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.

Device scales

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

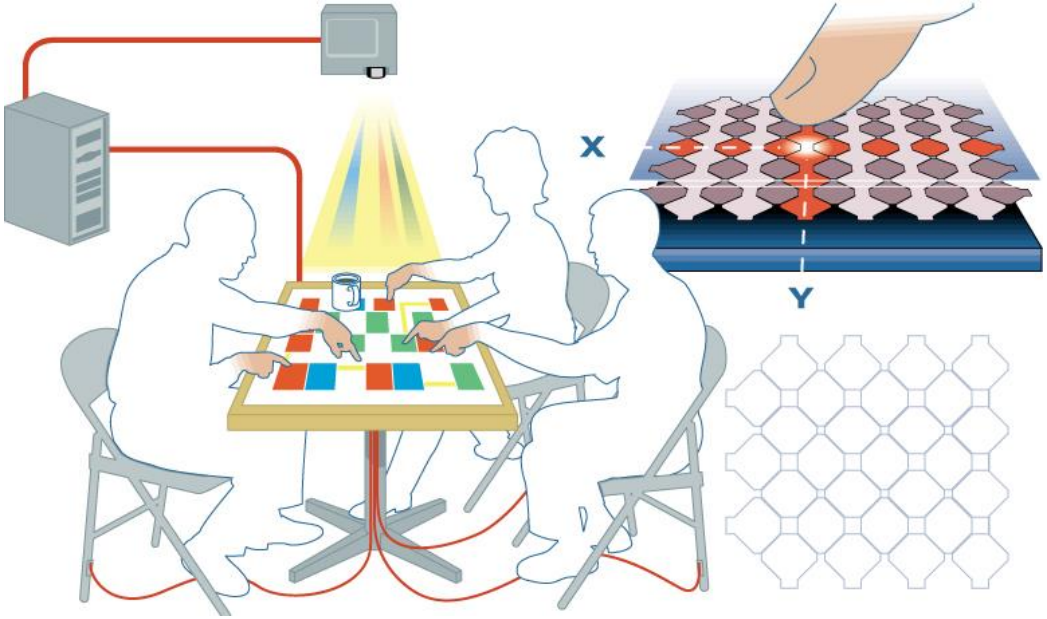
Device scales

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

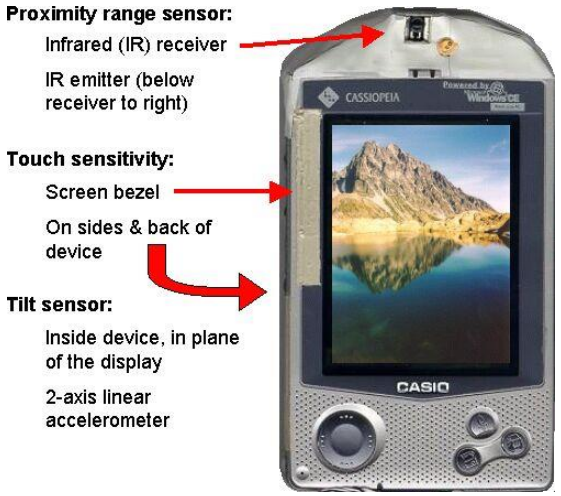
Defining the Interaction Experience

- 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

Different Inputs



Capacitive sensing on a table



Sensors on a PDA

Multi-scale and distributed output

- Screens of many sizes
  - (very) small

  - (very) large

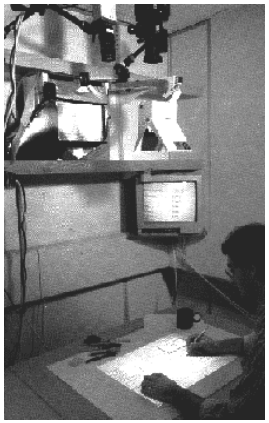
- Distributed in space, but coordinated

The output experience

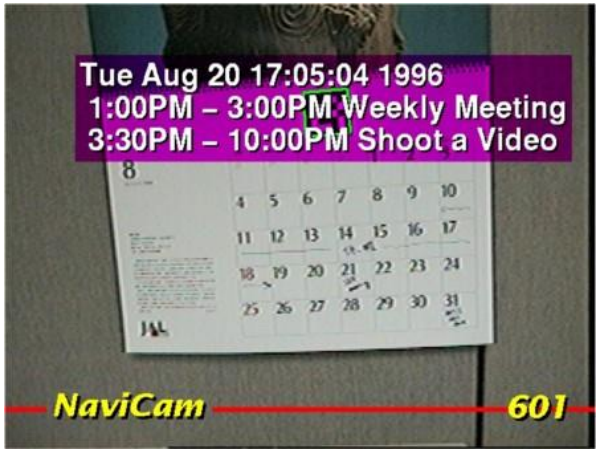
- More than eye-grabbing raster displays
  - Ambient: use features of the physical environment to signal information
