Programming of Interactive Systems (Interfaces et Systèmes Interactifs) ISI-2012, HCID 103

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Week 1 : b. Ergonomics & HCI, History, Styles

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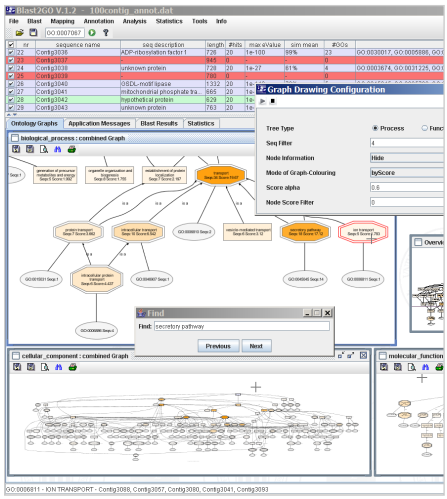
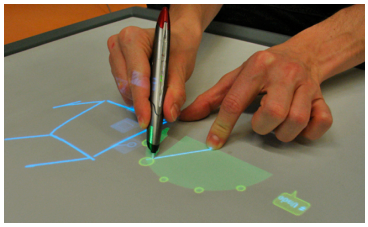
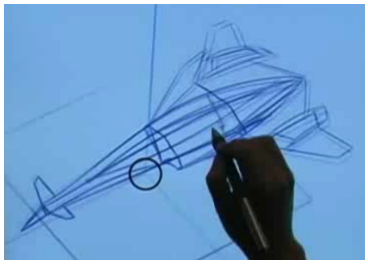
(part of this class is based on previous classes from Anastasia, and of T. Tsandilas, S. Huot, M. Beaudouin-Lafon, N.Roussel, O.Chapuis)

interactive systems







ergonomics and hci

Ergonomics and HCI

Ergonomics (human factors) :

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being, security, and overall system performance.

International Ergonomics Association

Ergonomics and HCI

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International Ergonomics Association

Ergonomics

Physical

Cognitive

Organizational

Environmental

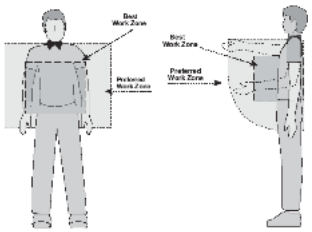
Ergonomics

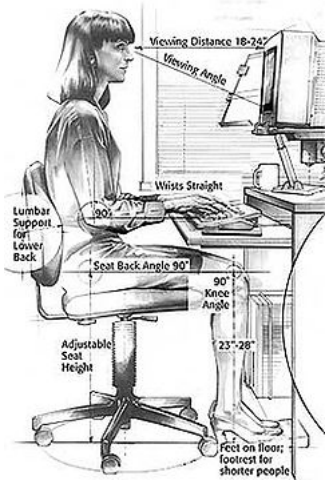
Physical

Cognitive

Organizational

Environmental





Ergonomics

- Physical
- Cognitive
- Organizational
- Environmental

Ergonomics

- Physical
- Cognitive
- Organizational
- Environmental

Ergonomics

Physical

Cognitive

Organizational

Environmental

Ergonomics

influences
- mechanical engineering and physics
- psychology
- physiology and kinesiology

...
combined with observations and studies

Traditionally goal is to give **precise guidelines**

Ergonomics = Ergos + Nomos

Greeks and Egyptians
Frederick W. Taylor (1900) on coal shoveling
Frank B. Gilbreth (1911) on bricklaying
2nd world war – birth of «human factors»
military influence (even today)

Space and Information Age ➔ HCI

Ergonomics and HCI

HCI :

"HCI is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."

