CSE 6326/PSYC6315

Introduction

Outline

- Goals of the course
  - appreciation of the role of human sensation & perception in the effective design of advanced displays
  - survey of current/emerging issues in displays technology
  - use of modern display technology to study perception

- Today- broad overview of some application domains
  - concentrate on applications of *immersive displays*
  - much of what we cover on perception has relevant for other application domains such as graphics, speech recognition/synthesis, computer vision, …

Some trends in HCI

- Early interfaces switches, cards -> text/ console based interfaces -> desktop/ windows metaphors
- The majority of current processors are embedded in other systems. Humans are increasingly interfacing with these devices
- Trend towards more naturalistic interaction

- Increasingly humans are ‘in the loop’
- Exponential rise in computing power but displays and input devices are still limited as is human processing capability

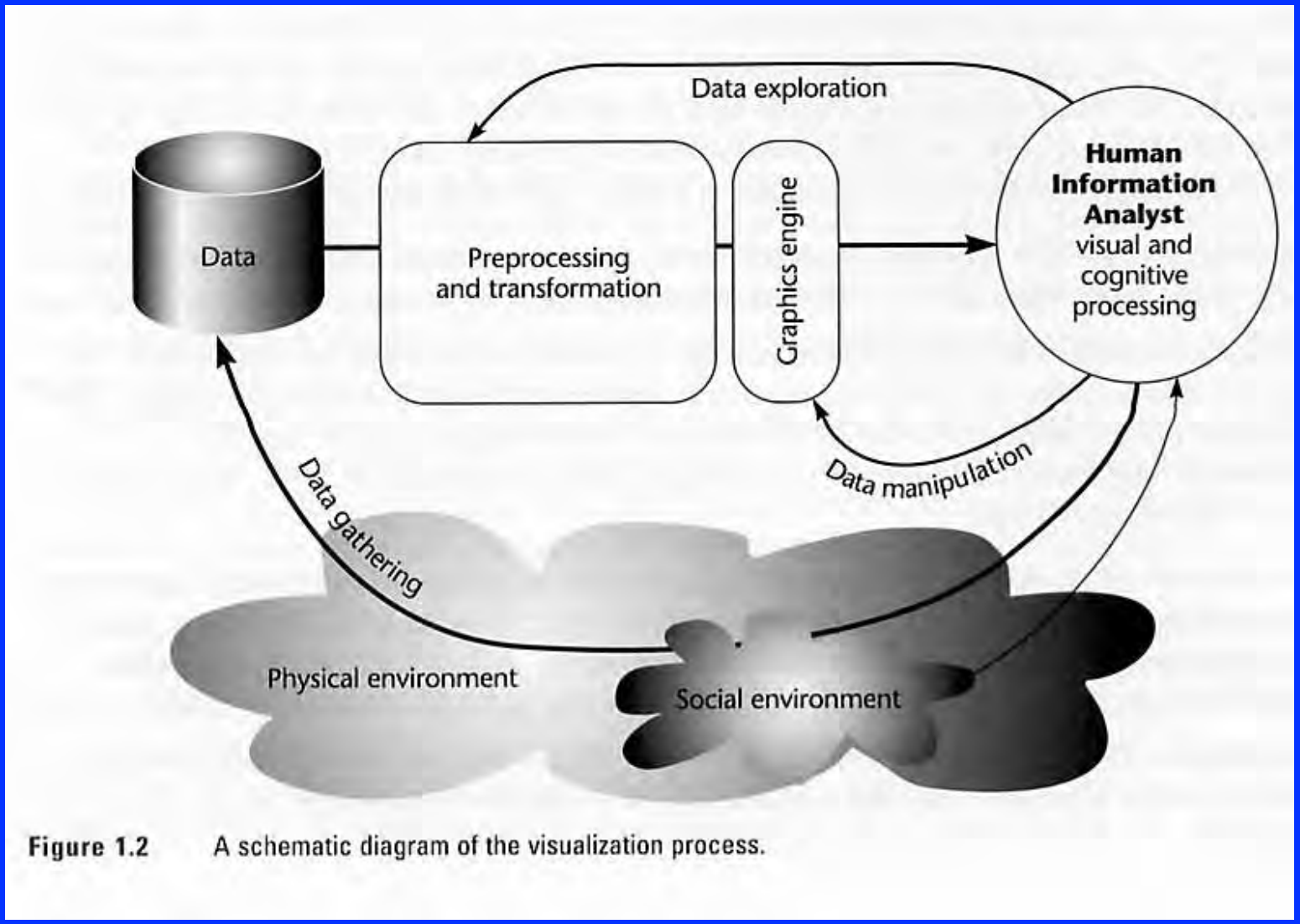
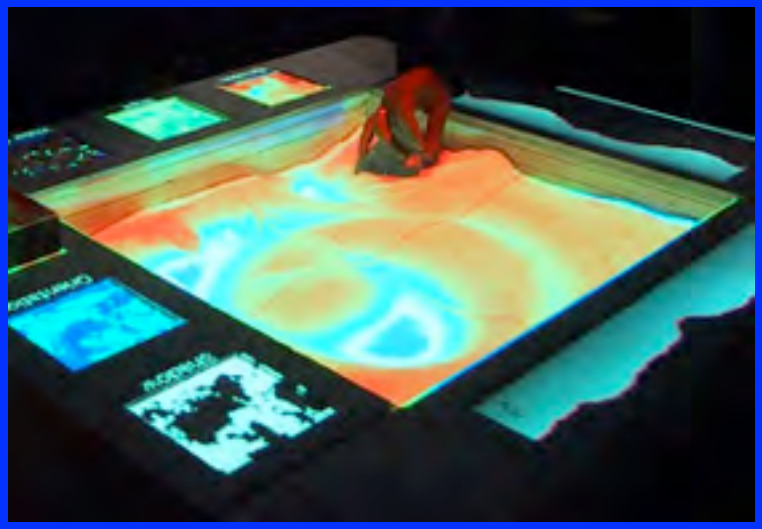


Figure 1.2 A schematic diagram of the visualization process.

