Tangible Interfaces and Multi-Modal Interfaces

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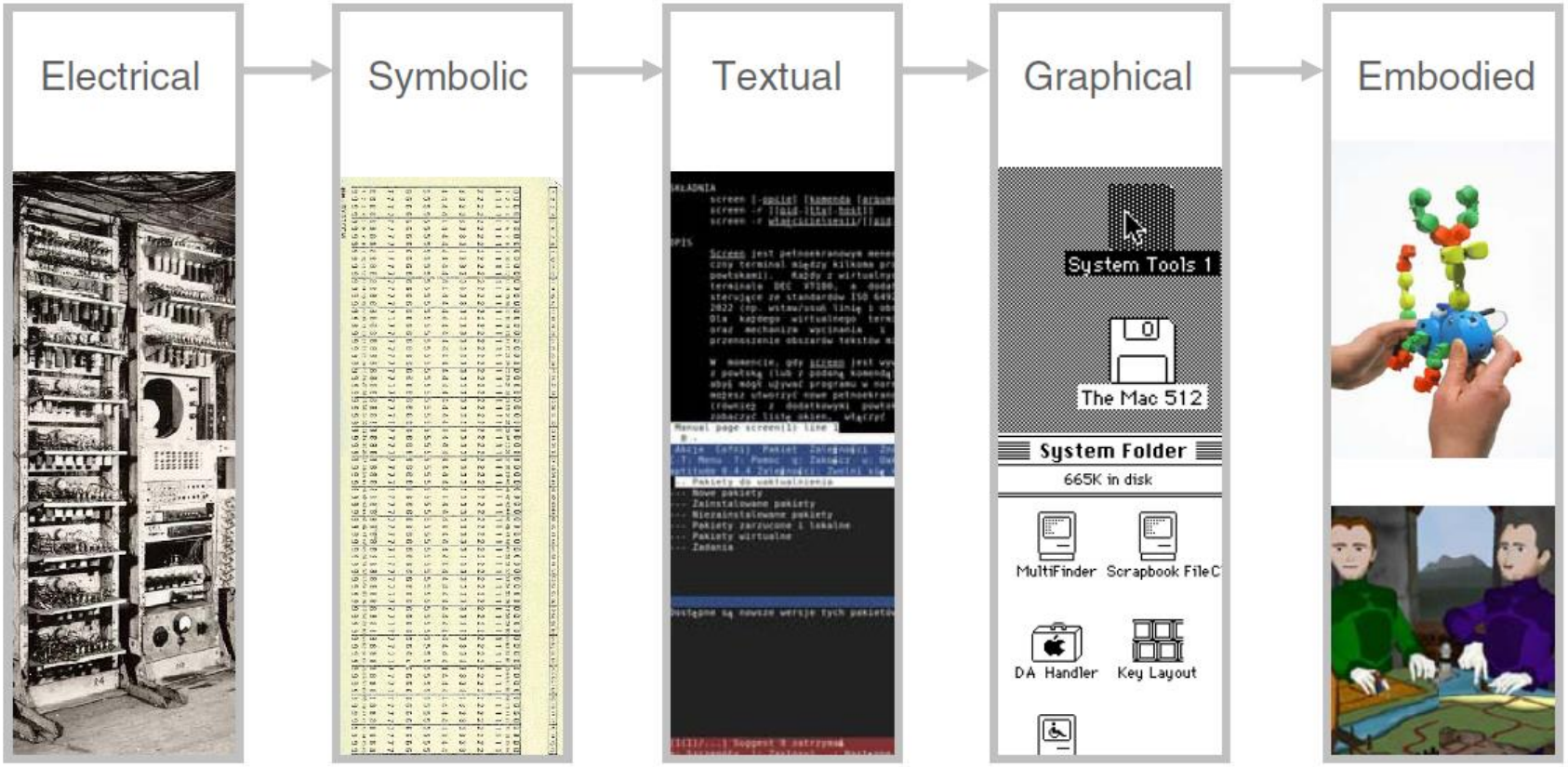
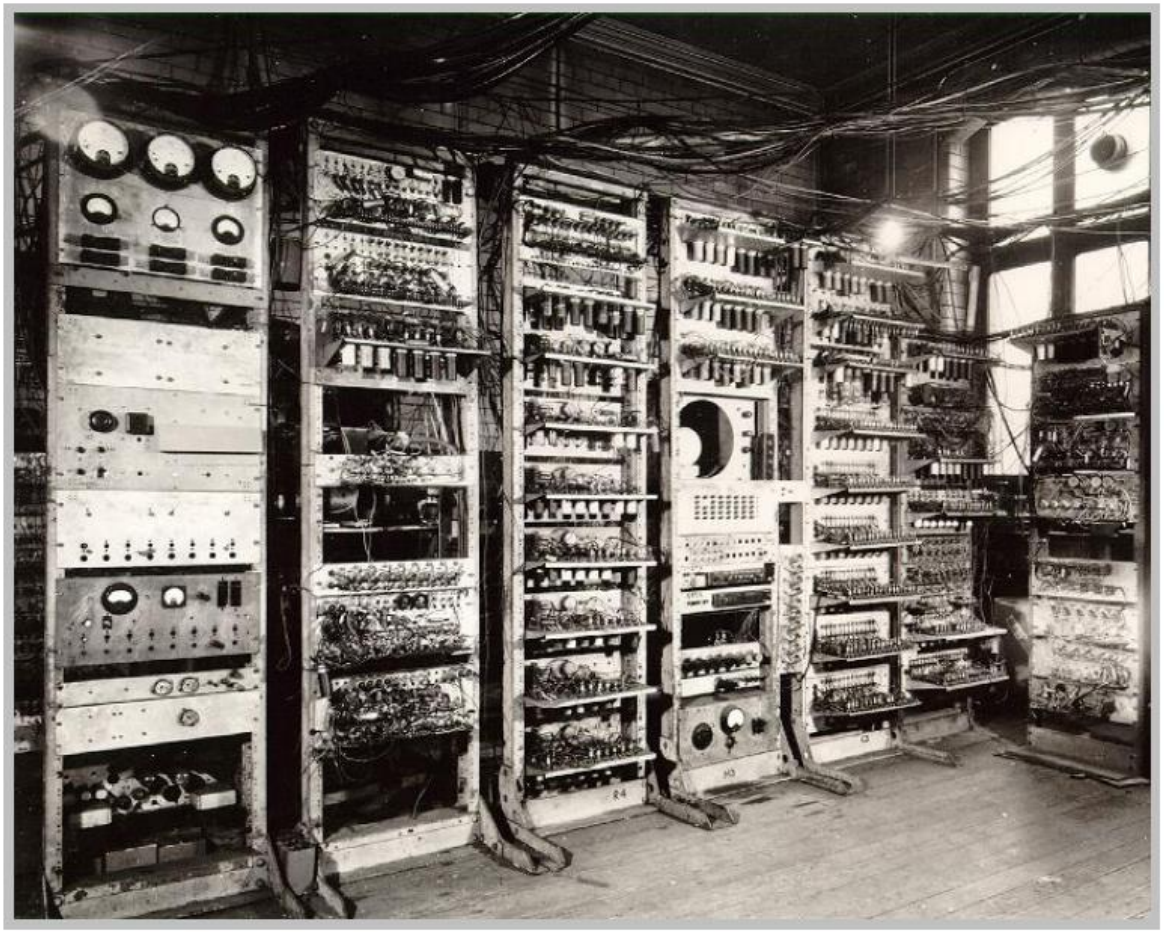
Historical Development of UI