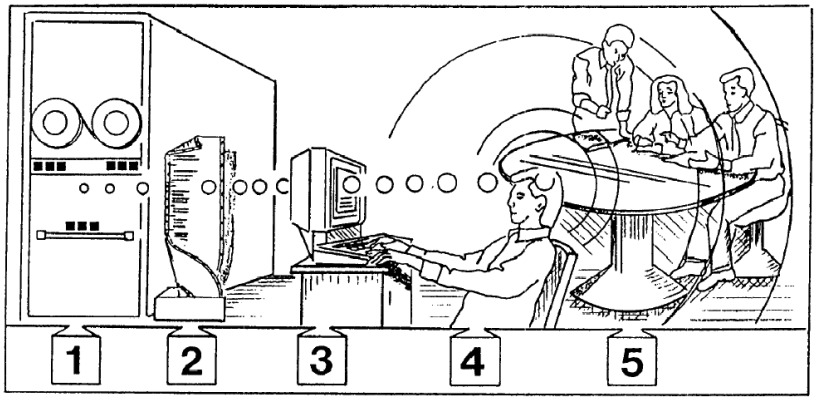
(an) ACM definition

hci you know

… or not

a brief history of hci

the history of interfaces

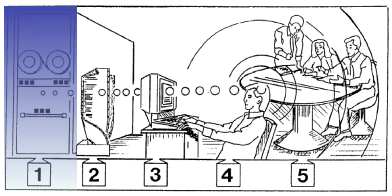


Grudin (1990) The computer reaches out: The historical continuity of interface design

the history of interfaces

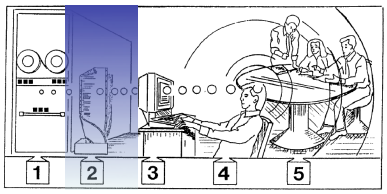
Phase 1 (Interface as hardware)

- 1950s
- Engineers / programmers
- Electrical engineering

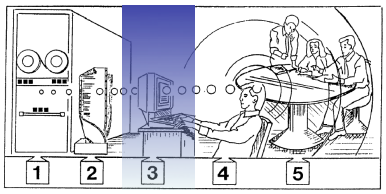


Phase 2 (Interface as software)

- 1960s-1970s
- Programmers
- Punched cards, batch processing
- Users (indirect)
- Computer Science



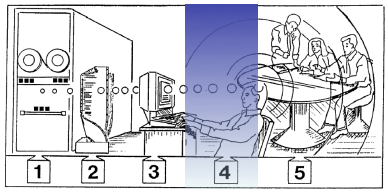
the history of interfaces



Phase 3 (interfaces as terminals)

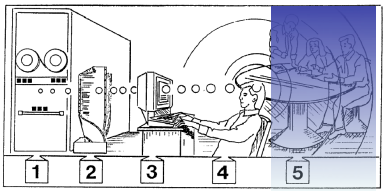
- 1970s-1990s
- End users (time-sharing)
- Human factors, cognitive psychology, graphic design
- Time sharing creates the illusion of a personal machine
- User can afford to think "at the terminal"
- Focus on user behaviour and productivity
- Computer mediated human-human interaction (CSCW)
  - Messages / Shared file systems

the history of interfaces



Phase 4 (Interface as dialogue)

- 1980s-
- Personal computers
- Many end users
- More cognitive psychology, graphic design



Phase 5 (Interface as work setting)

- 1990s-
- Widespread use of networks
- Groups of end users, communities
- Social psychology, anthropology, organizational studies

the history of interfaces

Phase 6 (?)

- 2000s-
- Mobile computing
- Mobile users, ad-hoc communities
- Pervasive / ubiquitous computing
- Domestic computing
- Social computing
- Anthropology, arts and drama

the history of interfaces

influences

Computer science

- Software engineering
- Technological advances – user interfaces

Human factors & psychology

- Computer programming and usage
- Work environments

Cognitive science

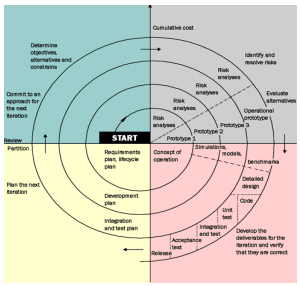
- Models, theories, frameworks

the history of interfaces

software engineering

- Software crisis ➔ software engineering

- specifications
- « Waterfall » and « Spiral » dev. models
- iterative development
- prototyping



Spiral model

the history of interfaces

technological progress

- Speed increase
  Motivated more applications
- Cost decrease
  Made interfaces accessible to different people
- New technologies
  Different interaction needs

the history of interfaces

human factors / ergonomics

- Guides for improving interface design
- Guides for evaluation of interfaces

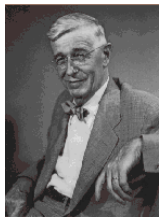
- First psychological studies in HCI
  - Programming psychology (Software psychology ’60s)
  - Behavior of programmers (Weinberg 1971)
  - Comparison of batch processing and time-sharing
  - Response time and productivity
  - Individual differences (Sackman 1970)
  - Design principles de (Hansen 1971)

