CS 66.460

Introduction to Graphical Human-Machine Interfaces

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A History of Human-Computer Interaction

The Evolution of Human-Computer Interaction

HCI Technology	*Information Encoding*	*B*	*D*	*M*	*S*
Text–based CRT	ASCII Text	X			
GUI	Bitmapped displays	X			
Multimedia	Bitmapped displays, sound, speech output	X	X		
VR	3D Graphics, 3D Sound, speech recognition/output, tactile	X	X	X	X

B= Blind/Visually Impaired, ***D***= Deaf/Hearing Impaired, ***M***= Motor, ***S***= Speech

Chronology of HCI Developments

	1945-1955 Pioneer	1955-1965 Historical	1965-1980 Traditional	1980-1995 Modern	1995-? Future
UI Paradigm	batch processing	command languages	full screen (menus, forms)	WIMP	noncommand based interfaces
Terminal Technology	TTY typewriter	line oriented terminals "glass TTY" CRT	full screen terminals	graphical displays desktop workstations heavy portables	"Dynabook" multimedia I/O easily portable cellular modem
User Types	experts pioneers	technocrats professional computerists	specialized groups without computer knowledge	business professionals hobbyists	everybody
Operating Mode	one user	batch central processing	time sharing remote access	single user PCs	networked single user embedded systems
Programming Language	machine language	assembler	high level languages	problem oriented languages spreadsheets	nonimperative visual programming

From Usability Engineering, Nielsen, 1993

The MEMEX (Vannevar Bush, 1945)

- ❐ Problem: new knowledge not reaching the people who benefit from it
- ❐ Solution:

  ``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."

The MEMEX (continued)

- The MEMEX introduces concepts of hypertext:
  - ***desk, slanting screens, buttons, levers, and keyboard***
  - ***uses mircofilm for storage***
  - ***new material can be added via microfilm or by direct entry via ``dry photography”***
  - ***supports indexing, cross-referencing, keywords***
  - ***supports associative indexing via links and creation of “trails” which can later be followed***
  - ***allows annotations - comments, and marginal notes***
  - ***envisions multimedia i/o: other senses, such as, speech and audio***

J.C.R. Licklider (1960)

- Objective: Man-Computer Symbiosis

  ‘‘The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today.’’

- Developed goals that must be achieved as a pre-requisite to achieving man-computer symbiosis

J.C.R Licklider (continued)

- ❐ Immediate Goals
  - *time sharing of computers among many users*
  - *electronic i/o for the display and communication of correlated symbolic and pictorial information*
  - *interactive real-time system for information processing and retrieval*
  - *large scale information storage and retrieval*

J.C.R Licklider (continued)

- ❐ Intermediate Goals:
  - *facilitation of human cooperation in the design and programming of large systems*
  - *combined speech recognition, hand-printed character recognition, and light pen editing*
- ❐ Long term goals:
  - *natural language understanding (syntax, semantics, pragmatics)*
  - *speech recognition of arbitrary computer users*
  - *heuristic programming*

Sketchpad (Sutherland's MIT PhD Thesis, 1963)

- ❐ Sophisticated drawing package
- ❐ Many innovations still found in today's GUIs:
  - ***hierachical structure of pictures made up of sub-pictures***
  - ***object-oriented programming: master picture from which instances are created***
  - ***constraints: as methods for specifying the details of the underlying geometry of pictures and having the system maintain them***
  - ***icons: used to represent more complex items***
  - ***copying: of pictures and constraints***
  - ***input devices: light pen***

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Sketchpad (continued)

- ❐ Innovations (continued):
  - ***independent coordinate systems: separation of screen coordinates from drawing coordinates***
  - ***recursion: to apply operations to children of hierarchical structures***

Advances in Computer Graphics

- input devices such as data tablets (1964)
- powerful display processors, capable of real-time image manipulation (1968)
- introduction of low-cost graphics terminals (1970s)
- operating system support for interactive graphics under timesharing systems
- new programming languages for embedded graphics support

Advances in Computer Graphics (continued)

- new applications flourished
  - ***computer-aided math libraries (1968)***
  - ***3D computer graphics / molecular modeling (1968, 1977)***
  - ***animation, movies, sequencing of images (1966, 1969)***

Douglas Engelbart

- augmentation of human intellect (1963)

  ``... increasing the capability of man to approach a complex problem situation, gain comprehension to suit his particular needs, and to derive solutions to problems."

