

Introduction to Human-Computer Interaction

2. Definition and History

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Human-Computer Interaction

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- A discipline concerned with the **analysis, design, implementation, and evaluation** of **interactive computing systems** for human use and with the study of major phenomena surrounding them.
 - from ACM SIGCHI Curricula for Human-Computer Interaction, 1992
- A broad term that covers all aspects of the ways in which people interact with computing systems

What are “Humans”?

- Simply, us.
- Humans have different age, sex, skill, background, expertise, handedness, education, language, culture, ...
- One single design may not work for all.



What are “Computers”?

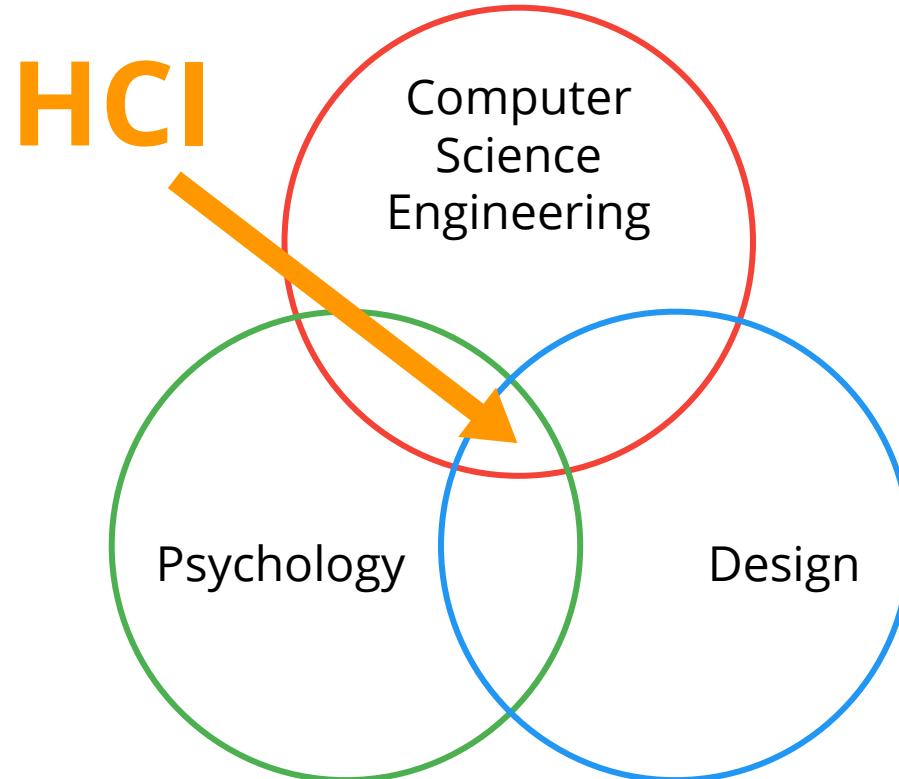


HCI is Interdisciplinary

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- Computer science
- Engineering
- Ergonomics and human factors
- Cognitive/social psychology
- Design
- Art
- Anthropology/sociology



HCI Topics

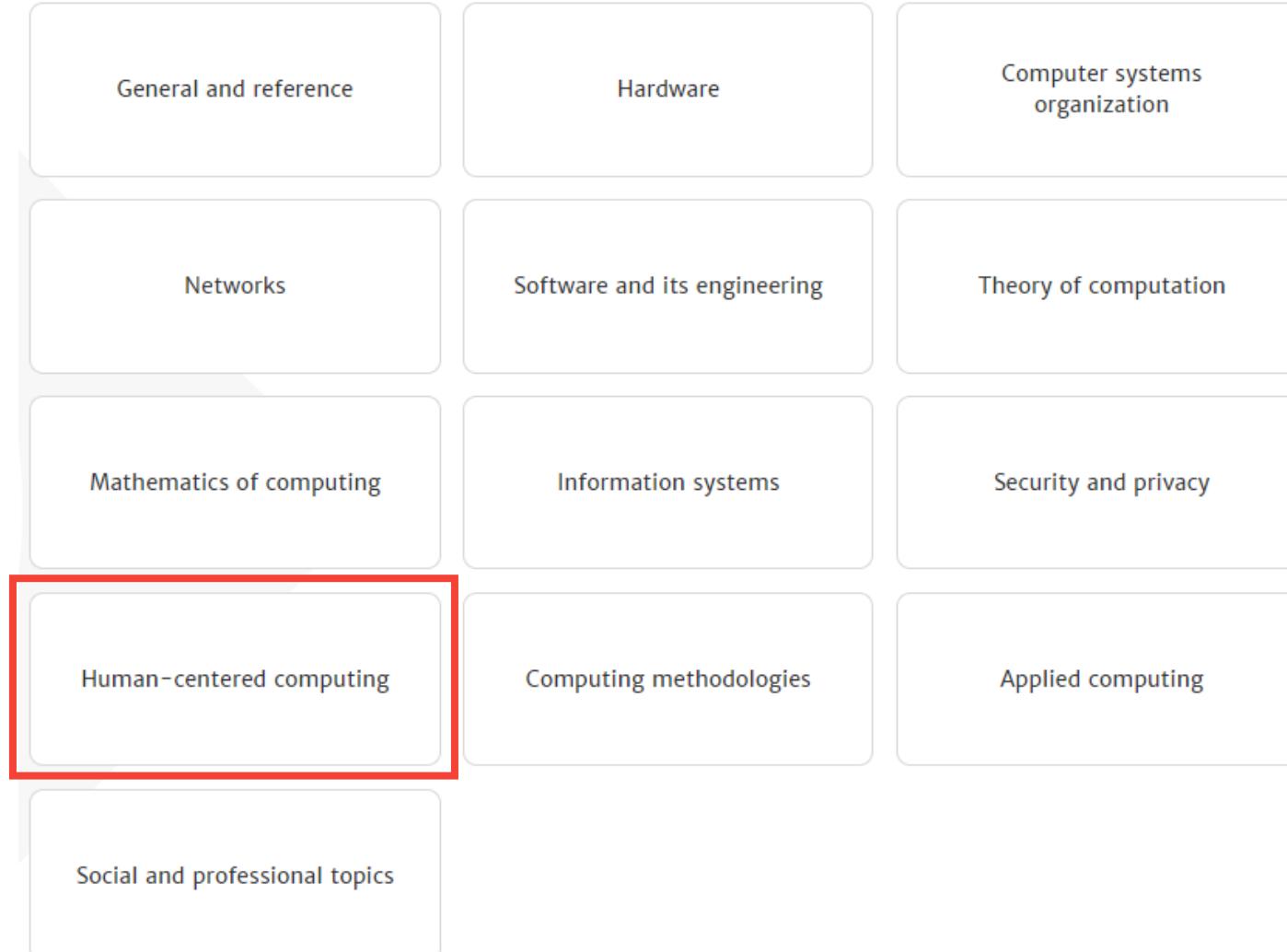
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- Human-Computer Interaction is everywhere!
- User Experience and Usability, Learning, Education and Families, Interaction Beyond the Individual, Games and Play, Privacy and Security, Visualization, Health, Accessibility and Aging, Design, Interaction Techniques, Devices and Modalities, Understanding People, Engineering Interactive Systems & Technologies, Critical and Sustainable Computing
 - from CHI 2021 Website

Position

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Position

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Human computer interaction
(HCI)

Interaction design

Collaborative and social
computing

Ubiquitous and mobile
computing

Visualization

Accessibility

Position

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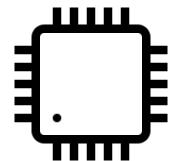


What is a Good Design?

- The user only sees the interface of a system no matter how the system is fast and sophisticated.
- ***Humans should come first.***
- A computing system would be **ineffective** if the user cannot fully utilize it.
- Make systems **usable**.

Computer Science is about...

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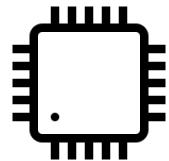
Fast
Secure
Power-efficient
Error-free
Maintainable
Cheap
Small
Reliable
Standard-compliant
Modular

HCI is about...

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Useful
Usable
Used



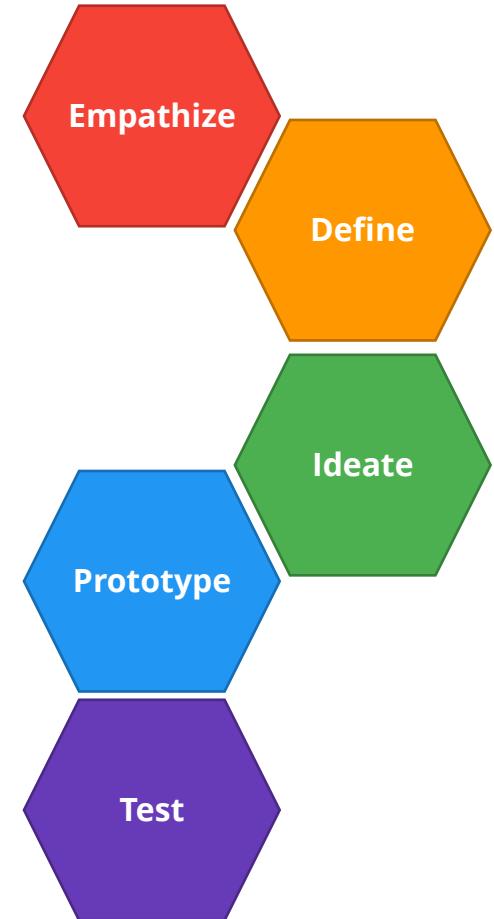
User-Centered Design

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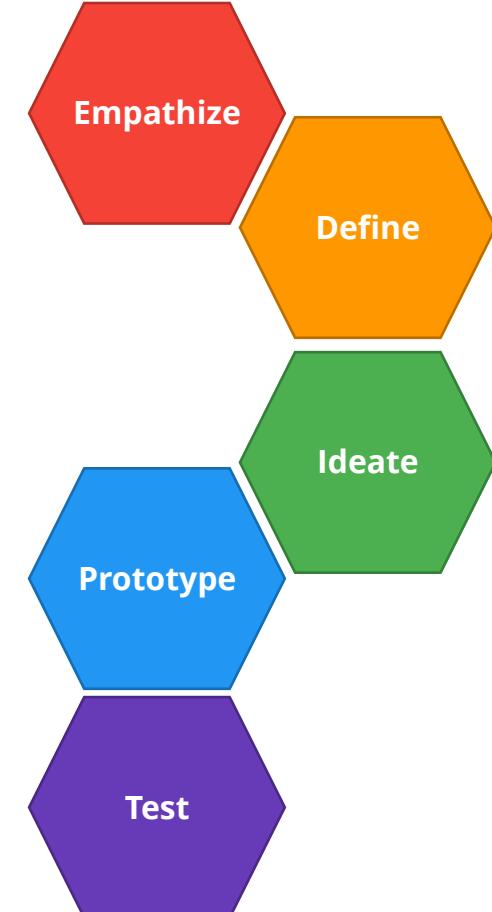
Design Thinking Process
(by Stanford d.school)

- How to make an effective design? **User-Centered Design (UCD)**!
- UCD: an iterative design process in which designers focus on the users and their needs in each phase of the design process
 - You need actual users.
 - Be iterative



User-Centered Design

- Understand your users
 - needs, wants, goals, tasks, context, etc.
- Define the problem space
- Design based on the data collected from studying users and their experiences
- Prototype
- Test
- ***Iterate!***



The Goal

- The goal of HCI “*is to develop or improve the safety, utility, effectiveness, efficiency and usability of system that include computers.*”
 - From Interacting with computers, 1989, p3
- What is “usability?”

