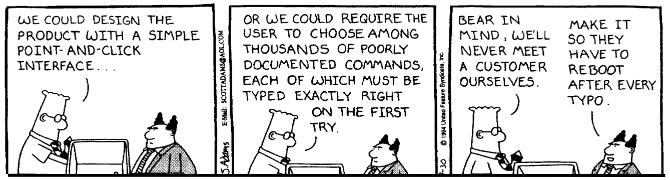
Human-Computer interaction

Session 5

User interface styles and technology

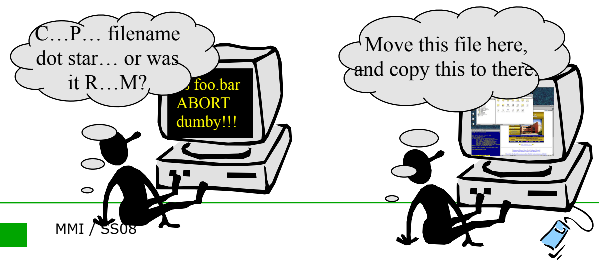


Recall

- Different styles to build user interfaces
  - command line
  - form filling
  - point (select) & click
  - menues
- Graphical user interfaces (GUI)
  - **WIMP** - Windows, Icons, Menues, Pointer
  - More „widgets": buttons, scrollbars, etc.
  - „look & feel": appearance, semantics, and behavior of widgets

Direct manipulation (Shneiderman, 1982)

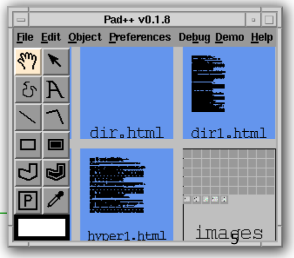
- **Directly manipulate** the object of interest
  - objects must be visible and distinguishable in the UI
  - can act as if in a workplace
  - rapid, reversible, incremental actions and feedback
    → can see results as you go
- Example: resizing a rectangle by dragging its corners
- Enables different ways of thinking about the interaction



Enhanced graphical interfaces

- *3D workspaces*
  - infinite virtual space
  - Light, size, and occlusion give depth impression
  - a lot like WIMP, but point & click in 3D (how does a 3D button look like?)

- *ZUI's: Zoomable UI's*
  - Navigation like panning a video camera
  - Zooming in on objects



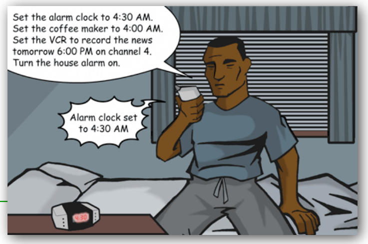
- Virtual Reality
  - VRML

Year	Paradigm	Implementation
1950s		*Switches, punched cards*
1970s	*Typewriter*	*Command-line interface*
1980s	*Desktop*	*Graphical user interface, direct manipulation*
1980s+	*Spoken Language*	*Speech recognition/synthesis, natural language processing, dialogue systems*
1990s+	*Natural interaction*	*Perceptual, multimodal, interactive, conversational, tangible, adaptive*
2000+	*Social interaction*	*Agent-based, anthropomorphic, social, emotional, affective, collaborative*

Natural language

(later session)

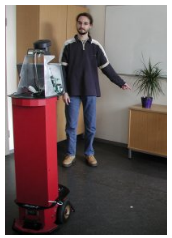
- **Just say** what you want the machine to do
  - familiar and intuitive
  - spoken or typed
- Problems
  - must deal with phonology, syntax, semantics, pragmatics
  - inherently vague, ambiguous, situated
- Solutions
  - restrict to sub-language or only few fixed key words
  - interactive dialogue with feedback, alignment, repairs, etc.



Multimodal interfaces

(later session)

- Using multiple means and styles of interacting in **combination**, e.g. point & click plus speech


Agent-based interfaces

- Artifacts that have human-like appearance, are experts for special tasks, communicate back naturally, are proactive, etc.
- Paradigm shift from *tool* to *companion*

Interface technology

A 'typical' computer system

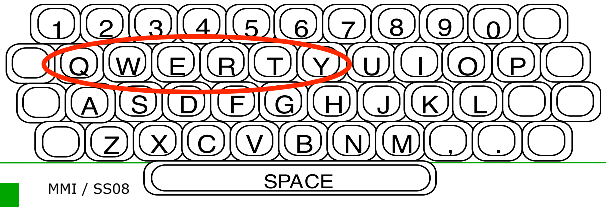
?