From Ware, 2004

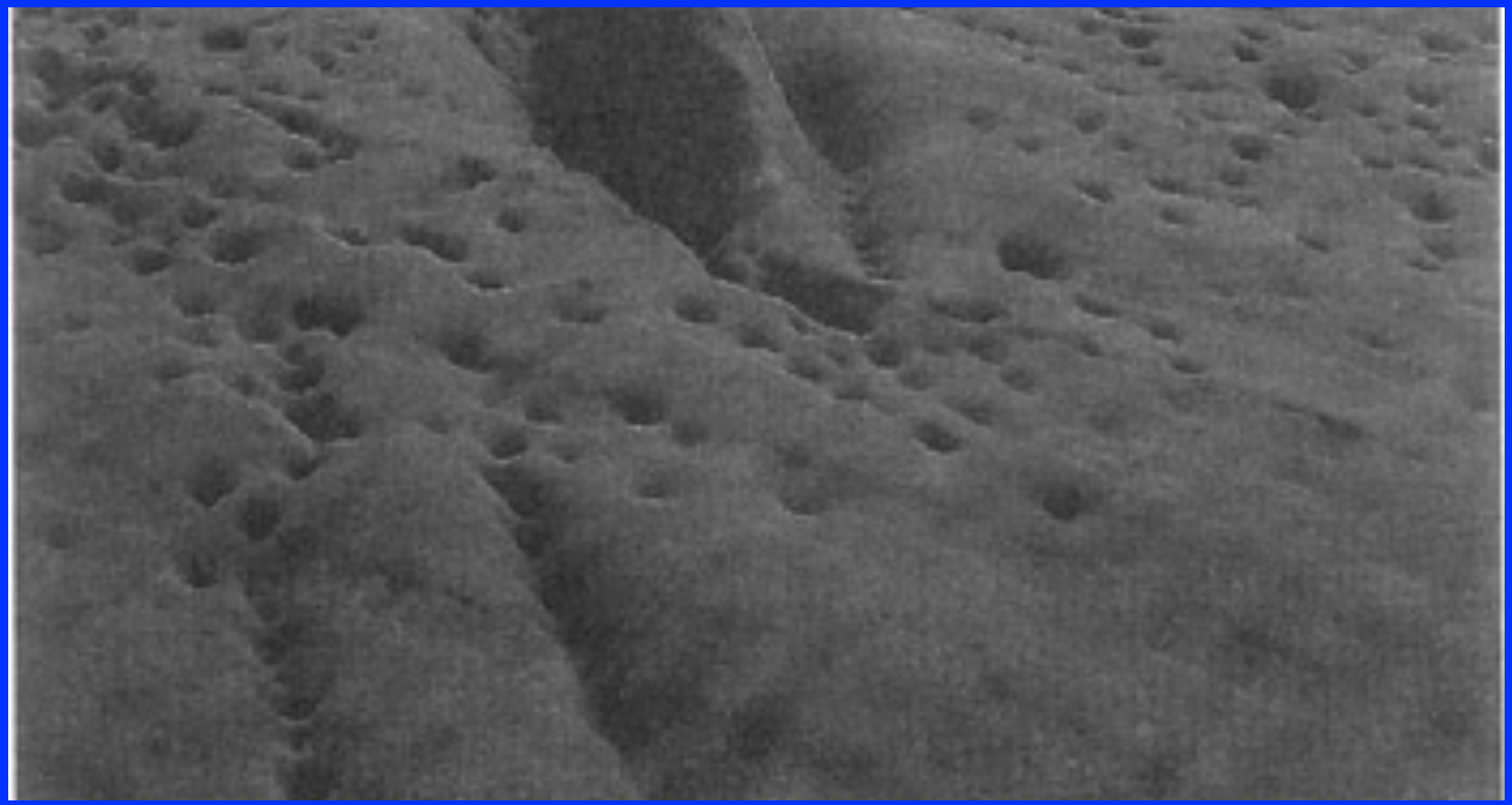
- Tangible user interfaces



http://tangible.media.mit.edu/projects/sandscape/

- Displays present data or information
  - Can be realistic and naturalistic (I.e. photorealistic graphics)
  - Or abstract (text, visualisation, mathematical equations, symbology …)

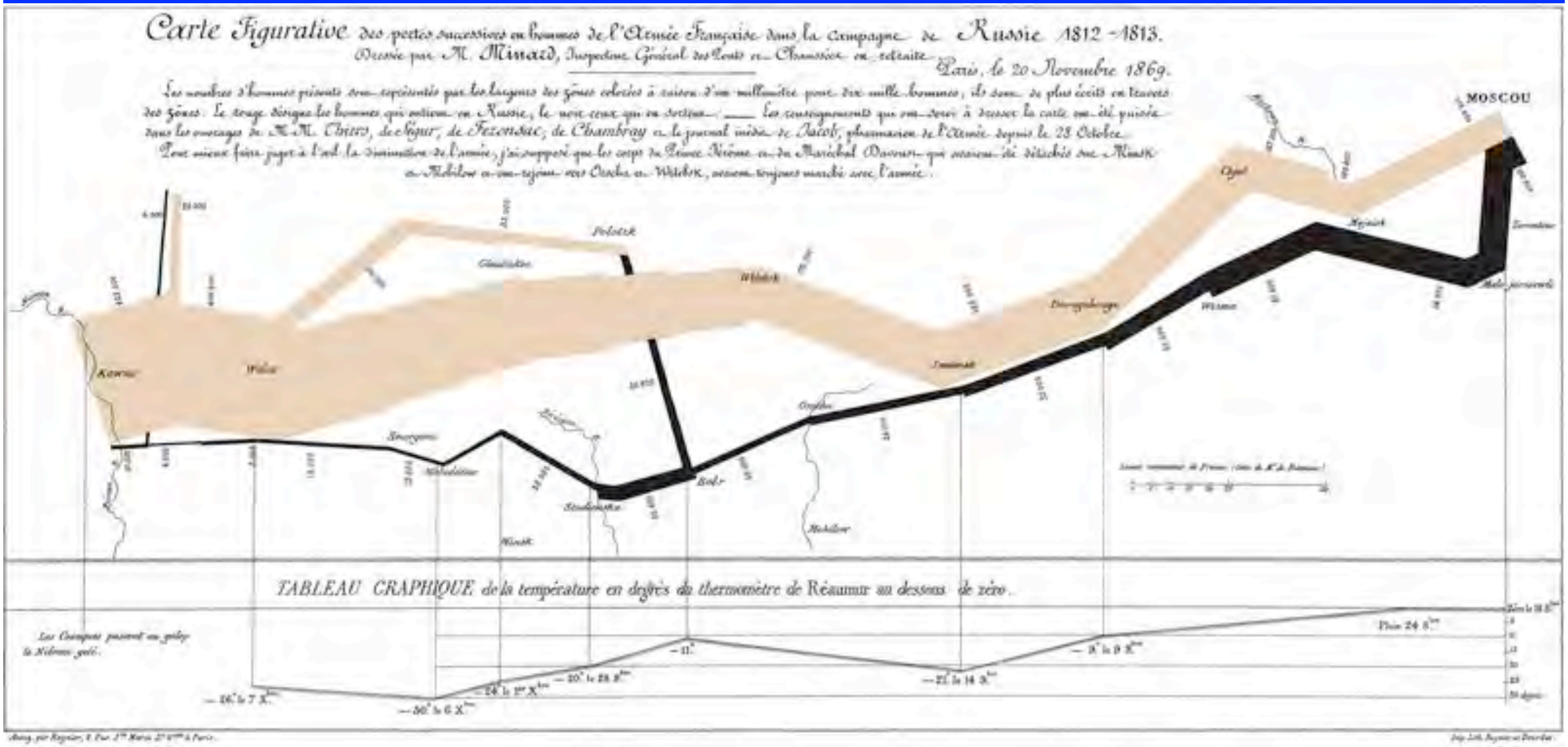
Visualization



From Ware 2004
Passamoquoddy Bay multi-beam sonar visualization.
Data courtesy of the Canadian Hydrographic Service

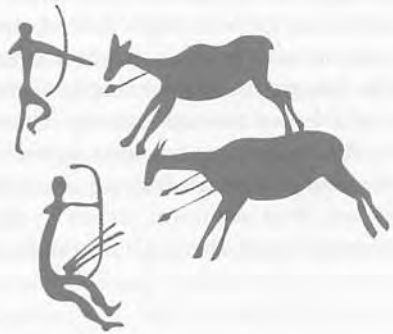
Visualization advantages

- Ability to present and understand large amounts of data (10^6 measures)
- Emergent properties (pock marks)
- Allow for detection of errors and artifacts (ship roll causes banding)
- Multiscale pattern detection.
- Visualization facilitates hypothesis formation

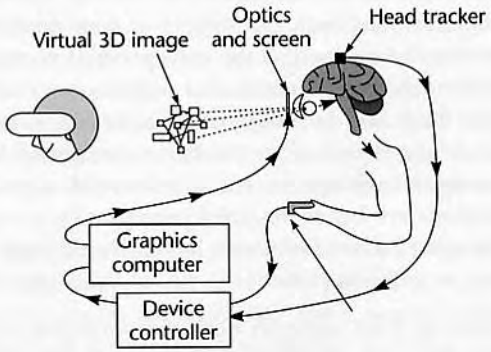

Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.
Paris, le 20 Novembre 1869.
MOSCOU
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

Harry Beck's London Underground Map (images from Wikipedia)

a Cave painting



b VR diagram



c Equation

$$\chi \propto \int_{1}^{\infty} \varpi \oint_{\lambda} \left\| \frac{\Pi \lambda_{i}}{\oint \Psi} \right\|$$

Figure 1.3 Three graphics. Each could be said to be a visualization.

