

# **IN4MATX 241: Ubiquitous Computing**

**Class 1:**  
**History of Ubiquitous Computing**

Daniel Epstein

# Today's class

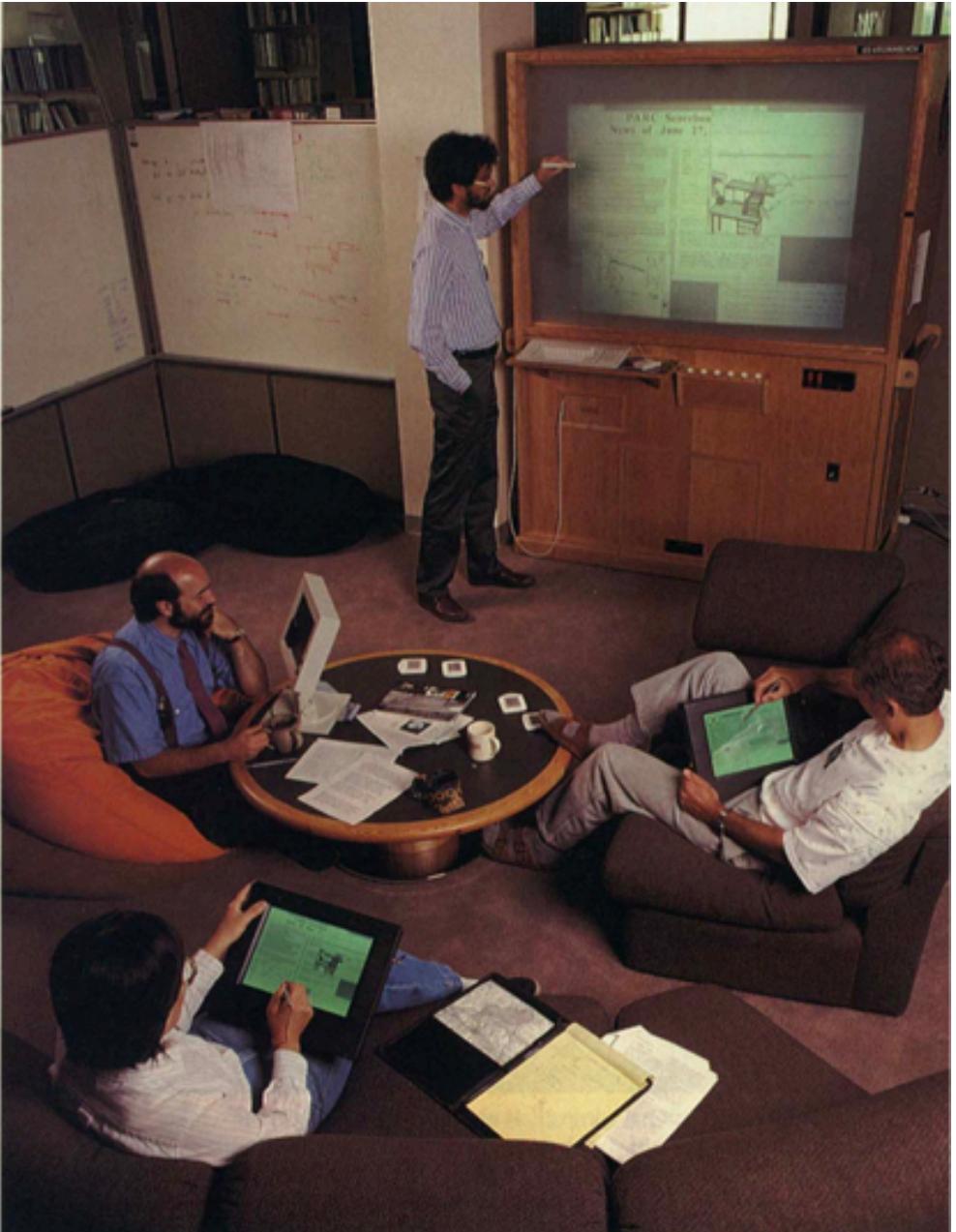
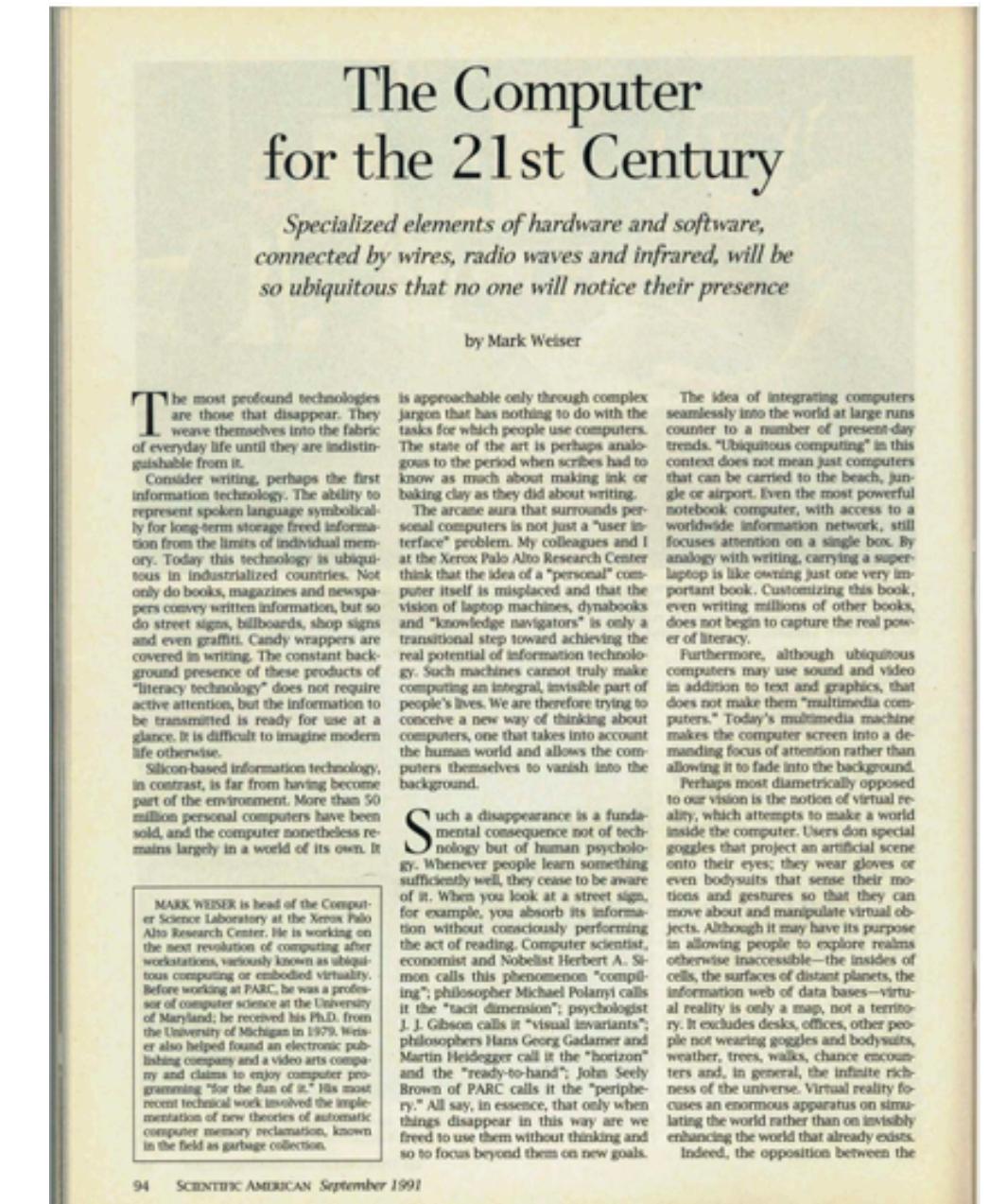
- Defining ubiquitous computing
- Course overview

**Discussion time!**

**What is Ubiquitous Computing?**

# The Computer for the 21st Century

- Published in Scientific American, 1991
- Coined “Ubiquitous Computing”
  - Reflective and speculative
- I hope you like the early-90's ads



# Three waves of computing



Mainframe  
computing



Personal  
computing

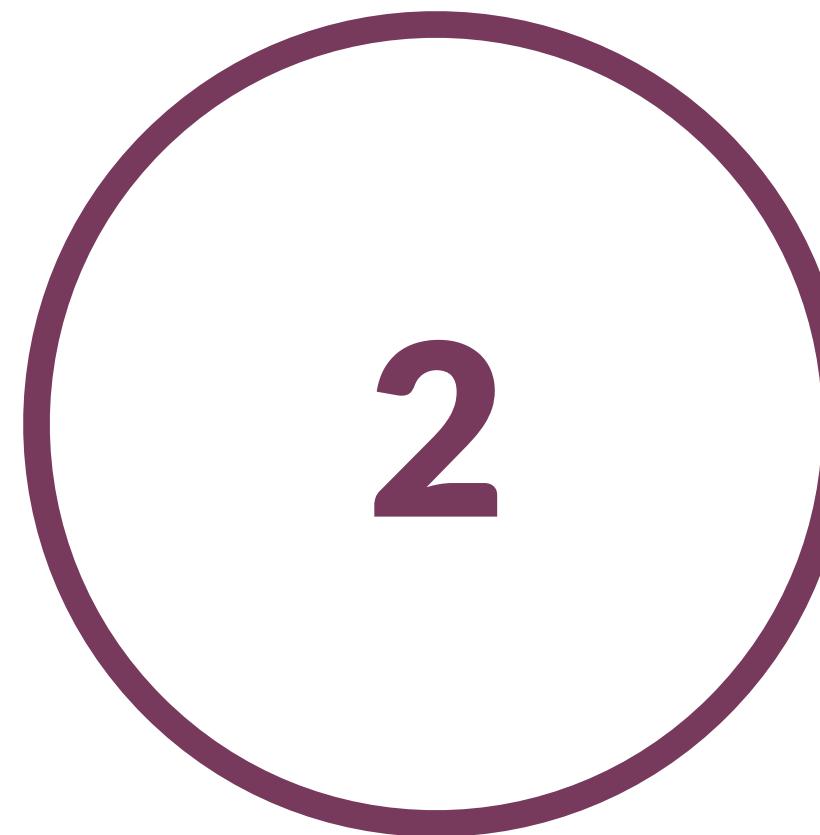


Ubiquitous  
computing

# Three waves of computing



Mainframe  
computing



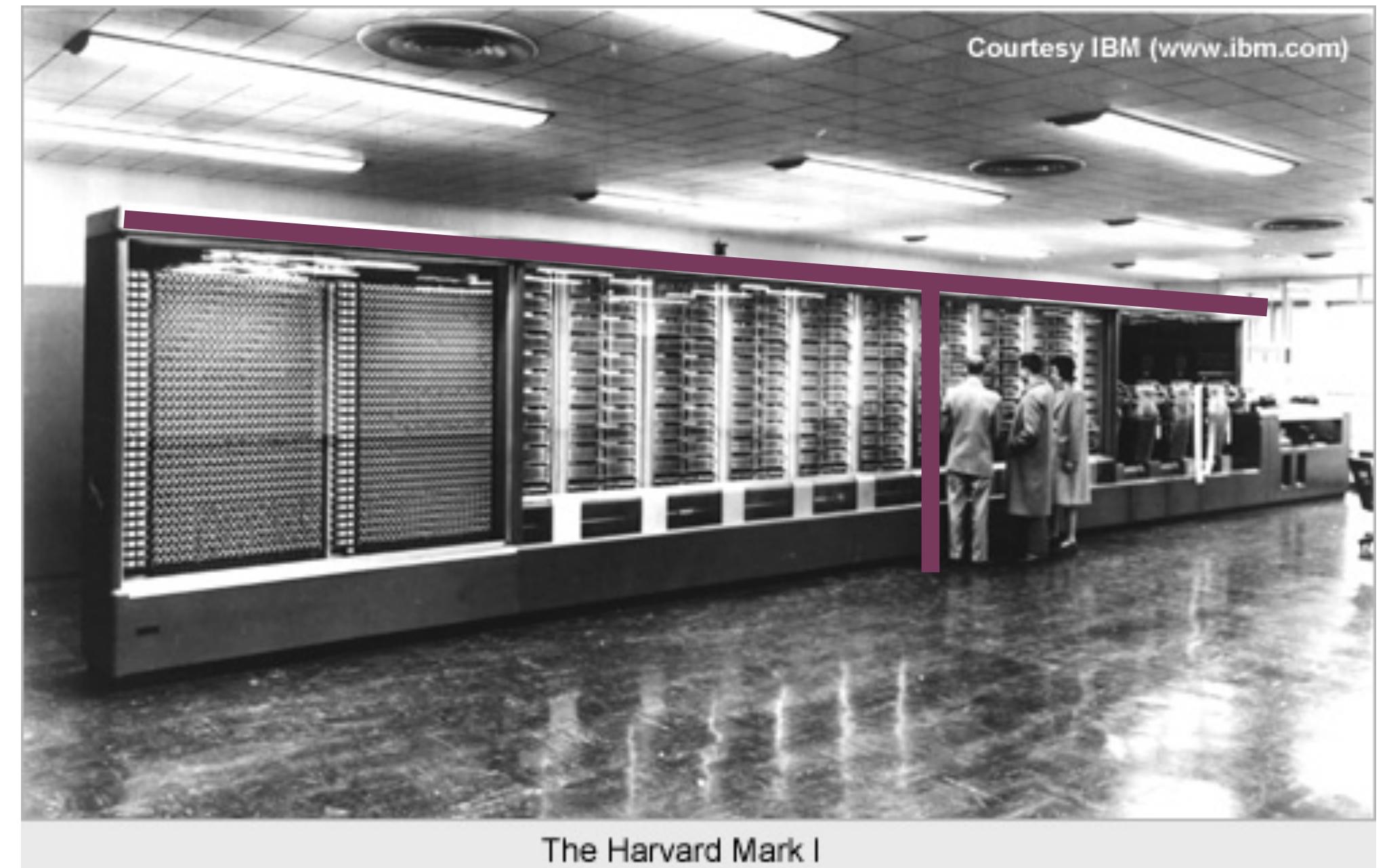
Personal  
computing



Ubiquitous  
computing

# First wave: mainframe computing

- Harvard Mark I
- Large (55 feet wide, 8 feet high, 5 tons)
- Expensive (enclosure alone was \$50,000 in 1945!)
- Used to calculate implosion during the Manhattan Project