the history of interfaces

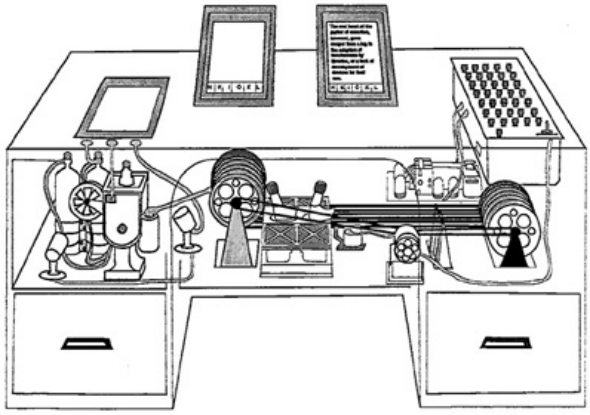
cognitive sciences

- Multidisciplinary approach
  - linguistics, anthropology, philosophy, psychology and computer science
- Study of
  - perception, cognitive processes
- Guidance
  - Provide guidance at early stages of the software development process

« as we may think »

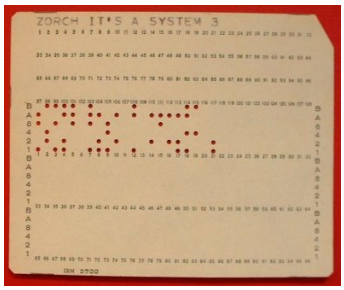


- MEMEX and Hypertext (1945)
  - Vannevar Bush: "As We May Think"



batch interfaces

(1945 - 1968)



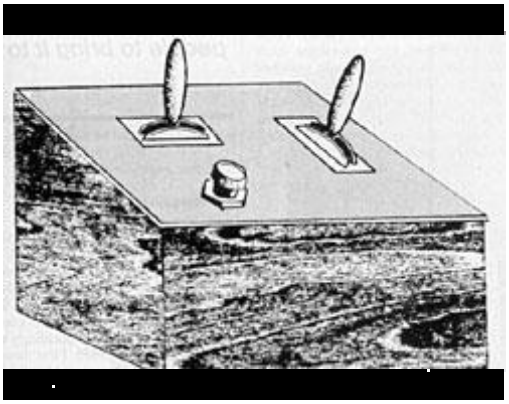
punched card

game interfaces

Spacewar!

- MIT - Steve "Slug" Russel (1961)
- DEC PD1

"mini-computer"

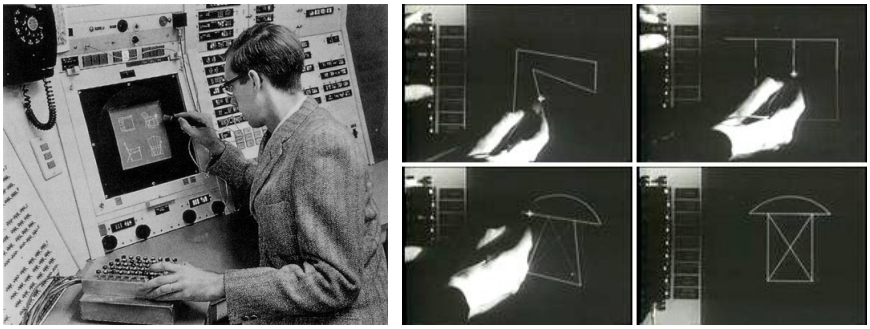


Sketchpad – Ivan Sutherland (1963)

- PhD thesis in MIT
  - 1st graphical interface

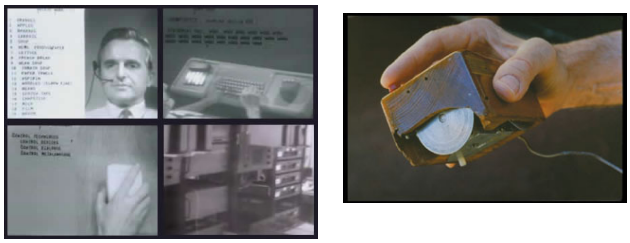
http://www.youtube.com/watch?v=mOZqRJzE8xg

  - graphical screen
  - pointing devices (optical pen) and buttons
  - design, zoom, copy-paste, icons, geometric constraints



NLS/Augment – Douglas Engelbart (1968)

- Stanford Research Institute
  - the idea to augment human intellect and use a network (oNLine System)
  - invention of mouse, keyboard & function buttons
  - hypertext links (Vannevar Bush (1945)
  - collaborative work, video-conference, document sharing