Usability

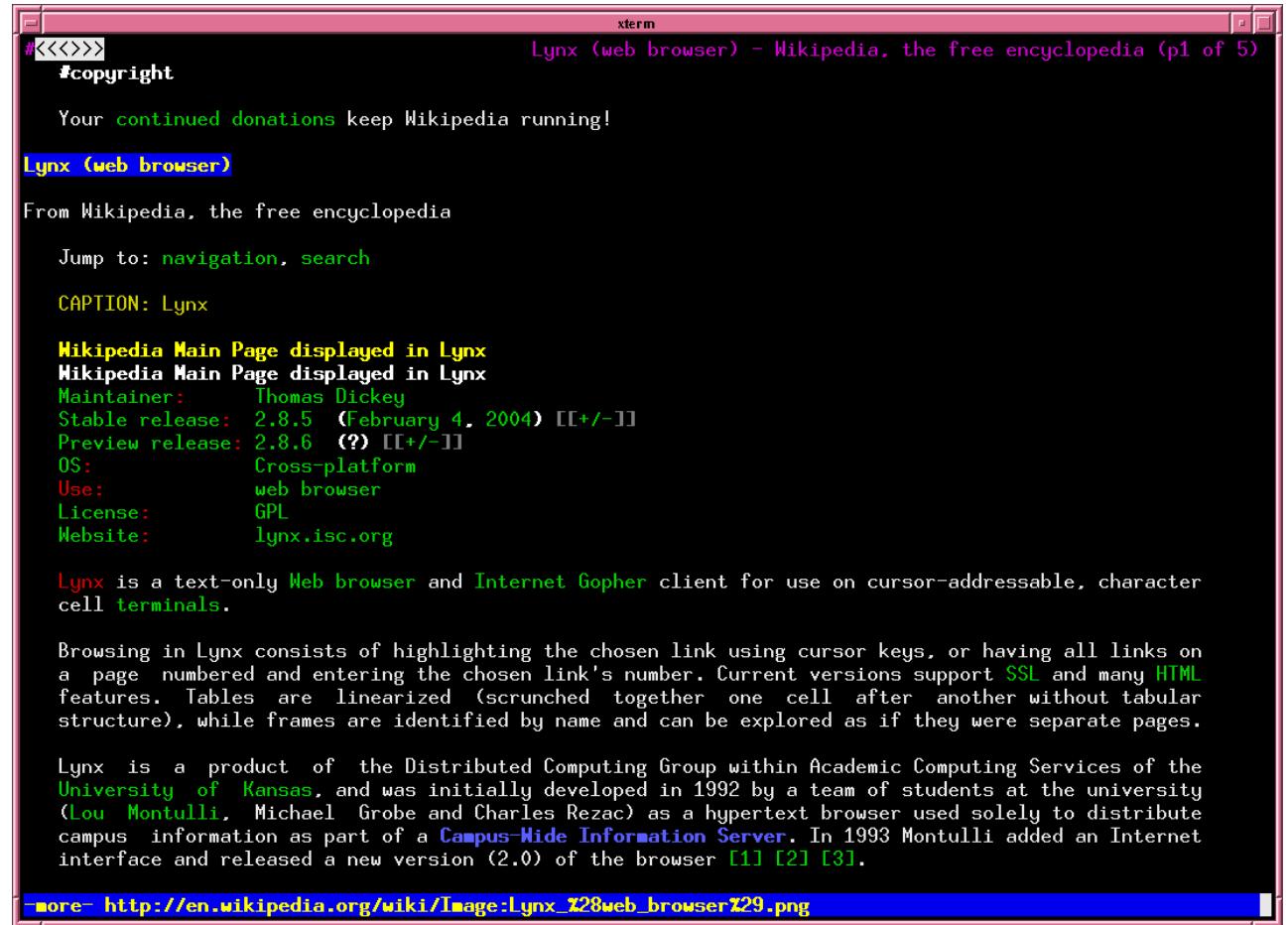
- **Usability** is a measure of how well a specific user in a specific context can use a product/design to achieve a defined goal effectively, efficiently and satisfactorily.
- **Usefulness** is a measure of how well a product allows a user to accomplish a task or objective.
 - <-> Useless
- Many products **are useful but not usable**.
 - You can do your job with them (useful) but not effectively (not usable).
- c.f.) Used

Usability Examples

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- A CLI Web browser is useful but not usable for many users.

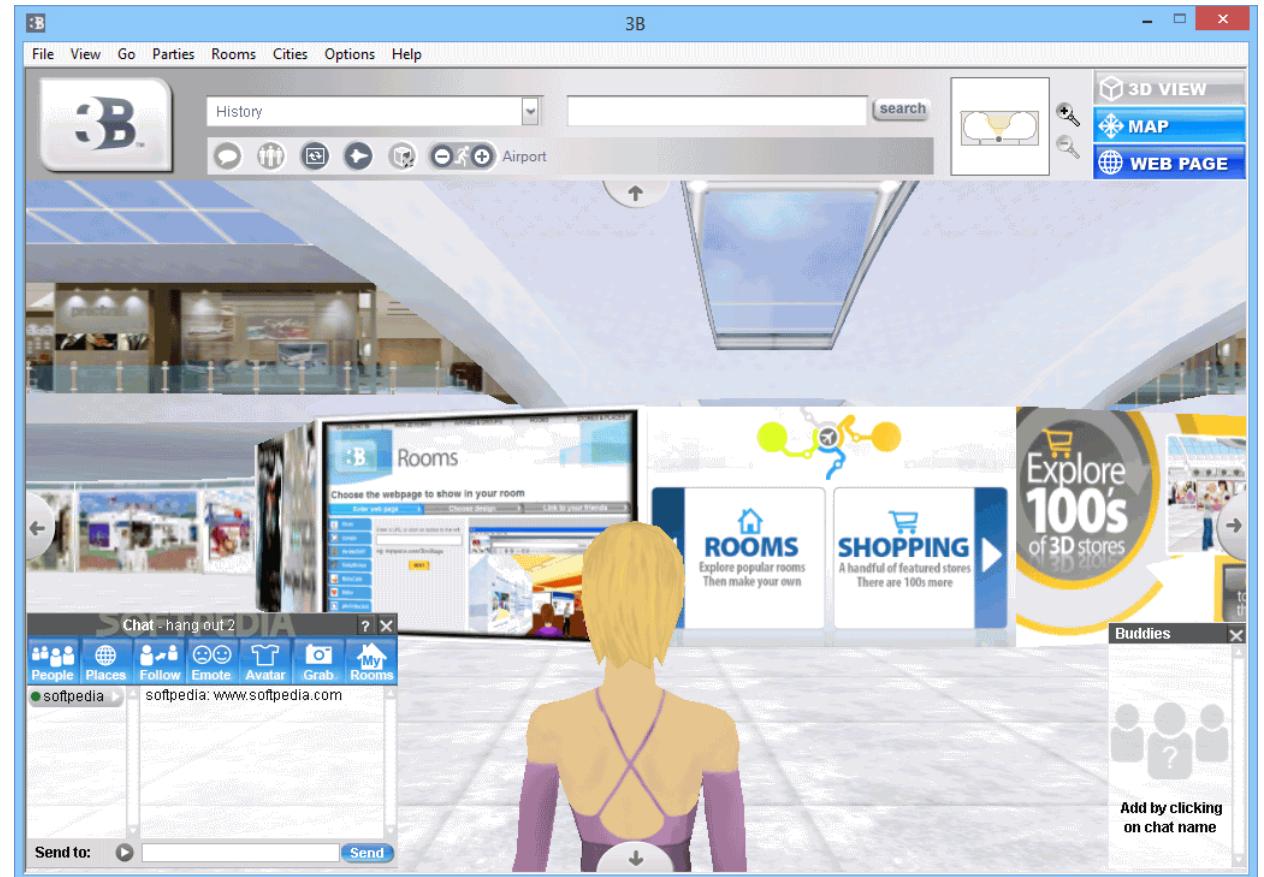


Usability Examples

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- A 3D Web browser may be useful and usable but is not used these days.



Usability Examples

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- Modern Web browsers are useful, usable, and used.



Usability Goals

- (Have good utility)
- Effective to use (effectiveness)
 - No error
- Efficient to use (efficiency)
 - speed or performance
- Easy to learn (learnability)
 - time to learn
- Easy to remember how to use (memorability)
 - human retention over time
- Safe to use (safety)
- Satisfaction

Beyond Usability – Affection

- Three levels (or aspects) of Emotional Design by Don Norman
- **Visceral design** – appearance, is it beautiful?
 - Branding – shapes, colors, texture
- **Behavior design** – usability, is it usable?
 - Accomplishing or failing to complete the goals
- **Reflective design** – Does it appeal to my self-image?