- Extended Bush's Memex:
  - ***hierarchical structures for ordinary documents***
  - ***group creation and problem solving***

- Invented the mouse (1965) as a replacement for light pens for use in his NLS system

Douglas Engelbart's NLS System (1965-1968)

- Implemented many concepts still in use today

  document processing
  - ***modern word processing***
  - ***hierarchical hypertext***
  - ***multimedia (mixed text and graphics)***

  input/output
  - ***invented the mouse (1965)***
  - ***one-handed chord keyboard***
  - ***high resolution display***
  - ***view control and tiled windows***
  - ***specially designed furniture***

Douglas Engelbart's NLS System (continued)

shared work

- ***shared files***
- ***personal annotations***
- ***electronic messaging (e-mail)***
- ***desktop conferencing (video/audio managed by computer)***
- ***shared displays (what you see is what I see)***
- ***multiple pointers***

user testing to see how people worked

the need for training

Ted Nelson

- ❒ coined the term ``hypertext'' (1965)
- ❒ more interested in lateral links not just hierarchical ones
- ❒ interested in individual exploration
- ❒ extension of document ties that could combine contributions from people with no formal ties
- ❒ a global ``docuverse''
- ❒ his book **Computer Lib/Dream Machines** (1974) describes what machines can do for people rather than businesses

The Personal Workstation: Innovations at XeroxPARC in the 1970s

- ❒ The Xerox Alto (1979)
  - ***used by an individual***
  - ***significant local processing power and memory***
  - ***high resolution bit-mapped displays, keyboard, and mouse***
- ❒ Pioneered developments of GUIs and applications
  - ***text editing, drawing, document processing, e-mail***
  - ***windows, menus, scrollbars, mosue control and selection, WYSIWYG***
- ❒ Pioneered local area networks for workstations (1975)
  - ***ethernet***

The Personal Computer

- ❒ The Dynabook (Alan Kay, 1977)
  - ***conceptualized of a notebook computer; cardboard prototype***

    ``...a self-contained knowledge manipulator in a portable package the size of an ordinary notebook...”
  - ***features:***

    powerful processor

    lots of memory

    high resolution graphics

    high fidelity audio
- ❒ The Altair 8800 (1975)
  - ***appeared in Popular Electronics home computer people could build for around $400***

The Xerox Star (1981)

- designed for business professionals in an office environment
- comprehensive combination of many ideas developed at XeroxPARC and other pioneering systems:
  - ***user conceptual model via the desktop metaphor***
  - ***direct manipulation***
  - ***property/option sheets to specify appearance of objects***
  - ***what you see is what you get (WYSIWYG)***
  - ***universal generic commands that are used throughout the system (e.g., move, copy, edit, delete)***
  - ***high degree of consistency, look and feel***
  - ***modeless interaction***
  - ***limited amount of user tailorability***

The Xerox Star (1981)

- first system based on many principles now known as usability engineering
  - ***inspired design from a decade of previous work***
  - ***extensive paper and pencil prototyping***
  - ***usage analysis***
  - ***human factors experiments with users***
  - ***iteratively refining the design***
- Other techniques now central to HCI development:
  - ***design first, then code***
  - ***use object oriented techniques***
  - ***participation of graphic designers***

The Xerox Star (1981)

❒ Not a commercial success

- ***cost: almost $15,000; IBM introduced a cheaper machine***
- ***limited functionality: no spreadsheet***
- ***lacked an open architecture: no 3rd party application development***
- ***perceived as too slow***
- ***direct manipulation was overly used and not the best in some cases***

Apple Computer

❒ Apple Lisa (1983)

- ***based on ideas from Xerox Star***
- ***could be used as an office tool but also individuals***
- ***at $10,000 was cheaper than the Star***
- ***but... also failed...***

Apple Computer (continued)

- Apple Macintosh (1984)
  - ***same ideas from the Lisa, but much improved***
- Reasons for success
  - ***cheaper: only $2500***
  - ***previous systems prepared the market***
  - ***``second generation,'' many problems with Lisa were fixed***
  - ***open architecture and powerful developers toolkit***
  - ***published interface guidelines: consistent look and feel for apps***
  - ***excellent graphics and emergence of desktop publishing***
  - ***Apple had marketing expertise, distribution channels, and experienced computer sales and support staff***