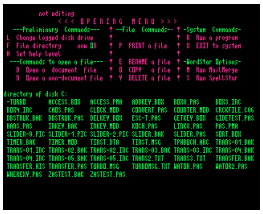


http://sloan.stanford.edu/mousesite/1968Demo.html

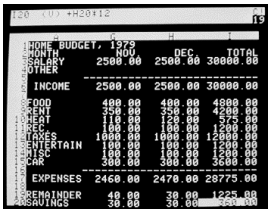
textual interfaces

(1969 - 1983)

- command line, menus and input screens



First text editor
WordStar (MicroPro, 1979)

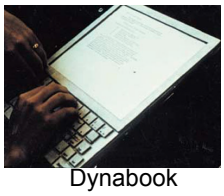


First spreadsheet: Visicalc
Dan Bricklin (1979)

Apple][(1977)

Xerox PARC (70s)

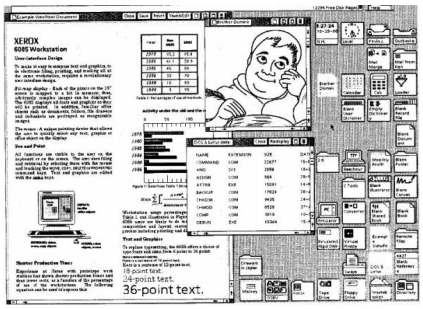
- PARC : Palo Alto Research Center created in 1970
  - PARC grouped divers tallents, interested in photocopying but also desktop computers
  - 3 researchers/engineers won a Turing award
- OO Programming (Smalltalk)
- Ethernet
- Portable computers
- Laser printers
- WIMP : Windows, Icons, Menus & Pointers



Dynabook

Xerox Star (1981)

$16,500



http://interaction.lille.inria.fr/~roussel/digital-library/media/1982-Star-CHI85.mov

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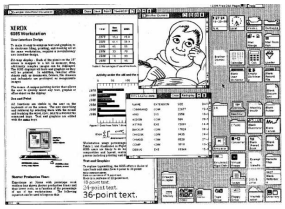
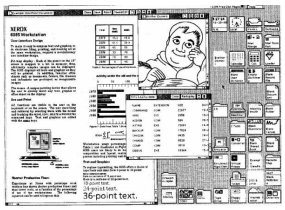


market failure

- design influenced by software needs (based on task analysis, scenarios, 600-700 heurs of video)
- native function on a network
- GUI based on office/desk metaphor
- use of icons and windows and the idea of WYSIWYG
- system focusing on documents (users do not know the applications)

Xerox Star (1981)

$16,500

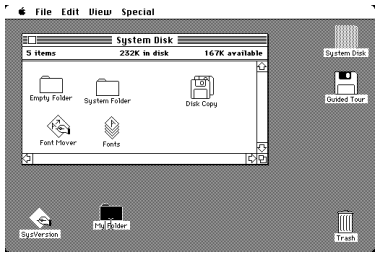


- market failure
- too innovative, powerful, different
- target market missed (e.g: no spreadsheets)
- expensive ($16,500)
- closed architecture (impossible to develop applications outside Xerox)
- political reluctance to expand market beyond printers

... but it greatly influenced current systems

Apple Macintosh (1984)

$2,495



Apple Macintosh (1984)

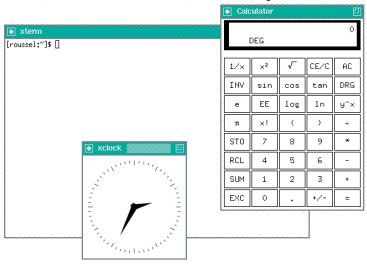
$2,495

- commercial success, more mature and a more open public
- aggressive price ($2,500) accessible to larger public
- menu bar, modal dialog boxes and visible applications inherited from l'Apple][
- UI toolkit to help external developers
- detailed style guides to help consistence between apps
- three key applications: Finder, MacPaint, MacWrite

http://interaction.lille.inria.fr/~roussel/digital-library/media/1984-Macintosh.mov

X Windows (1984)

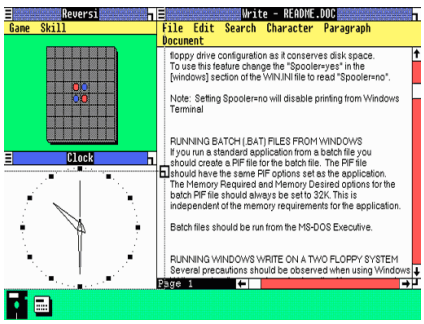
- Athena project of MIT : connect 4000 UNIX machines, from different sponsors (DEC, IBM, Motorola, etc.)