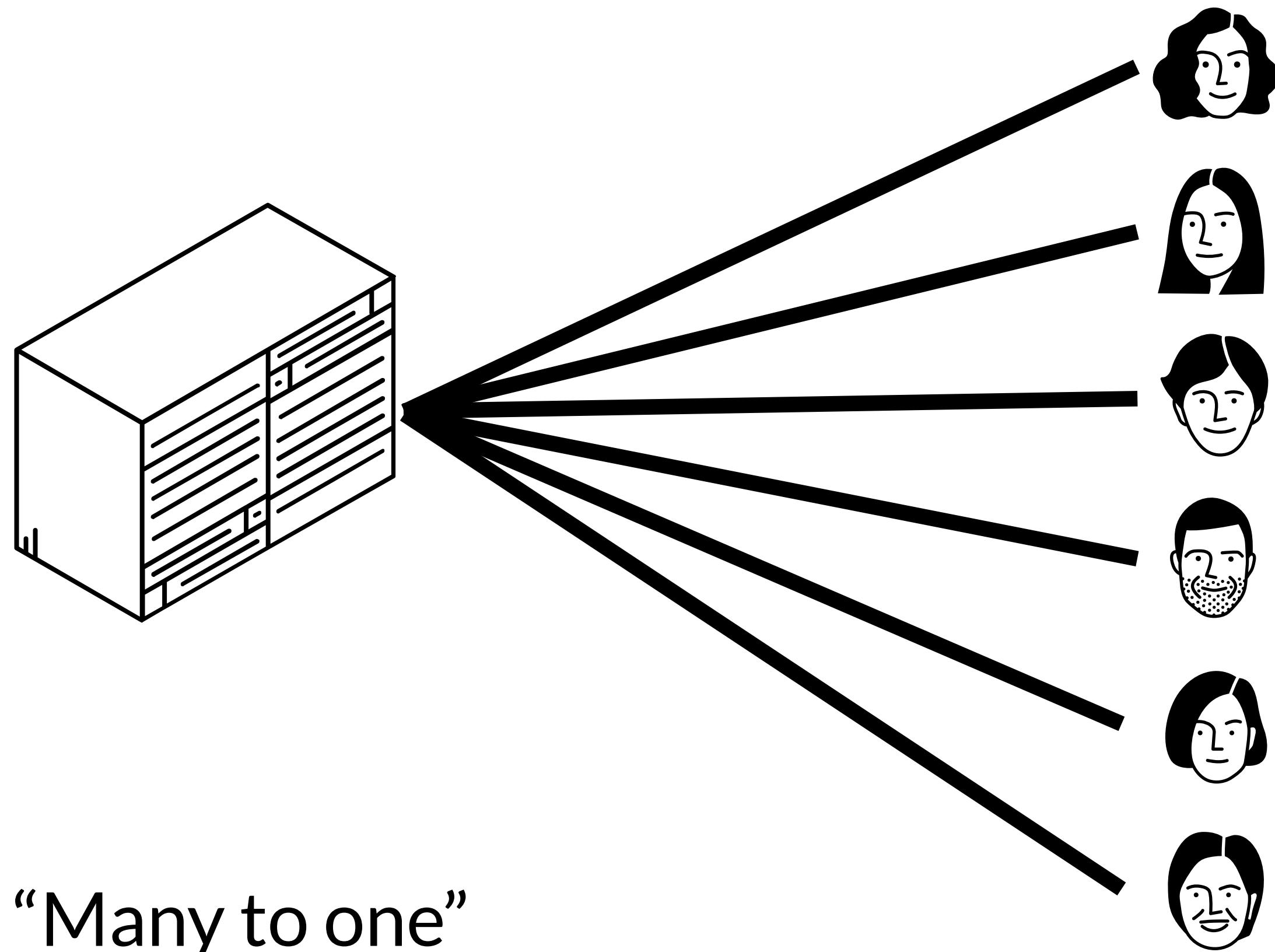


# First wave: mainframe computing

- Batch processing
  - Write your program on punch cards
  - Wait your turn for the computer
  - Run program, hope it works
  - If it doesn't, you'll have to fix it and wait for your next turn
  - Efficient use of resources, but poor interactivity

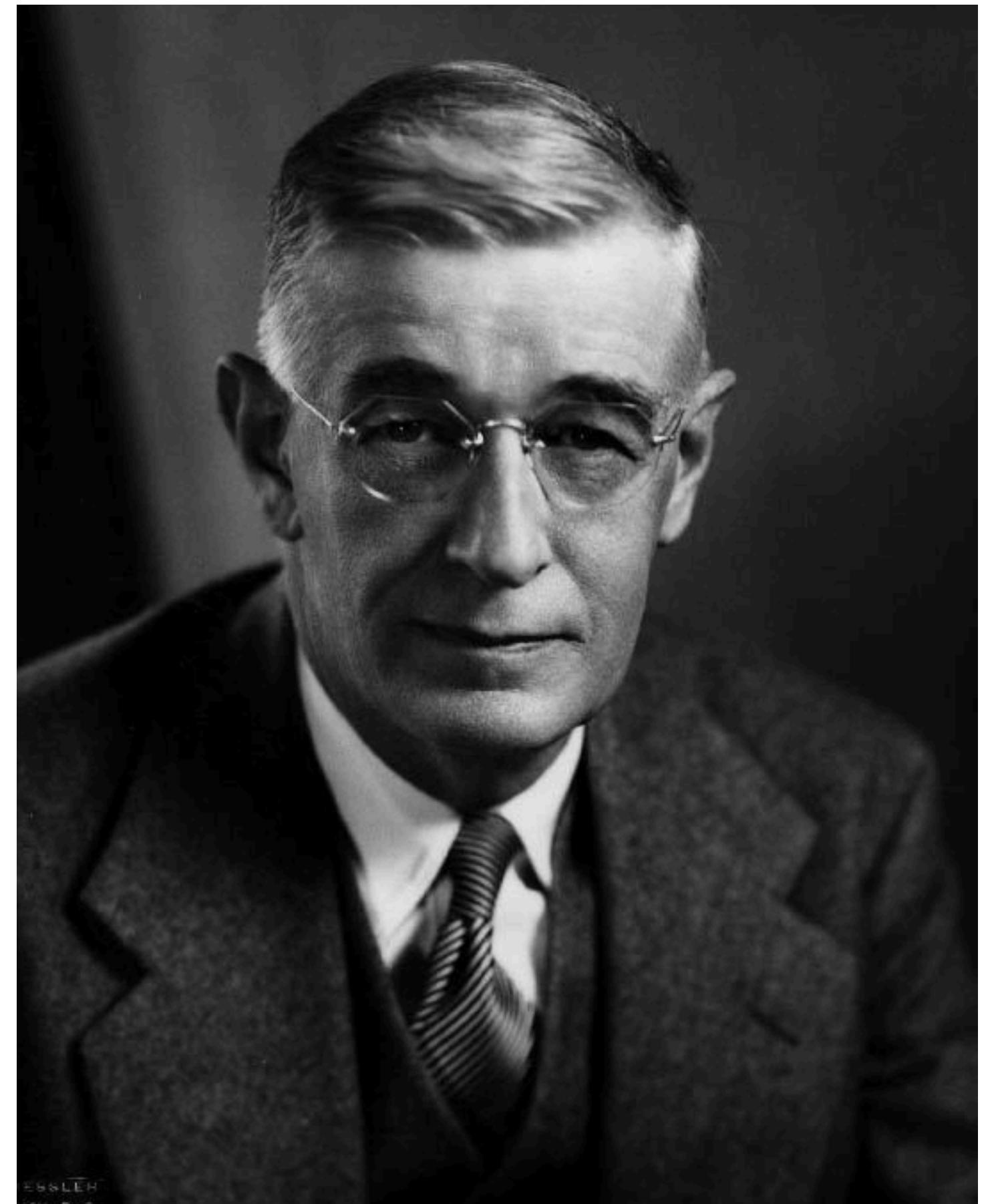


# First wave: mainframe computing



# Vannevar Bush

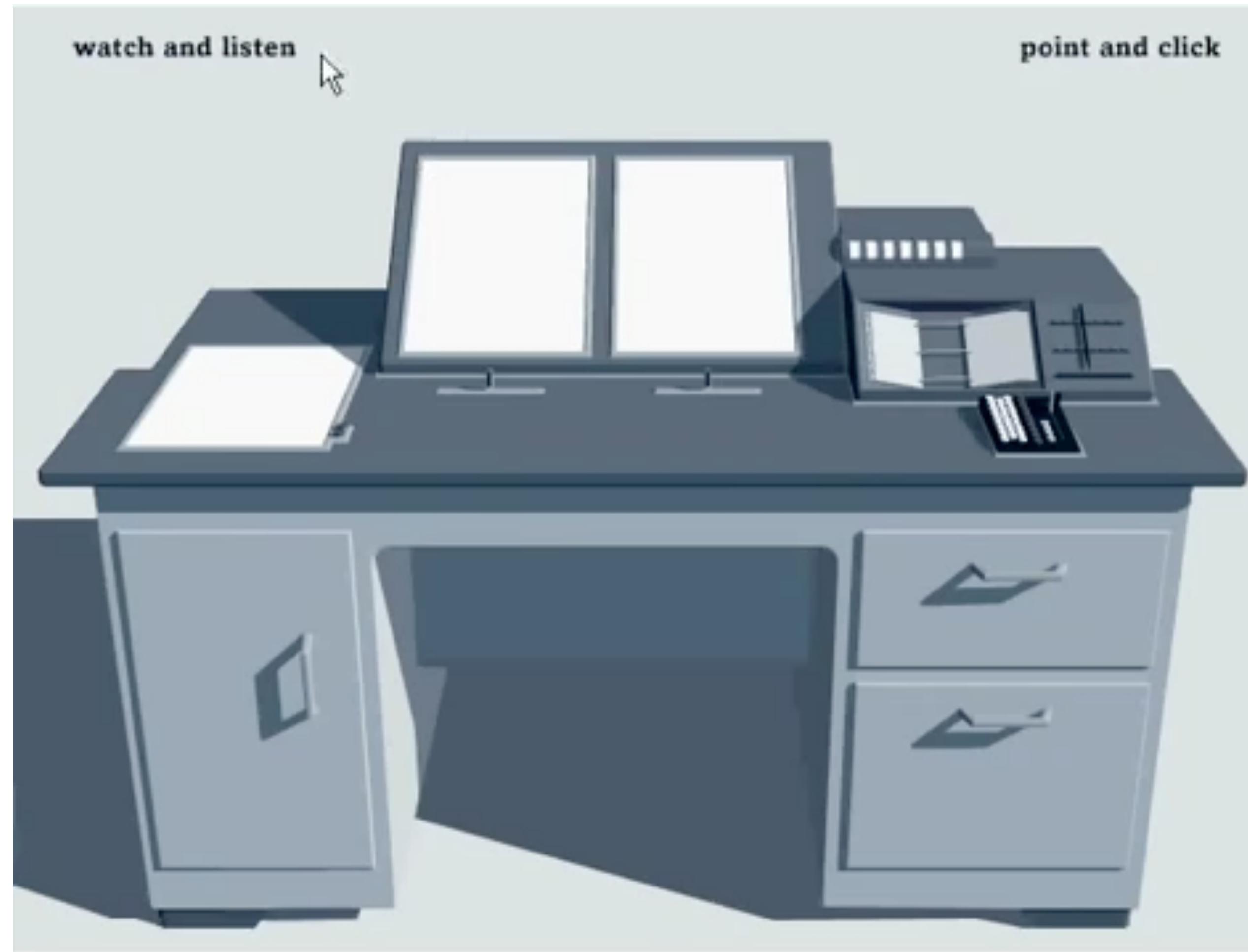
- Faculty at MIT
- Oversaw National Defense Research Committee, which led the Manhattan Project
- Post-war, helped define mission of the National Science Foundation
  - Federal government funds universities
  - Universities do basic scientific research
  - Research helps economy and defense