From Ware 2004

- Increased interest in matching of display and representation of data to human sensory and cognitive abilities
  - Sensory representations (no training, little influence of instruction, immediate, cross-cultural)
  - Arbitrary representations (learned, conventions, easily forgotten, embedded in culture, formally powerful , can change rapidly)
  - Most representations are hybrids

- Natural modes of interaction
  - Speech, 3D manipulation, gesture
- Natural modes of display
  - Interactive, dynamic, immersive three-dimensional imagery
  - Simulated environments
  - Mapping of abstract data to virtual worlds
- Natural interaction for entertainment, art and simulation

- Matching of display and representation of data to human sensory and cognitive abilities (Ware 2004)
  - Sensory representations (no training, little influence of instruction, immediate, cross-cultural)
  - Arbitrary representations (learned, conventions, easily forgotten, embedded in culture, formally powerful , can change rapidly)
  - Most representations are hybrids

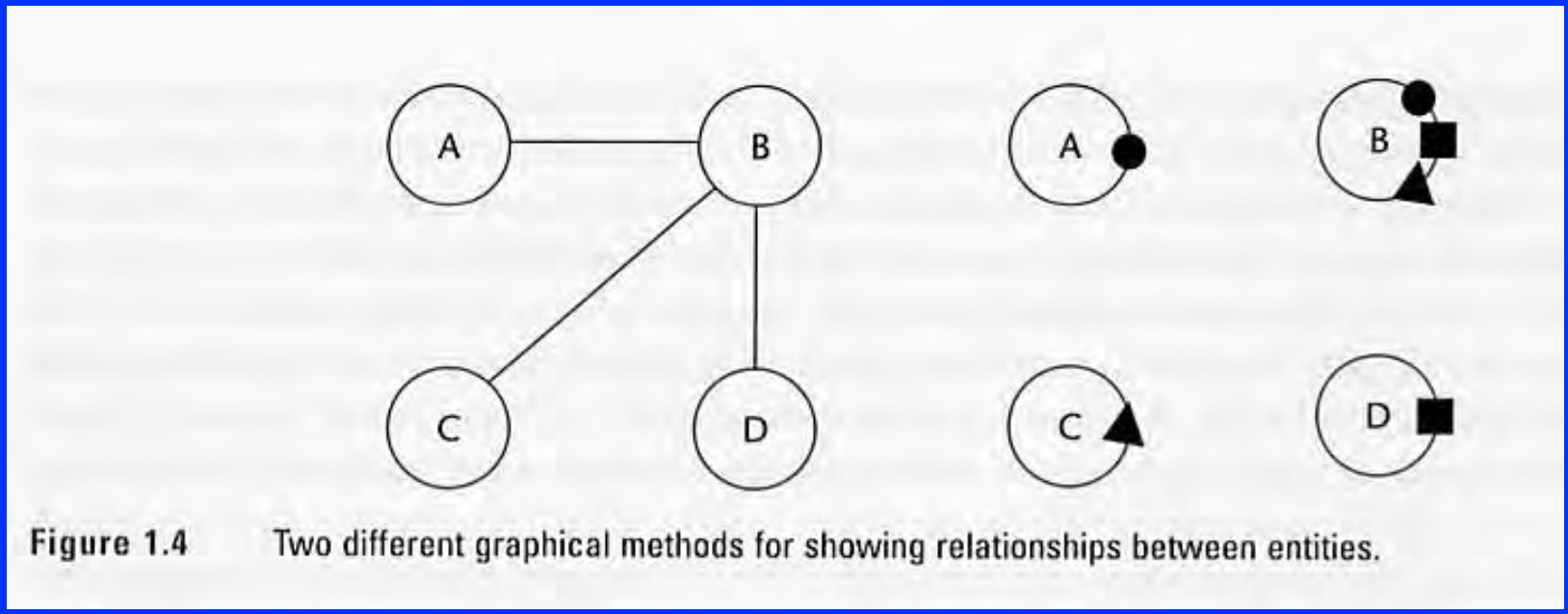
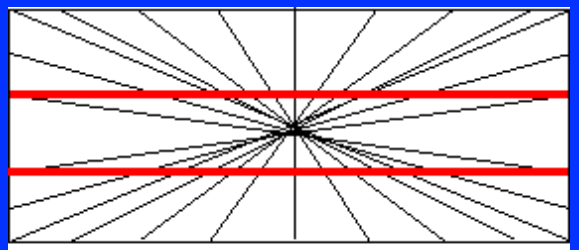


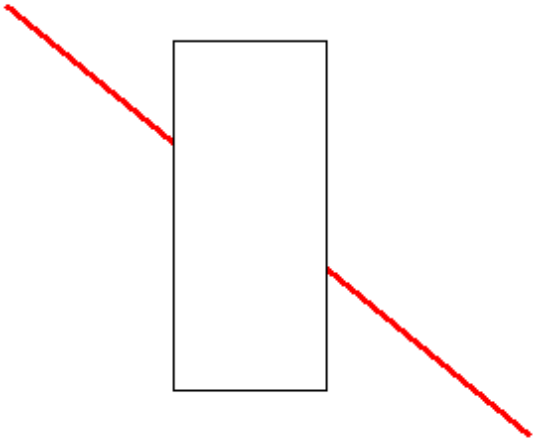
Figure 1.4 Two different graphical methods for showing relationships between entities.