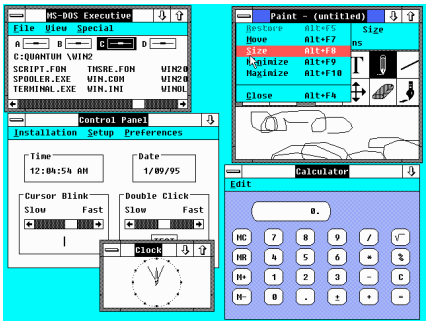
- client/server model:
  - division of what/how to facilitate portability
  - transparent use of network that permits remote displays

MS Windows (1985)

- Moved to overlapping windows



Microsoft Windows 1



Microsoft Windows 2 (1987)

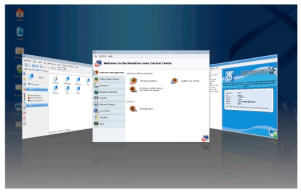
Desktop interface (1984 -)

- more power and new uses (network), but little change in interaction:

WIMP (Window, Icon, Menu & Pointing)

Apple OS X 10.5

Microsoft Vista



Mandriva Linux 2008

- .... that does not mean its a bad thing!

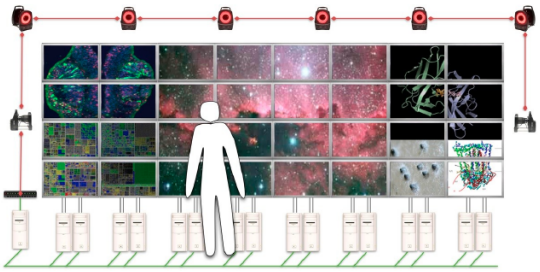
http://www.scottberkun.com/blog/2010/the-future-of-ui-will-be-boring/

HCI

- does not follow Moor's law

Original Macintosh		**iMac 21"**
Jan 1984 - $2500	x0.6	Sep 2013 - $1500
CPU 68000 - 0.7 MIPS RAM 128kB Floppy 400kB	x140000 x36000 x2000000	CPU i5 – 100.000 MIPS RAM 8GB Hard disk 1 TB
9" b&w 512x342 keyboard, mouse WIMP desktop	x2 / x10 idem idem	21" colors, 1920x1080 keyboard, mouse WIMP desktop

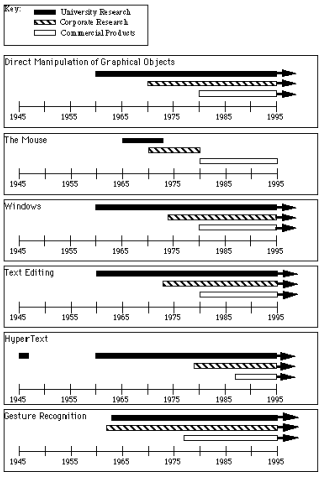
that being said … WILD in LRI



- screen wall :
  - 5.5m x 1.8m
  - 20480 x 6400 = 131 million pixels
  - 32 screens of 30", in a 8x4 configuration
  - driven by a cluster of 18 PC,
  - linked by a high speed network
- 3D motion capture system that tracks users in real time
- Multi-touch interactive tables

HCI and research

- most innovations come from research labs (academic or industrial)



more details

- http://www.cs.cmu.edu/~amulet/papers/uihistory.tr.html

interaction styles & paradigms

interaction paradigms

Computer as a tool ← our focus
- 1st person interfaces
- goal: augment user

Computer as a partner
- 2nd person interfaces
- goal: delegate tasks

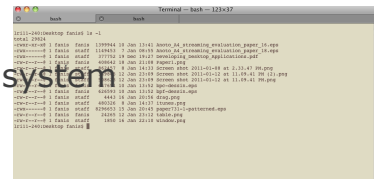
Computer as a medium
- 3rd person interfaces
- goal: human communication (e.g. CSCW)