# As We May Think

- Published in Atlantic Monthly, 1945
- [http://www.theatlantic.com/magazine/print/1945/07/as-we-may-think/  
3881/](http://www.theatlantic.com/magazine/print/1945/07/as-we-may-think/3881/)
- In part, set out to define a post-war scientific research agenda
  - Speculative, not reflective

# Memex (1945 speculative design)



<https://www.youtube.com/watch?v=c539cK58ees>

(video from 1995 animation presented at SIGIR, not from 1945)

# Memex (1945 speculative design)

- Linking information across devices and sources
  - Hypertext, the foundation of the web
- Pen-based annotation of primary sources

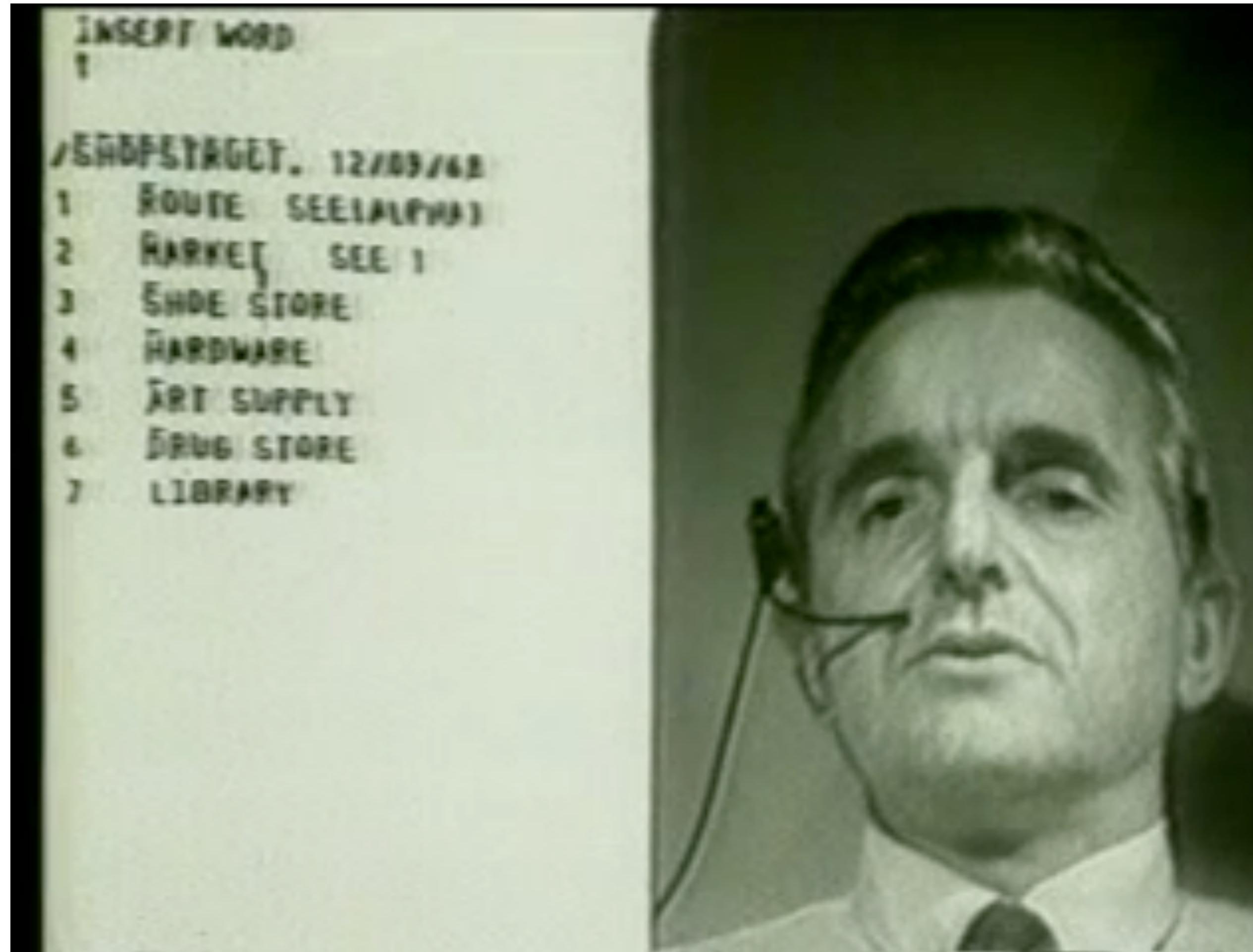


# Command-Line interfaces (1960's)

- Originally used in a terminal connected to a mainframe
  - Was eventually integrated into personal computing (in Unix, etc.)
- A person could change execution based on output
- Enabled real-time debugging



# Doug Engelbart's NLS (1968)



The image is a composite of two photographs. On the left, a screenshot of the NLS (Augment) interface is displayed. The screen shows a menu with the following options:

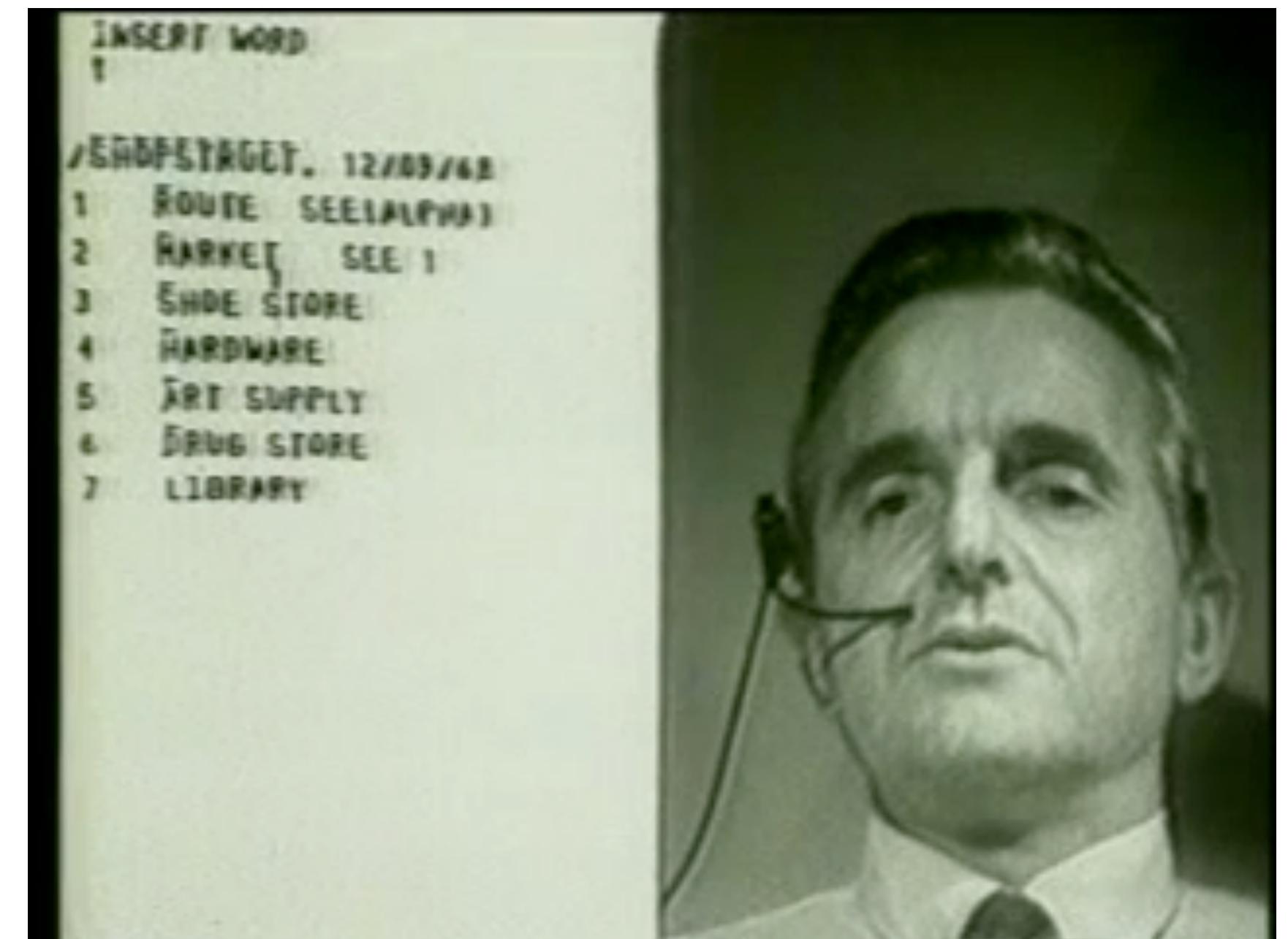
- 1 INSERT WORD
- 2
- 3 /SHOPSTREET. 12/03/68
- 4 ROUTE SEE ALPHABET
- 5 MARKER SEE 1
- 6 SHOE STORE
- 7 HARDWARE
- 8 ART SUPPLY
- 9 DRUG STORE
- 10 LIBRARY

On the right, a black and white portrait photograph of Doug Engelbart is shown from the chest up. He is wearing a light-colored shirt and a dark tie, and has a microphone attached to his shirt.

<http://www.douengelbart.org/firsts/1968-demo-interactive.html>

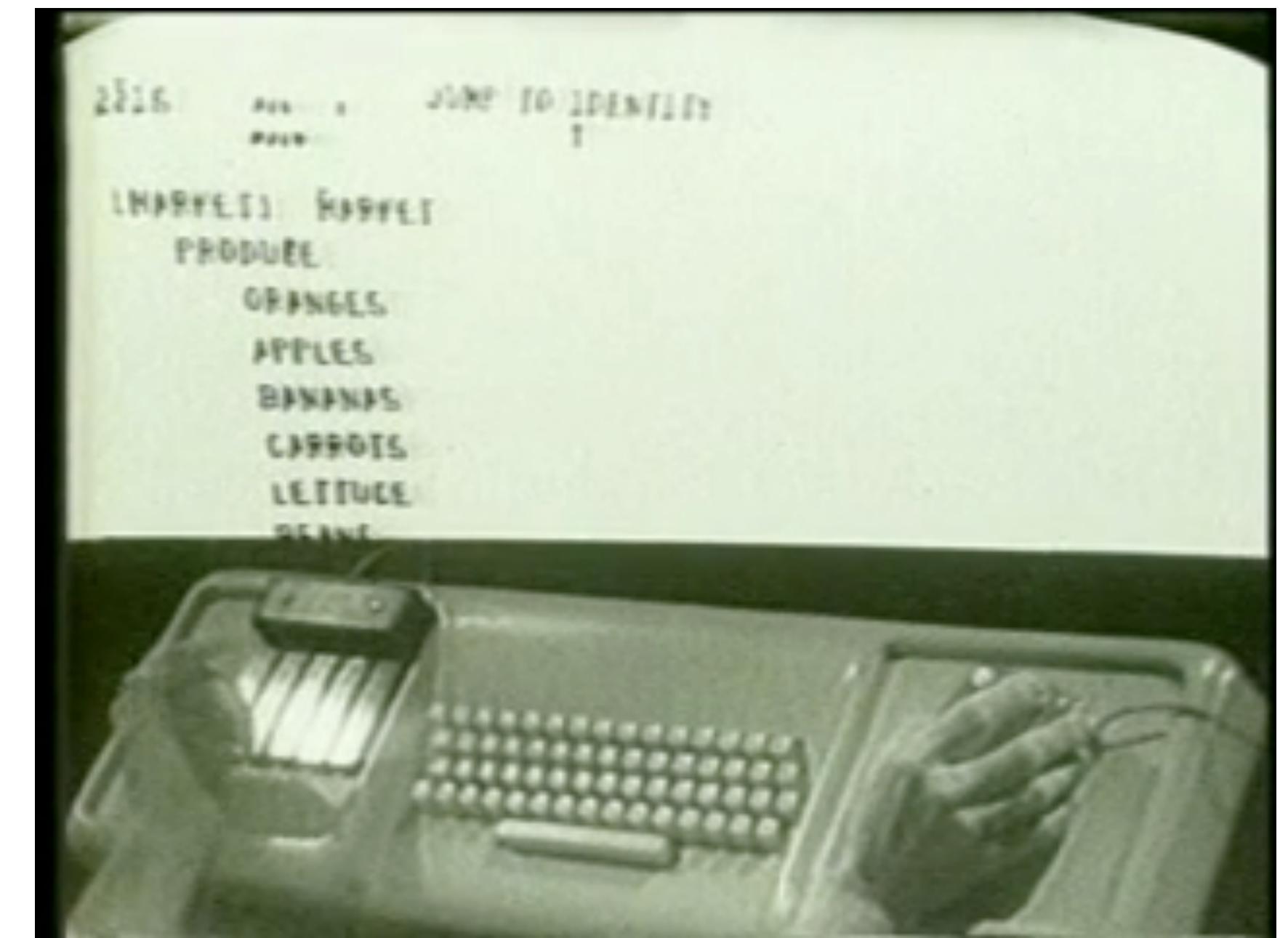
# Doug Engelbart's NLS (1968)