From *Where the Action Is* (Dourish, 2001)

Historical Development of HCI

Electrical

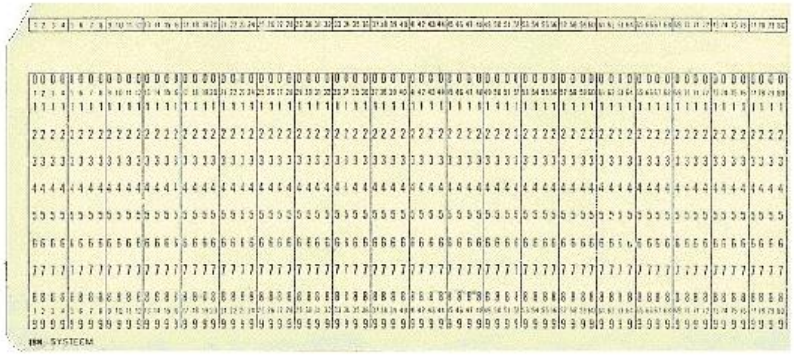


The Small Scale Experimental Machine, AKA "Baby" built at Manchester University in 1948.

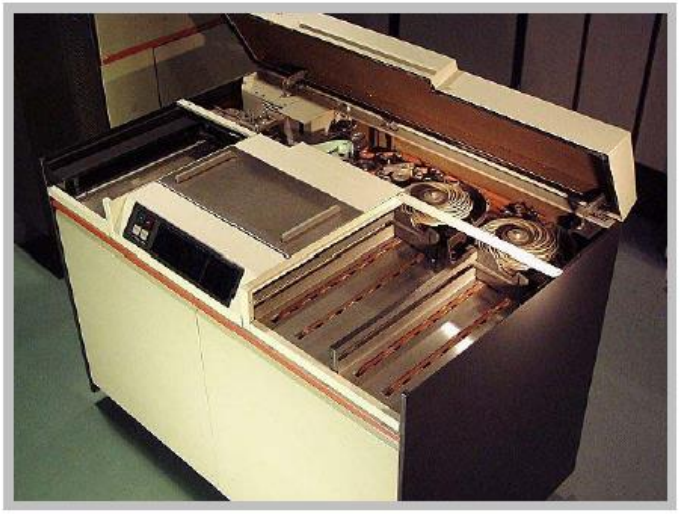
- Special purpose devices (e.g., automatic calculation of missile trajectories, patterns in coded messages)
- To program the machine for different tasks, electrical circuits need to be changed
- Interacting with the system required a thorough understanding of the electronic design