Ware 2004

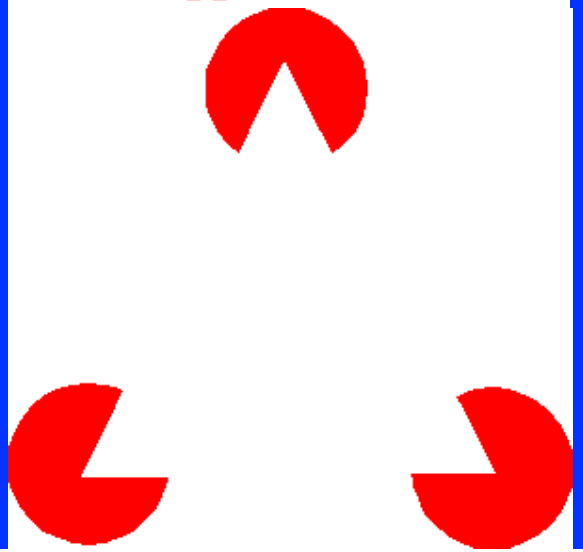
http://www.yorku.ca/eye/illusion.gif

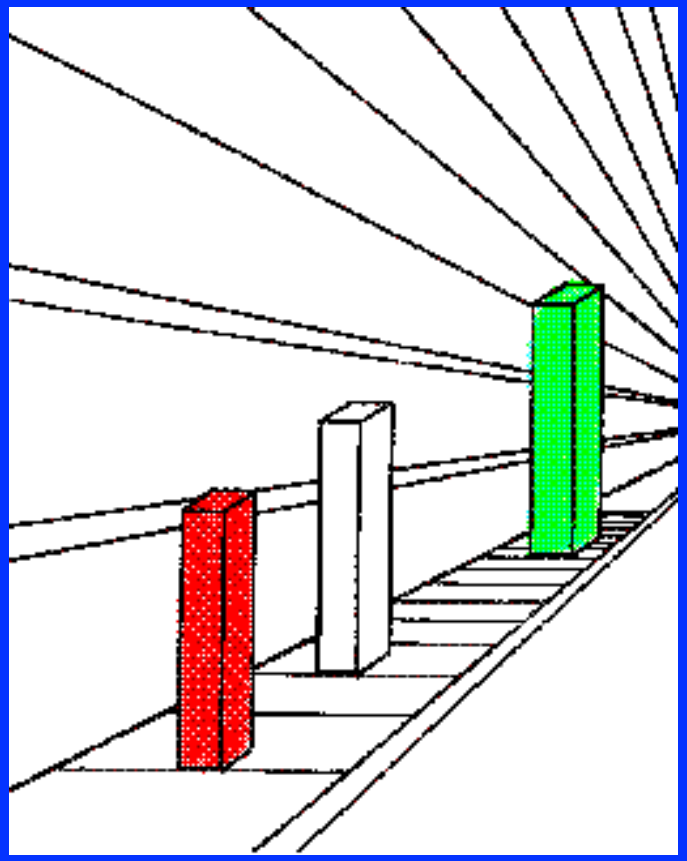


Hering Illusion



Poggendorff Illusion





Illusions tend to be immediate, occur without training and resist cultural differences or instructional bias. Interpretation of images and symbology is not arbitrary but reflects underlying perceptual mechanisms determined by genome and development.

1. Non-immersive displays

- Workstations and PC to support three-dimensional design, animation, visualisation …
- Gaming, VRML …
- With tracking etc. get ‘Fish-tank VR’ – a window into a VE

2. Aircraft Simulators

- Early air powered link trainer 1929 (Ed Link)
- Most mature and successful application of immersive displays
- advanced, high fidelity visuals, motion
- automobiles, ships etc

Modern CAE Ltd. simulators

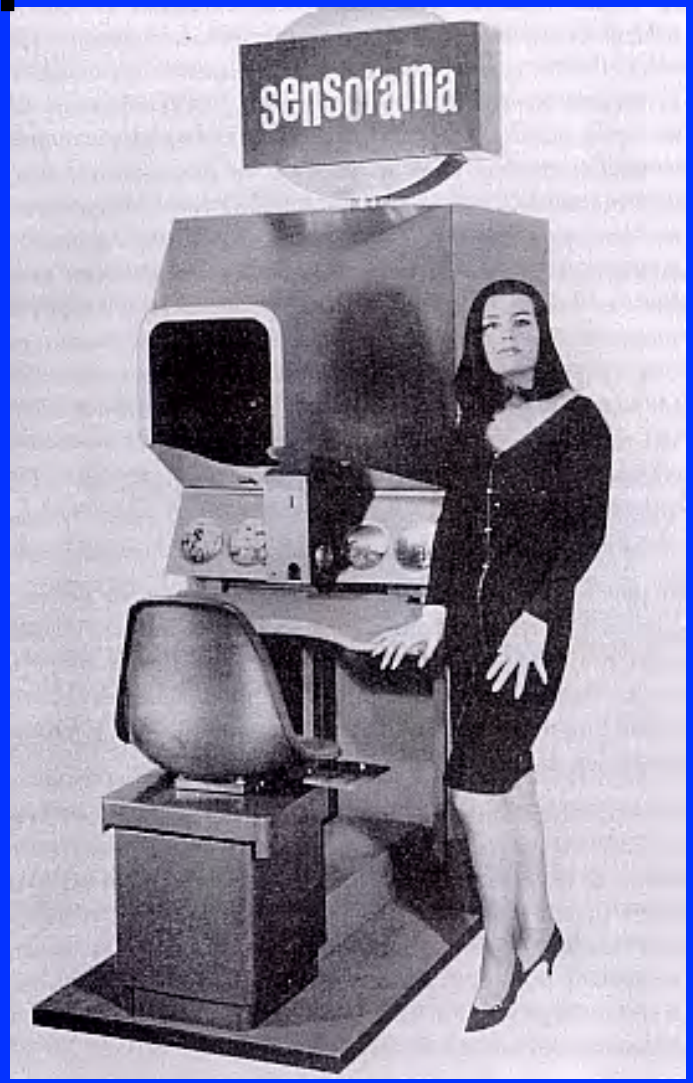

ACTROS

3. Virtual Reality (VR)

- Term Virtual Reality introduced by Lanier (VPL Research) late 1980s
- Many prefer the term Virtual Environments (VE)
  - less emphasis on HW gadgetry
  - more distance from VR hype
- Goal is to simulate a compelling synthetic environment using *displays/effectors* in response to user actions sensed by *sensors*

Sensorama

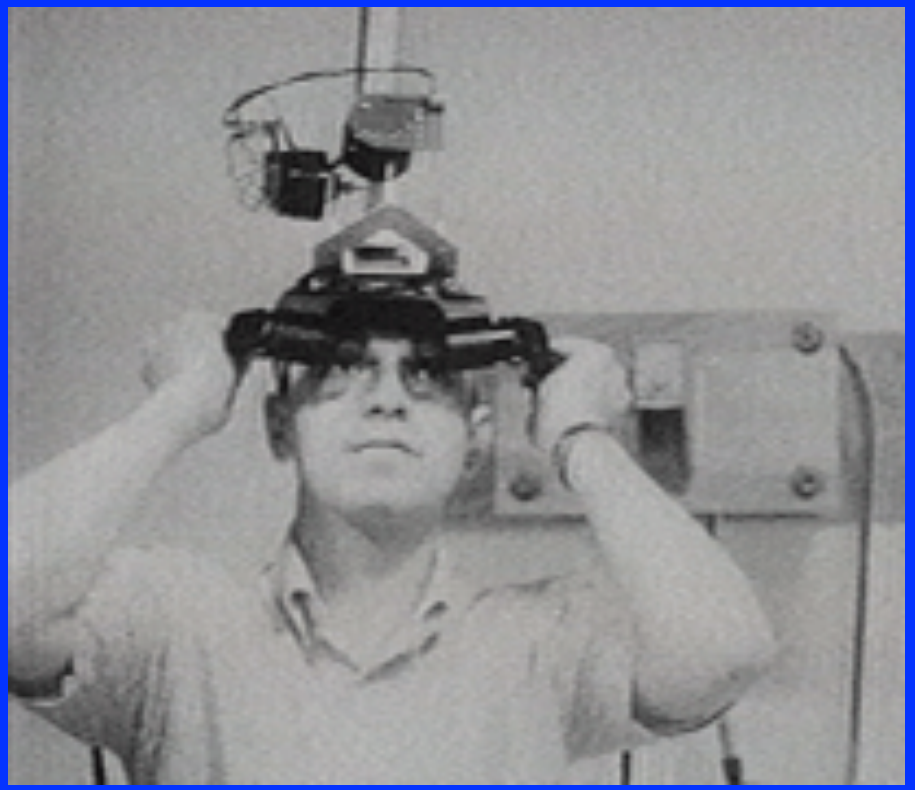
- Heileg's 'sensorama' 1956
- multisensory motorbike simulator
  - stereos imagery, stereophonic sound, seat vibration, wind, and odour to enhance the film