- First working hypertext system
- Invention of the mouse
- Simple graphics  
(earlier systems had this,  
but used in a full system here)



# Doug Engelbart's NLS (1968)

- It introduced other ideas as well
  - A chording keyboard
  - Remote collaboration
- Some people thought he “faked it”
- Others thought it was irrelevant because “the terminal can do the same”
- Won Turing Award in 1997



# Three waves of computing



Mainframe  
computing



Personal  
computing



Ubiquitous  
computing

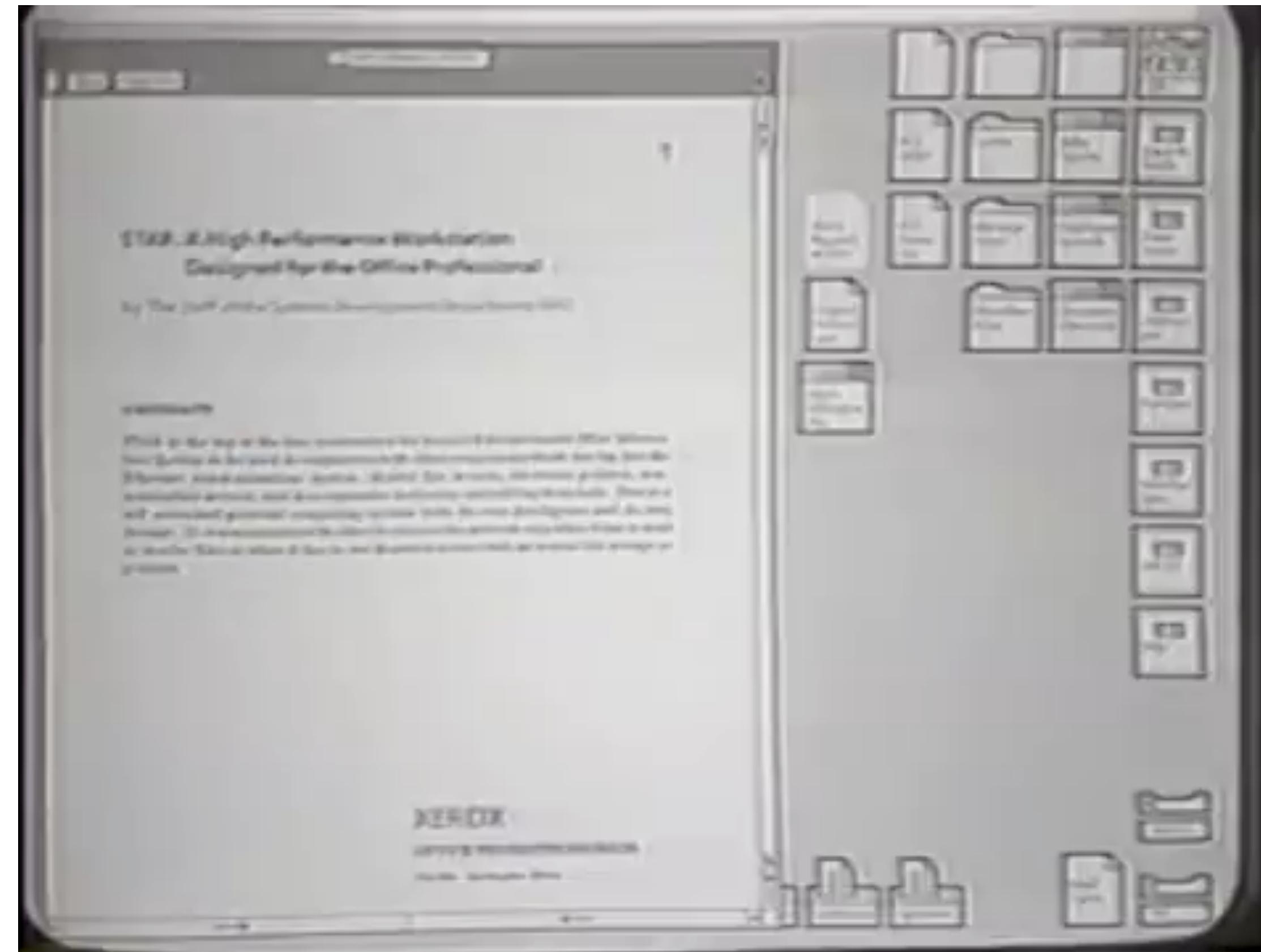
# Second wave: personal computing

- First introduced by Xerox
- Xerox Alto, 1973
  - Mouse
  - Chording keyboard
- Xerox Star, 1981
- Xerox models
  - were commercially unsuccessful
- Still expensive, too few applications



# Second wave: personal computing

## Xerox Star (1981)

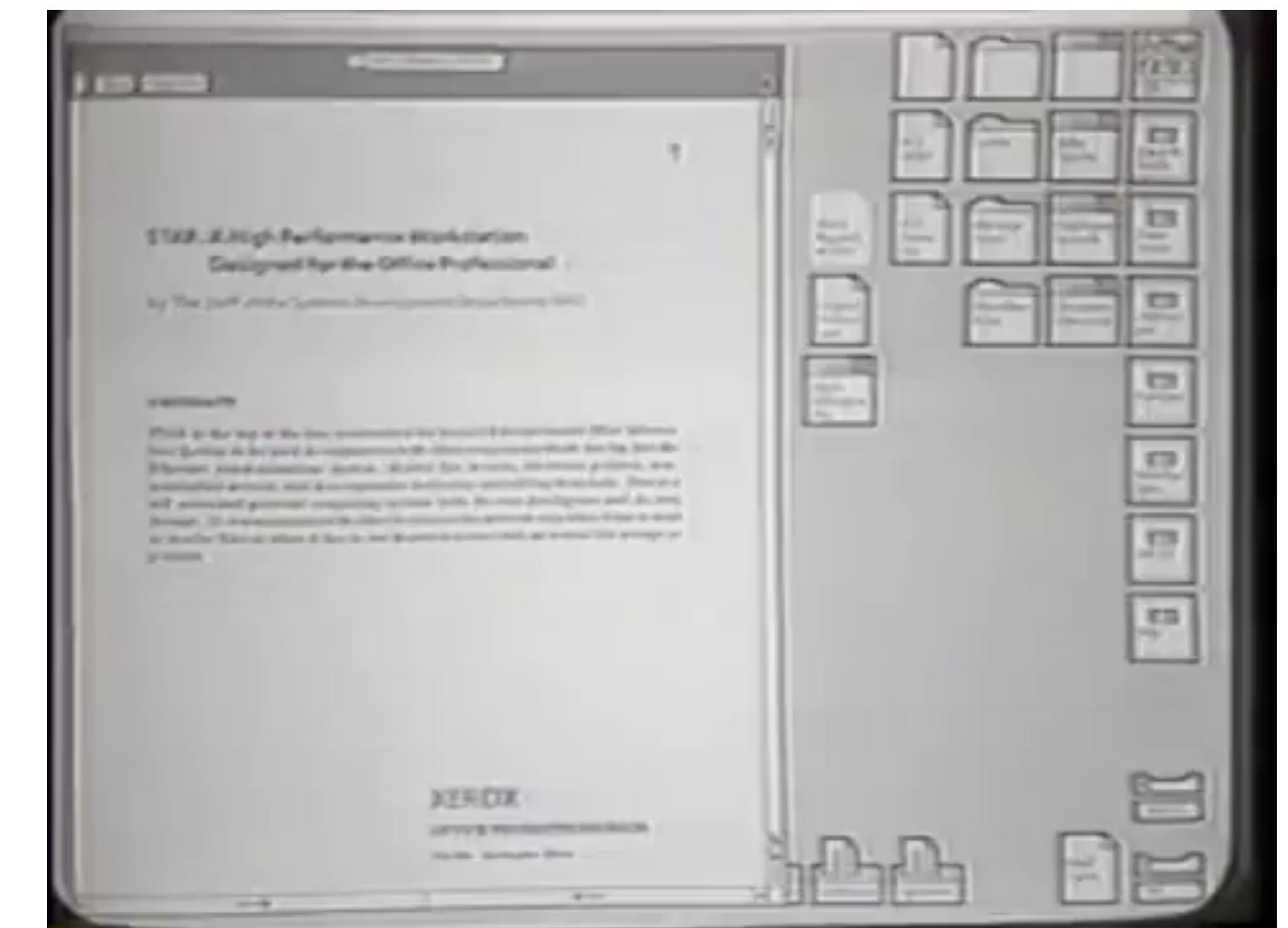


<https://www.youtube.com/watch?v=ODZBL80JPqw>

# Second wave: personal computing

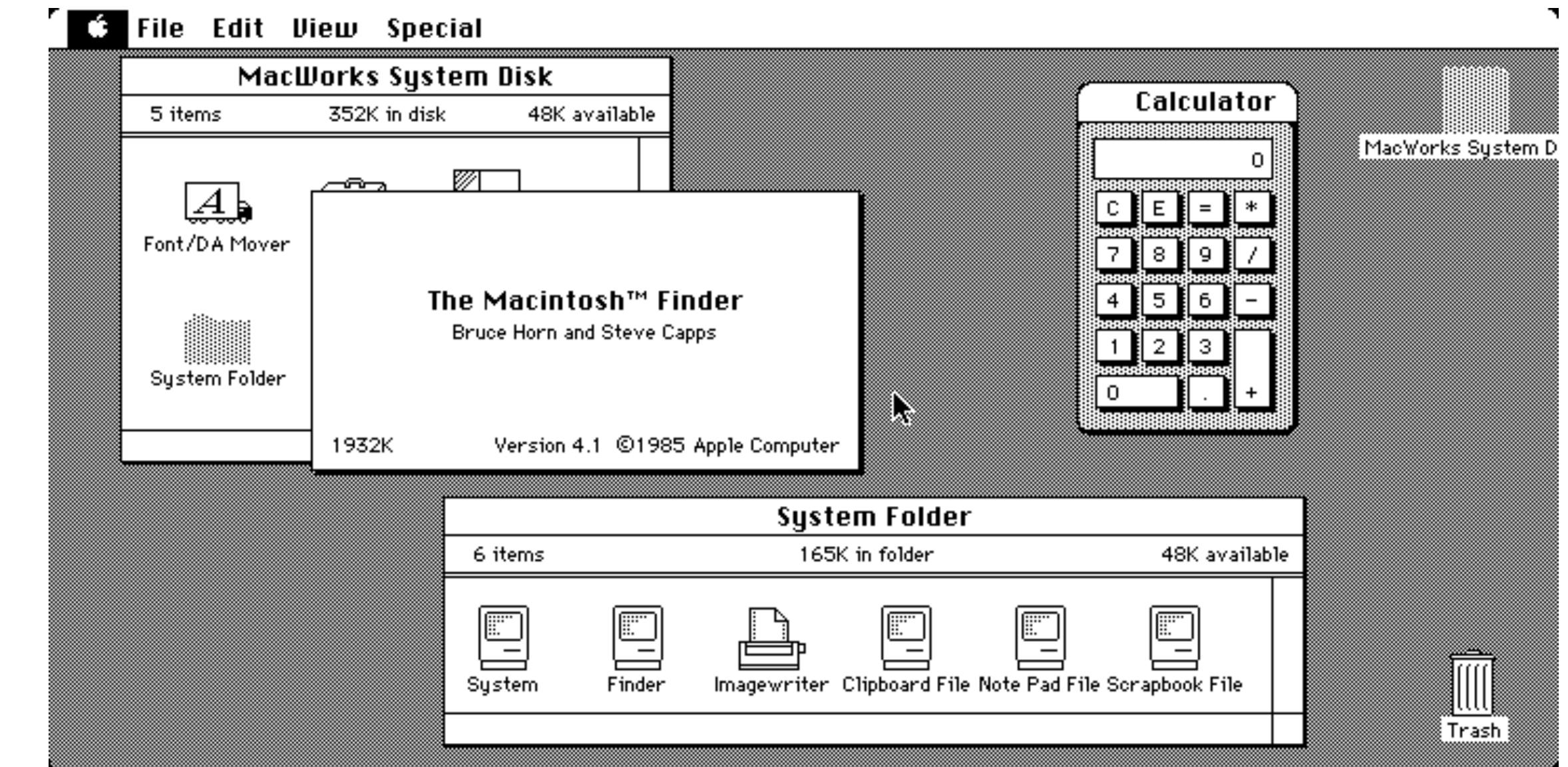
## Xerox Star (1981)

- Software running in windows
- Desktop with icons for navigating between files and programs
- Super slow!