Historical Development of HCI

Symbolic



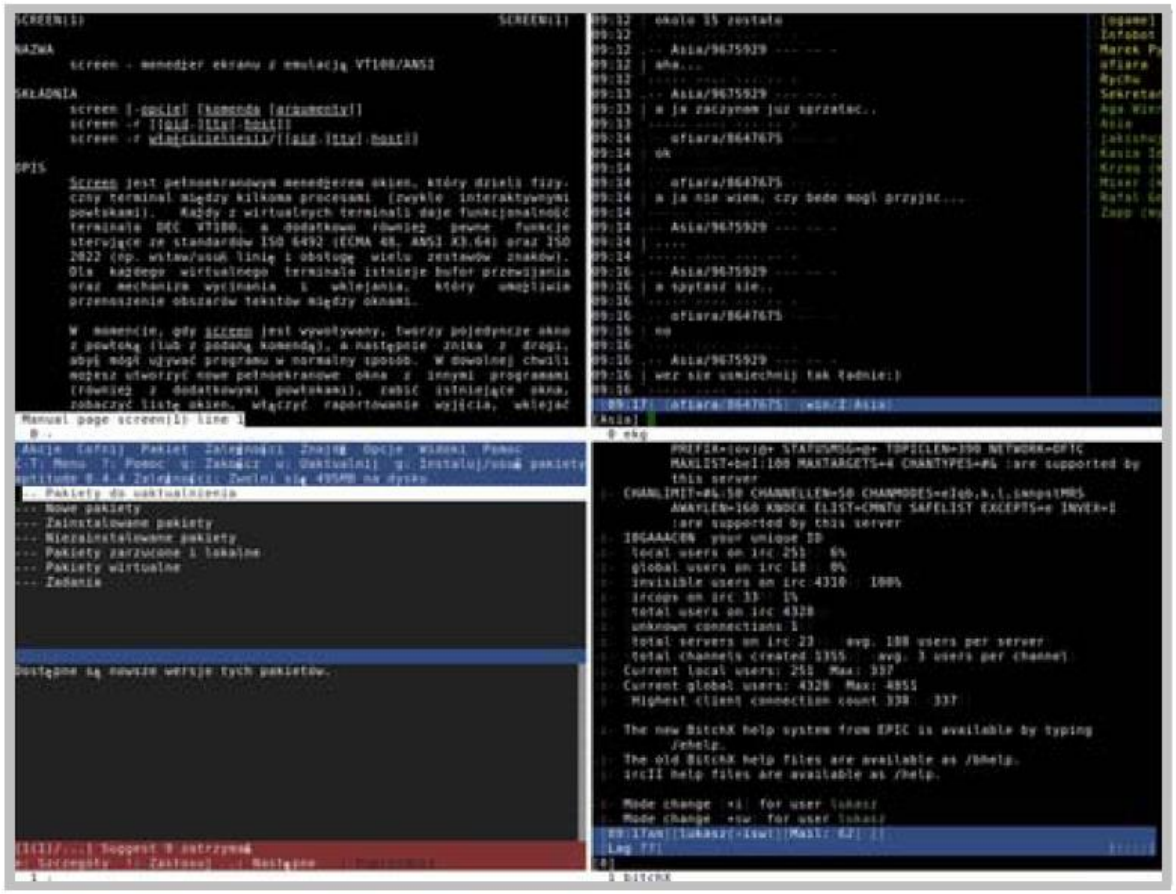
- Introduction of programming systems
- More regularized instructions available across a wider range of machines
- Symbolic forms of interaction is not textual (e.g., punched cards)



IBM 29 card punch (circa 1950's)