Head Mounted Displays

- M.L. Heilig (1960) binocular television-based Head-Mounted Display (HMD). Also Stanton 1956 (US Patent 3,059,519)
- First computer-based HMD system at MIT (Ivan Sutherland, 1967). Considered by many the ‘father’ of VR.
- ***Visually-coupled system – display driven by movement of head; images for current viewpoint (Furness, 1969)***

- Binocular display
- Wire frame display
- Mechanical tracker
- ‘Sword of Damocles’
- Tested in Bell helicopter



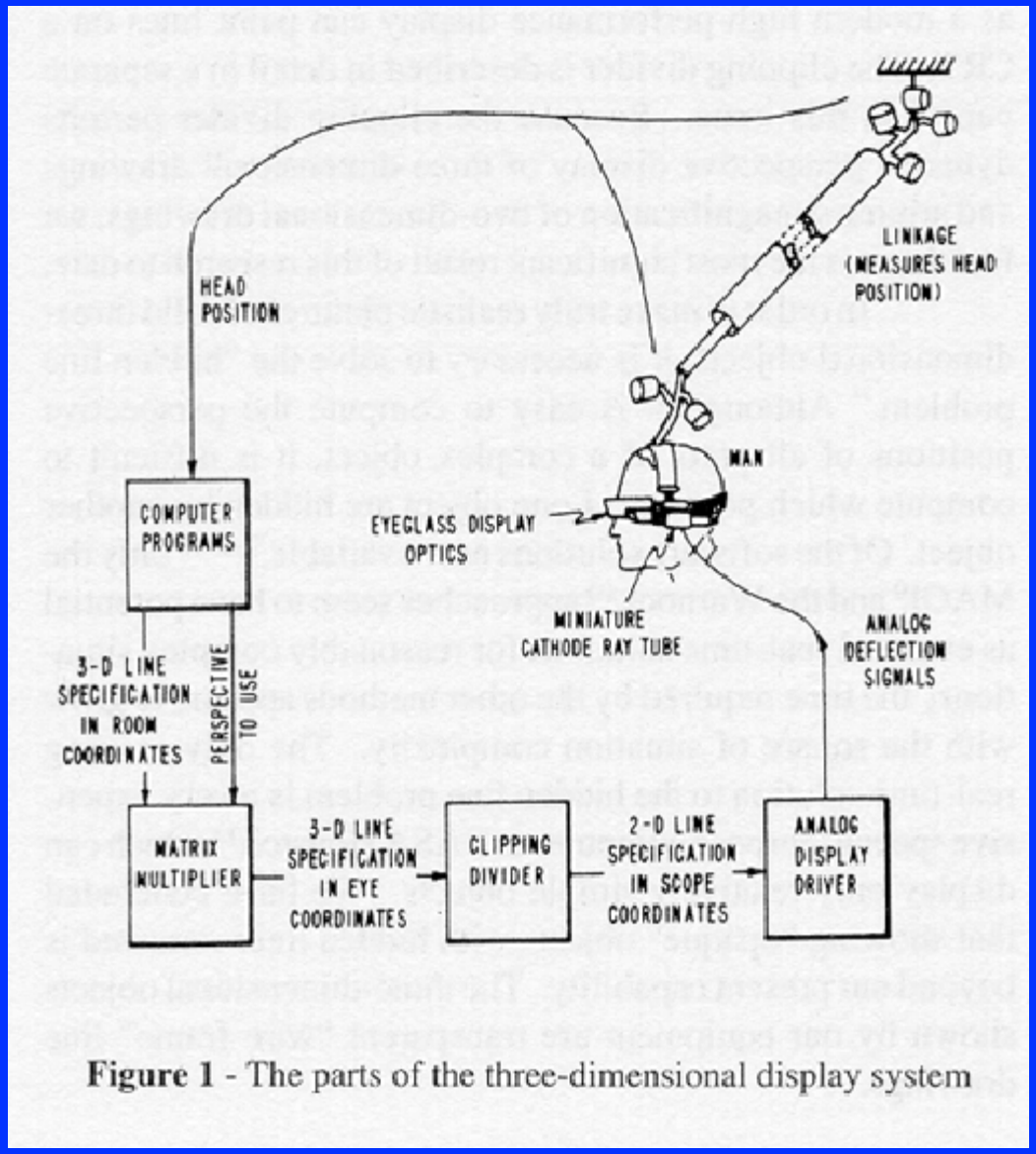


Figure 1 - The parts of the three-dimensional display system

Artificial Reality

- Kreuger (1991) – 'An artificial reality must dominate the participant's senses with synthetic stimuli that define the context for an experience that the person will accept as real'
- Kreuger explored his artificial reality in a number of artistic systems (e.g. Videoplace 1985)

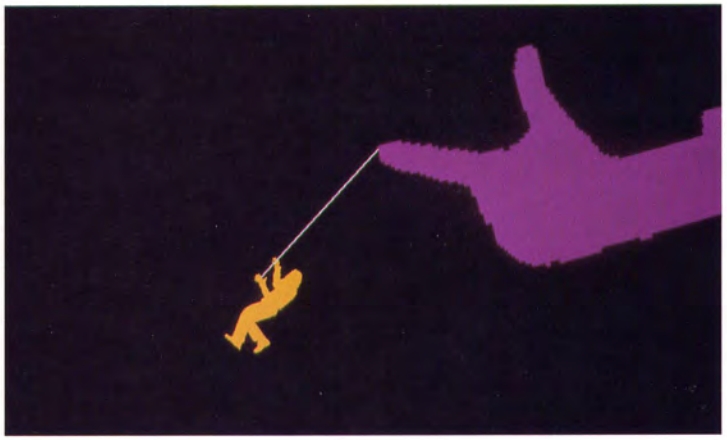


Plate 5
HANGING BY A THREAD.
The VIDEOPLACE participant's image dangles from a graphic string suspended from the VIDEODESK participant's finger. By moving from side to side, the VIDEOPLACE participant can cause his image to swing. Since the two people can be a distance apart, this two-way interaction is really a playful teleconference.