- screen with text and graphics/windows
- keyboard
- mouse/trackpad
- variations
  - desktop
  - laptop
  - PDA

- Devices vs. interaction
  - existing **devices dictate** the possible styles of interaction
  - devices especially **designed for** certain interaction modes
  - if we use different devices, then the interface can support different styles of interaction

Keyboards

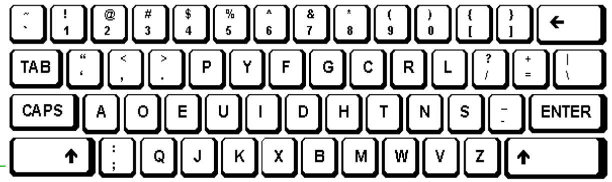
- Inherited from type writers, first keyboard in 1874 ("Remington No. 1")
- Standard layout: „QWERTY", but arrangement not optimal for typing!
  - meant to prevent typewriters jamming
  - but, common combinations of consecutive letters placed at different ends of the keyboard
  - Anecdote: try typing "typewriter"



Alternative keyboard layouts

Dvorak

- since 1932
- common letters under dominant fingers
- biased towards right hand
- common combinations of letters alternate between hands
- 10-15% improvement in speed and reduction in fatigue
- But - large social base of QWERTY typists produce market pressures not to change



Special purpose keyboards

- designed to reduce fatigue and *repetitive strain injury* (RSI)

Maltron left-handed keyboard for one handed use

Kinetics keyboard

Phone pads and T9 entry

- use numeric keys with multiple presses

  2 – a b c 6 - m n o
  3 - d e f 7 - p q r s
  4 - g h i 8 - t u v
  5 - j k l 9 - w x y z

  hello = 4433555[pause]555666

  surprisingly fast, but not ergonomic

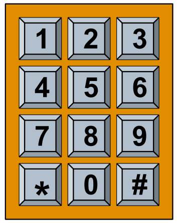
- T9 algorithm for predicting entries
  - type as if single key for each letter
  - use dictionary to guess right word
  - hello = 43556 …
  - give options when ambiguities like 26 -> 'am' or 'an'

Numeric keypads

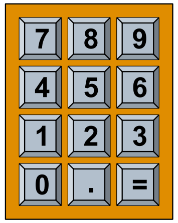
for entering numbers quickly

- calculator, PC keyboard numpad
- Telephone, ATM

not the same!!



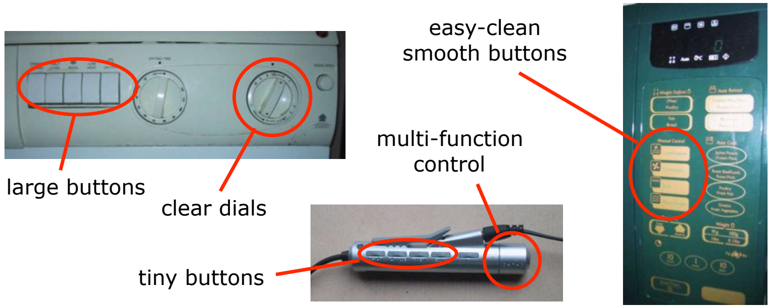
telephone



calculator/ keyboard

Physical controls

- specialist controls needed …
  - industrial controls, consumer products, etc.



Example: BMW iDrive

- *single* multi-purpose device for controlling climate, navigation, entertainment, communication
  - not used very often
- haptic feedback: feel small 'bumps' for each item
  - makes it easier to select options by feel
- slides backwards & forwards, rotates

Example: BMW iDrive

- Significant controversy among users, the automotive media, and critics
- Criticisms include
  - steep learning curve, short but intensive training
  - causes driver to look away from the road too much
  - system reactions too slow
- became labelled "iDistract" and "iCrash"

- In some countries, such as the USA and Australia, BMW includes a warning that the user must accept before using the iDrive

Input devices

Mouse

- very common, easy to use
- buttons (1-3 on top, wheel)
- Mechanical vs. optical

Trackball

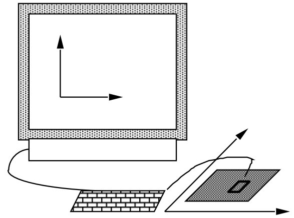
- separate buttons for picking
- meant to reduce RSI