Historical Development of HCI

Textual

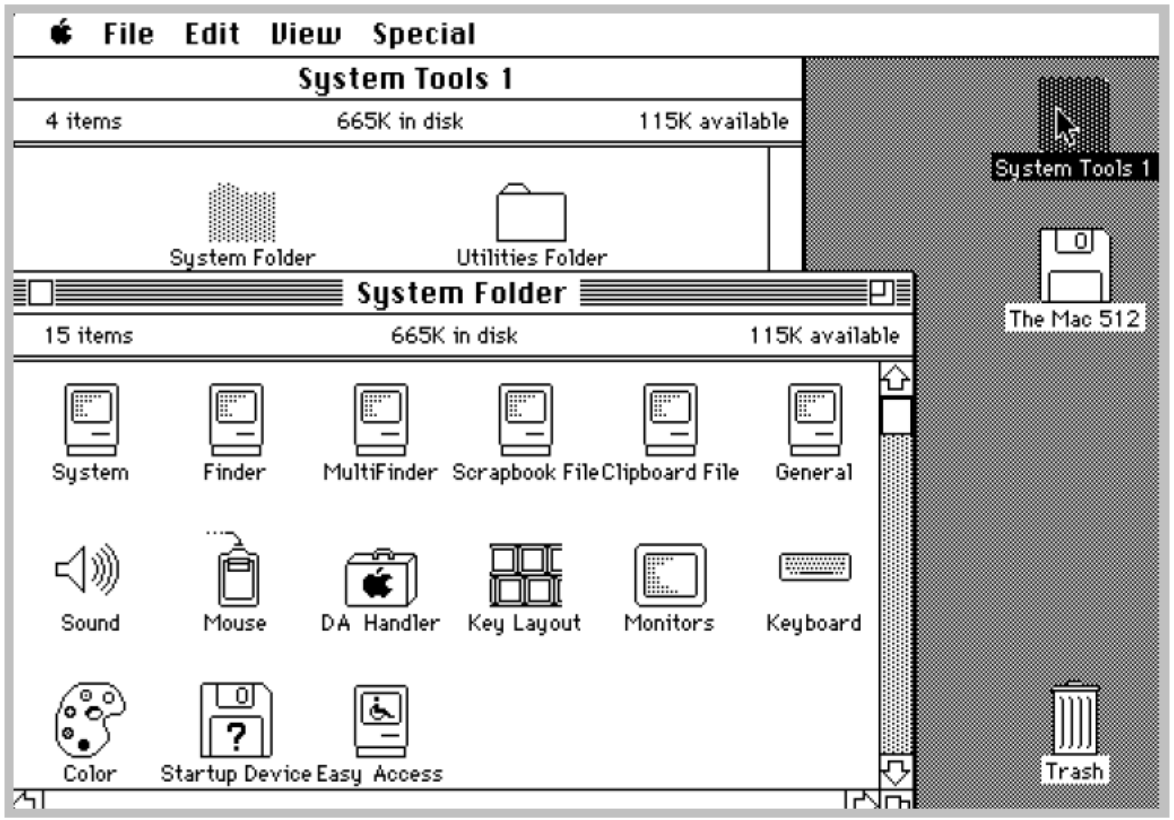


- Takes advantage of the best-developed form of symbolic interaction: written language
- More like a “dialog”

E.g., early UNIX, DOS

Historical Development of HCI

Graphical



Macintosh System 4.2, 1987

Turning interaction into two-dimensional space rather than a one-dimensional stream of characters

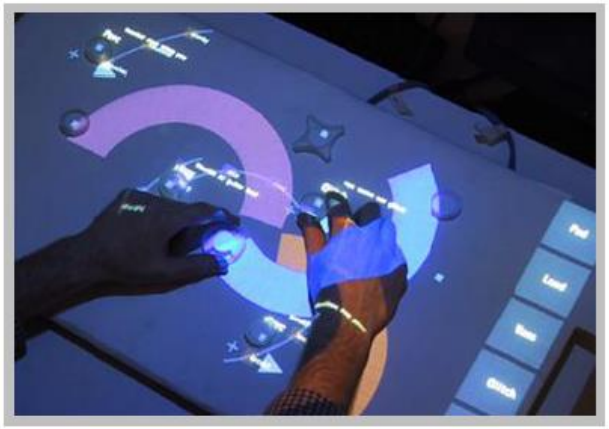
Tangible Interfaces

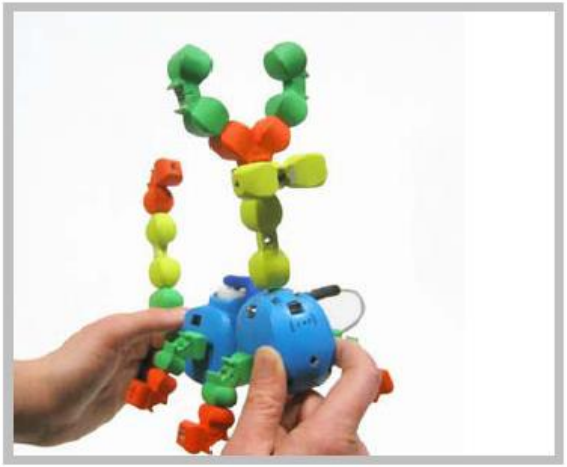
Motivation

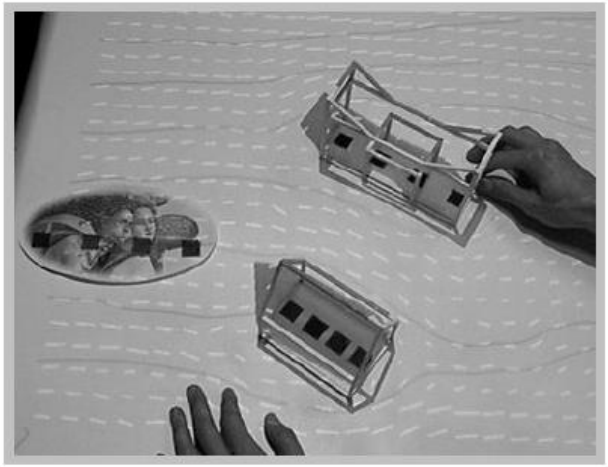
- Desire to remove divide between electronic and physical worlds
  - Bring benefits of computation (the virtual world) beyond confines of the screen, to the rest of life
  - Making crossing between “bits and atoms” seamless (or at least a lot easier)
    - Put information “in our hands” in a rather literal way