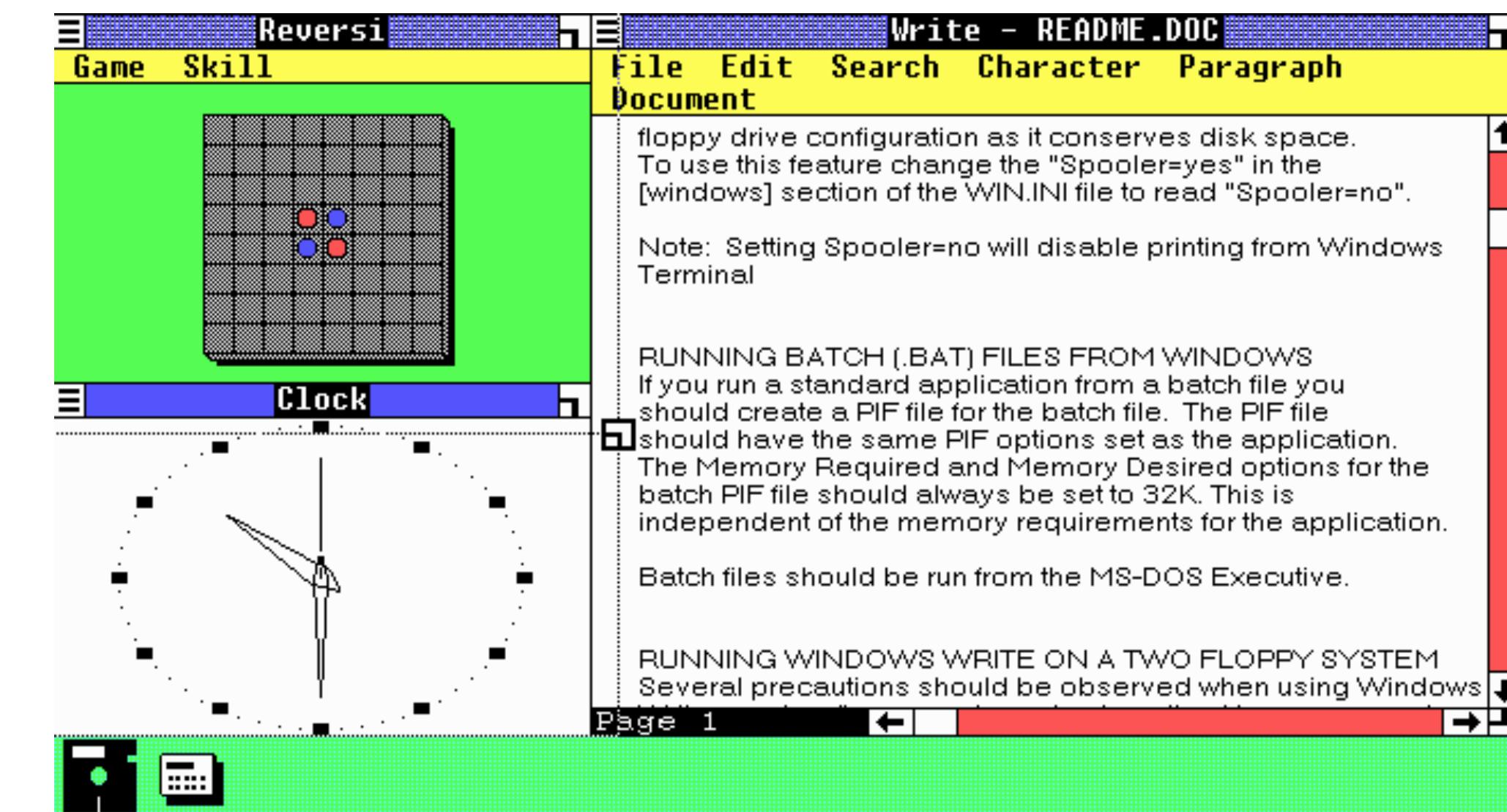
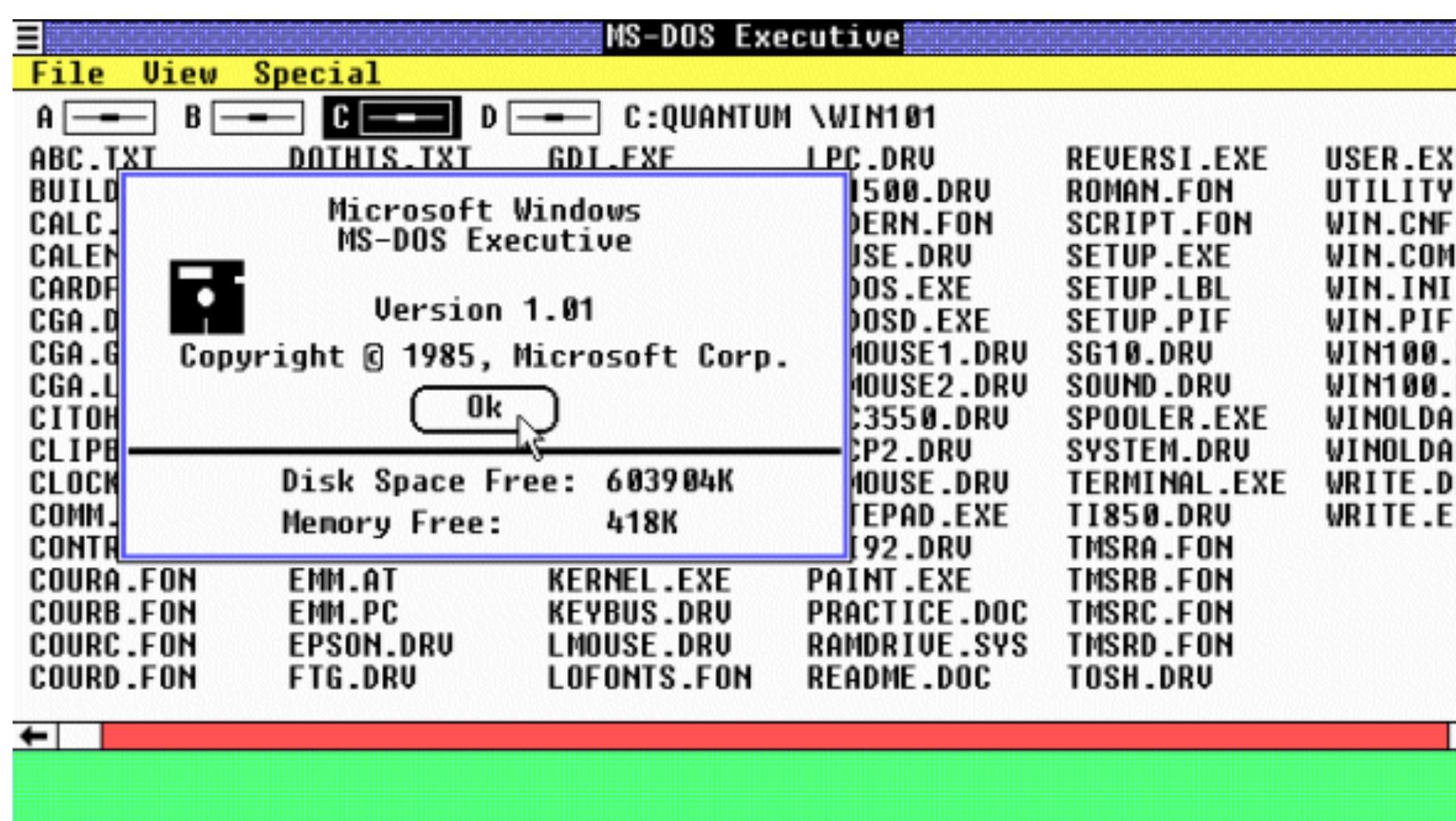
# Second wave: personal computing

## Macintosh (1984)



# Second wave: personal computing

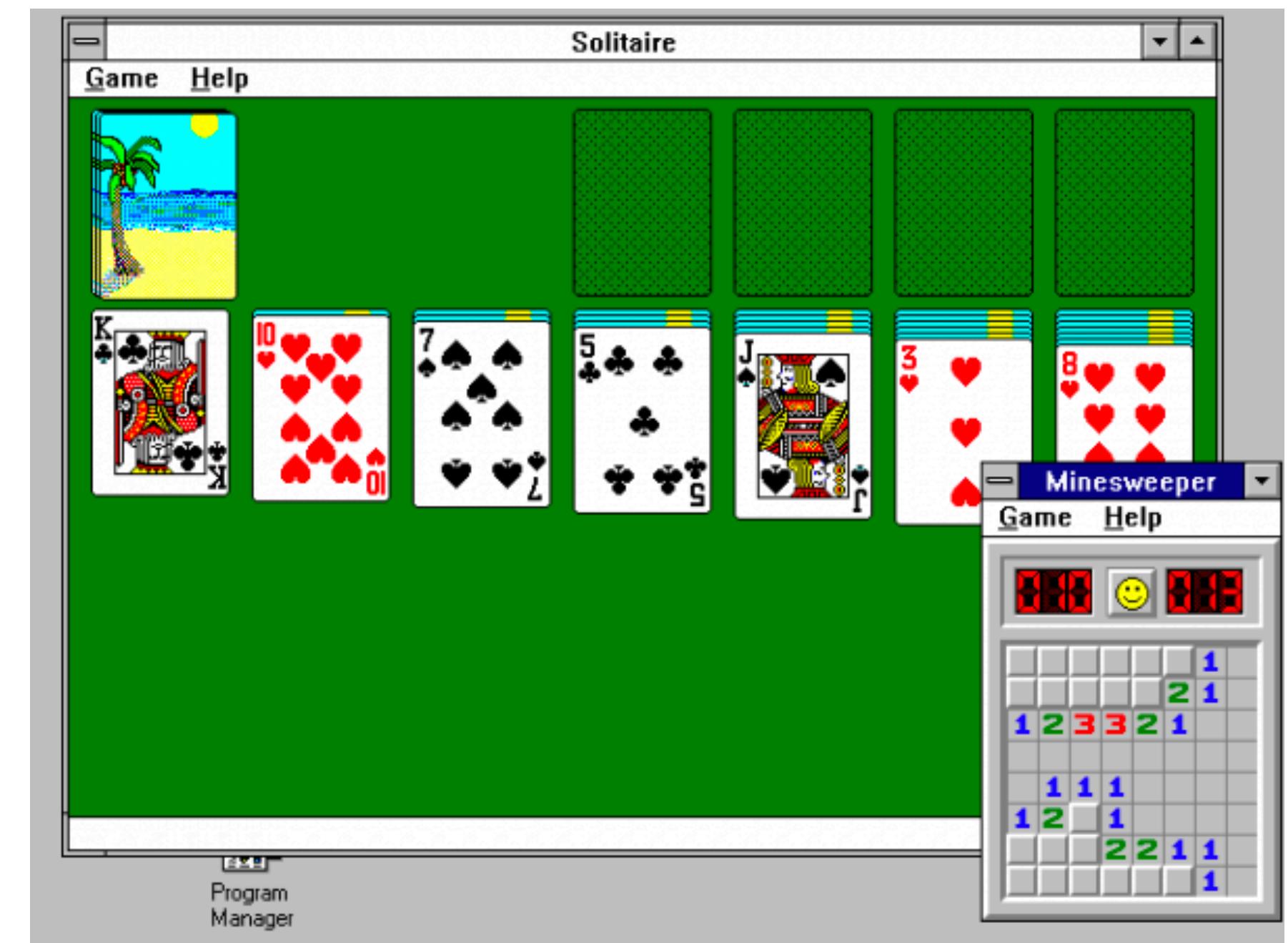
## Windows 1.0 (1985)