  - Peripheral: designed to be in the background
- Examples:
  - The Dangling String
  - The Water Lamp (shown)

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 techiques 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 use VR, 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

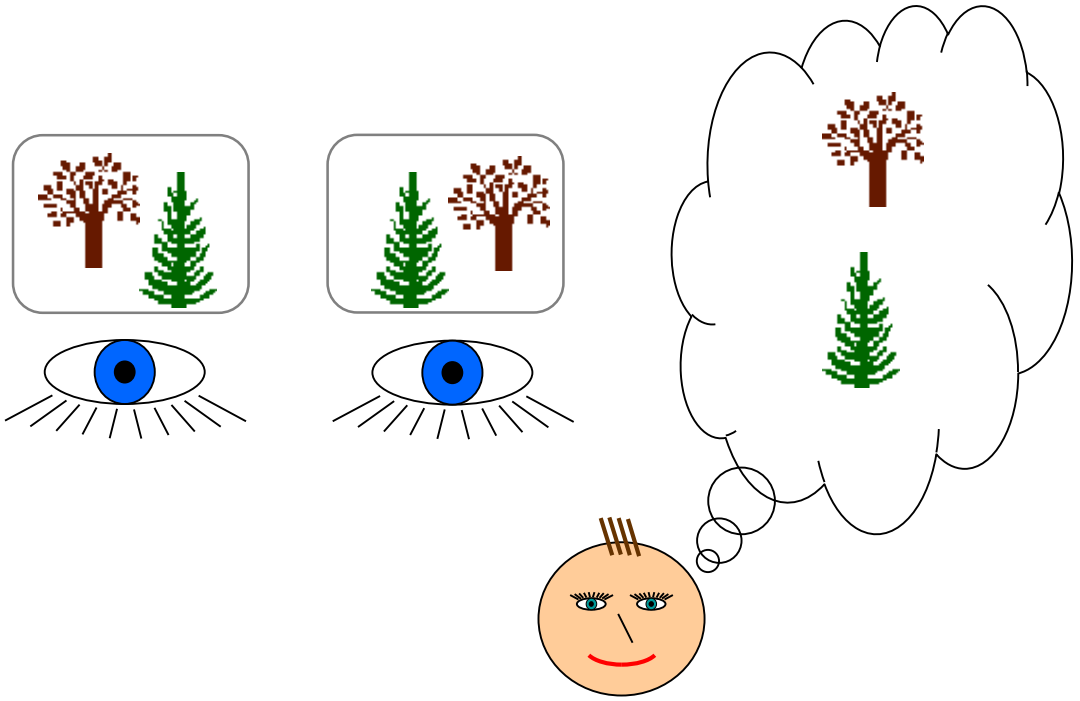
AR – mixing virtual and real

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

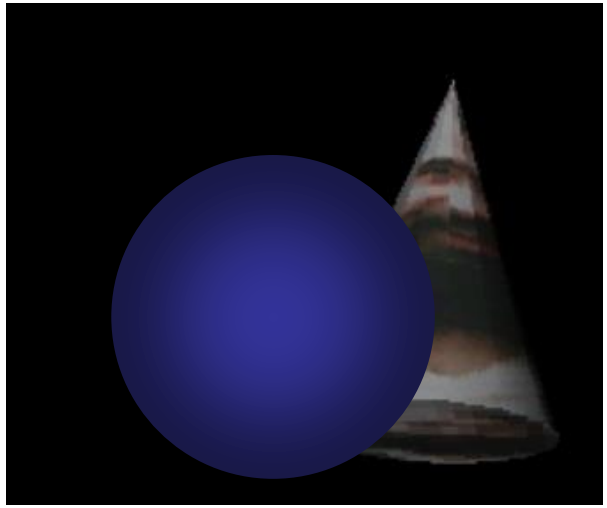
- VR
  - computer simulation of the real world
    - mainly visual, but sound, haptic, gesture too
  - experience life-like situations
    - too dangerous, too expensive
  - see unseen things:
    - too small, too large, hidden, invisible
      - e.g. manipulating molecules
- the experience
  - aim is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