Historical Development of HCI

Tangible Interaction





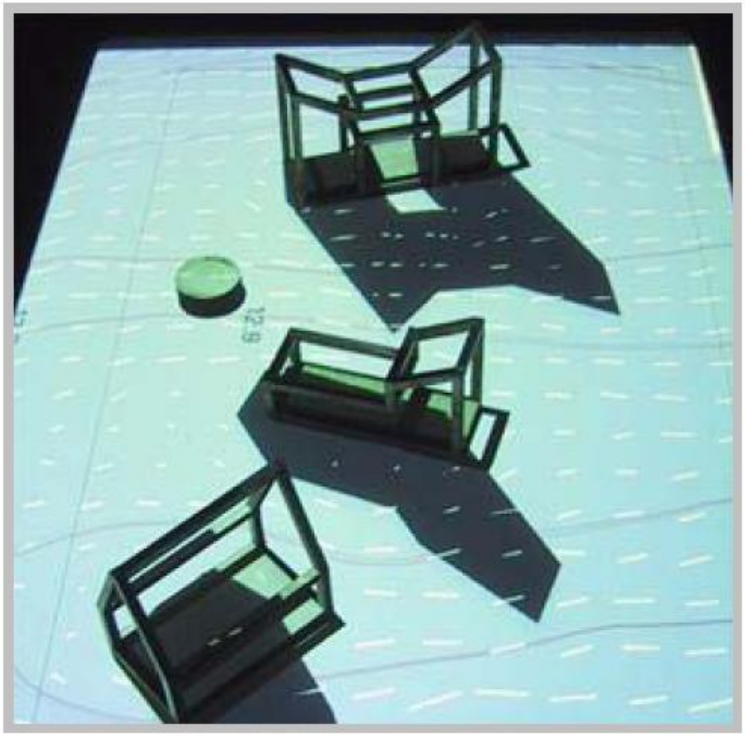


- Computation that moves beyond desktop
- Interaction is incorporated more richly in our daily experience of the physical world

TUI vs. GUI

TUI

Tangible bits
Coincidence of input and output space



GUI

Painted bits
Generic remote control


metaDESK
Tangible Media Group
MIT Media Laboratory

Tangible Interfaces

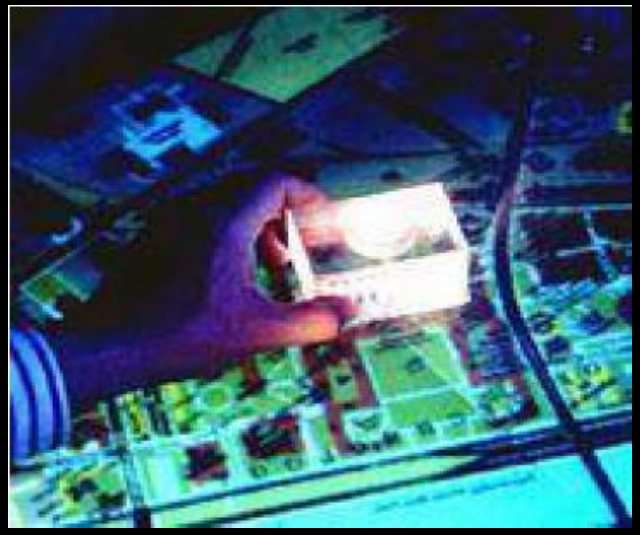
A tangible user interface is a user interface in which a person interacts with digital information through the physical environment.

More about TUIs

1. Some input event occurs. This input event is typically a physical manipulation performed by a user with her hands on some ‘‘everyday physical object,’’ such as tilting, shaking, squeezing, pushing, or, most often, moving.
2. A computer system senses this input event, and alters its state.
3. The system provides feedback. This output event is via a change in the physical nature of some object—it alters its display surface, grows, shrinks, makes a sound, gives haptic feedback, etc.

Example 1: metaDESK

- **Input object:** indicative of a building
- **Input:** positions and rotations
- **Output object:** augmented desktop
- **Output**: altered display of the workspace