# Second wave: personal computing

## Windows 3.0 & 3.1 (1990 & 1992)

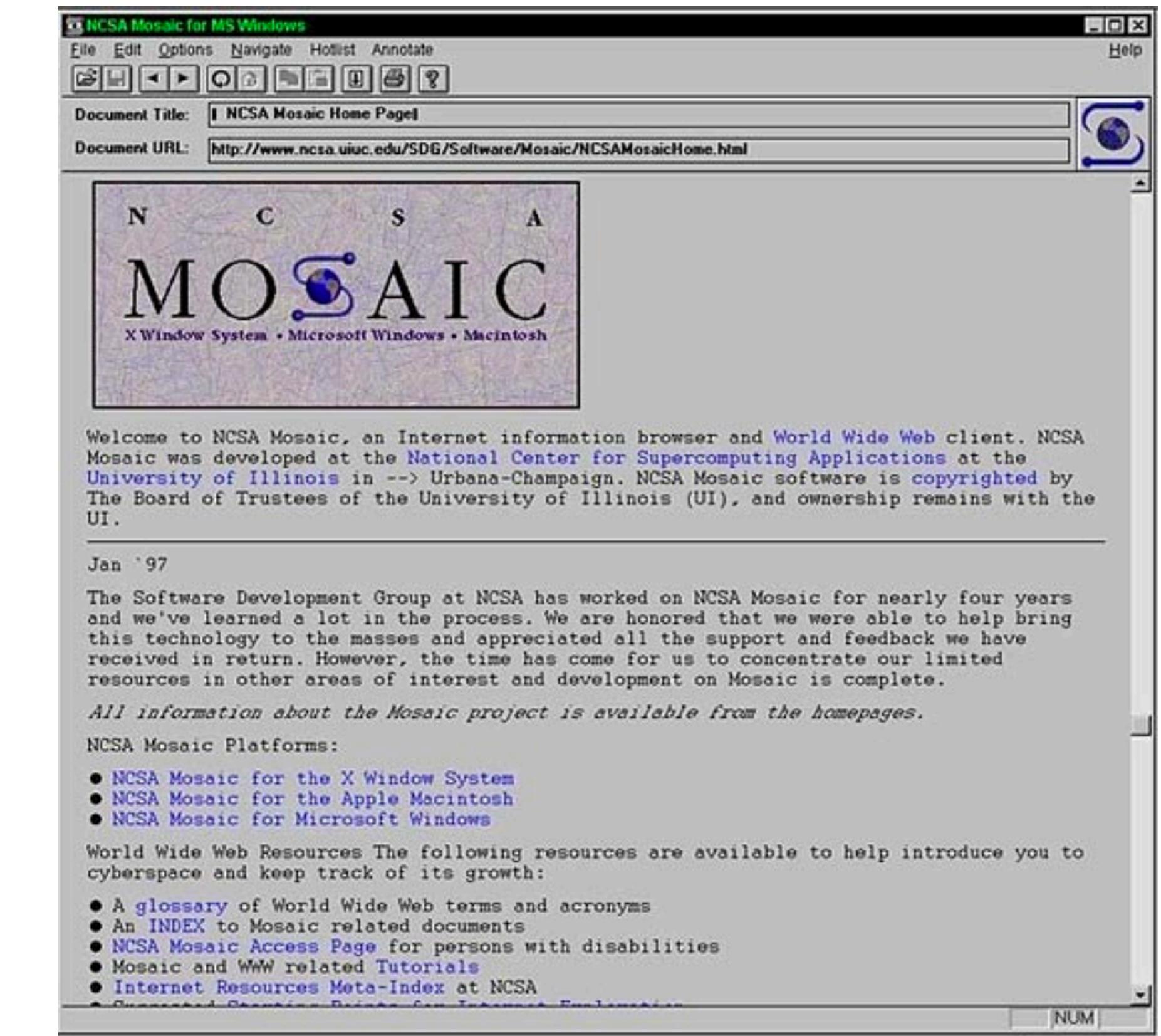
- Windowing became primary
- Added games: Solitaire, Minesweeper, and FreeCell!
  - These were a trick to teach mouse skills



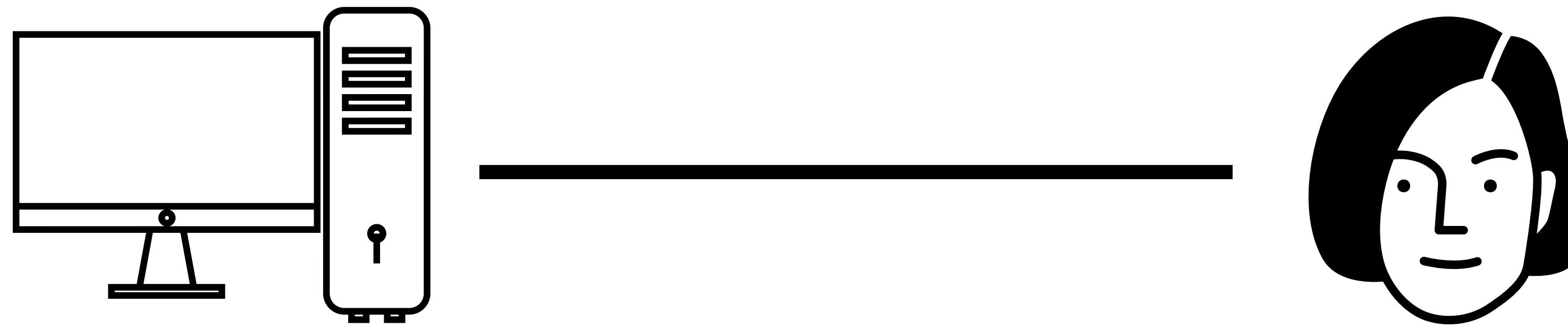
# Second wave: personal computing

## Mosaic Web Browser (1993)

- Originally for Unix systems, later ported to Mac and Windows
- “First” graphical web browser
- Microsoft IE came in 1995
- Apple didn’t make a browser until Safari in 2003



# Second wave: personal computing



“One to one”

# Three waves of computing



Mainframe  
computing



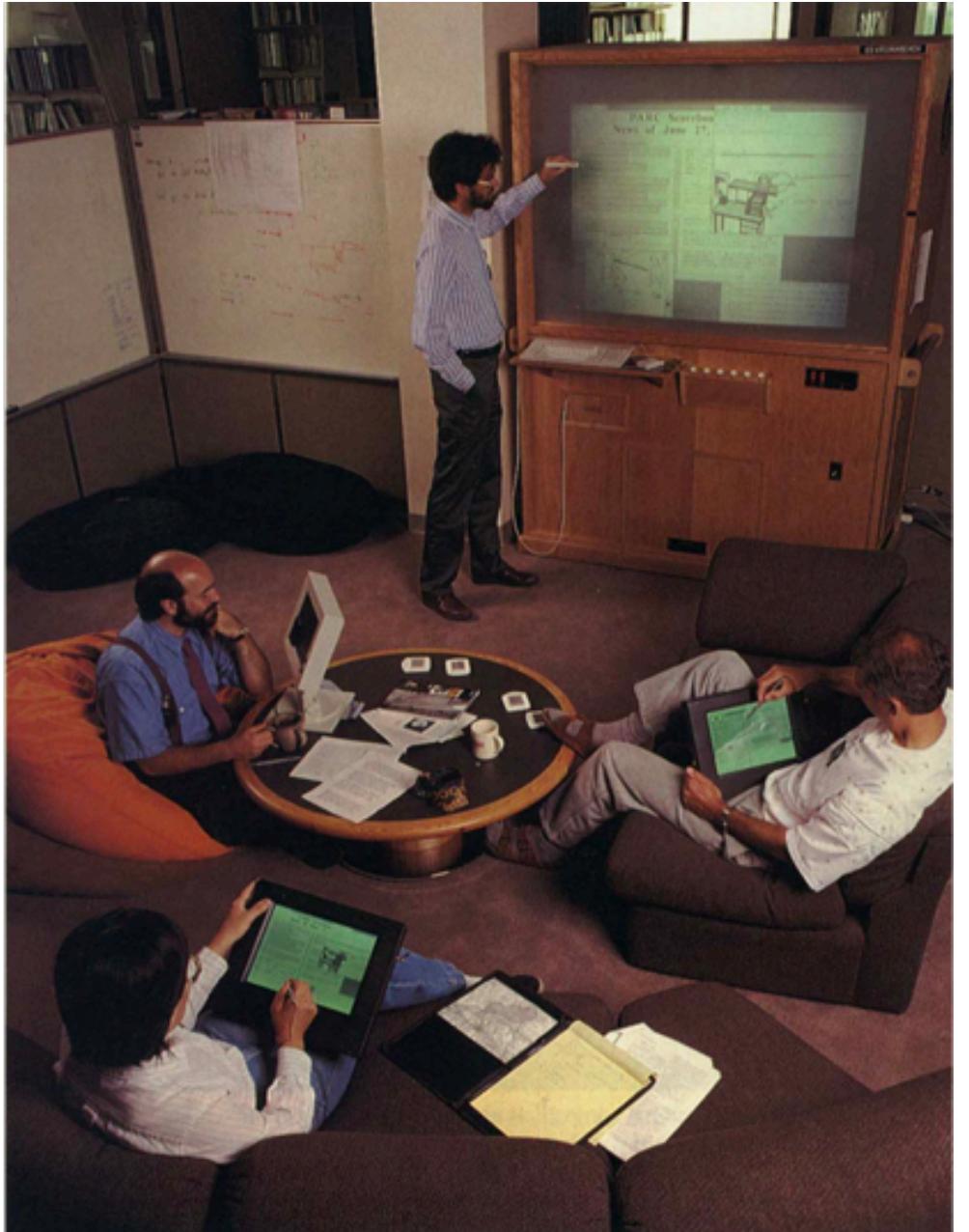
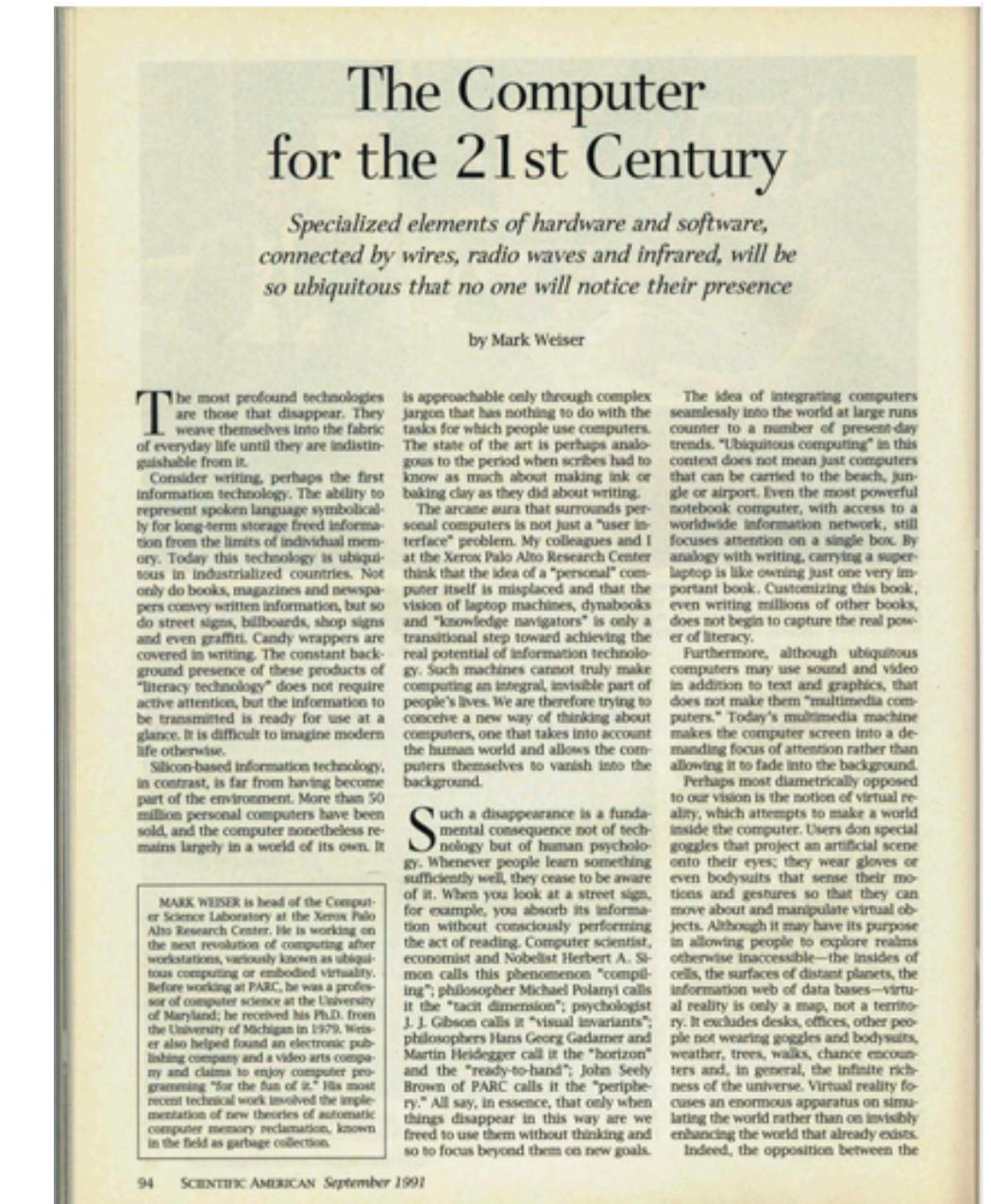
Personal  
computing



