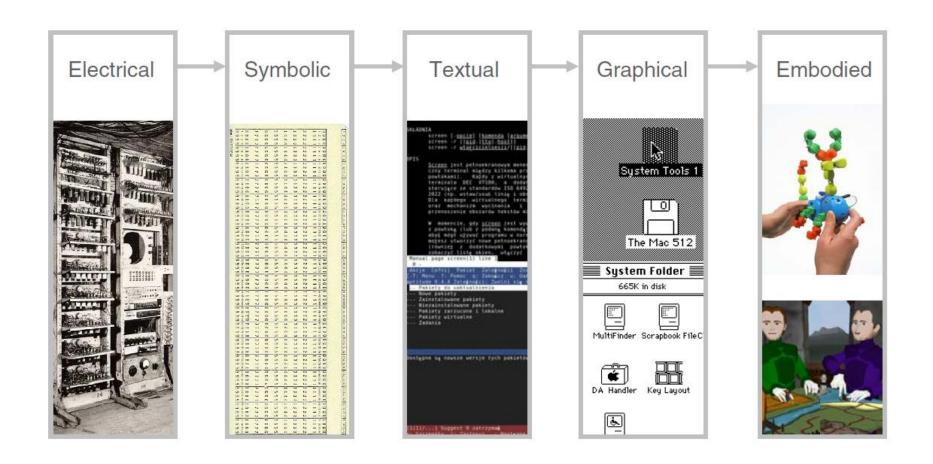
# Tangible Interfaces and Multi-Modal Interfaces

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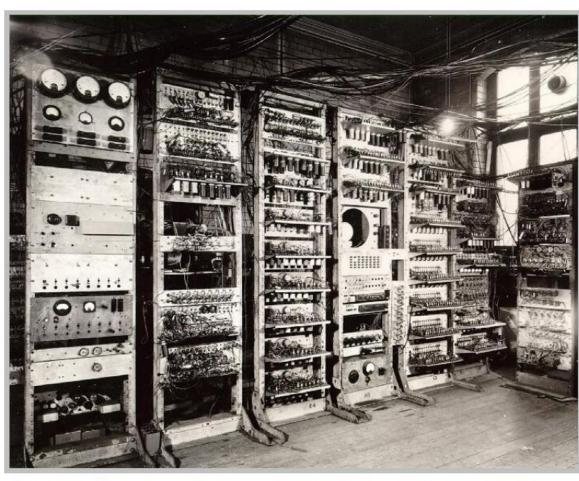
## **Historical Development of UI**



Electrical Symbolic Textual Graphical Embodied

### **Historical Development of HCI**

### **Electrical**

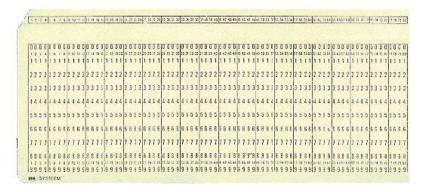


- Special purpose devices (e.g., automatic calculation of missile trajectories, patterns in coded messages)
- To program the machine for different tasks, electrical circuits need to be changed
- Interacting with the system required a thorough understanding of the electronic design

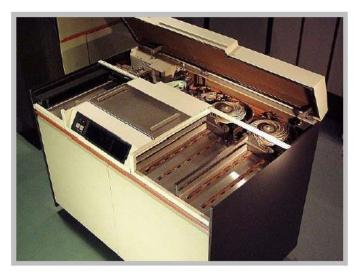
The Small Scale Experimental Machine, AKA "Baby" built at Manchester University in 1948.