CAVE

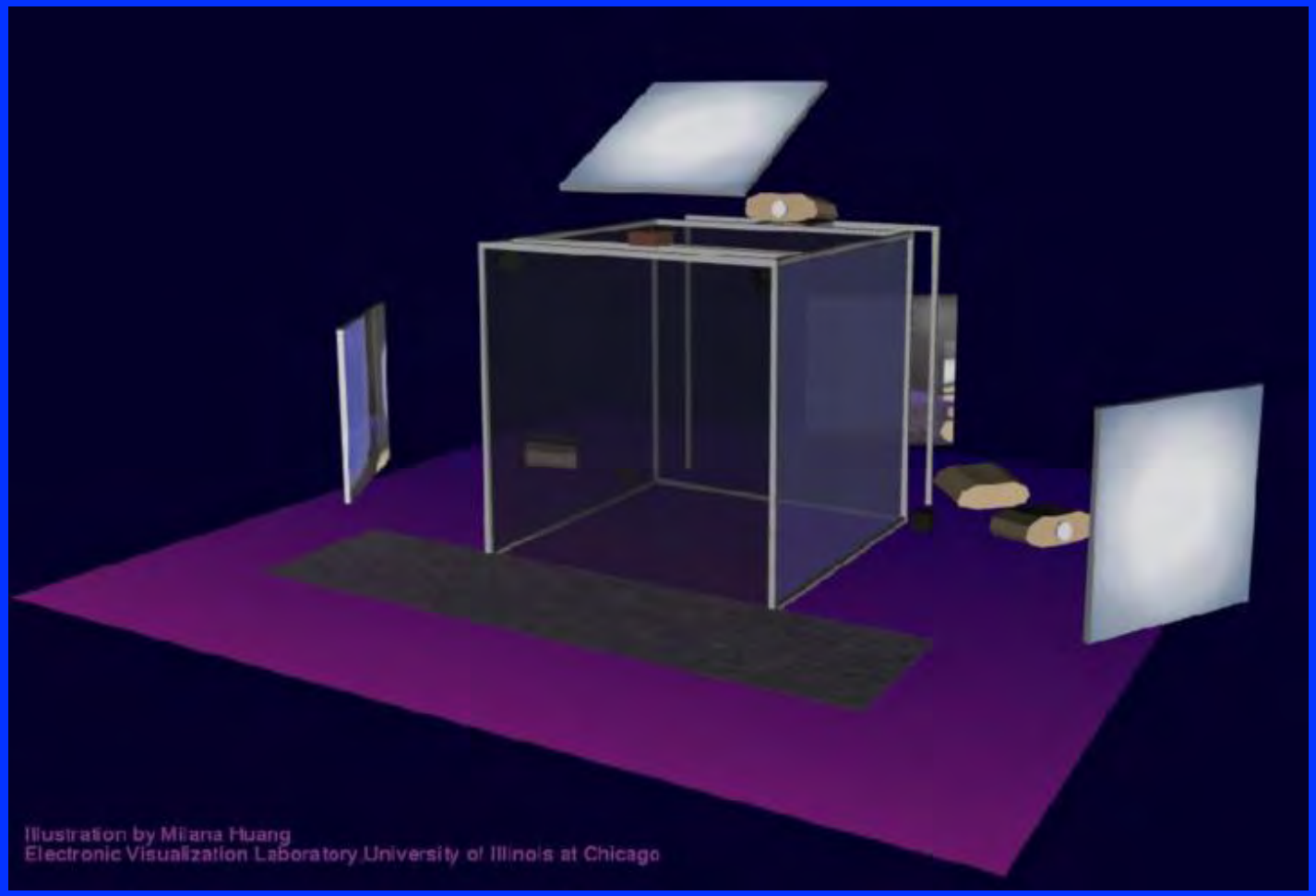
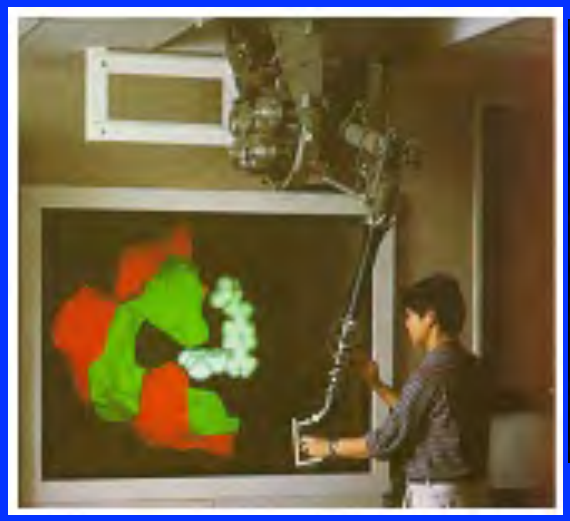


Illustration by Milana Huang
Electronic Visualization Laboratory University of Illinois at Chicago

VE Applications

- entertainment (e.g. theme park rides)
- scientific visualization
- tele-presence, tele-collaboration
- tele-operation, (including laproscopic surgery, surgical robots)
- architectural walkthrough
- CAD/CAE