Beyond Usability – Affection

- Visceral – Does the watch look beautiful?
- Reflective – What will my friends think when they see me wearing this watch?
- Users may put up with functional issues if they believe they will gain other, non-functional benefits from it.
 - Loyalty

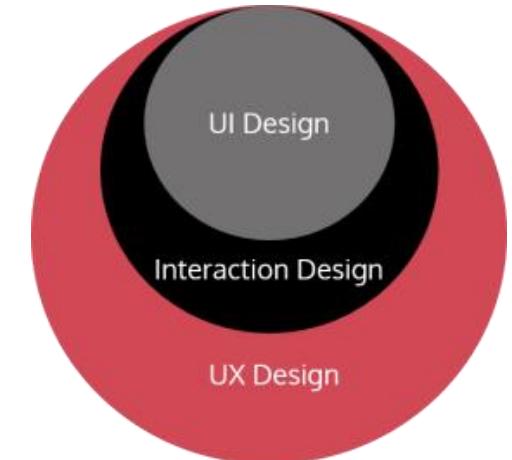


Interface vs Interaction vs Experience

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- **User Interface (UI)**: the space where interactions between humans and computers occur.
 - Narrowly, it means what you see (graphical elements).
 - Desktop interface, mobile interface, ...
- **User Interaction**: what you do to achieve a certain goal.
 - Keystrokes, gestures, voice, touch, ...
- **User Experience**: what you feel during/after the use of a product.



Source: UIUXTrend.com

User Experience

- **User Experience:** “a person’s perceptions and responses that result from the use or anticipated use of a product, system or service”
 - ISO 9241-210
- How a product behaves and is used by people in the real world
 - “every product that is used by someone has a user experience: newspapers, ketchup bottles, reclining armchairs, cardigan sweaters.” (Garrett, 2003)
- We cannot design a user experience, only design **for** a user experience.

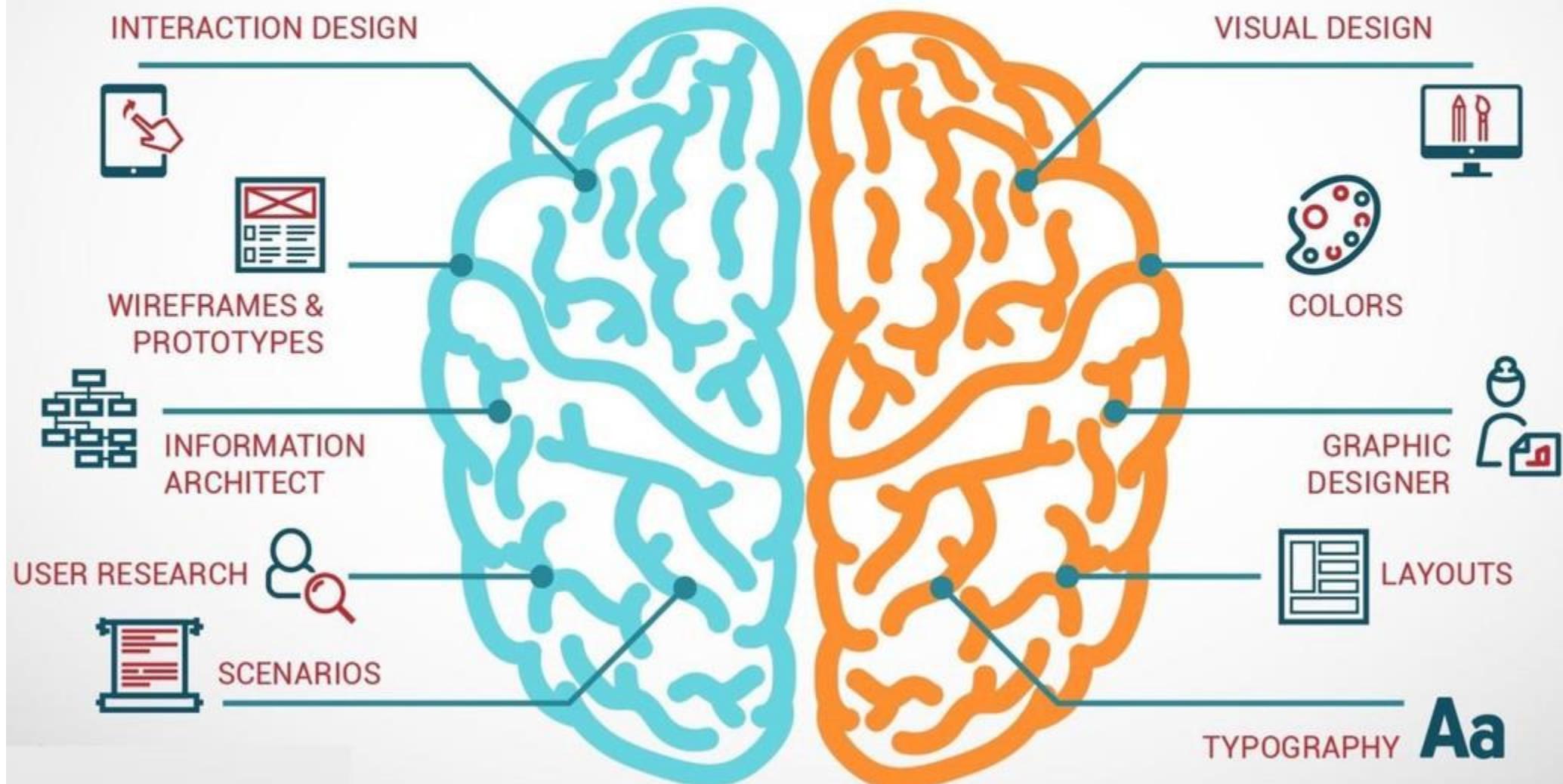
User Interface vs User Experience





Do not make humans
fit into the system!

UX & UI DESIGN

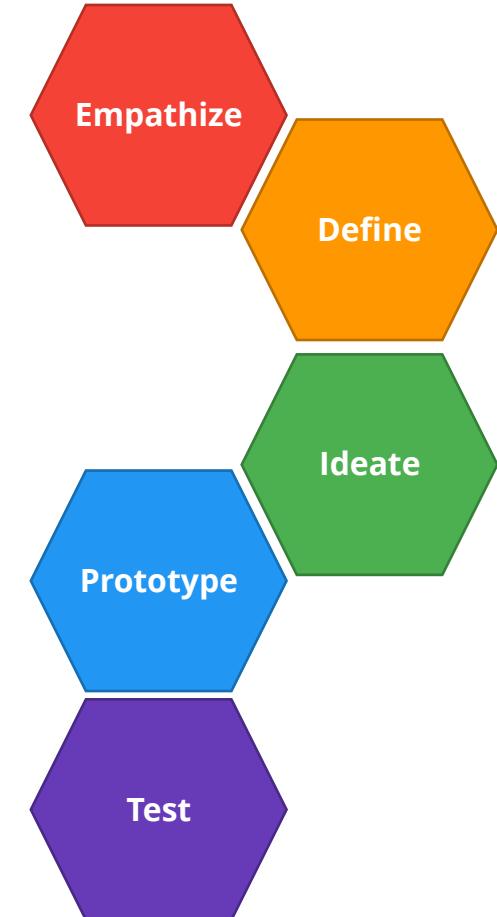


User Experience Goals

- **Desirable:** satisfying, enjoyable, fun, entertaining, motivating, rewarding, aesthetically pleasing, emotionally fulfilling, ...
- **Undesirable:** boring, unpleasant, frustrating, patronizing, making one feel stupid, annoying, childish, gimmicky, ...
- Subjective feedback

Summary: Definition

- **HCI** focuses on the widening gap between humans and computers.
 - Narrowly, we design user interfaces.
 - Ultimately, we want to design for user experience.
- What is our weapon? User-Centered Design!
 - Empathize, define, ideate, prototype, test, ... and ITERATE!
 - We will design a product following UCD.
- Usefulness vs usability vs used



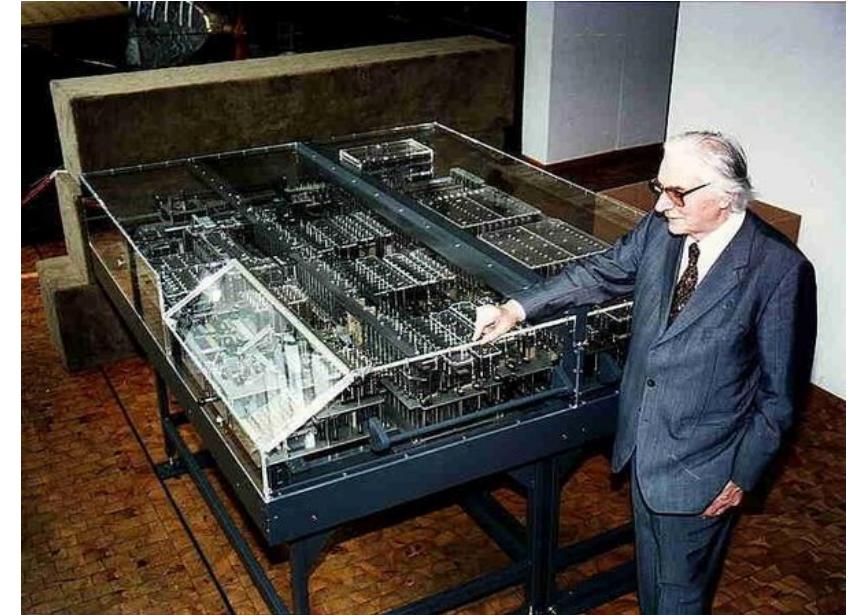
Babbage Difference Engine (1820s-1830s)

- Automatic mechanical calculators
- Can compute polynomial functions
- “The father of today’s computer”
- A design with “printer” (realized in 2000)



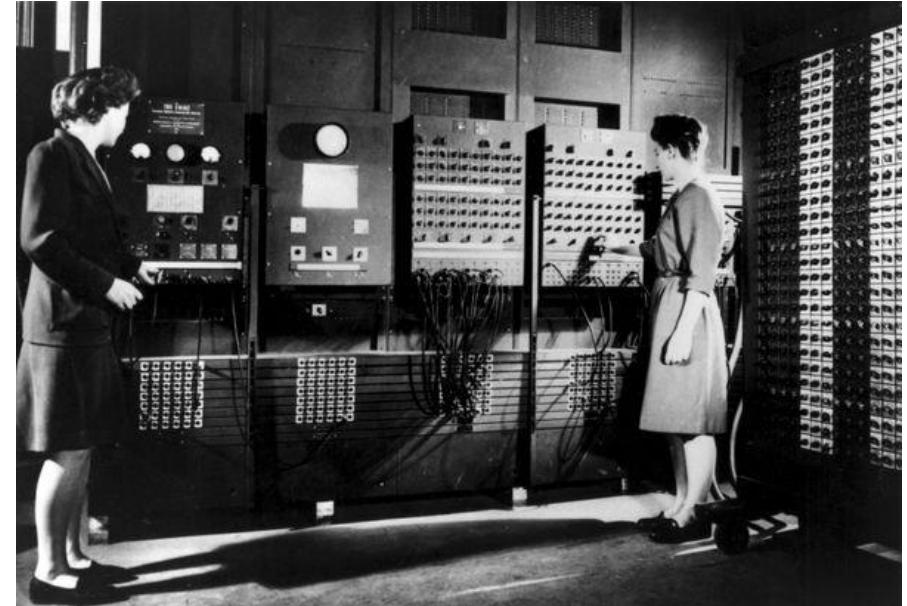
Z1 (1936)