Example 2: Doll's Head

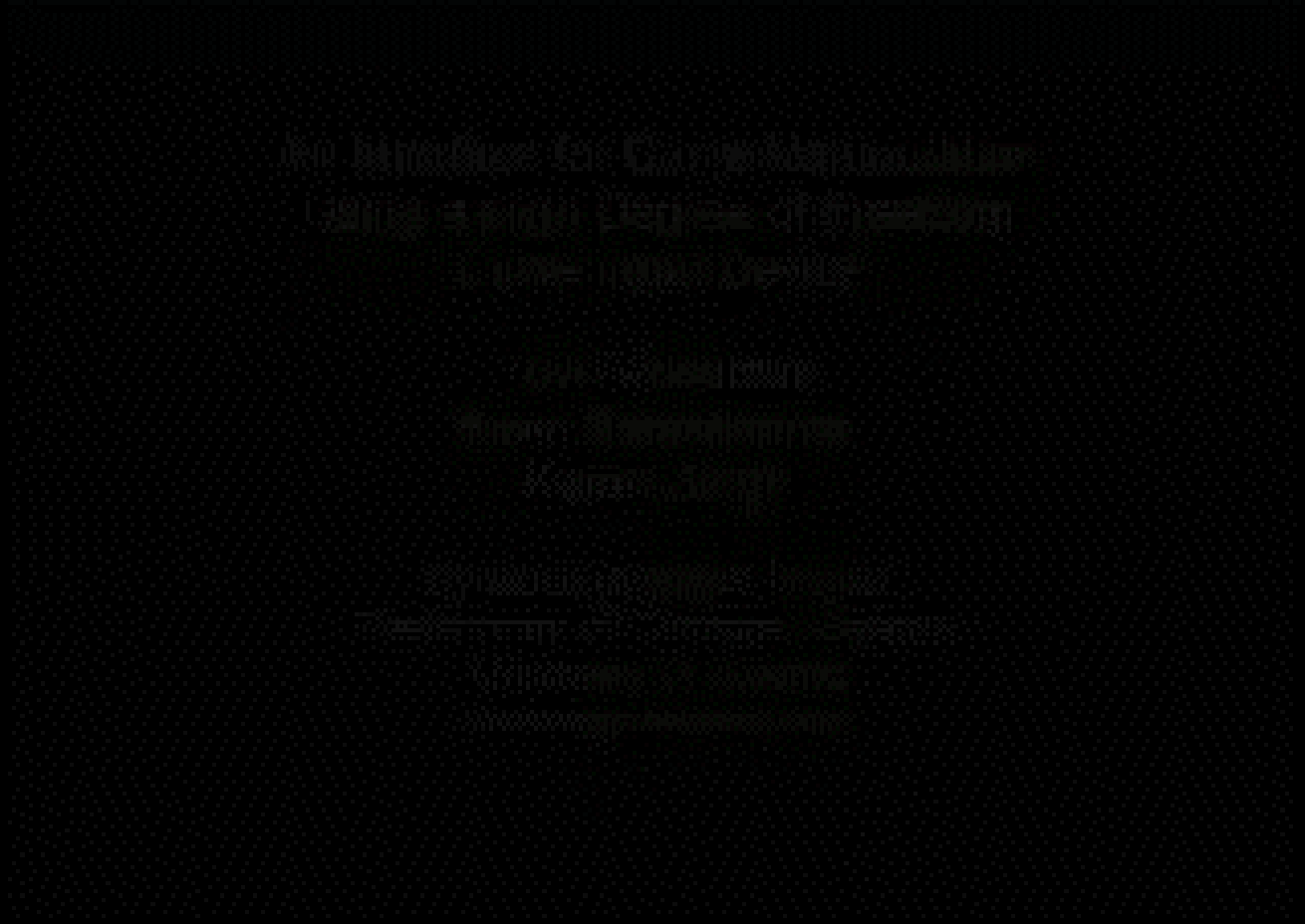
- **Input object:** doll's head and a plate
- **Input:** positions and rotations
- **Output object:** computer monitor
- **Output:** altered display of the display

Hinckley et al. (1994)

A real-world example

DataTile

A Curve Input Device



Embodiment

Full, nearby, environmental, distant

How closely tied is the input focus to the output focus? To what extent does the user think of the states of the system as being ‘‘inside’’ the object they are manipulating? To what extent does the user think of the state of computation as being **embodied within a particular physical housing?**

Full Embodiment

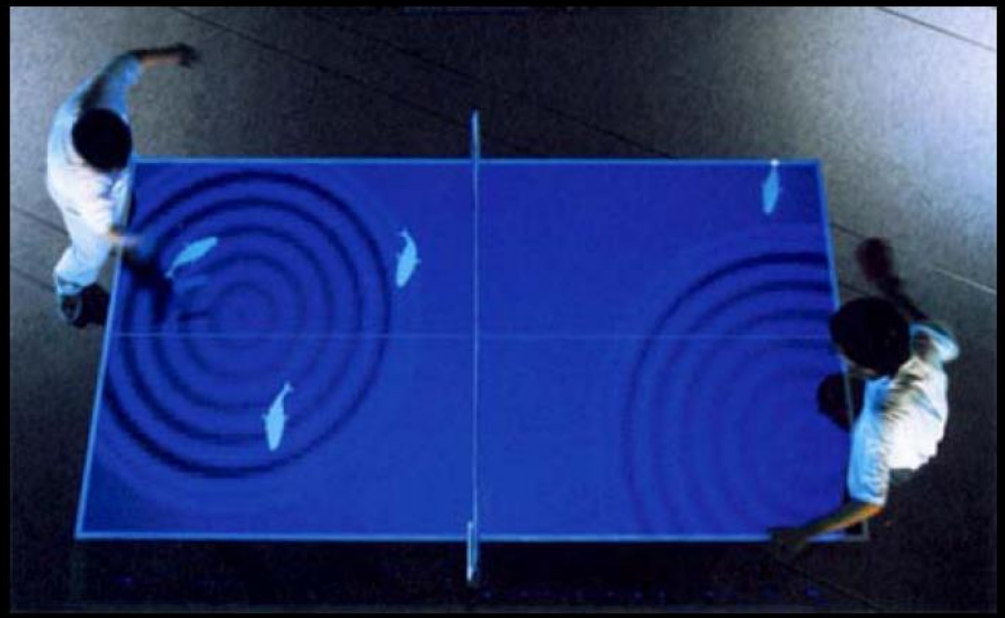
- The output is the input device, input output coincidence

