the canvas. On it, you arrange colored gumballs. The 16 columns represent the 16th-notes in a measure. Each color is mapped to a specific sample.

Because the output is generated in the form of MIDI events, the Bubblegum Sequencer can be used to control any kind of audio hardware or software.

If you'd like to know more about the Bubblegum Sequencer, read our course paper.

Demo

Here's a video showing some of the Bubblegum Sequencer's current features:

(Download video as .mov file)

How it's done

News

New: German electronic music magazine De-Bug covers Bubblegum Sequencer (PDF)

See us at Maker Faire 2008, May 3-4 in San Mateo!

Tangible User Interfaces

Augmented everyday objects

Embodiment of mechanisms for interactive control with tangible representations

Music bottles

[Ishii et al., 2000]

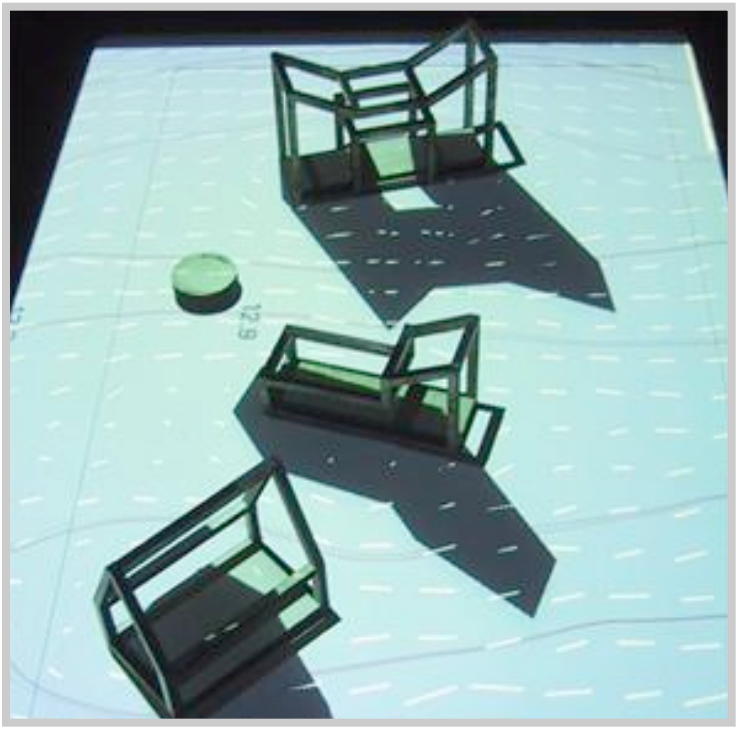
I/O Brush

[Ryokai, Marti, & Ishii, 2004]