interaction styles

- Conversational
- Direct manipulation
- Gestural
- Crossing
- …

conversational interfaces

- Command line dialogue
  - Dialogue/syntax imposed by system



✓ Easy to program, robust, little computational resources needed

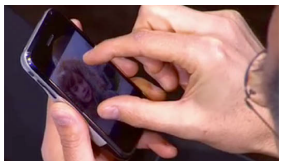
but…

- Difficult to learn, counter-intuitive

gestural interaction

- 2D gestures: commands in touch & pen interfaces

http://interaction.lille.inria.fr/~roussel/digital-library/media/2004-gr-mm.mov

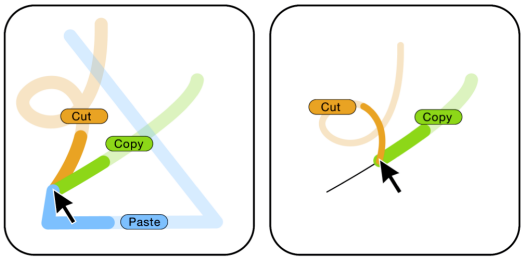

- 3D gestures: hand and body gesture recognition

http://interaction.lille.inria.fr/~roussel/digital-library/media/2002-minority-report/2002-minority-report-clip.mov

http://vimeo.com/2229299


command activation with gestures

Gestural input and learning



OctoPocus (Bau, 2008) http://vimeo.com/2116172

crossing and steering

beyond "clicking"

- Crossing: trigger actions when crossing

http://interaction.lille.inria.fr/~roussel/digital-library/media/2004-CrossY.mov/
http://www.lri.fr/~dragice/foldndrop/

- Steering: commands that depend on trajectory
  example: hierarchical menus

http://www.youtube.com/watch?v=WPbiPn1b1zQ

bi-manual interaction

Cinematic chain model (Guiard 1987):

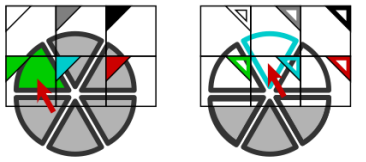
- action of dominant hand is w.r.t. to context from non-dominant hand
- dominant hand for precise movements, non-dominant frame of reference
- actions of non-dominant hand precede those of dominant

Examples:

- Toolglass: "Tool" manipulated by non-dominant and actions on the "Tool" and application with dominant
- Pan and zoom: pan with dominant hand and zoom with non-dominant

« toolglasses »

- Pallets of filters overlaid on objects of interest



(Bier, 1994)

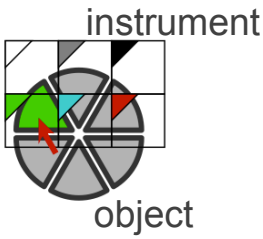
http://www.youtube.com/watch?v=BwIAcczLUUA

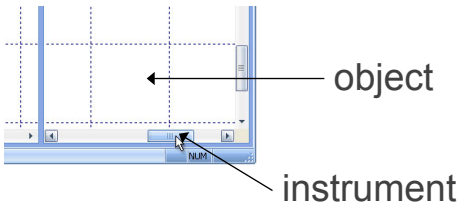
- Bi-manual interaction
  - left hand positions the filters (toolglasses)
  - right hand selects filters on an object

instrumental interaction

(Beaudouin-Lafon, 2000)

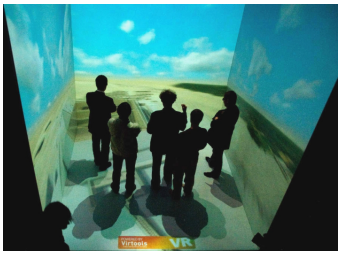
- Model (or style) of interaction, extension of direct manipulation (later)
- « Instrument » : intermediary between user and object of interest that it manipulates





virtual reality

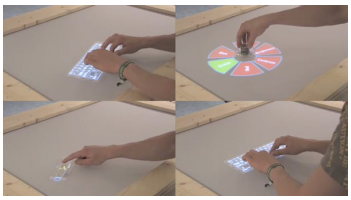
user immersion (sensor + motor)
input? usually body tracking or speech