Joystick

- Absolute vs. isometric: pressure of stick = cursor velocity
- buttons for selection

Mouse

- Located on desktop
  - requires physical space
  - little arm fatigue
- Only relative movement detectable
- Movement of mouse moves screen cursor
  - Cursor oriented in (x, y) plane, mouse movement in (x, z) plane …



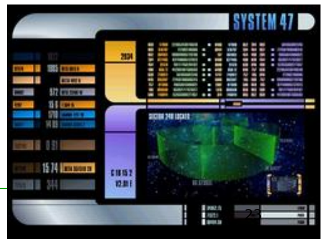
- *indirect* pointing device
  - device itself doesn't obscure screen
  - accurate and fast
  - hand-eye coordination poses problems for novice users

Note, in practice every monitor has fingerprints!

Touch-sensitive screen

- Detect the presence of finger or stylus on the screen.
  - works by interrupting matrix of light beams, capacitance changes or ultrasonic reflections
  - *direct* pointing device

- Advantages:
  - fast, and requires no specialised pointer
  - good for menu selection
  - suitable for use in hostile environment, clean and safe from damage.
- Disadvantages:
  - finger can mark screen
  - Imprecise, finger is fairly blunt
  - lifting arm is tiring



Stylus & light pen

Stylus

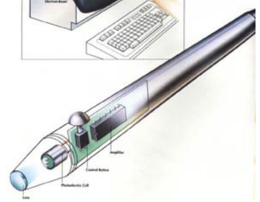
- small pen-like pointer to draw directly on screen
- may use touch sensitive surface or magnetic detection

Light Pen

- detects light from screen
- does not work with LCDs
- now rarely used

both …

- *direct* pointing, obvious to use
- can obscure screen



Handwriting recognition

- Text can be input into the computer using a pen and a digesting tablet
- Lots of technical problems:
  - capturing all useful information - stroke path, pressure, etc., in a natural manner
  - segmenting into individual letters
  - interpreting individual letters
  - coping with different styles of handwriting
  - speed

- Used in PDAs and tablet computers, leave the keyboard on the desk!
- But…

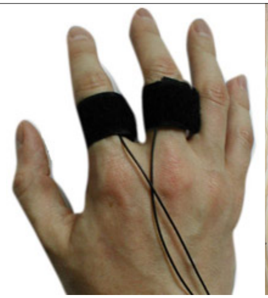
Speech recognition

- Almost every device comes with a mic
- Improving rapidly
- Most successful when:
  - single user – initial training and learned peculiarities
  - limited vocabulary systems
  - used with headset or telephone
- Problems with
  - external noise interfering
  - imprecision of pronunciation, speed, varying prosody
  - large vocabularies
  - different speakers and dialects

Dictate directly to your Mac with ViaVoice, but remember to speak slowly and clearly.

Eyegaze

- control interface by eye gaze dir.
  - e.g. look at menu item to select it
- uses laser beam or infrared light reflected off retina
- mainly used for evaluation
- potential for hands-free control
- high accuracy requires headset
- cheaper and lower accuracy devices available, sit under the screen like a small webcam



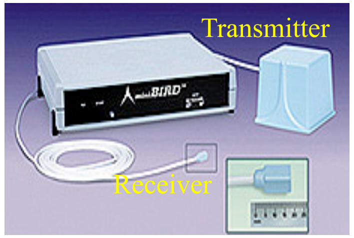
- Other fancy input devices
  - iris scanners, body temperature, heart rate, galvanic skin response, blink rate, goniometry
  - possible applications: emotion recognition (affective computing), life signal monitoring, etc.

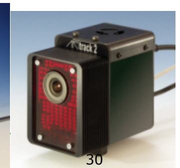
Positioning in 3D (6 DOF)

- SpaceBall
- SpaceOrb
- Space Mouse

Moving in 3D - Tracking systems

- Electromagnetic
  - Noisy, affected by metal
- Optical
  - Marker reflect IR light
  - Combined to unique spatial configuration per tracked position
  - >3 IR cameras needed to cope with occlusions





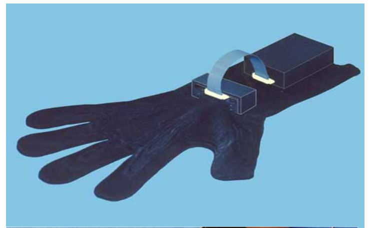
Tracking systems

- Acoustic (ultrasound)
  - Distance inferred from travel time of sound
  - No interference, inexpensive, sensitive to air temperature & noises
- Inertia
  - Only 3 DOFs (orientation)
  - Use gyroscopes & accelerometers
  - Less noise, lag
- Hybrids
  - Inertia (orient.)
  - acoustic (pos.)