- The world's first binary computer
 - Another mechanical computer invented by Konrad Zuse
 - programmable (Boolean logic)
- A 22-bit floating point value adder and subtracter
- A 64-word floating point memory
- 20,000 parts and 1,000 kg weight



ENIAC (1943)

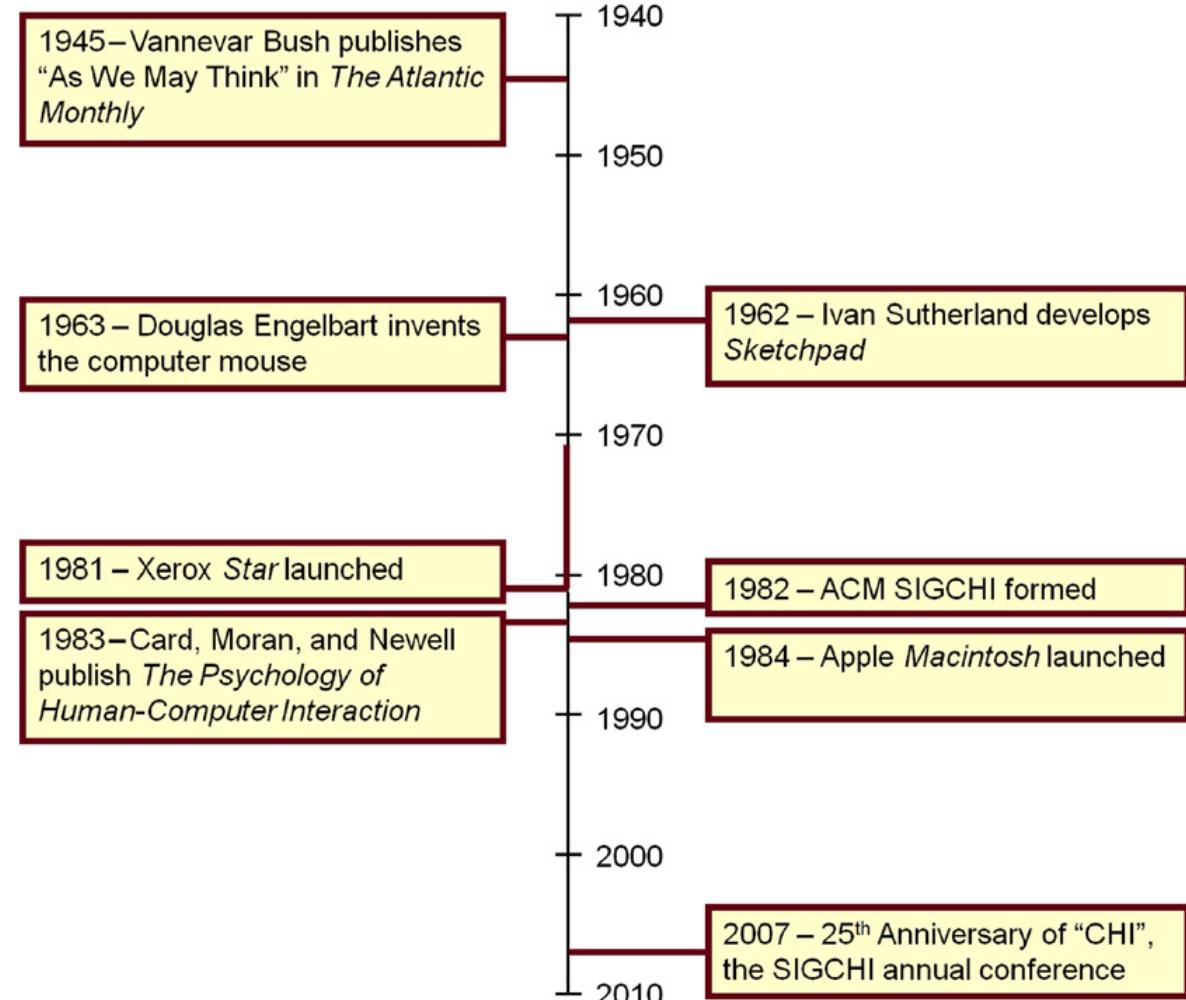
- The world's first **electronic** computer
 - Electronic Numerical Integrator and Computer
- Programmable
- Turing-complete
- ~ 18,000 vacuum tubes (still, no transistor)



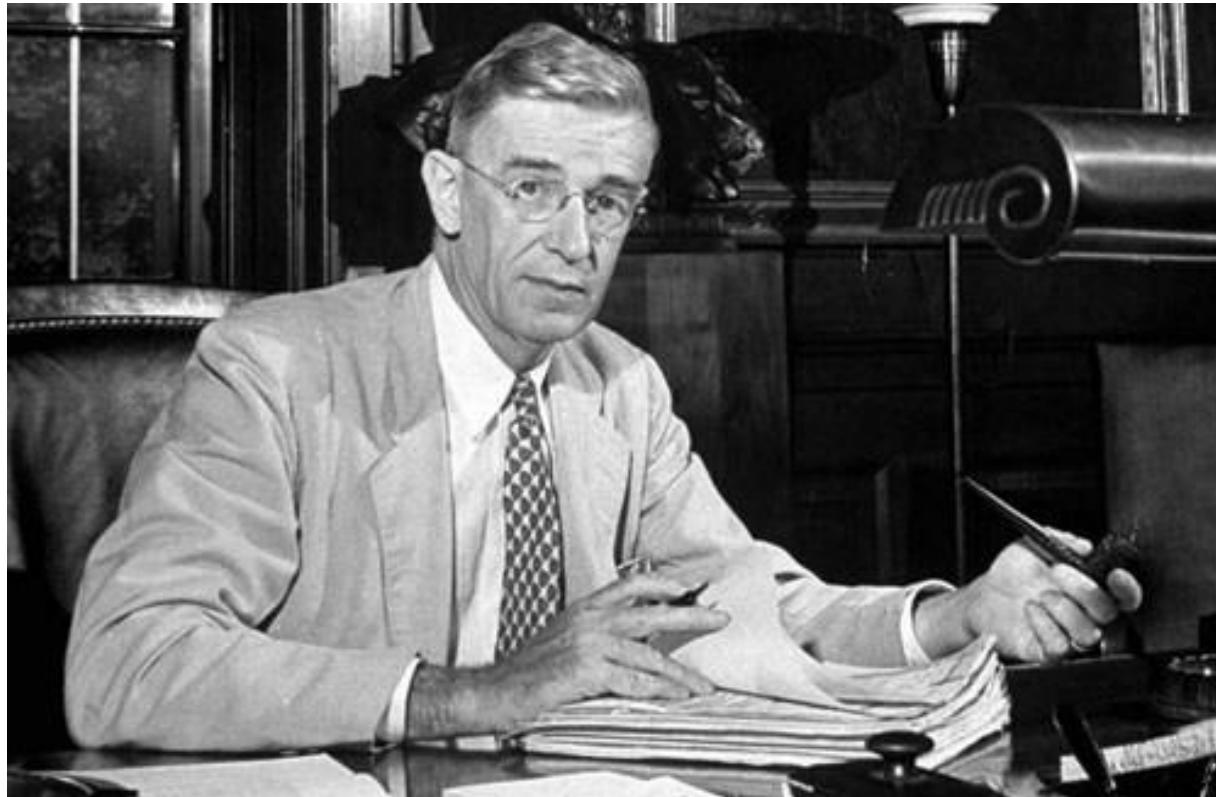
Early Computers and Interaction

- Early computers in 1940s were too precious, too complicated, to allow the average human to mess with them.
 - User == Designer == Scientist == Engineer == Maintainer
- All users were *experts*
 - They knew what they had to do.
 - They had a “mental model” of computers
- But in 1980s, things changed. Computers started to spread out to people’s desks in workplaces and homes.
 - User != Designer
 - The emergence of HCI

Big Events in HCI



"As We May Think" by Vannevar Bush (1945)