media player



F. Brooks, project Grope

http://www.hitl.washington.edu/research/exposure/

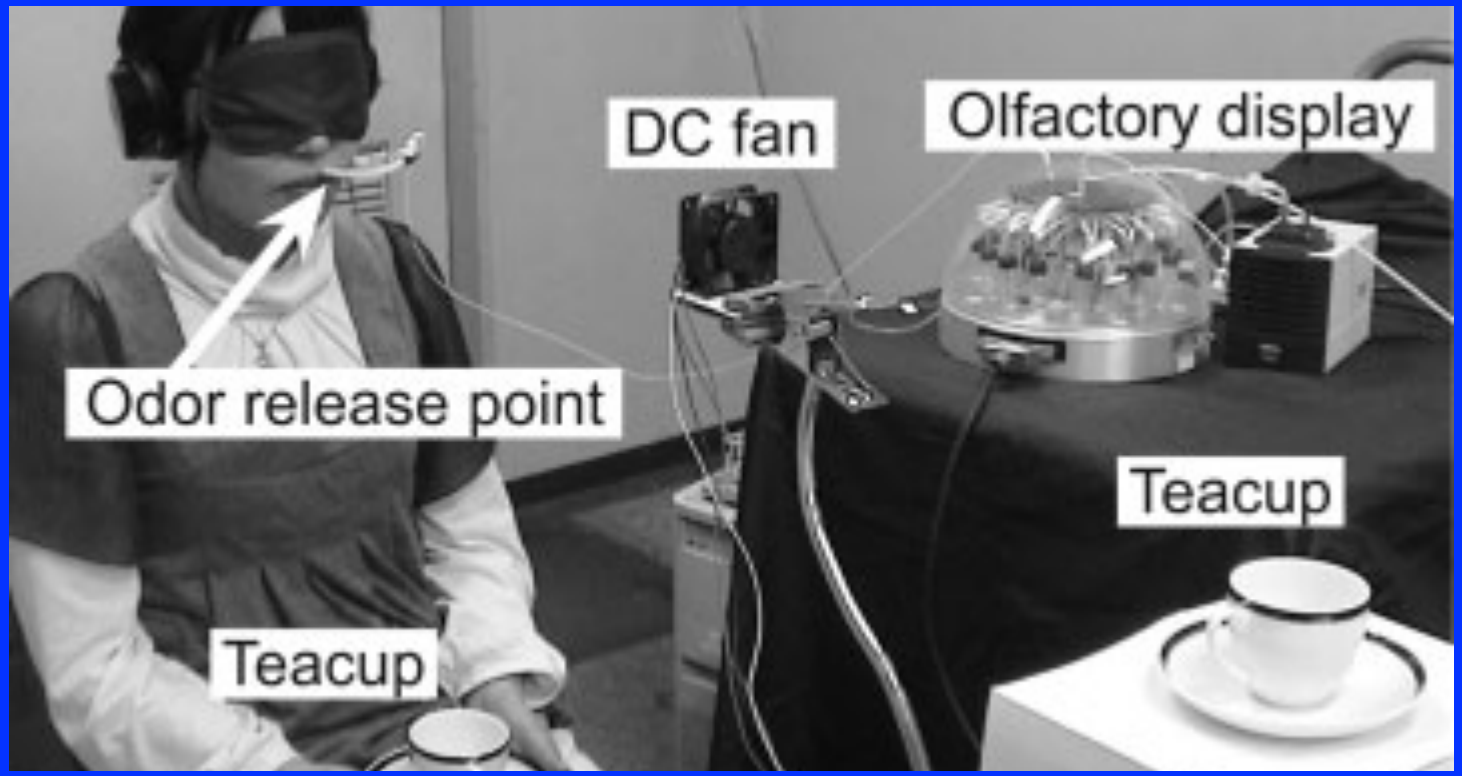
http://www.cs.unc.edu/~walk/

www.vrac.iastate.edu/research/ visualization/tornado/

UNC nanomanipulator

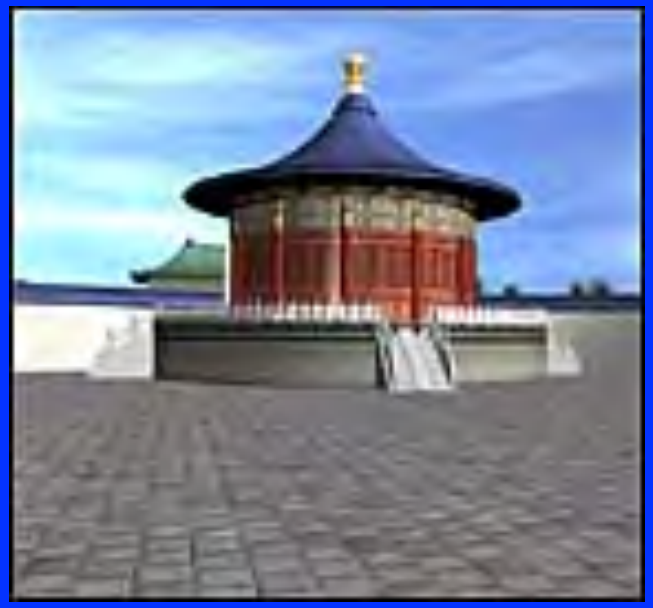
VR in Psychotherapy for Social Phobias (Slater)

Even VR smells

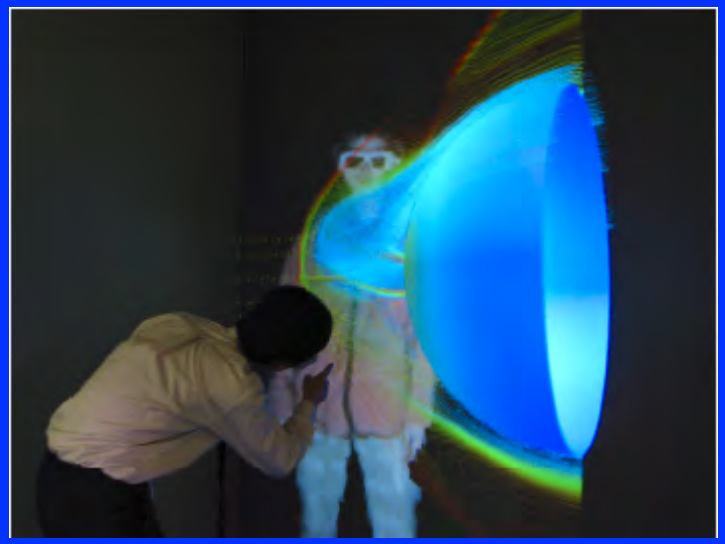


Matsukura et al, 2010, Presence, 19, 513-26

City Planning/Heritage- Virtual Beijing (Iowa State)



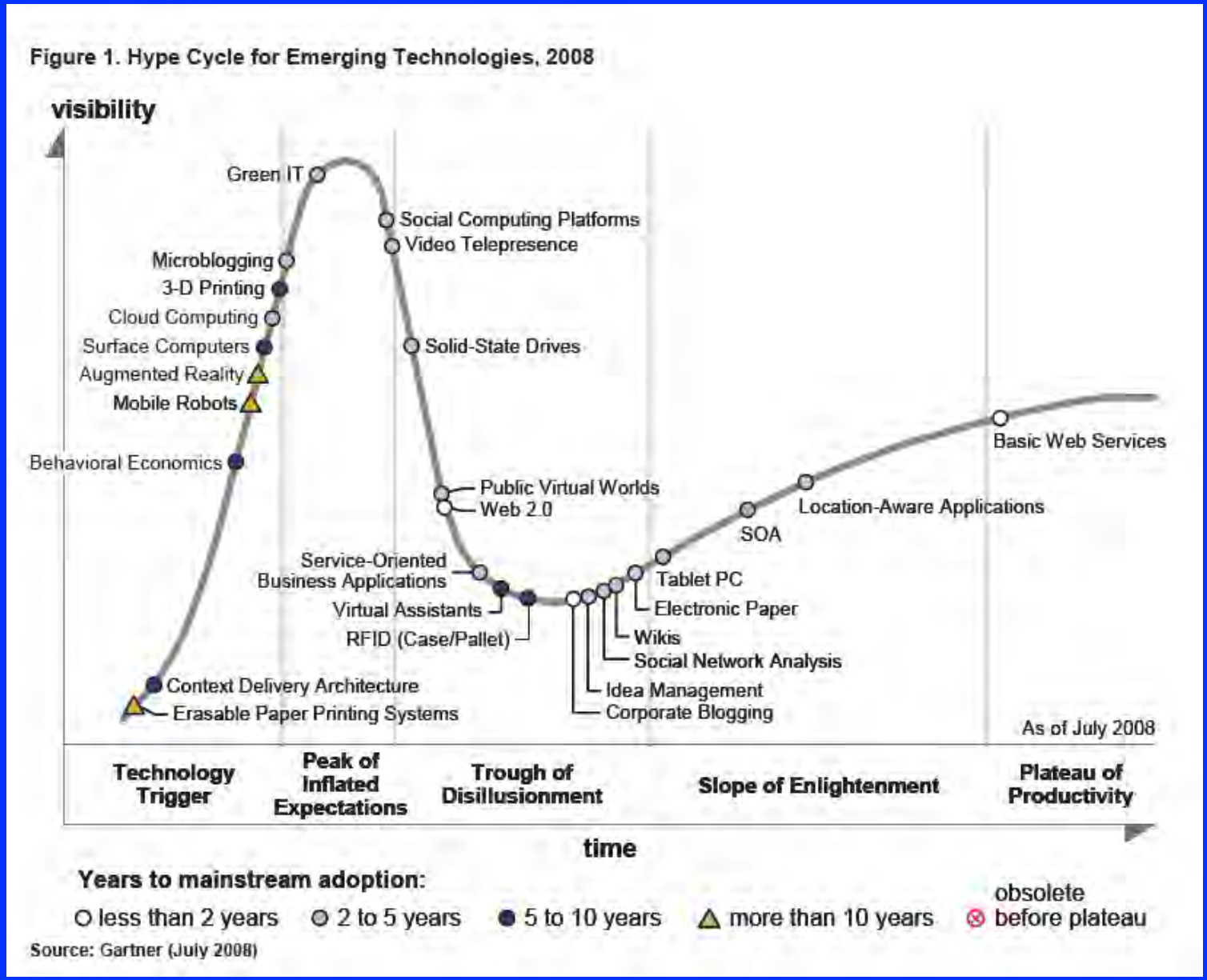
Scientific Visualization



Flow Visualisation
University of Tsukuba

- VR popularized in media in 1990s. Past the peak of its ‘hype cycle’

media player



Examples dated but could fill with modern examples

4. Teleoperation

- remote operation of a robot, vehicle …
- timely visual and motor feedback is essential

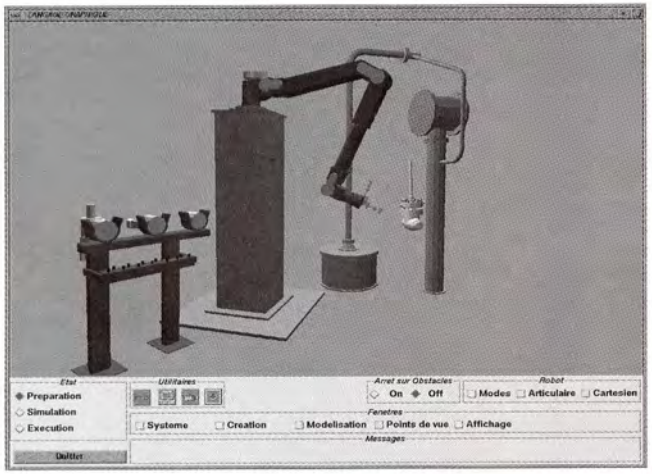


FIG. 48.9. TAO 2000: A VE-based graphical programming for nuclear maintenance (gate inspection mission case, (*left*); the whole system with the MA23 master force feedback arm (*right*). Courtesy of Gravez and Fournier, Advanced Teleoperation Service, CEA, France.