on the desktop

- headset VR
  - expensive, uncomfortbale
- 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

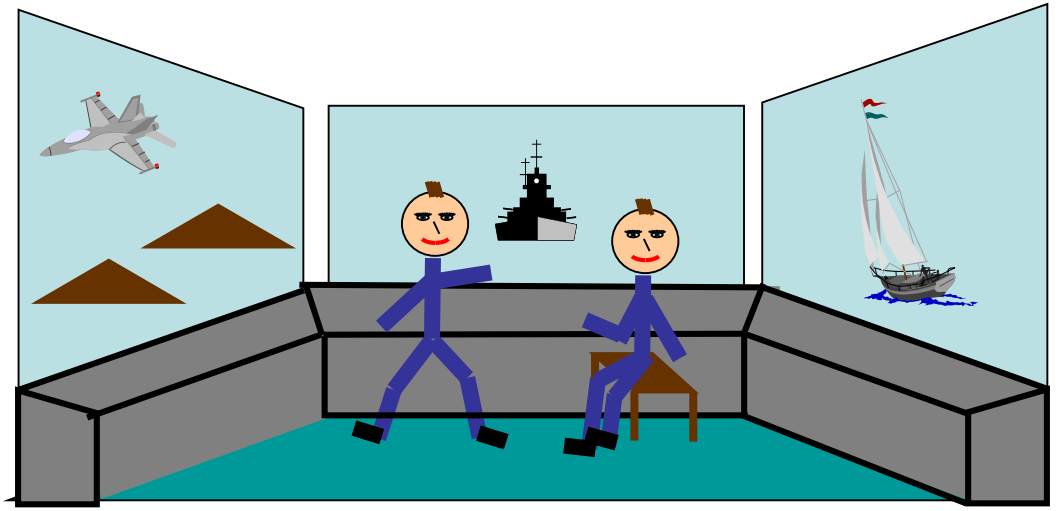
```
#VRML V1.0 ascii

Separator {
  Separator {    # for sphere
    Material {
      emmissiveColor 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

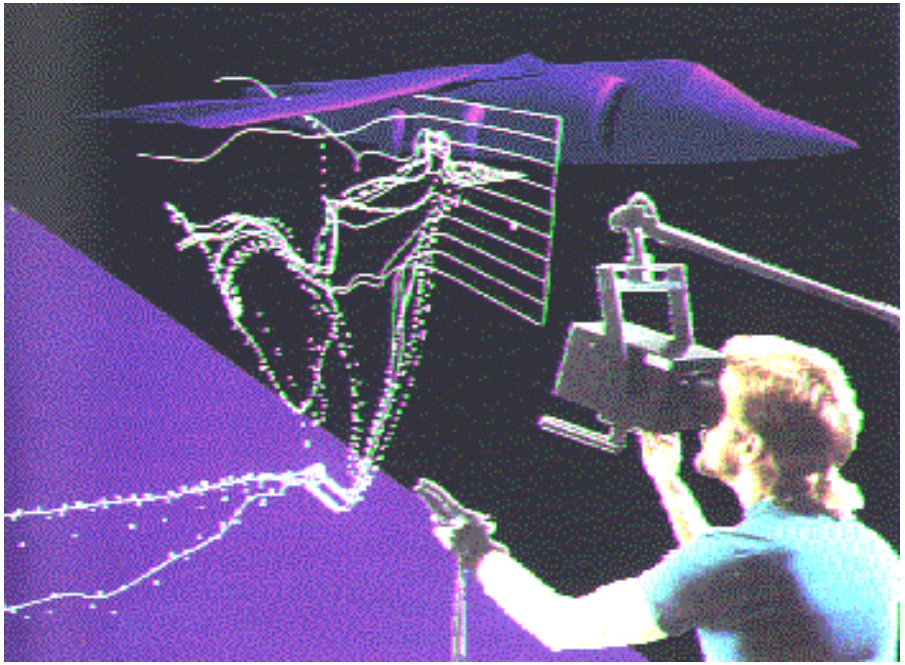
scientific and technical data

- 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