Intersense IS-300

Data Gloves

- Tracks the user’s finger postures and movements
- Bi-metal, fibre optics, exoskeleton, etc.
- Common types
  - CyberGlove
    - 18 sensors
    - 22 sensors
  - 5DT Glove
    - 5 sensors
    - 16 sensors

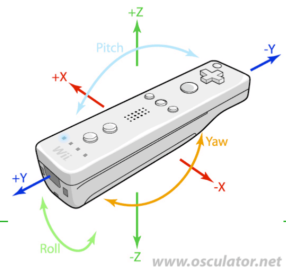


Tracked point & click devices

- Space Mouse
- Ring Mouse
- Fly Mouse
- Wand

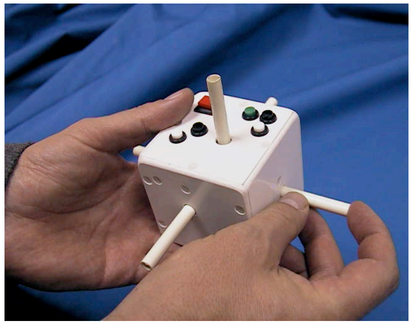
Exmaple: Wii controller

- Infrared camera
- Accelerometers
- Buttons
- Transmission to Wii console via Bluetooth



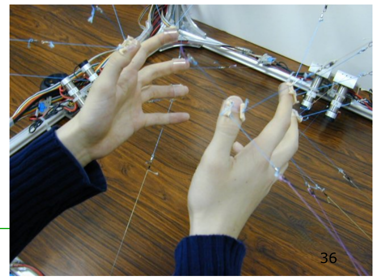
Cubic Mouse

- 12 DOF input device
- Tracks position and rotation of rods using potentiometers
- Other shapes and implementations possible
  - Mini Cubic Mouse
  - …



Touch, feel, smell

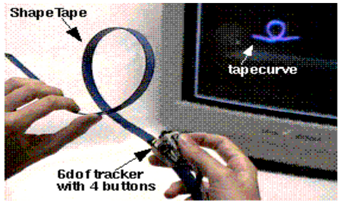
- touch and feeling important
  - in games … vibration, force feedback
  - in simulation … feel of surgical instruments
  - called *haptic* devices
- texture, smell, taste
  - current technology very limited



More fancy input devices

Cyberglove with haptics

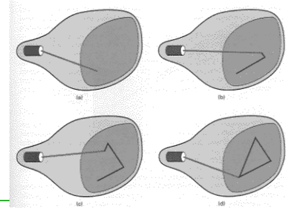
Treadmill types (e.g. bicycles)



Shape tape

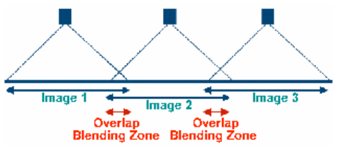
Output devices

- Bitmap devices: CRT vs. LCD
- Random Scan (Directed-beam refresh, vector display)
  - draw the lines to be displayed directly
  - no jaggies (“Treppeneffekt”)
  - lines need to be constantly redrawn
  - rarely used except in special instruments



Large scale displays

- used for meetings, design, lectures, etc.
- technologies
  - plasma – usually wide screen
  - video walls – lots of small screens together
  - projected – RGB lights or LCD projector
  - back-projected - frosted glass + projector behind
  - powerwalls - lots of projectors



Sensorama

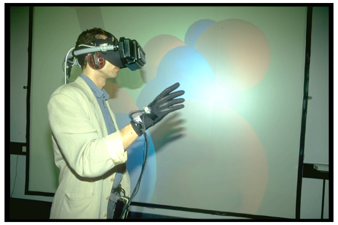
- Morton Heilig designed the first multisensory virtual experiences in 1956 (patented in 1961)
- *The Sensorama* combined projected film, audio, vibration, wind, and odors.
- The five "experiences" included
  - a motorcycle ride through New York
  - a bicycle ride
  - a ride on a dune buggy
  - a helicopter ride over Century city
  - a dance by a belly dancer.