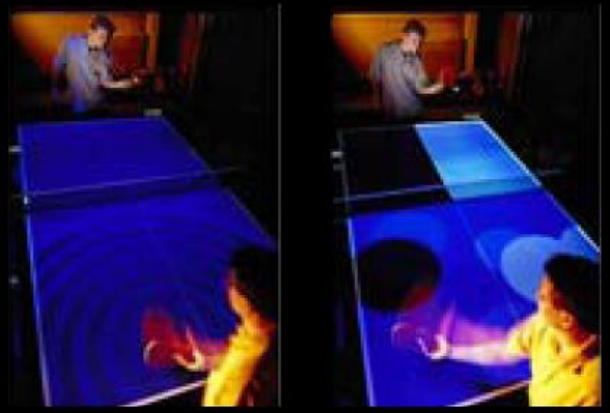
Gummi

Flexible Display Interaction

Nearby Embodiment

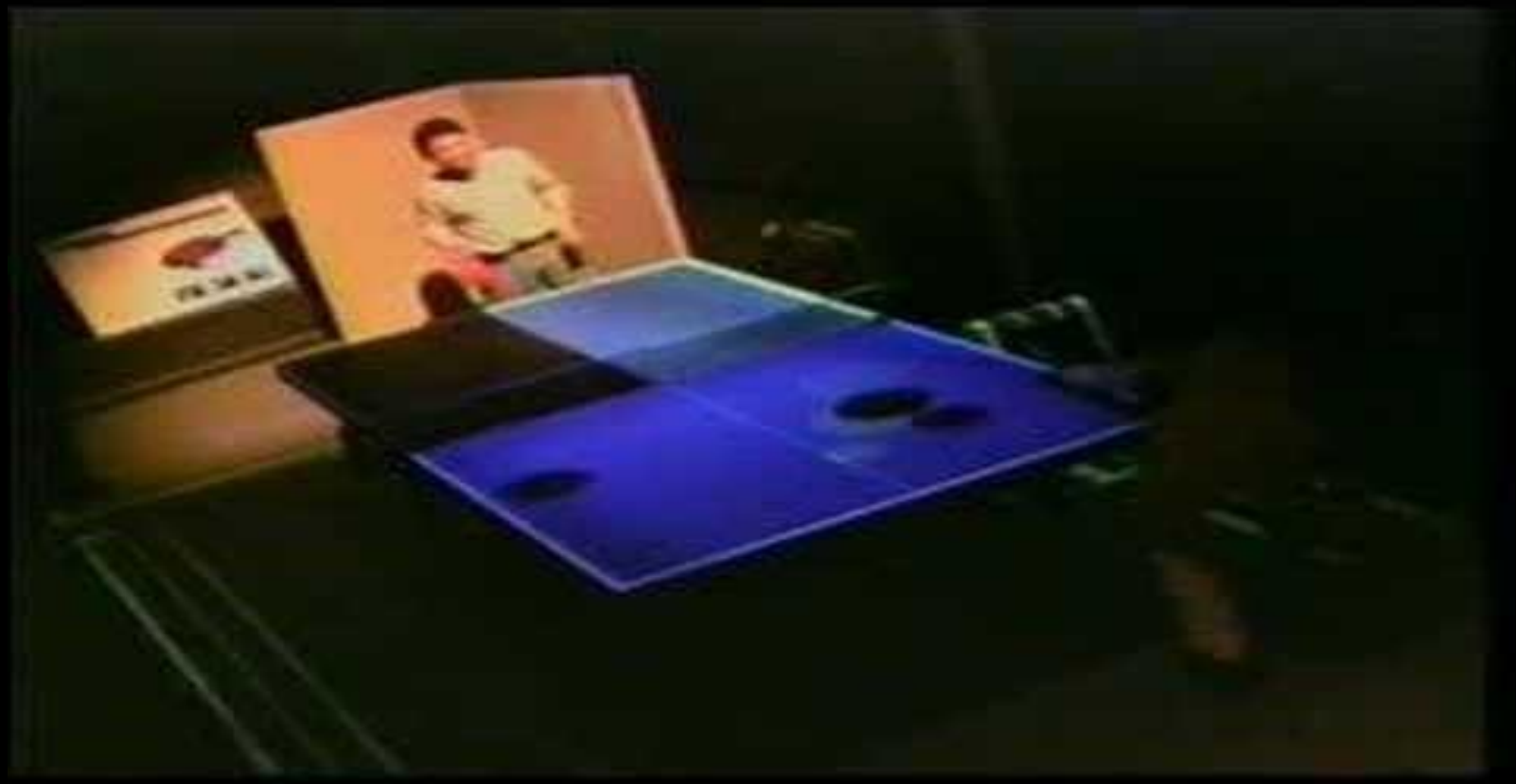
- The output is tightly coupled to the focus of the input