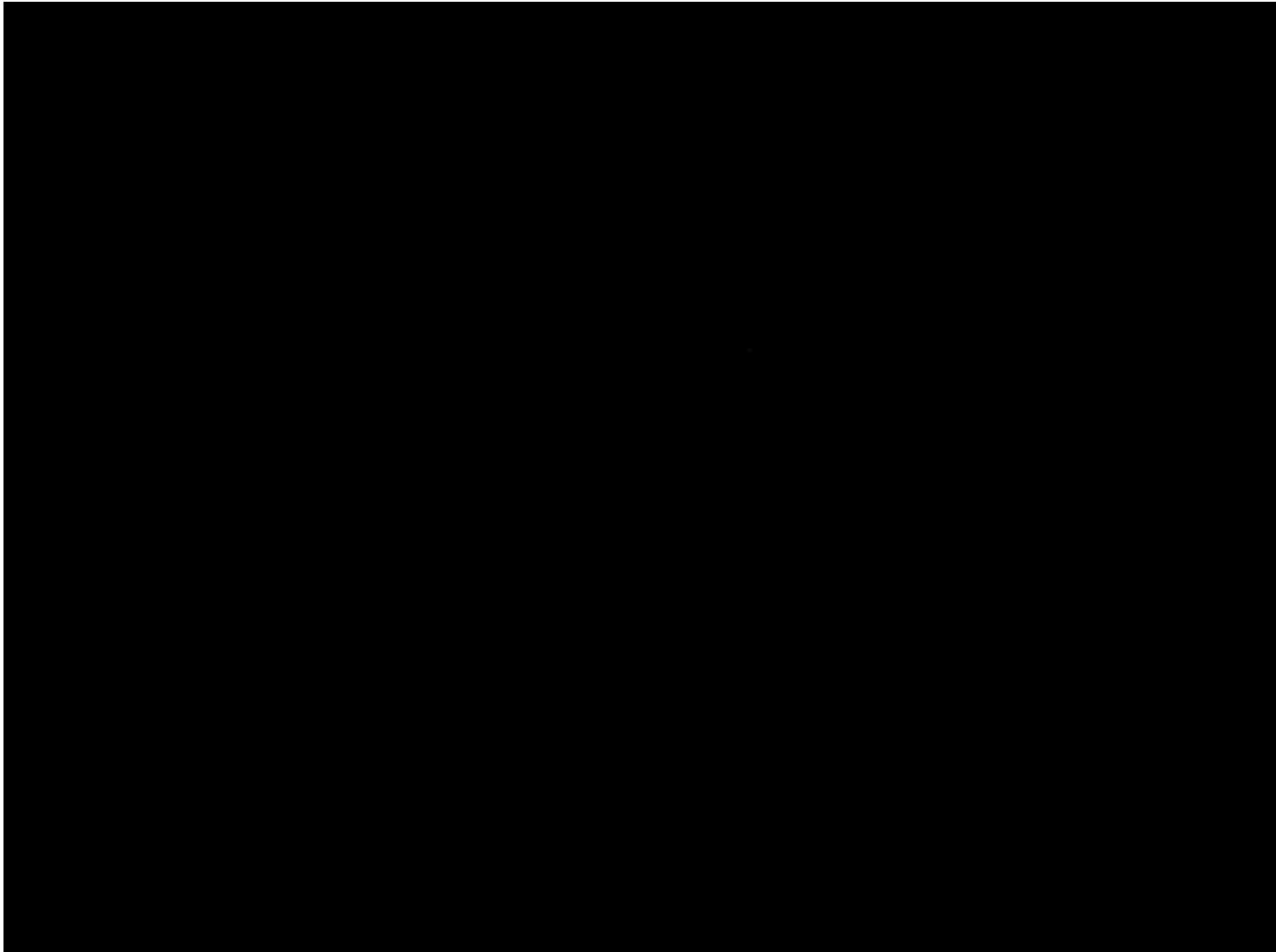
As We May Think (1945)

- An essay that anticipated many aspects of information society.
 - <https://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/>
- He envisioned:
 - Hypertext
 - Personal computers
 - The Web
 - Speech recognition
 - Online encyclopedias

As We May Think

- “Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, "memex" will do. **A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory.**”
- “**Wholly new forms of encyclopedias** will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified.”

Sketchpad (1963)



Sketchpad (1963)

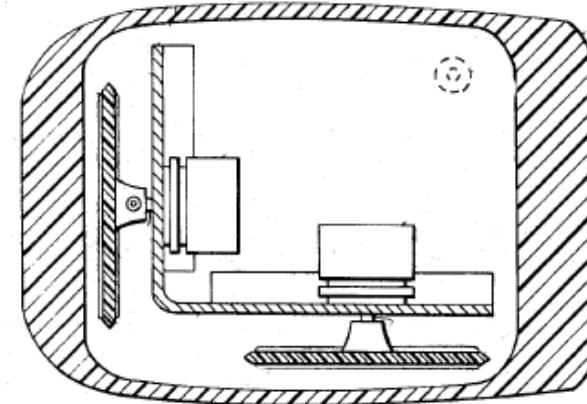
- A computer program written by Ivan Sutherland in the course of his PhD thesis
 - 1988 Turing Award
 - 2 handed interactions
 - Immediate feedback
 - Magnetic snap
 - Constraints
- “talking to computer graphically”
- “making computers almost like a human assistance”

Direct Manipulation

- *Direct manipulation*
 - Term coined by Ben Shneiderman in 1983
 - “Direct manipulation: A step beyond programming languages”
- Sketchpad is an example of direct manipulation
 - Visibility of objects
 - Incremental action and rapid feedback
 - Reversibility
 - Exploration
 - Syntactic correctness of all actions
 - Replacing language with action

Mouse (1963)

- A hand-held pointing device invented by Douglas Engelbart



HCI's First User Study

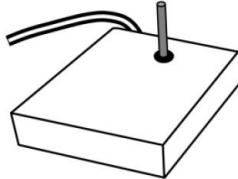
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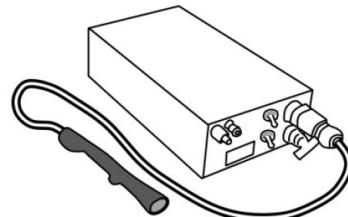
- Compared the following selection interfaces ([paper link](#))



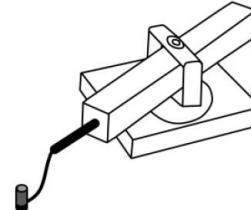
Mouse



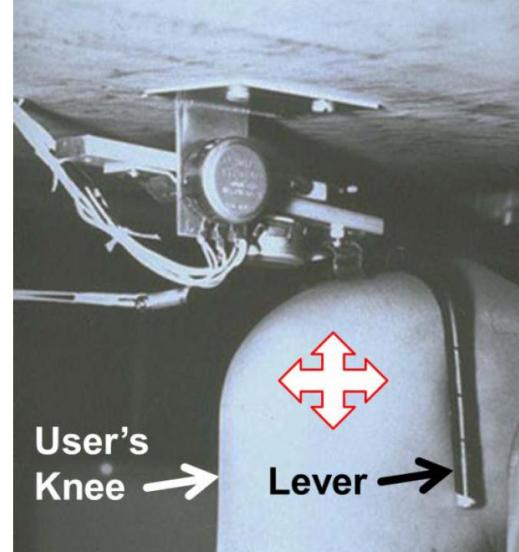
Joystick



Lightpen



Grafacon



Knee-controlled lever

Display-Selection Techniques for Text Manipulation

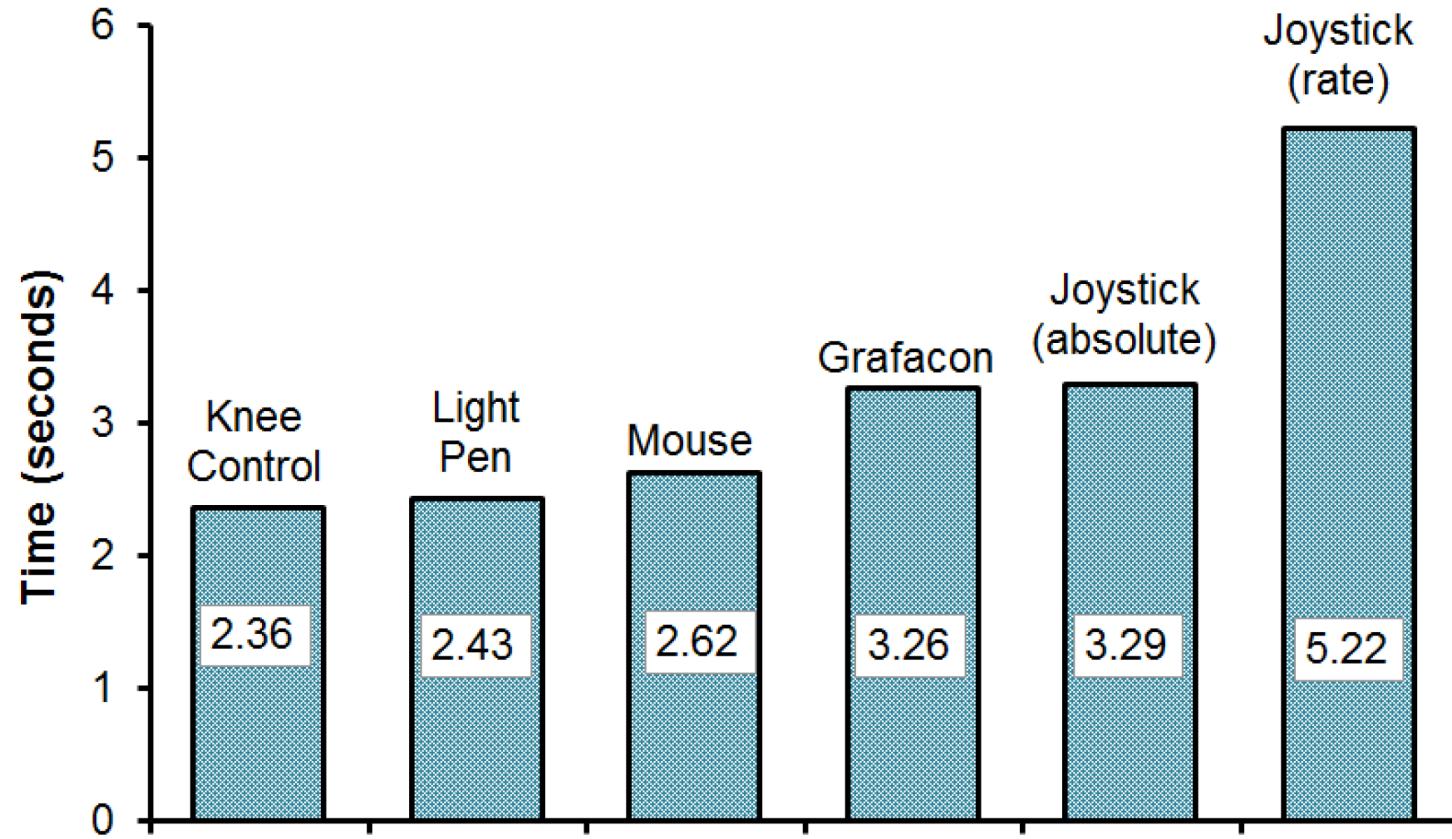
WILLIAM K. ENGLISH, MEMBER, IEEE, DOUGLAS C. ENGELBART, MEMBER, IEEE,
AND MELVYN L. BERMAN