Head-mounted display (Sutherland, 1968)

- small TV screen for each eye
- slightly different angles
- (Mechanical) tracking

Head-mounted displays

- Main advantages
  - Scene completely surrounds user
  - sharp and brisk
- Classical disadvantages
  - Field of view (FOV) is narrow
  - Early devices heavy, cause fatigue
  - Can't see others
- Now, light-weight see-through HMDs

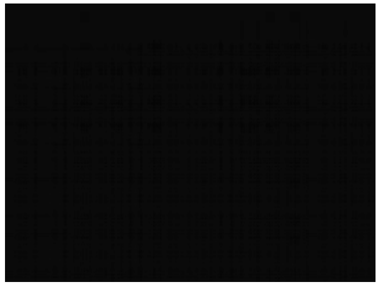


VR motion sickness

- time delay (>100ms)
  - move head … lag … display moves
  - *conflict:* head movement vs. eyes
- depth perception
  - objects presented at different stereo distances
  - but all focused in same plane (monitor)
  - *conflict:* eye angle vs. focus
- conflicting cues => sickness
  - motivate improvements in technology

BOOM (Binoccular Omni Orientation Monitor)

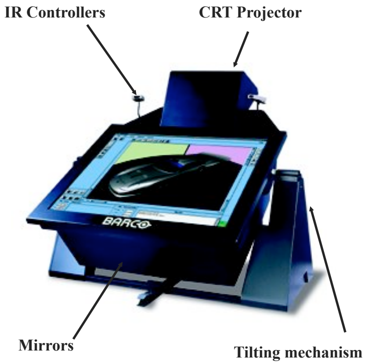
- High resolution
- Wide Field of View
- User must not carry heavy weight
- tracking with minimal lag
- Limited user movement
- Requires the user to hold onto the BOOM for control



Workbench

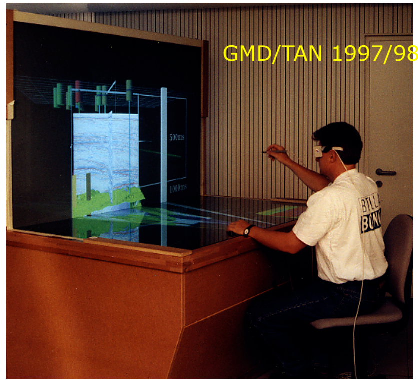
- Table-top metaphor
- Change display orientation
- Integrate real & virtual

- Less immersion
- Occlusion/cancellation
- $$$



Two-Sided Workbench

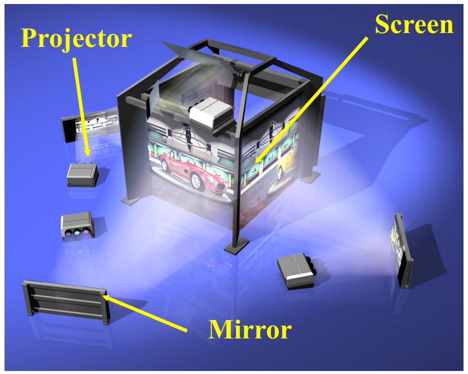
- View volume
- Telepresence
- $$$



CAVE

- Multi-wall (usually 4)
- Provides wide FOV
- Can see other people
- Stereo more realistic

- Missing walls break illusion
- Brightness
- $$$



Technological limitations on interface performance

Computation bound
- Computation takes time, causing frustration for the user

Storage channel bound
- Bottleneck in transfer of data between storages

Graphics bound
- Updating displays requires effort - nowadays helped by adding a graphics processor to take on the burden

Network capacity
- Many computers networked - shared resources and files, access to printers etc. - but interactive performance can be reduced by slow network speed

→ Reduced system responsivity and interactivity !

Needs to be taken into account!

- Designers tend to assume fast processors, and make interfaces more and more complicated
- Problems occur, because processing cannot keep up with all the tasks it needs to do
- Examples:
  - *cursor overshooting* because system has buffered keypresses
  - *icon wars* - user clicks on icon, nothing happens, clicks on another, then system responds and windows fly everywhere
- Also problems if system reacts too fast
  - e.g., help screens may scroll through text much too rapidly to be read

- **Next session**
  How to use all this to build a „usable" system?