

 **HUMAN-COMPUTER INTERACTION** THIRD EDITION DIX FINLAY ABOARD BEALE

chapter 20

ubiquitous computing and augmented realities

ubiquitous computing and augmented realities

- ubiquitous computing
 - filling the real world with computers
- virtual and augmented reality
 - making the real world in a computer!

Challenging HCI Assumptions

- What do we imagine when we think of a computer?
 - “The most profound technologies are those that disappear.”* Weiser
- 1990's: this was not our imagined computer!

Ubiquitous Computing

- Any computing technology that permits human interaction away from a single workstation
- Implications for
 - Technology defining the interactive experience
 - Applications or uses
 - Underlying theories of interaction

Scales of devices

- Weiser proposed
 - Inch
 - Foot
 - Yard
- Implications for device size as well as relationship to people

Device scales

- Inch
 - PDAs
 - PARCTAB
 - Voice Recorders
 - smart phones
- Individuals own many of them and they can all communicate with each other and environment.

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Device scales

- Foot
 - notebooks
 - tablets
 - digital paper
- Individual owns several but not assumed to be always with them.



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Device scales

- Yard
 - electronic whiteboards
 - plasma displays
 - smart bulletin boards
- Buildings or institutions own them and lots of people share them.



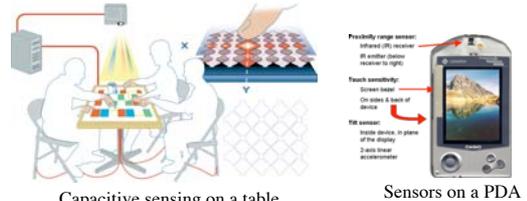
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Defining the Interaction Experience

- Implicit input
 - Sensor-based input
 - Extends traditional explicit input (e.g., keyboard and mouse)
 - Towards "awareness"
 - Use of recognition technologies
 - Introduces ambiguity because recognizers are not perfect

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Different Inputs



Capacitive sensing on a table

Sensors on a PDA

Proximity range sensor: Infrared (IR) receiver at ambient display (shown to right)

Touch sensitivity: Screen base (On axis & back of device)

IR sensor: Inside device, in plane of the display & data base controller

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Multi-scale and distributed output

- Screens of many sizes
 - (very) small
 - (very) large
- Distributed in space, but coordinated



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The output experience

- More than eye-grabbing raster displays
 - Ambient: use features of the physical environment to signal information
 - Peripheral: designed to be in the background
- Examples:
 - The Dangling String
 - The Water Lamp (shown)



Merging Physical and Digital Worlds

- How can we remove the barrier?
 - Actions on physical objects have meaning electronically, and vice versa
 - Output from electronic world superimposed on physical world



A "digital" desk



An augmented calendar

Application Themes

- Context-aware computing
 - Sensed phenomena facilitate easier interaction
- Automated capture and access
 - Live experiences stored for future access
- Toward continuous interaction
 - Everyday activities have no clear begin-end conditions

New Opportunities for Theory

- Knowledge in the world
 - Ubicomp places more emphasis on the physical world
- Activity theory
 - Goals and actions fluidly adjust to physical state of world
- Situated action and distributed cognition
 - Emphasizes improvisational/opportunistic behavior versus planned actions
- Ethnography
 - Deep descriptive understanding of activities in context

Evaluation Challenges

- How can we adapt other HCI techniques to apply to ubicomp settings?
 - Ubicomp activities not so task-centric
 - Technologies are so new, it is often hard to get long-term authentic summative evaluation
 - Metric of success could be very different (playfulness, non-distraction versus efficiency)

ambient wood

- real wood! ... filled with electronics
- light and moisture meters
 - recorded with GPRS location
 - drawn on map later
- 'periscope'
 - shows invisible things
 - uses RFID
- triggered sound





City - shared experience

- visitors to Mackintosh Interpretation Centre
 - some on web, some really there
- interacting
 - talk via microphones
 - 'see' each other virtually
- different places
- different modalities
- shared experience






virtual and augmented reality

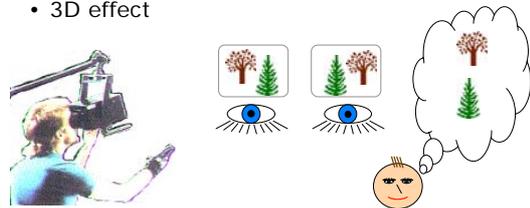
- VR - technology & experience
- web, desktop and simulators
- AR – mixing virtual and real

virtual reality technology

- headsets allow user to “see” the virtual world
- gesture recognition achieved with DataGlove (lycra glove with optical sensors that measure hand and finger positions)
- eyegaze allows users to indicate direction with eyes alone
- whole body position sensed, walking etc.