e.g. a head mounted display and a cave

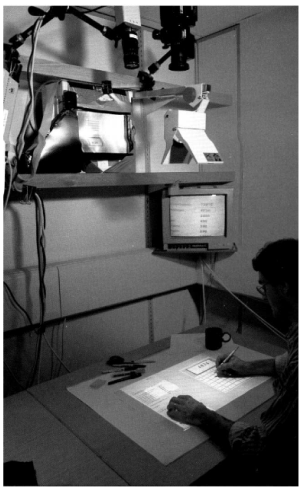
augmented and mixed reality

Augmenting physical objects

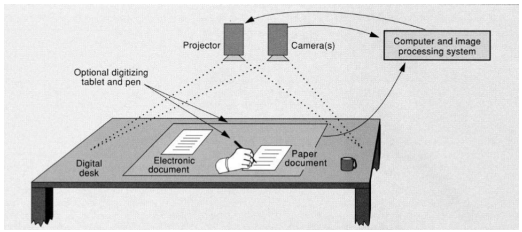



Tangible interfaces:
- Use physical objects as an interface
- Examples: Paper on a screen, physical widgets on an interactive table, use of a PDA as a lens

mixed and augmented reality



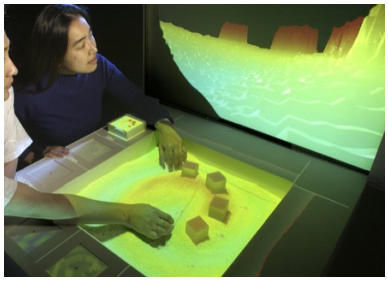
augmented desk



DigitalDesk (Wellner, 1993)
http://youtu.be/S8lCetZ_57g

tangible interaction

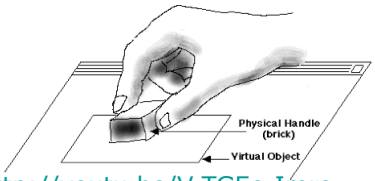
Interaction with virtual *information* by manipulating physical objects



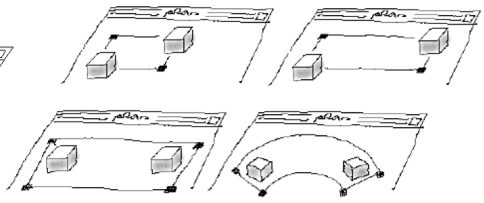
http://youtu.be/0h-RhyopUmc
http://youtu.be/I2rDHUUkd5Y

graspable interfaces (Fitzmaurice, 1995)

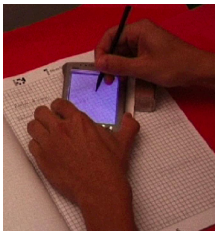
- physical objects: control virtual *objects*
- direct mapping between the properties of the physical and the virtual object
- physical constraints guide interaction



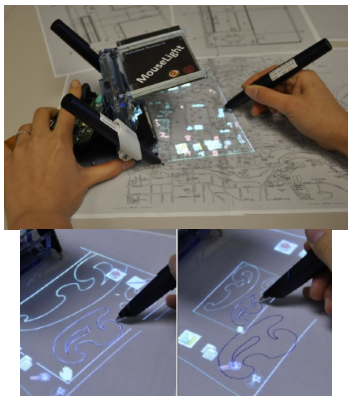
http://youtu.be/V-TGEe-Imro



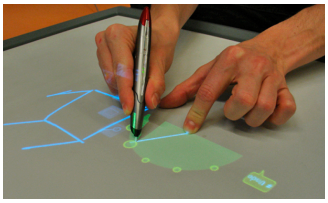
augmented paper



physical « Toolglass »
(Mackay, 2002)

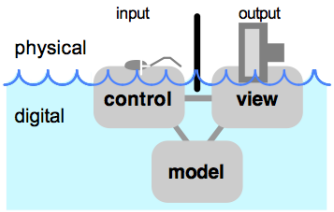


Projection on paper with
pocket-projectors (Song, 2010)

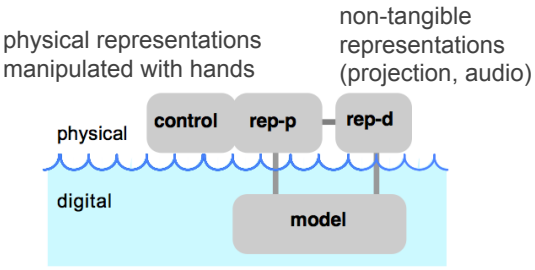


Paper and touch table
(Brandl, 2008)

tangible interaction model

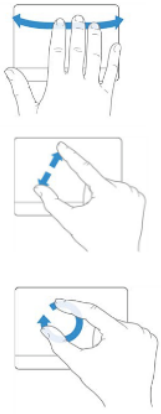


model MVC for GUIs (later)



model for tangible interfaces

multi-touch interaction



In real life we use two hands and ten fingers

Multi-touch interaction
- allows parallel actions
- reduces task complexity
- reduces action time
- close (?) to real life interaction

direct manipulation

Ben Shneiderman (1983)