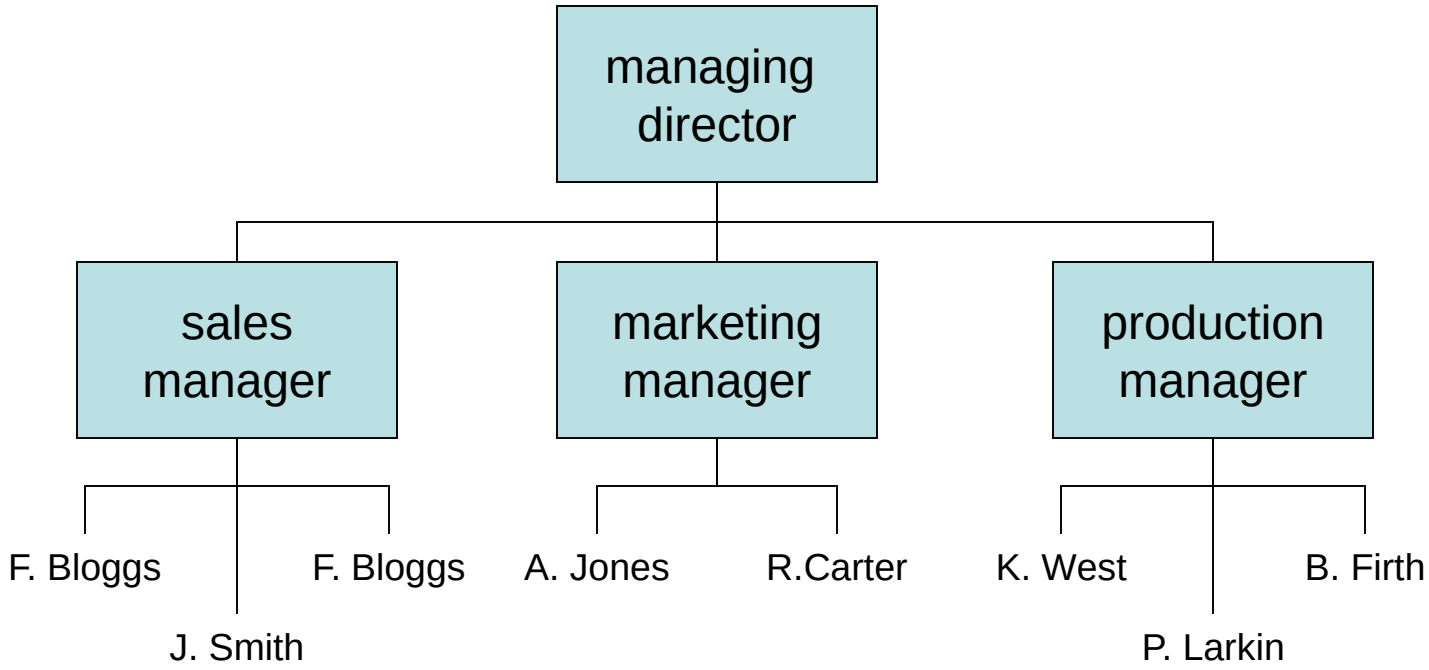
structured informnation

- scientific data – just numbers
- information systems … lots of kinds of data

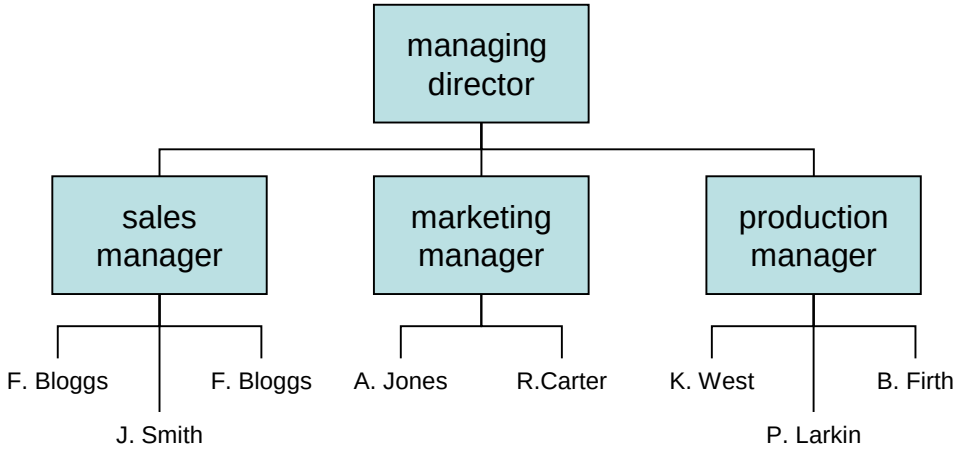
- hierarchies
  - file trees, organisation charts
- networks
  - program flow charts, hypertext structure
- free text …
  - documents, web pages

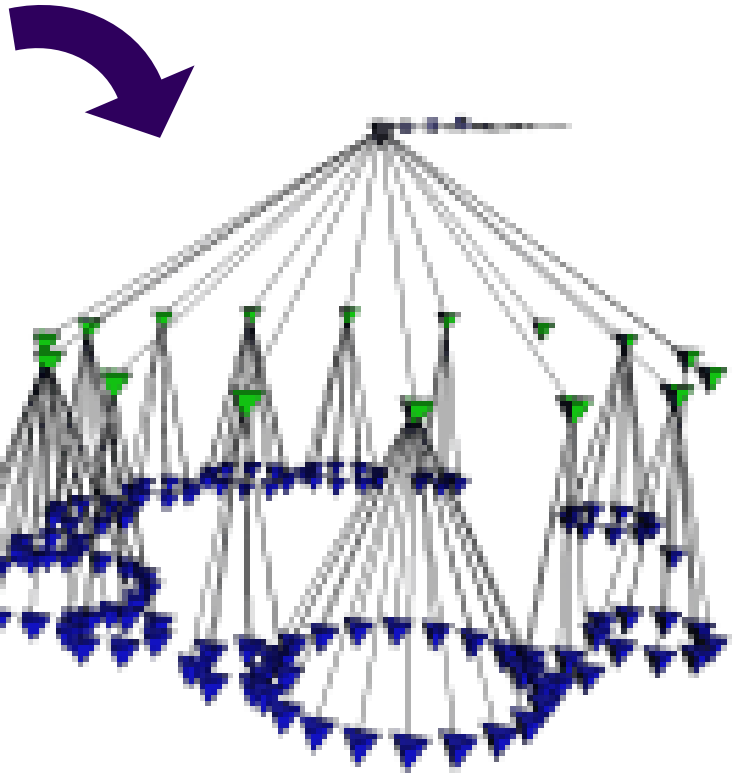
visualising hiererchy

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



wide hierarchies … use 3D?

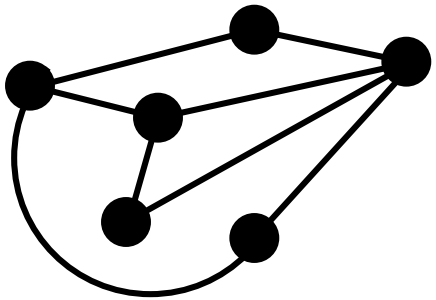




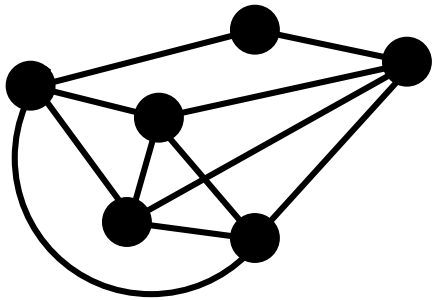
- cone trees (Xerox)
- levels become rings
- overlap ‘OK’ in 3D

networks in 2D

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



Planar graph



Non-planar graph

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

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!