VR headsets

- small TV screen for each eye
- slightly different angles
- 3D effect



immersion

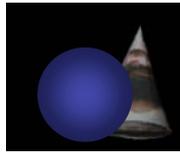
- VR
 - computer simulation of the real world
 - mainly visual, but sound, haptic, gesture too
 - experience life-like situations
 - too dangerous, too expensive
 - see unseen things:
 - too small, too large, hidden, invisible
 - e.g. manipulating molecules
- the experience
 - aim is immersion, engagement, interaction

on the desktop

- headset VR
 - expensive, uncomfortable
- desktop VR
 - use ordinary monitor and PC
 - cheap and convenient
- in games ...
- and on the web
 - VRML – virtual reality markup language

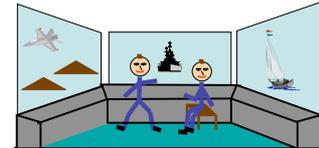
VRML ... VR on the web

```
#VRML V1.0 ascii
Separator {
  Separator { # for sphere
    Material {
      emissiveColor 0 0 1 # blue
    }
    Sphere { radius 1 }
  }
  Transform { translation 4 2 0 }
  Separator { # for cone
    Texture2 {
      filename "big_alan.jpg"
    }
    Cone {
      radius 1 # N.B. width=2*radius
      height 3
    }
  }
}
```



command and control

- scenes projected on walls
- realistic environment
- hydraulic rams!
- real controls
- other people



- for:
 - flight simulators
 - ships
 - military

augmented reality (AR)

- images projected over the real world
 - aircraft head-up display
 - semi-transparent goggles
 - projecting onto a desktop
- types of information
 - unrelated – e.g. reading email with wearable
 - related – e.g. virtual objects interacting with world
- issues
 - registration – aligning virtual and real
 - eye gaze direction

applications of AR

- maintenance
- overlay instructions
 - display schematics

examples

- photocopier engineers
 - registration critical arrows point to parts
- aircraft wiring looms
 - registration perhaps too hard, use schematic

applications of VR

- simulation
 - games, military, training
- VR holidays
 - rainforest, safari, surf, ski and moon walk
 - ... all from your own armchair
- medical
 - surgery
 - scans and x-rays used to build model then 'practice' operation
 - force feedback best
 - phobia treatment
 - virtual lifts, spiders, etc.

information and data visualisation

VR, 3D and 2D displays
scientific and complex data
interactivity central

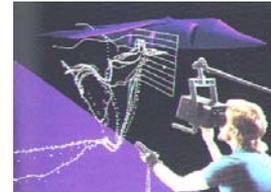
scientific and technical data

- number of virtual dimensions that are 'real'
- three dimensional space
 - visualise invisible fields or values
 - e.g. virtual wind tunnel
- two dimensional space
 - can project data value up from plane
 - e.g. geographic data
 - N.B. viewing angle hard for static visualisation
- no 'real' dimensions
 - 2D/3D histograms, scatter plots, pie charts, etc.

virtual wind tunnel

- fluid dynamics to simulate air flow
- virtual bubbles used to show movements

- 'better' than real wind tunnel ...
 - no disruption of air flow
 - cheaper and faster

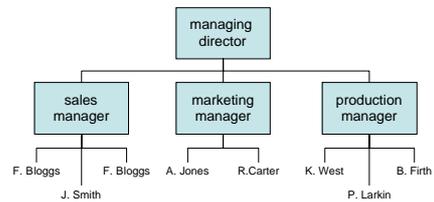


structured information

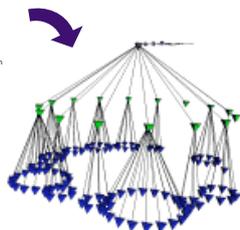
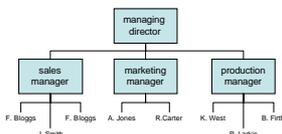
- scientific data – just numbers
- information systems ... lots of kinds of data
- hierarchies
 - file trees, organisation charts
- networks
 - program flow charts, hypertext structure
- free text ...
 - documents, web pages

visualising hierarchy

- 2D organisation chart
 - familiar representation
 - what happens when it gets wide?



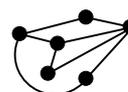
wide hierarchies ... use 3D?



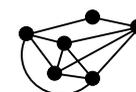
- cone trees (Xerox)
- levels become rings
- overlap 'OK' in 3D

networks in 2D

- network or 'graph':
 - nodes – e.g. web pages
 - links – may be directed or not – e.g. links
- planar – can draw without crossing
- non-planar – **any** 2D layout has crossings



Planar graph

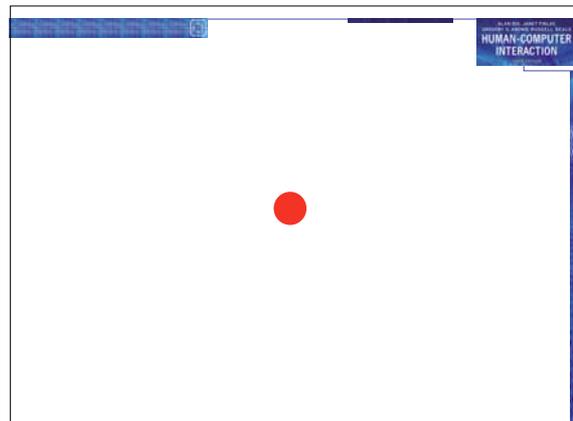


Non-planar graph

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time and interactivity

- visualising in time
 - time dimension mapped to space
 - changing values: sales graphs, distance-time
 - events: Gantt chart, timelines, historical charts
 - e.g. Lifelines – visualising medical and court records
- using time
 - data dimension mapped to time
 - time to itself: fast/slow replay of events
 - space to time: Visible Human Project
- interactivity
 - change under user control
 - e.g. influence explorer



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between two worlds

- ubiquitous computing
 - computers fill the real world
- virtual reality and visualisation
 - real world represented in the computer
- augmented reality, ambient displays ...
 - physical and digital intermingled

... maturity

- VR and visualisation – commonplace
- AR, ubiquity ... coming fast!