1. Persistent representation of objects of interest
2. Use of physical actions instead of complex syntax
3. Operations are quick, incremental, reversible, and their effect on objects is immediately visible (**feedback**)
4. Incremental learning, to permit use of the interface with little prior knowledge

direct manipulation: an example

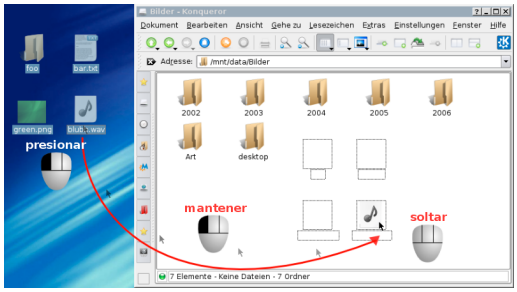
WIMP :
Window, Icons, Menus and Pointing

- Presentation
  - Windows, icons and other graphical objects
- Interaction
  - Menus, dialog boxes, text input fields, etc
- Input
  - pointing, selection, paths
- Perception-action loop
  - feedback

direct manipulation: examples

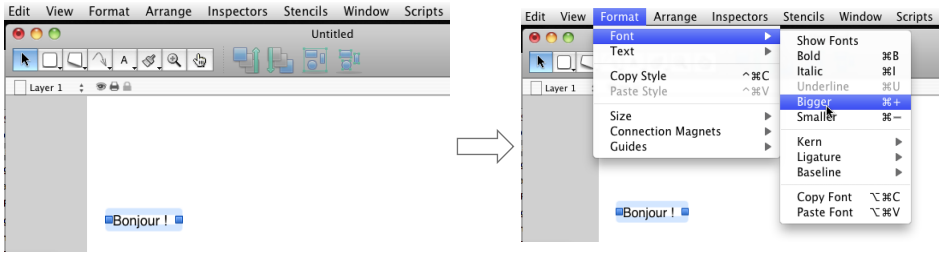
Editing documents WYSIWYG: What You See Is What You Get
Eg. : text editors (e.g., Word, OpenOffice), bitmap/vector graphics (e.g., Photoshop, Illustrator).
Counter-example: Latex ...

Icon interaction:
- Generic interface
- Use of metaphors
- drag-and-drop



http://www.youtube.com/watch?v=M0ODskdEPnQ

direct manipulation?



direct manipulation problems

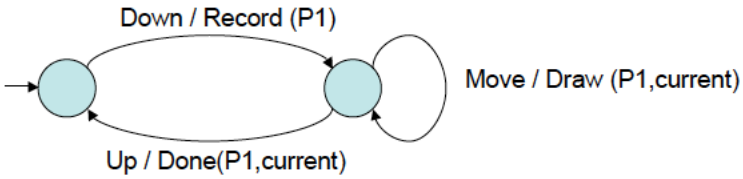
- Identifying objects of interest
  - example: styles in Word
- Immediate feedback difficult when there is a delay between action and result
- Direct or indirect manipulation?
  - menus, dialog boxes, scroll-bars, etc.

GUI interaction characteristics

- direct manipulation
- interaction with state machines
- elementary tasks (Foley & van Dam)
- interaction modes

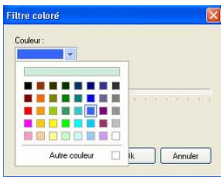
describing interactions: state machines (more later)

- Finite Automata
  State = interaction state
  Transition = input events
- State Machine
  actions associated to transitions
  conditions associated to transitions
- Example :



elementary tasks

- Entry
- Selection
- Triggering
- Scrolling
- Specification of arguments/properties
- Transformations



interaction modes

- Mode = state of the interface where input is interpreted differently than other modes
- Problem: mode switching

  Examples

  "vi" :
  Press "Esc" to go from command mode to edit

  "emacs" :
  Uses modifiers (e.g. Control and Meta) for command input

  tool palette :
  select a tool to activate it

interaction modes

- temporal
  - same action at different points in time has different effect
  - Problem : identify when to change the mode
  - Quasi-modes : temporal modes linked to a continuous physical action (e.g. press Shift)
  - Tools : temporal modes associated with a tool « in hand»
- spatial
  - same action at different locations has different effect
  - Problem : identify the available spatial modes
- An interface is a collection of modes