### **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)

Electrical Symbolic Textual Graphical Embodied

#### **Historical Development of HCI**

### **Textual**

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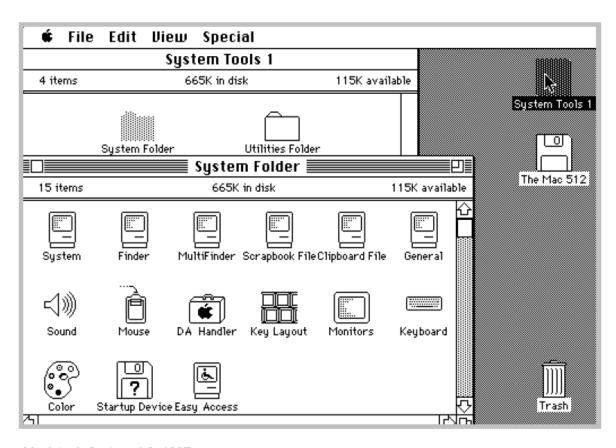
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```

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

### **Historical Development of HCI**

## **Graphical**



Turning interaction into two-dimensional space rather than a onedimensional 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

Electrical Symbolic Textual Graphical Embodied

### **Historical Development of HCI**

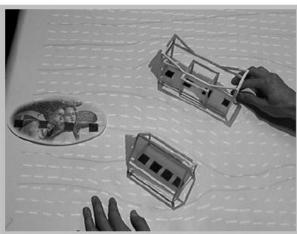
## **Tangible Interaction**





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

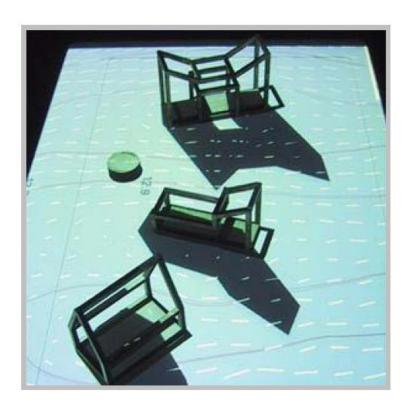




### TUI vs. GUI

### TUI

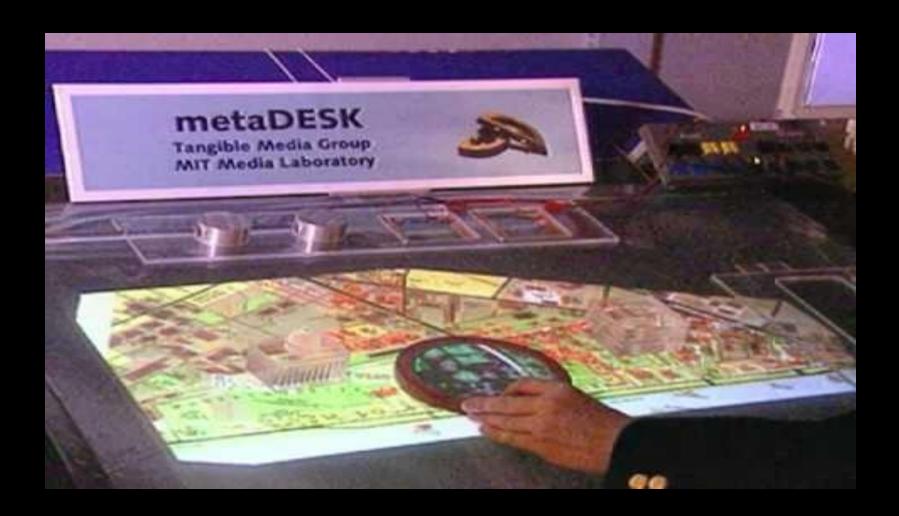
Tangible bits
Coincidence of input and output space