TUI vs. GUI

TUI

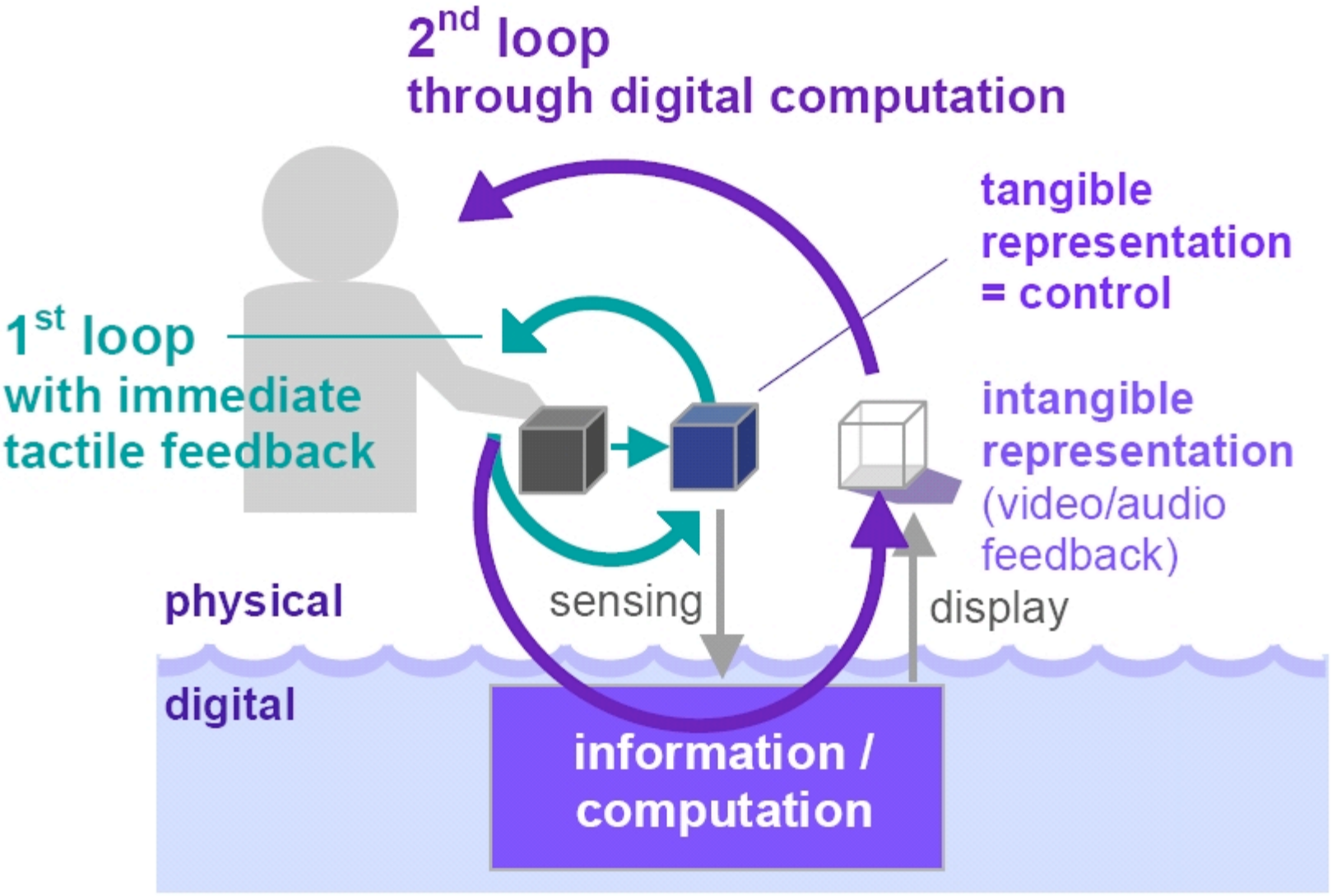
Tangible bits
Coincidence of input and output space