Ubiquitous  
computing

# Third wave: ubiquitous computing

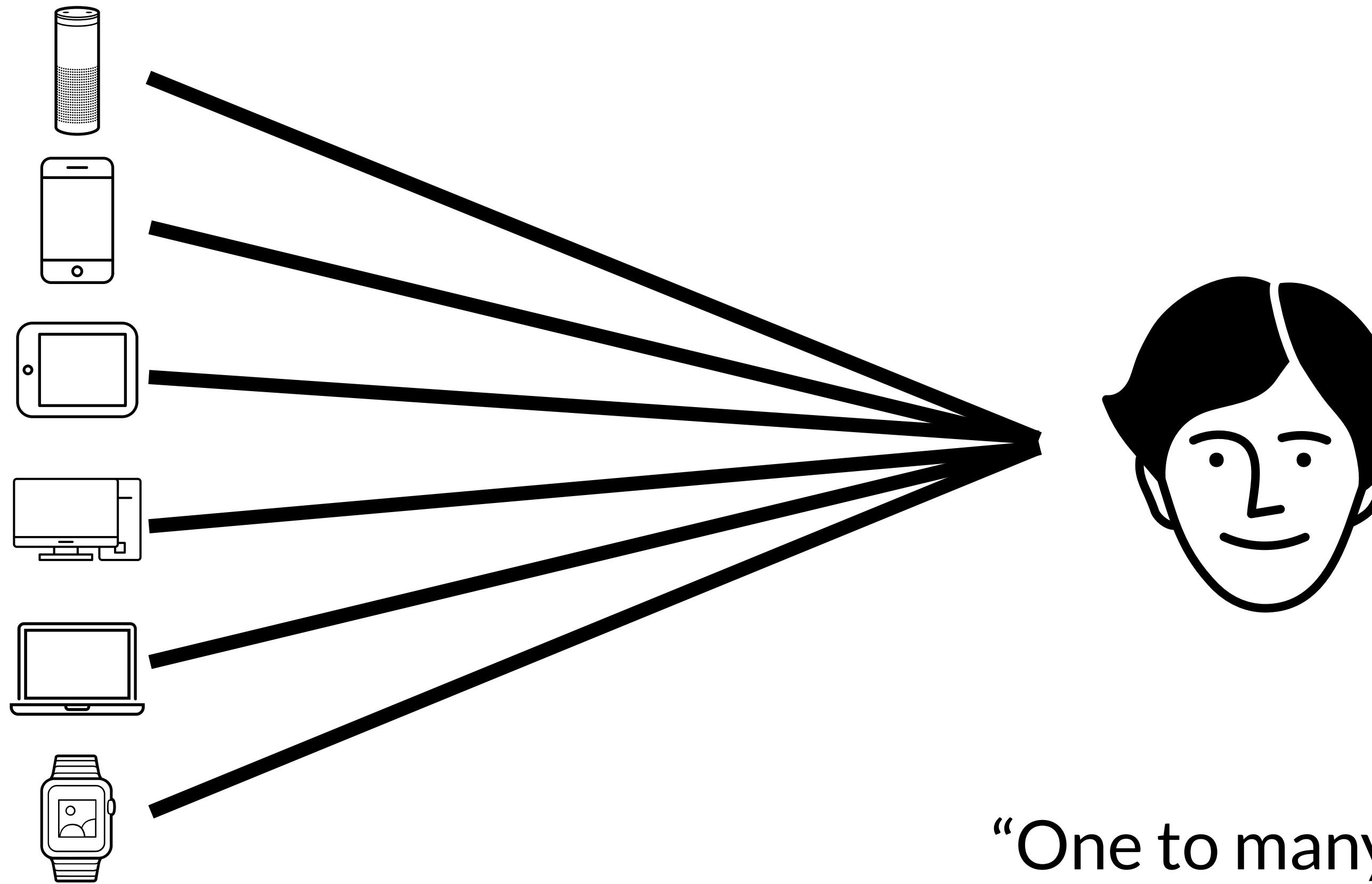
- Weiser speculated people would interact with three types of computers
  - Tabs: inch-scale devices, like post-its
  - Pads: foot-scale devices, like paper
  - Boards: yard-scale devices, like whiteboards
- Speculated devices would have shared ownership



# Third wave: ubiquitous computing



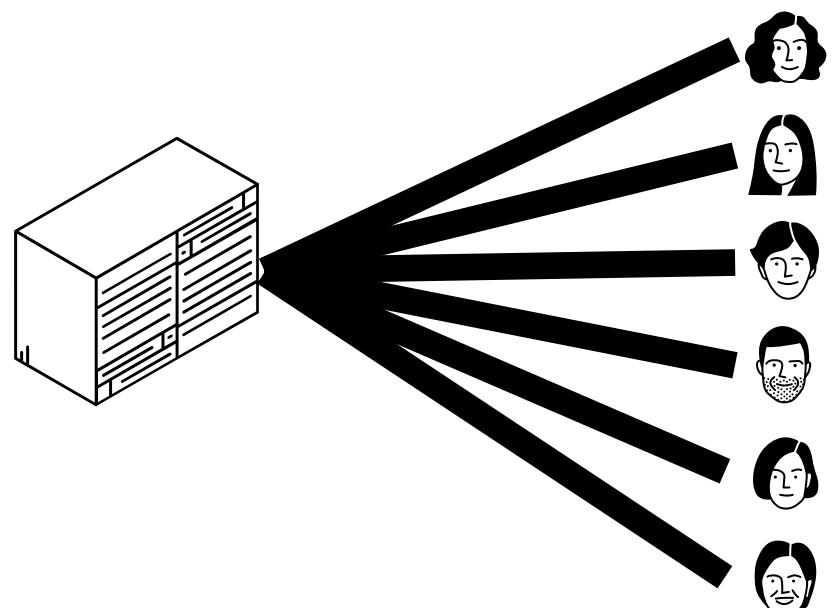
# Third wave: ubiquitous computing



# Three waves of computing



Mainframe  
computing



“Many to one”



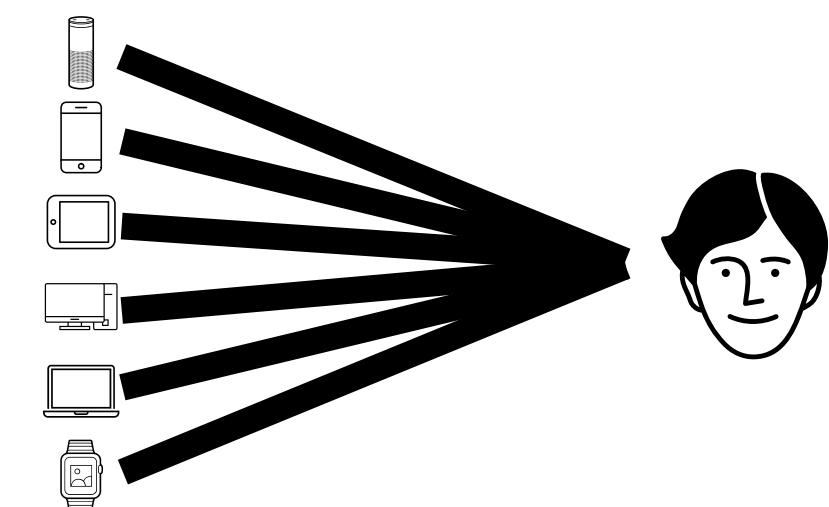
Personal  
computing



“One to one”

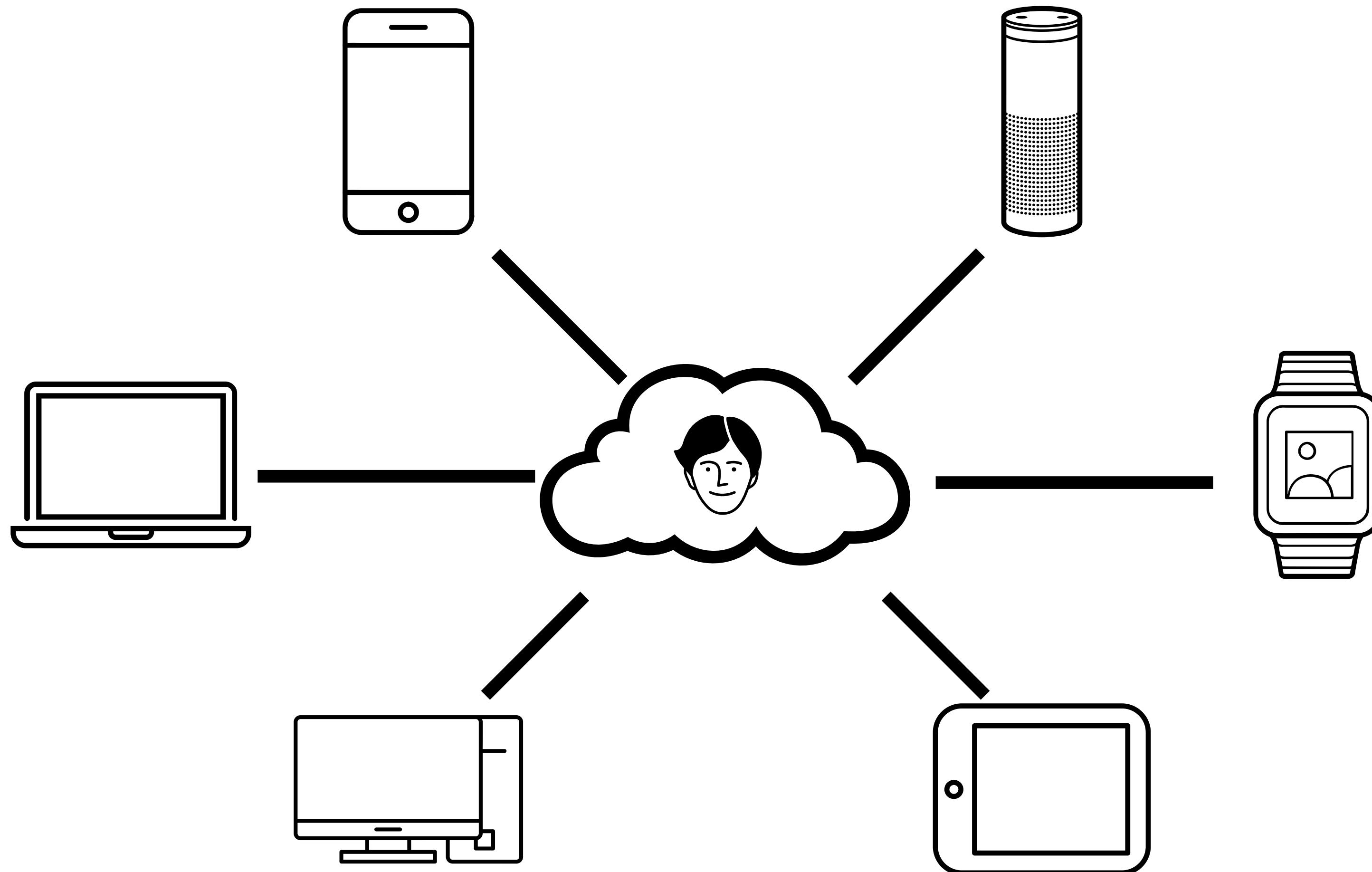


Ubiquitous  
computing



“One to many”

# One to many, synced over the cloud



# Fourth wave? Fifth wave?

- Some have argued we've already entered the next wave(s) of computing
- Cloud: shared backend
- Crowd: easy-to-access knowledge/computation from others
- Shroud: IoT devices embedded into our world



Gregory D. Abowd, Georgia Tech

Considering the technological changes across computing's first three generations, how might the next serve humanity? Three critical technologies—the cloud, the crowd, and the shroud of devices connecting the physical and digital worlds—define the fourth generation of collective computing.