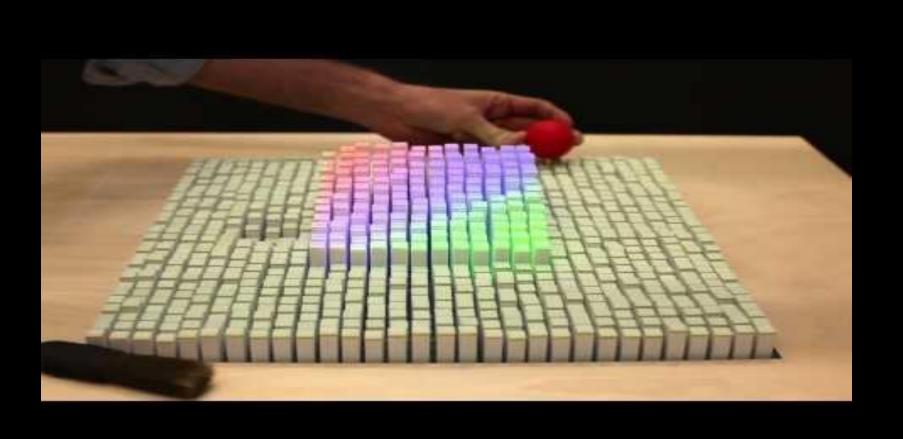


#### **GUI**

Painted bits Generic remote control







## **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



# 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

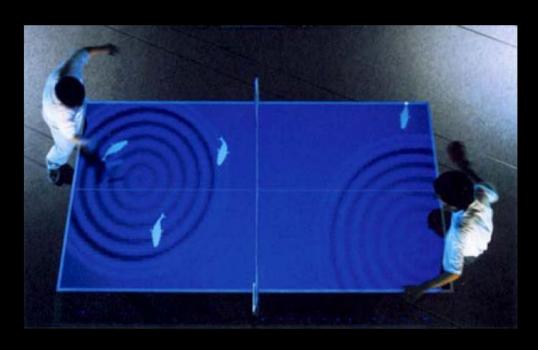


# Flexible Display Interaction



# **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

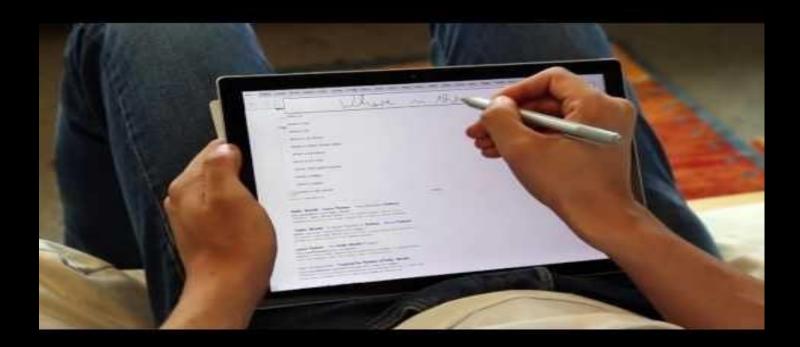
- Multimodal generally refers to an interface that can accept input from two or more combined modes
- Multimedia generally refers to an interface that produces output in two or more modes
- The vast majority of multimodal systems have been speech + pointing (pen or mouse) input, with graphical (and sometimes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

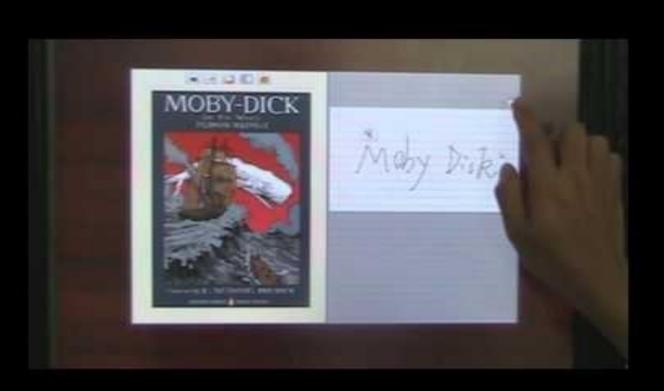
# Input Modalities

mouse

pen: recognized or unrecognized speech non-speech audio tangible object manipulation gaze, posture, body-tracking

 Each of these experiences has different implementing technologies







# **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