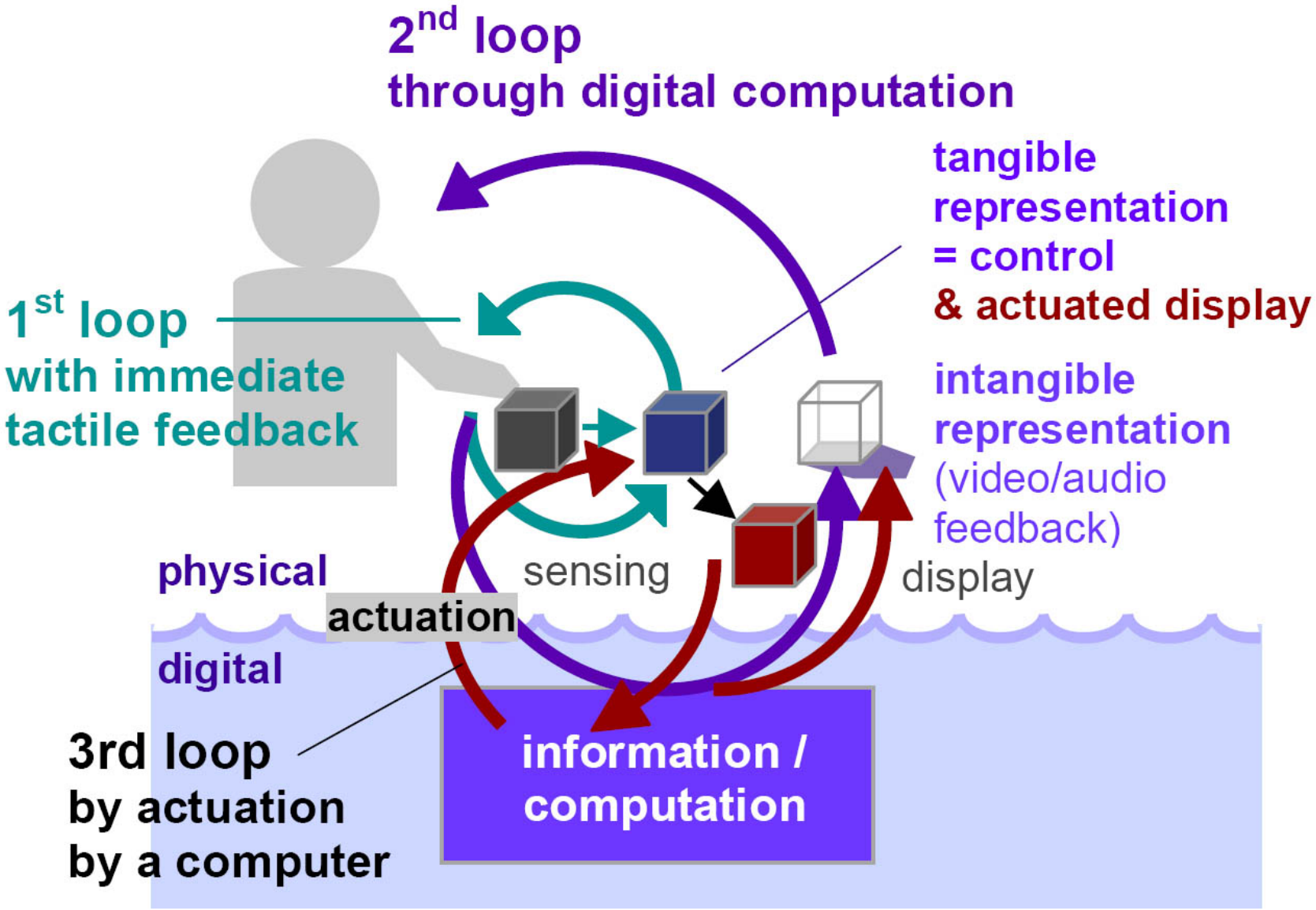
GUI

Painted bits
Generic remote control

Tangible User Interaction Loop [Ishii, 2006]



Tangible User Interaction Loop [Ishii, 2006]



TUI Interaction Loop

Combining the skillful hand with the reasoning mind

Tuesday Next Week (Sept 16)

- Tokens, tools, and containers
- Taxonomy of Tangible User Interfaces

For this Thursday (Sept 11th, 2008)

- Read Physical Computing:
  - Chapter 3 and p.228: Igoe & O'Sullivan (2004) Physical Computing.

- Don't forget to bring your laptop and lab kit on Thursday
- Post your lab homework (code and photo) on the course website
- Office hours this week: Tuesday (today), 3:30-4:30 in 110 South Hall

Midterm Project

Design a Tangible User Interface that takes advantage of your hands to manipulate digital information. Apply it to a topic of your research interest (e.g., tool for communication, learning/education, design, etc.). Your project may be based on a completely new design or redesign of familiar everyday objects.

- 9/23 Form a group (maximum of 3 members) for your project and write a 1-page proposal and post it on the course website
- 10/7 Progress sketches due (post your sketches on the course website)
- 10/14 In-class midterm project presentation. Present your slides and optional mockups

Final Project

You may expand your midterm project, or take a new approach. You may continue to work as a group (maximum of 3 members) or as an individual. If you work in a group, be clear about each member's role in the project.

- An interactive prototype to be exhibited at the final course exhibition on Dec 9, 2008. Your prototype is to demonstrate your original idea for a Tangible User Interface that takes advantage of your hands to manipulate digital information, and
- A write-up due Dec 15, 2008 in the ACM SIGCHI Extended Abstract format (6-8pgs)

Group forming exercise

1. Select topics you are interested in developing Tangible User Interface for (5 minutes)

2. Meet at least 15 people (15 minutes)
3. Form a group (10 minutes)

Thanks!