week 03

Tangible Bits

Implications for user interfaces
Lecture Outline

• Designing Interactions
• Tangible User Interfaces
• Group forming exercise
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

How do you...

...feel?

cool
hot

I handle
a button

do?

path

know?

map

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

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 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)
Designed affordances

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

Graphical

- **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

Macintosh System 4.2, 1987
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)
photo from Moggridge (2006)
Eyes are in charge

Eyes guide tools, read notations, appraise designs. Eyes see wholes, and compare many objects simultaneously. 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)
Hand-eye skills [adopted from McCullough, 1996]

coarse, discrete

fine, continuous

eyes-in-charge

- detecting events, e.g. someone entering classroom
- forcing objects

hands-in-charge

- sorting coins
- playing music
- sculpting
- knitting

- driving in stop and go traffic
### Hand-eye skills [adopted from McCullough, 1996]

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<thead>
<tr>
<th>coarse, discrete</th>
<th>fine, continuous</th>
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<td>eyes-in-charge</td>
<td>hands-in-charge</td>
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<td><strong>information tool users</strong></td>
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<td>detecting events, e.g. someone entering classroom</td>
<td>driving in stop and go traffic</td>
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<td>typing with a keyboard</td>
<td>pointing with a mouse</td>
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Tools

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

Tools and Mediation

Tools shape the way human beings interact with reality. The shaping of external activities eventually results in the shaping of internal ones, and vice versa.
Activity Theory

Tools and Mediation

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

Aesthetics of the tools lost in the flood of PCs?
Embodied Interaction

Electrical → Symbolic → Textual → Graphical → Embodied
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.
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]
Actuated Workbench

[Pangaro, Maynes-Aminzade, & Ishii 2002]
PICO
[Patten & Ishii 2007]
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]

1\textsuperscript{st} loop with immediate tactile feedback

2\textsuperscript{nd} loop through digital computation

Tangible representation = control

Intangible representation (video/audio feedback)

physical
digital

information / computation

display

sensing
Tuesday Week 3: Tangible Bits

Theory and Practice of Tangible User Interfaces

Tangible User Interaction Loop [Ishii, 2006]

2\textsuperscript{nd} loop through digital computation

1\textsuperscript{st} loop with immediate tactile feedback

3\textsuperscript{rd} loop by actuation by a computer

physical actuation
digital

sensing
tangible representation = control & actuated display

intangible representation (video/audio feedback)
display

information / computation
TUI Interaction Loop

Combining the skillful hand with the reasoning mind
Tuesday Next Week (Sept 18)

- Tokens, tools, and containers
- Taxonomy of Tangible User Interfaces
For this Thursday (Sept 13th, 2007)

• Read Physical Computing:
  • Analog input: p.102-104
  • Soldering: p.41-42

• Don’t forget to bring your laptop and lab kit on Thursday
• Post your lab homework (diffuser and code) 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.

- 9/25 Form a group (maximum of 3 members) for your project and write a 1-page proposal and post it on the course website
- 10/9 Progress sketches due (post your sketches on the course website)
- 10/23 In-class midterm project presentation. Present your poster and optional mockups
Group forming exercise

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

- Game
- Sustainability & Health
- Education
- Communication
- Music & Art

2. Meet at least 15 people (15 minutes)

3. Form a group (10 minutes)
Thanks!