Experiment Design

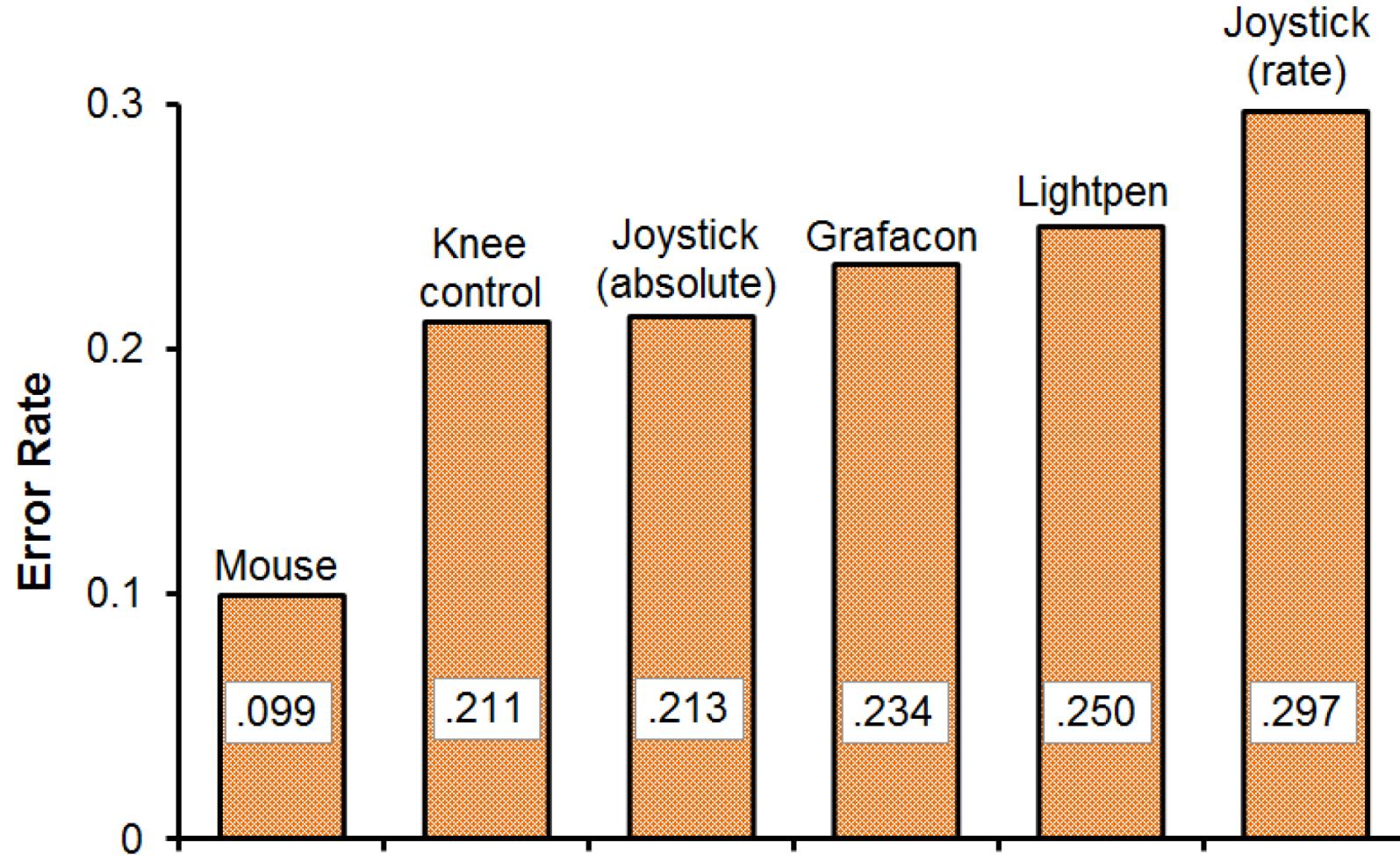
- **Independent variable:** “Input method” with six levels: mouse, light pen, Grafacon, joystick (position-control), joystick (rate-control), knee-controlled lever
- **Dependent variables:**
 - Task completion time (access time + motion time)
 - Error rate
- 13 participants + within-subjects design
- Task: Press spacebar, acquire device, position cursor on target, select target

Results

- Access time with the knee-controlled lever was zero (since the device is always “acquired”).
- Light pen use is fatiguing, since the user’s arm is held in the air in front of the display.



Results



NLS (1968)

- A computer collaboration system developed in 1968, designed by Douglas Engelbart.
 - oNLine System



NLS (1968)

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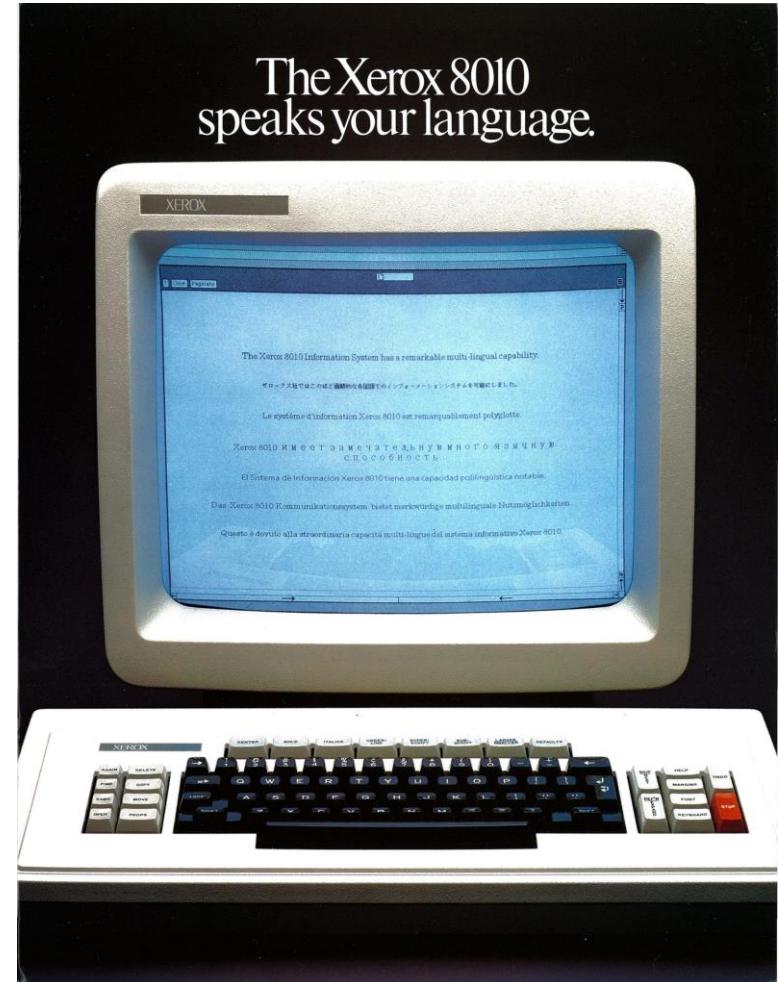
- Focused on making the user more “powerful”, not simply on making the system “easier to use”
- The computer mouse, multiple windows, computer-aided meetings, 2D editing, context-sensitive help, hypermedia, distributed client-server architecture ...
- Difficult learning curve (modes, mnemonic codes, ...)

Xerox Star (1981)

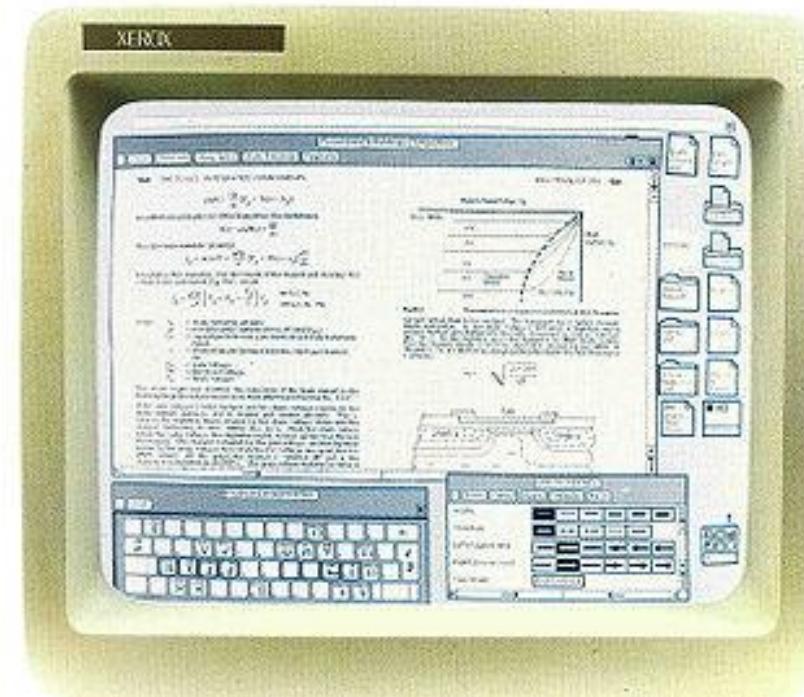
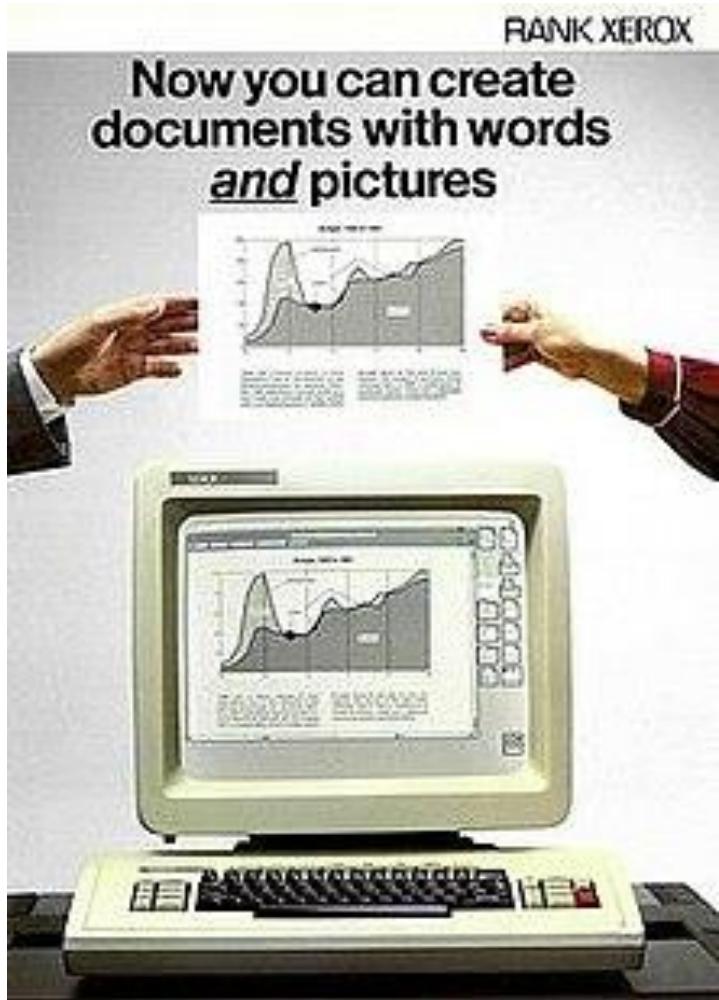
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- Star or Xerox 8010 Star Information System
- The first commercial GUI (Graphical User Interface) system
- **WIMP:** windows, icons, menu, and a pointing device
- **Direct manipulation**
- **WYSIWYG:** what-you-see-is-what-you-get
- Two-button mouse