Ping Pong Plus

Ping Pong Plus



Distant Embodiment

- The output is “over there” on another screen, or even another room, like a remote control

Doll’s head

MultiModal Interfaces

Some HCI definitions

- *Multimodal* generally refers to an interface that can accept input from two or more combined modes
- *Multimedia* generally refers to an interface that produces output in two or more modes
- The vast majority of multimodal systems have been speech + pointing (pen or mouse) input, with graphical (and sometimes voice) output

Input Modalities

mouse

pen: recognized or unrecognized

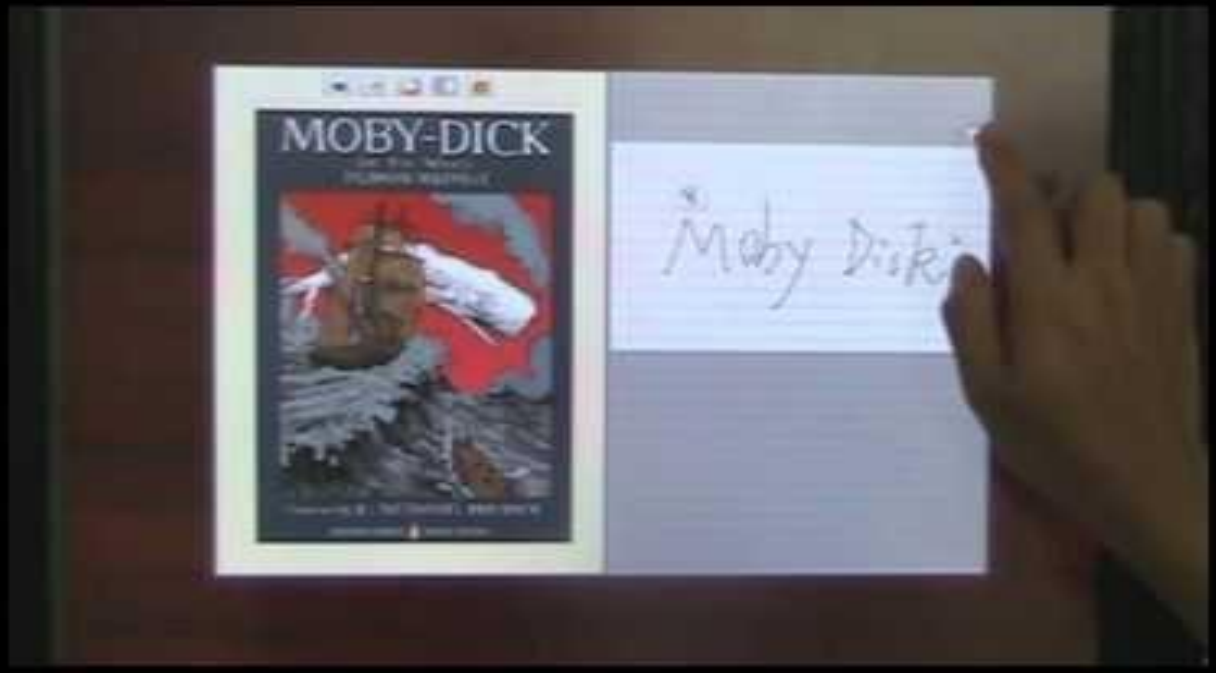
speech

non-speech audio

tangible object manipulation

gaze, posture, body-tracking

- Each of these experiences has different implementing technologies


MOBY-DICK
Moby Dick


tobii

Output Modalities

Visual displays

Haptics, e.g. force feedback

Audio

Smell

Taste

Multimodal Research is Driven By Technology

1990s – 2000s	**Speech Recognition, Pen Interface, Eye tracking, Speech Synthesis**
2000s – 2010s	**Context-Aware Computing, Motion Sensing, Facial Expressions, Mobile Display**
2010 – present	**6DOF Sensing (VR, AR), Richer Touch, Physiological Signal Sensing, Wearable Display**

Why Multimodal?

- Hands busy / eyes busy
- Mutual disambiguation
- Faster / higher bandwidth communication
- “More natural”

Why multimodal?

- More transparent, flexible, efficient, and powerfully expressive means of HCI

Flexibility

- Modality choice for different situations
- Modality choice for different functions
- Broader range of users
- Broader range of environments

What do you gain?

- Some speed and efficiency
- Improved error handling
  - Simpler language used leads to less recognition errors
  - Mutual disambiguation of different input modes

GUI vs multimodal

- GUI
  - Serial and discrete
- Multimodal
  - Parallel and probabalistic