<https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7383147>

# Fourth wave? Fifth wave?

- Argument is that we're in a “many-to-many” world, where computing is more connected and collective
- The waves are shorthand for interaction styles, so they can support whatever argument you want to make



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# Today's class

- Defining ubiquitous computing
- Course overview

# Course Overview

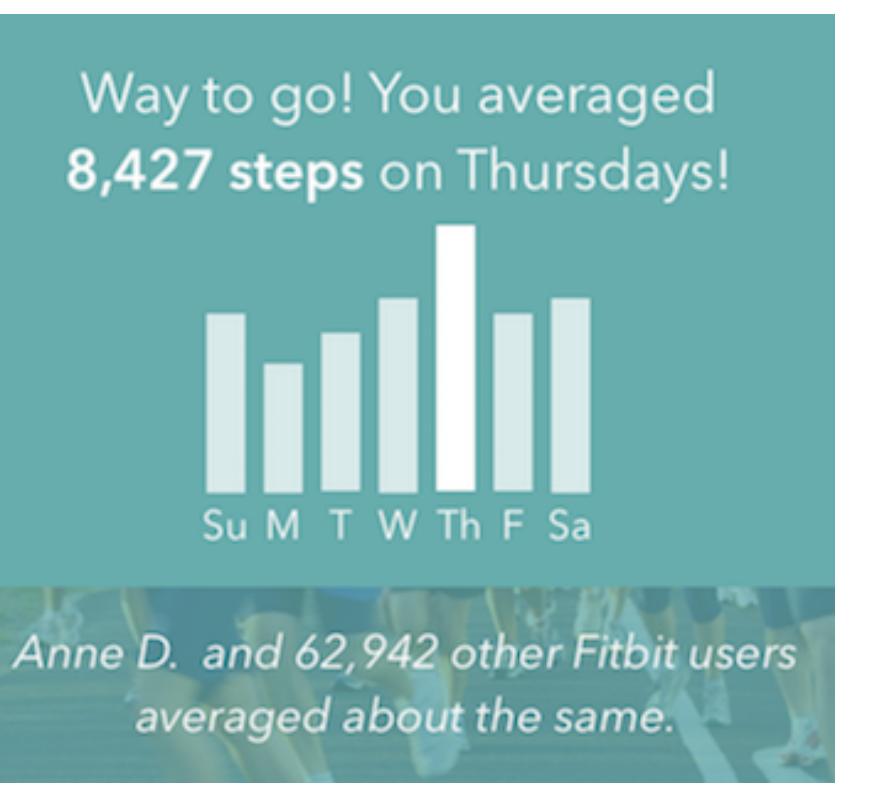
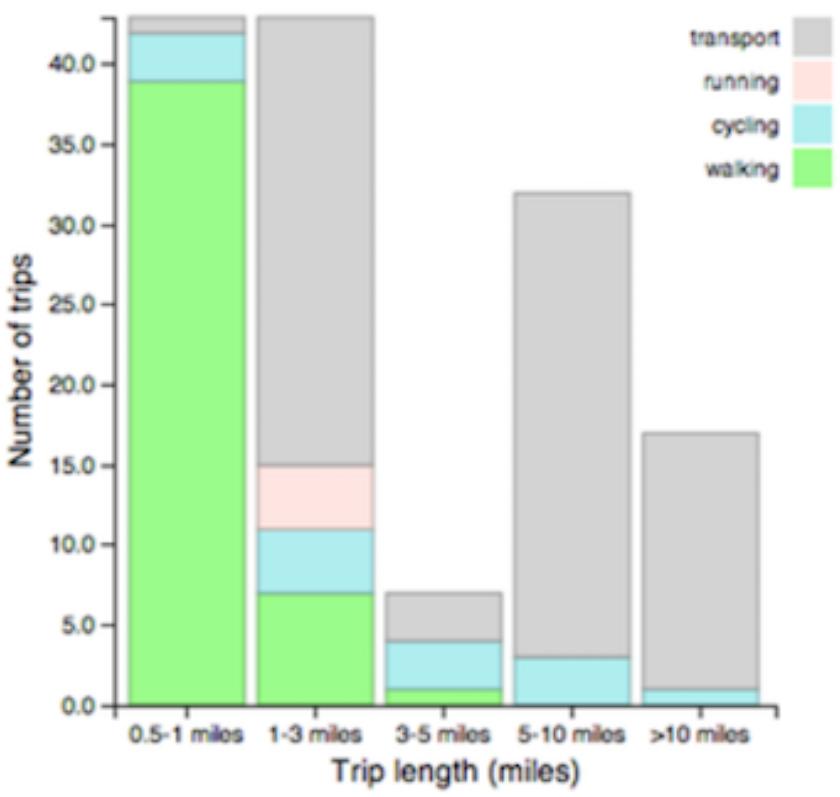
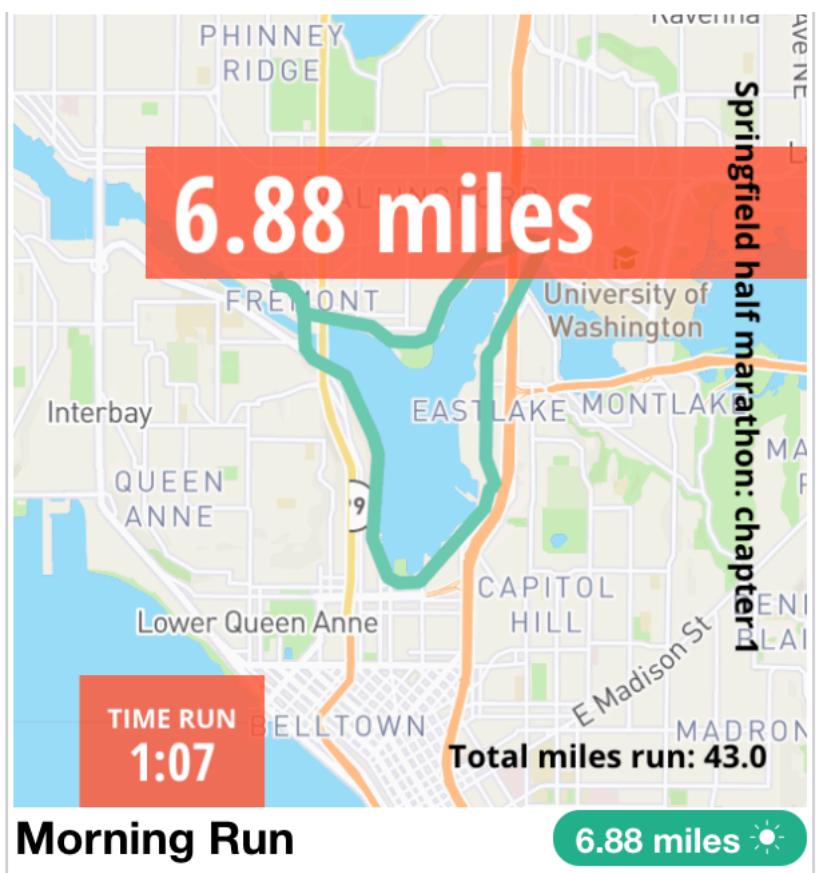
- Who I am
- Staying in touch
- Readings
- Assignments
- Project
- Grading
- Calendar overview

# Who I am

- Ph.D. Computer Science & Engineering,  
University of Washington 2018
- B.S. Computer Science,  
University of Virginia 2012
- Joined UCI Informatics in 2018  
Assistant Professor
- Internships at Microsoft & Adobe



# Who I am



# Who I am

- Broadly speaking, I work on Human Computer Interaction (HCI)
- Ubiquitous Computing is one of my sub-areas of focus
- I examine how ubiquitous technology can be best designed to help people achieve their goals



**Around the call!  
Say your name, program & year,  
and something fun about you**

# Staying in touch

- Web: <http://inf241-wi21.depstein.net/>
- Email me: [epstein@ics.uci.edu](mailto:epstein@ics.uci.edu)
- Slack: <https://uci-inf-241-wi21.slack.com/>
  - Information will go out to Slack first, and may not go out over email
- Office hours: generally by appointment (send me an email)
  - This & next week are a good time to discuss project ideas

# Readings

- Each week will cover a different topic connected to ubiquitous computing
- Readings will emphasize:
  - 1-2 *framing* papers which summarize and contextualize the topic
  - 1-2 *recent* papers of more specific contributions
- Doing the reading is a major component of the course
  - No exams

# Readings

- Post “reading queries” to Slack the Sunday night before class
- Short (1-2 sentences)
- Discussion of what the reading(s) made you consider;  
*not a summary of the reading(s)*
  - What did you find interesting or unusual?
  - What aspects of the work were particularly well done?
  - How might this research have informed other research or products you’ve seen?

# Readings

- One of you will lead discussion for each class
- Your goal is to be “the expert” on each week’s readings
  - Present on the background of the reading authors
  - Offer context on research that informed or was informed by this work
  - Guide the discussion to cover key points made in the reading
  - Bring in points discussed in the reading reports
  - Ensure a range of voices/perspectives are given the opportunity to speak

# Readings

- I have identified framing readings for each week
- Discussion leaders can choose the recent readings
  - I have provided some suggestions from the IMWUT venue, but you can also suggest another reading
- Let me know on Canvas what topics you are most (and least) interested in leading

# Assignments

- 2 assignments, focused on giving firsthand experience designing or developing Ubiquitous Computing systems
  - Assignment 1: promoting physical activity
  - Assignment 2: TBD, probably supporting conversational journaling
- You can choose between design (e.g., UX) and development (e.g., programming)

# Project

- Expected to be groups of 2
  - Singles and groups of 3 considered, but singles very highly discouraged
- Proposal, milestone, report

# Project

- The project is intended to produce *novel research* in Ubiquitous Computing
  - Or implementation, study design, etc. in support of later novel research
- For example, you might:
  - Implement a new ubiquitous technology, such as a novel method for sensing
  - Develop and execute a study which contributes some understanding of how people use ubiquitous technology
  - Rigorously evaluate a piece of existing ubiquitous technology
  - Design a ubiquitous technology which critically examines people's practices

# Project

- Some of you may have ongoing work that is relevant
  - It's fine, even encouraged, to "count" an ongoing research project for this class
  - So long as it connects to ubiquitous computing in some way
  - You may even be able to recruit classmates to help with your work!
- But I expect that a research project will be new to many of you
  - I'll create a Slack channel shortly with some project ideas
  - If you have an idea already, you can post it to that channel

# Grading

- 45% group project
  - 5% project proposal, 10% milestone report, 30% final report
- 30% assignments
  - 15% assignment 1, 15% assignment 2
- 10% reading reports
- 5% leading discussion
- 10% participation

# Course Overview

- Who I am
- Staying in touch
- Readings
- Assignments
- Project
- Grading
- Calendar overview

# Calendar overview

## Calendar

Your discussion leading group must choose two recent papers to assign for each week. I have assembled a list of recommendations for [recent papers](#). You may choose from these papers or suggest another paper(s) not on this list.

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**Mon Jan 4**      [Lecture on History & Course Overview \(slides\)](#)

Notes

There are no readings for this session.

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**Wed Jan 6**      [Visions of Ubiquitous Computing \(slides\)](#)

Discussion Leader: Daniel

Read the framing papers:

- Mark Weiser. [The Computer for the 21st Century](#). Scientific American 265, 3. 1991
- Gregory D. Abowd and Elizabeth D. Mynatt. [Charting Past, Present, and Future Research in Ubiquitous Computing](#). TOCHI 7, 1. 2000

Notes

There are no papers of current research contributions this session.

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**Mon Jan 11**      [Due: Discussion Leading Preferences](#)

[Lecture on Activity Recognition \(slides\)](#)

Read the framing paper:

- Andreas Bulling, Ulf Blanke, and Bernt Schiele. [A Tutorial on Human Activity Recognition Using Body-Worn Inertial Sensors](#). ACM Computing Surveys 33. 2014

<https://inf241-wi21.depstein.net/calendar>

# Final thoughts

- If you expect lectures and assignments on processing signals, printing nanomaterials, etc., there's a little, but not much
  - In part because I do not have the background necessary to teach such skills
  - But I also find creating new knowledge much more fulfilling
- You may use these skills in your projects, but you will be expected to pick them up on your own

# Final thoughts

- Instead, you will leave this class with:
  - Context about where ubiquitous computing fits in the history of technology
  - A better understanding of how to make ubiquitous technologies useful for people
  - The ability to critique a new device or system and improve upon it
  - Ideally, a research contribution in ubiquitous computing through your project

# **IN4MATX 241: Ubiquitous Computing**

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