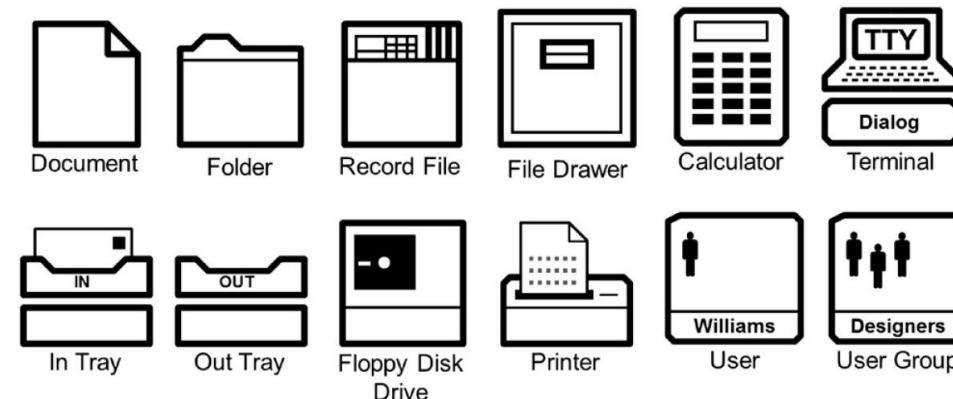


Xerox Star (1981)



Xerox Star (1981)

- The Star was intended as an *office* automation system.
 - Workers want to get their work done, not fiddle with computers.
 - The interface should be *invisible*.
- **Desktop metaphor:** a jump-start on knowing what to do
 - Pictorial representations (*icons*) provide immediate sense of what to do and how things work
 - “open a document” vs. “invoke a text editor”



IBM PC (1981)

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- Personal Computer
- IBM PC DOS (CLI, command-line interface)
- Commercial success
 - sales exceeded IBM's expectations by as much as 800%



Birth of HCI (1983)

- First ACM SIGCHI Conference
 - 1982 Conference on Human Factors in Computing Systems (CHI, [kai])
 - SIGCHI: ACM Special Interest Group on Computer-Human Interaction
 - Top #9 conference in computer science
- <https://sigchi.org/>



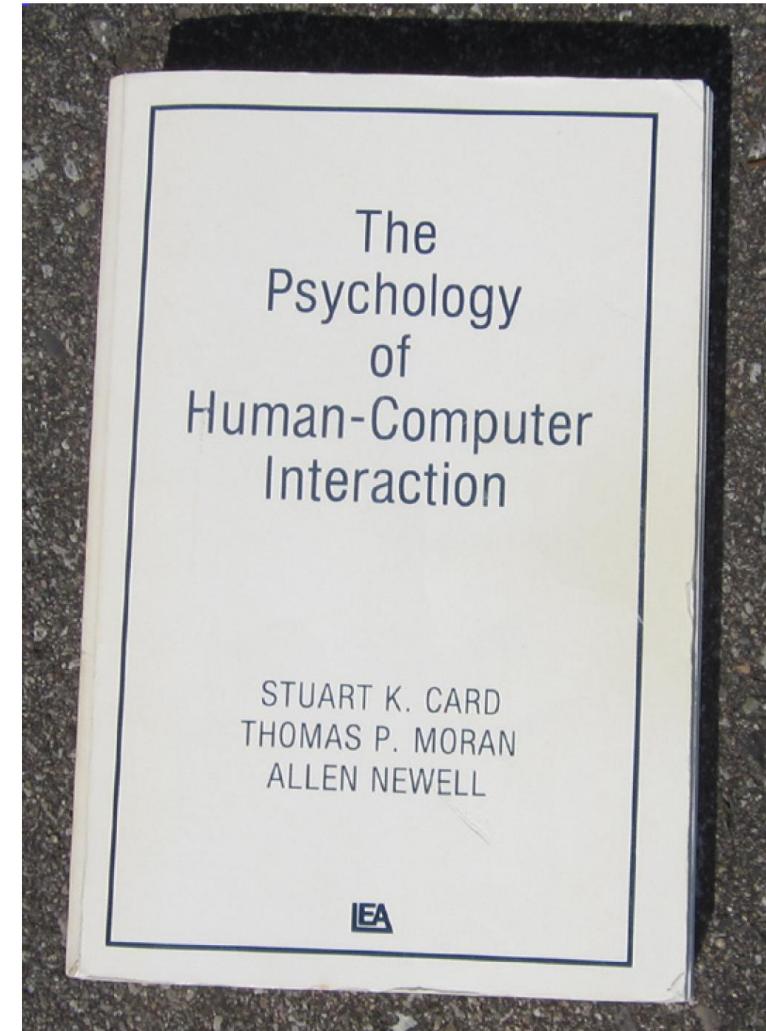
<https://www.guide2research.com/topconf/>

Card et al. (1983)

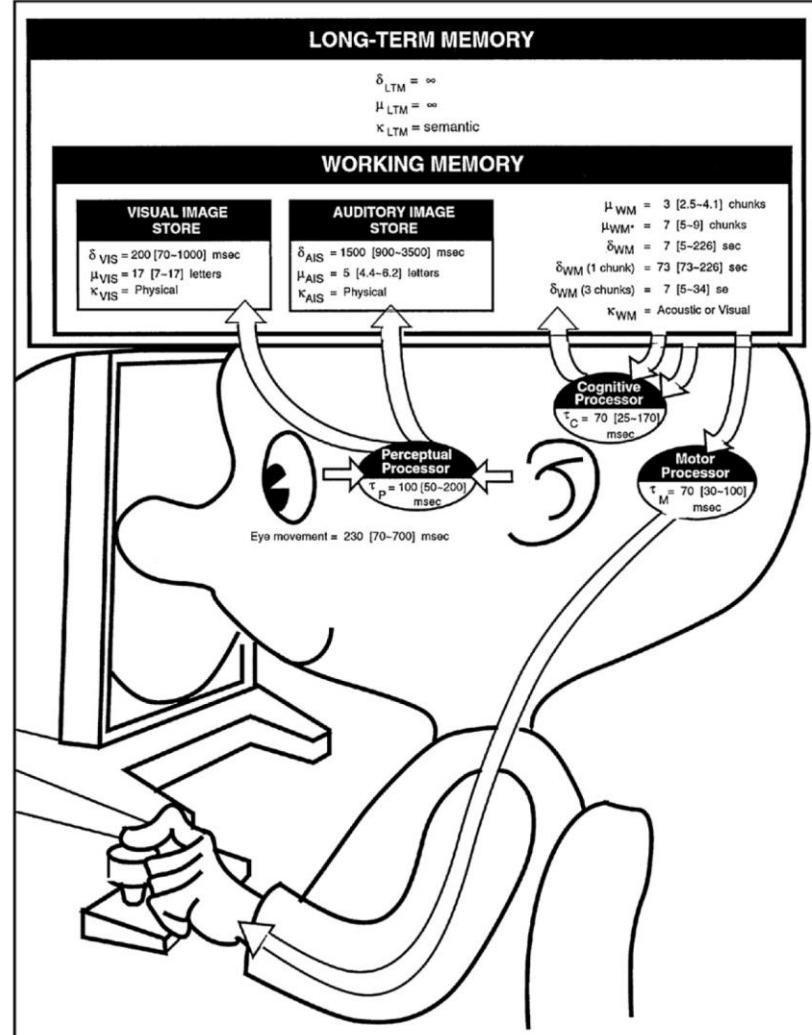
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- Card, Moran, and Newell's *The Psychology of Human-Computer Interaction*
 - Stuart Card, Tom Moran, and Allen Newell
 - From work done at Xerox PARC
- In this lecture, you will see a lot of “Card et al.”. This refers to this book.



The Model Human Processor (1983)

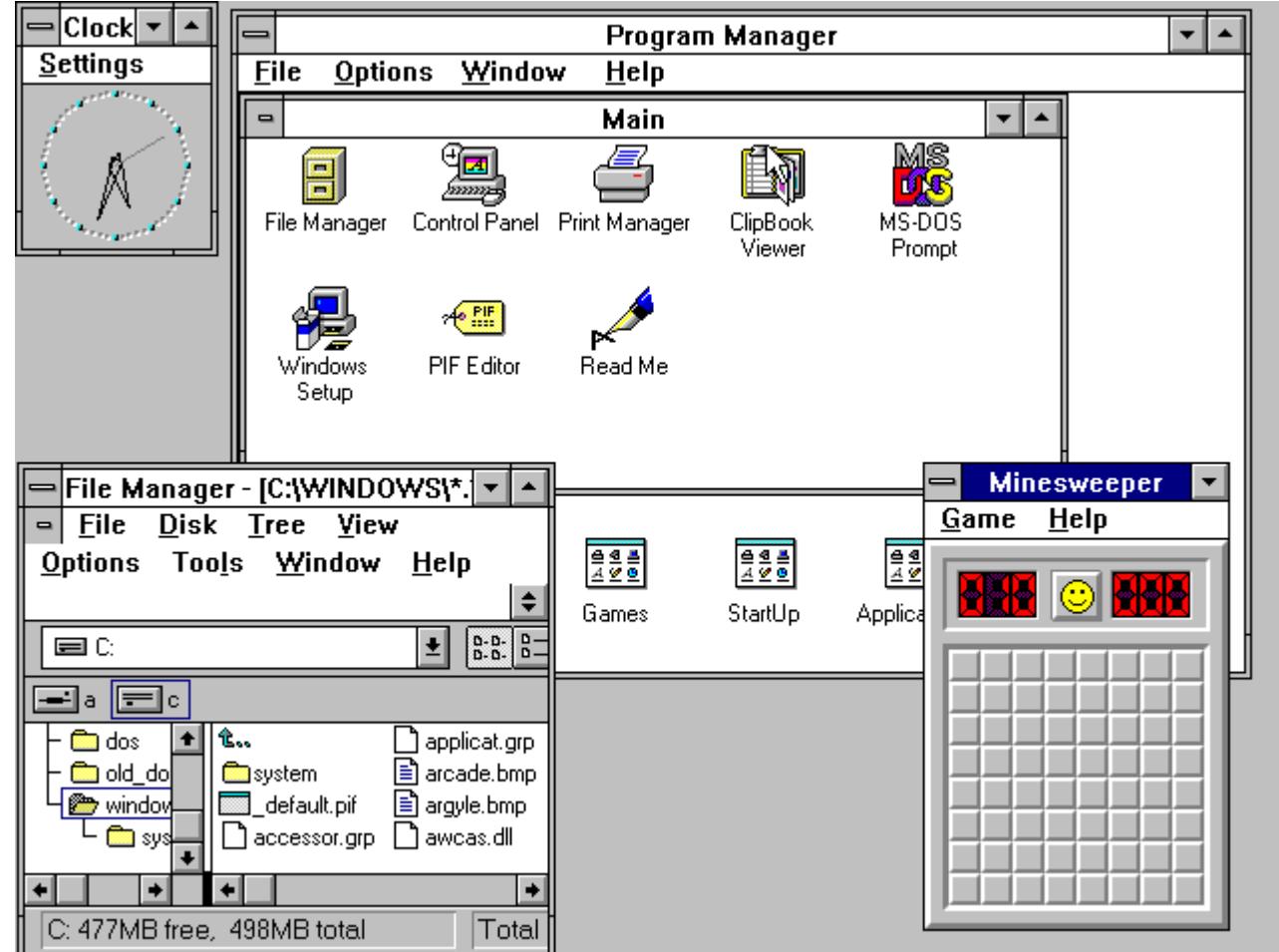


Apple Macintosh (1984)

- With a “genious” ad (<https://www.youtube.com/watch?v=VtvjbmoDx-I>)



Windows 3.1 (1992)

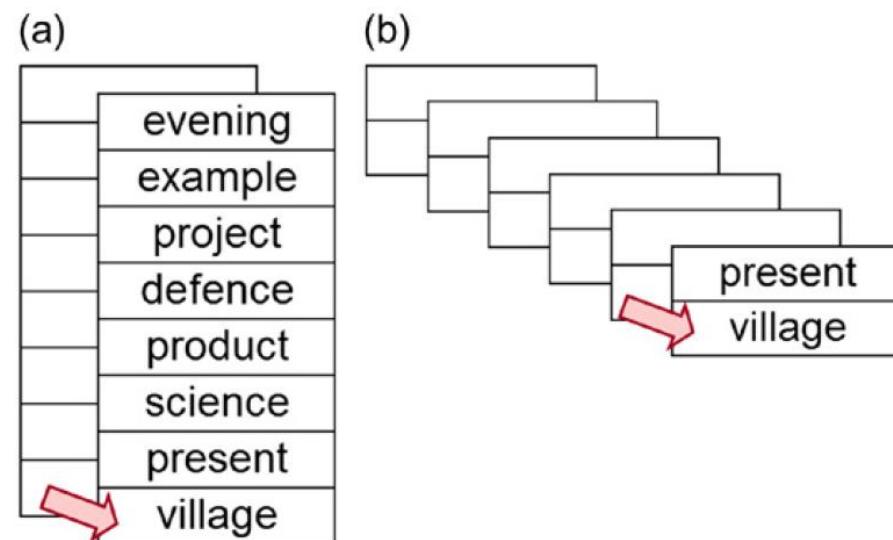


Growth of HCI Research

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- An example research question: how to design an effective menu?
 - Depth vs. breadth
 - Presence of a title on a submenu?
 - Age effect?
 - Auditory feedback?

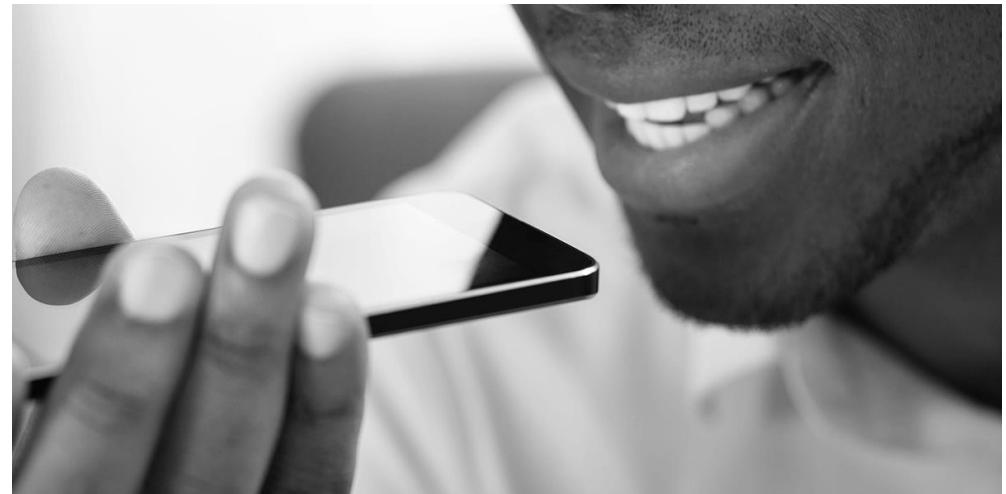


Multimodal Interaction

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Leap Motion
(gesture)



Voice interaction

Virtual Reality

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- Metaverse: a collective virtual shared space



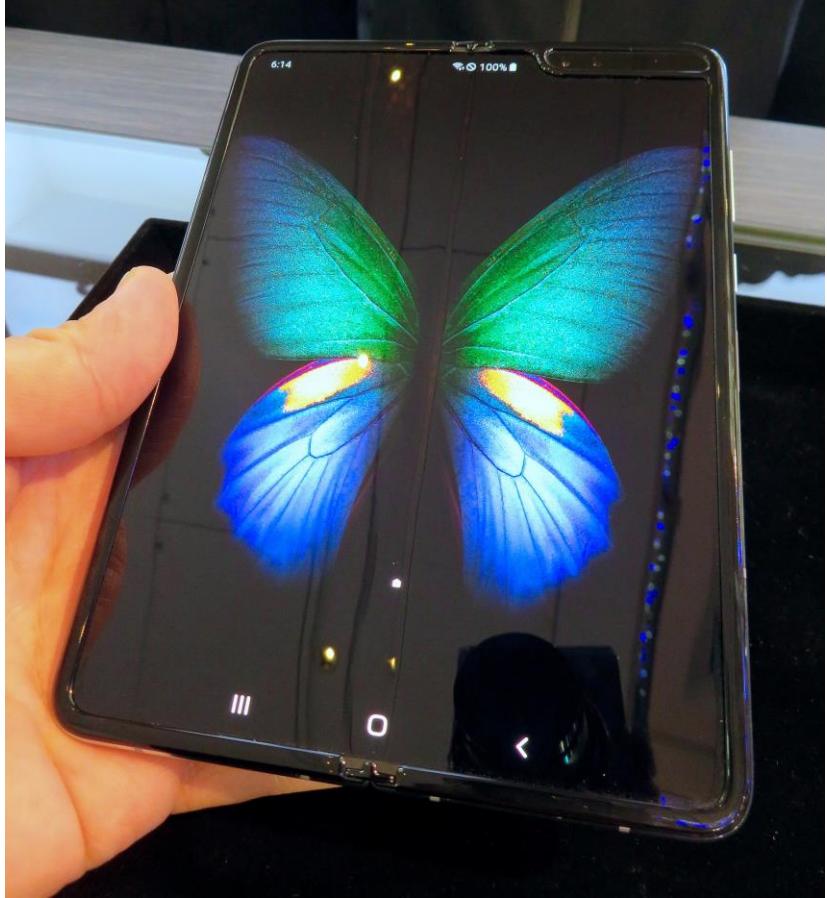
Fortnite
(<https://www.epicgames.com/fortnite/en-US/home>)



Ready Player ONE

Mobile Devices

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Samsung Galaxy Fold



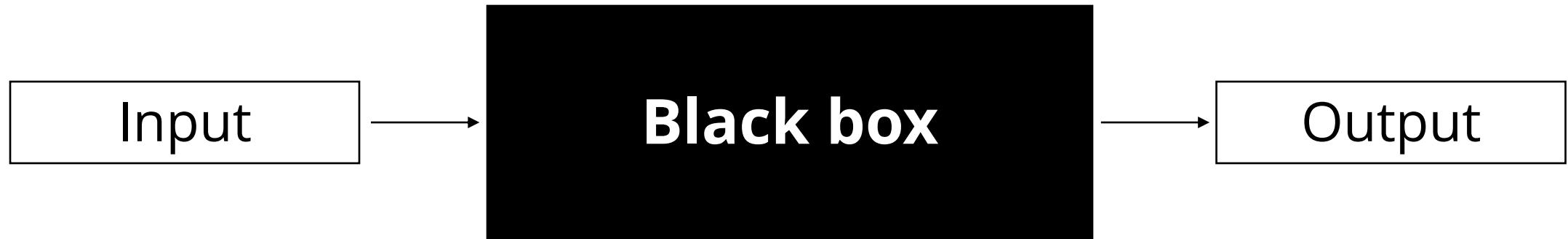
Microsoft Duo

Human-AI Interaction

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- Fairness, accountability, transparency, explainability, ...



COVID-19

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Zoom
(<https://zoom.us/>)



Gather
(<https://gather.town/>)

- Research precedes products!
- Two-finger gestures (Apple iPhone, 2007)
- Acceleration-sensing (Nintendo Wiimote, 2005)
- Wheel mouse (Microsoft Intellimouse, 1996)
- Single-stroke text input (Palm's Graffiti, 1995)

- Two-finger gestures (~~Apple iPhone, 2007~~)
 - Heort and Weinzapfel (SIGGRAPH, 1978)
- Acceleration-sensing (~~Nintendo Wiimote, 2005~~)
 - Harrison et al. (CHI, 1998)
- Wheel mouse (~~Microsoft Intellimouse, 1996~~)
 - Venolia (CHI, 1993)
- Single-stroke text input (~~Palm's Graffiti, 1995~~)
 - Goldberg and Richardson (CHI, 1993)

Credits

- Our textbook (Human-Computer Interaction by I. Scott MacKenzie)
- Ben Bederson, UMD HCIL
- François Guimbretière, Cornell University
- Jinwook Seo, Seoul National University