- most hyped (and demanding) application is tele-surgery
- surgical robots
- others applications include space robotics, hazardous waste handling, military applications

IEEE Spectrum, Jan 2002

5. Wearable computers

- Medical implants, prosthetics
- Early systems for roulette, card counting, aids for blind
- Mobile devices
- Sci-fi and literature
  - HG Wells
  - Gibson ‘Neuromancer’
  - Manfred Clynes, Nathan Kline ‘Cyborgs and Space’
  - Terminator

Google glass

6. Augmented and Mixed Reality

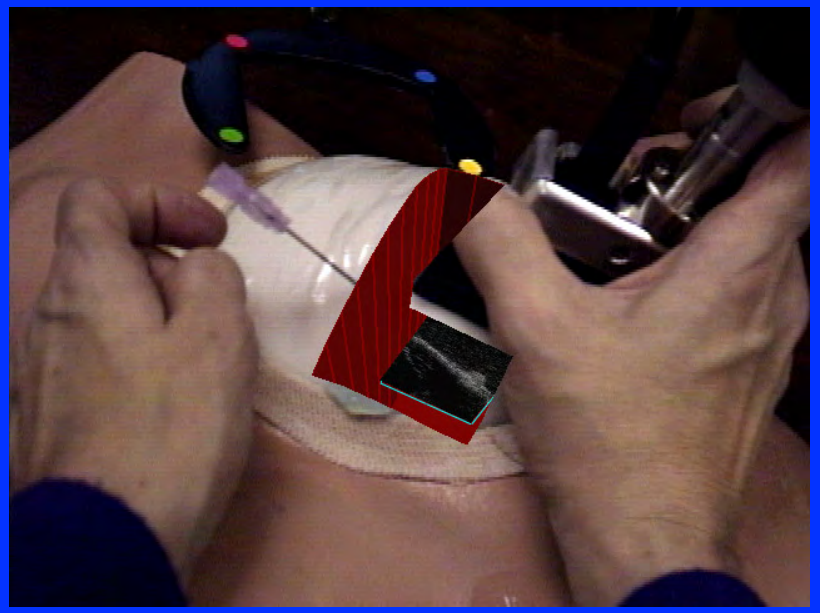
- Augmented reality: computer generated enhancement of real world images (or sounds …)
- Mixed reality – any display in which real and virtual features are combined
- Milgram's reality-virtuality continuum

Some AR Applications

- Medicine
- Computer Aided Design and Manufacturing
- Maintenance, Assembly
- Meter reading, parking tickets
- Enhanced and synthetic vision systems
- Navigation, situation awareness
- Collaborative computing

- Fuchs' early (and continuing) ultrasound example

Comm. ACM, July 2002

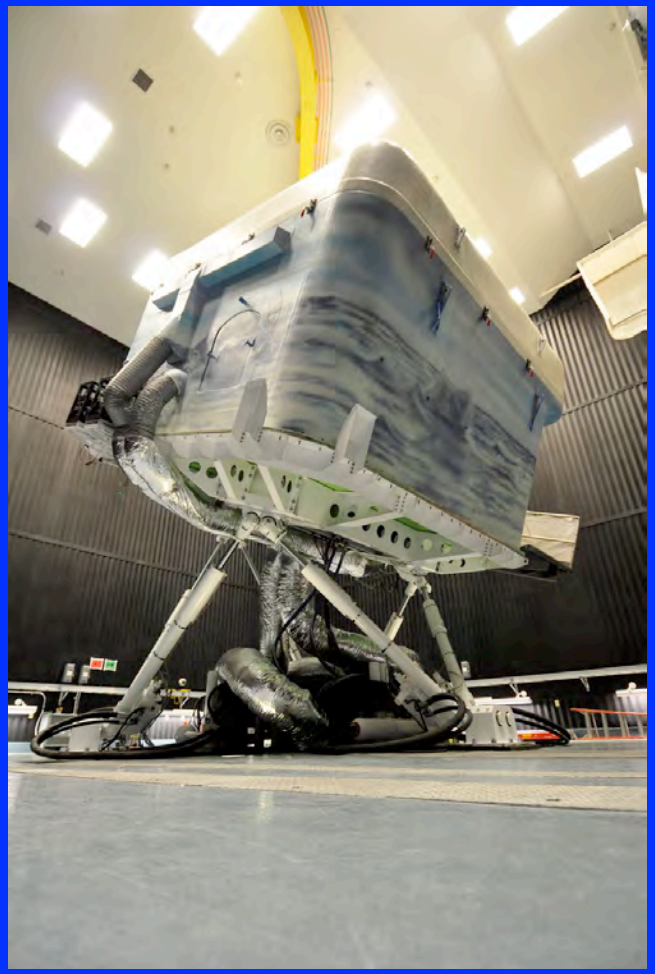


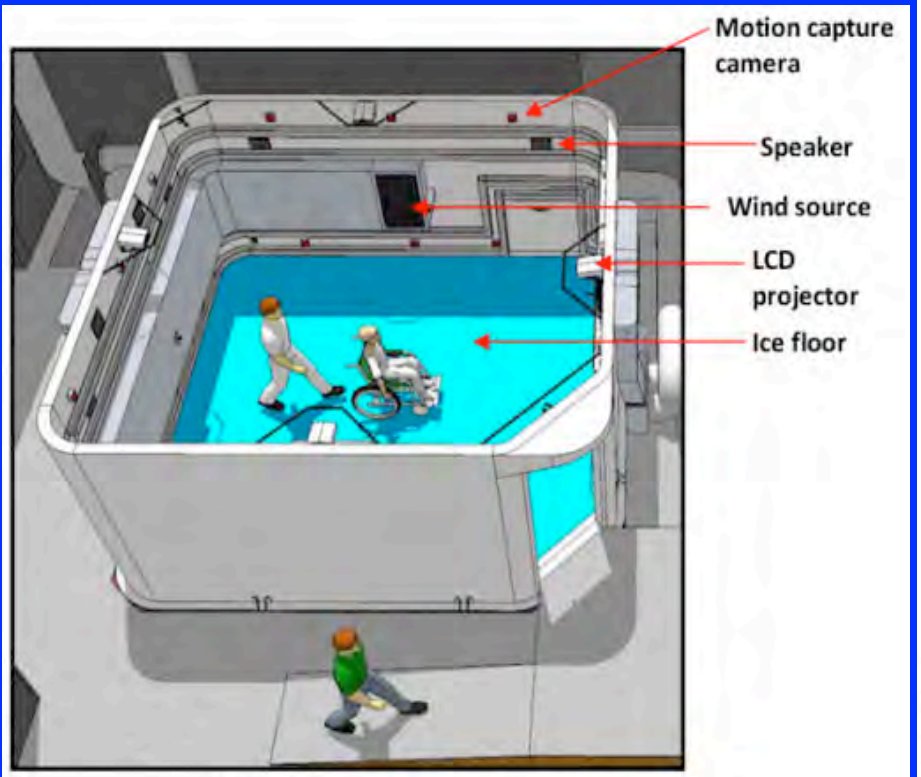
Fuchs' ultrasound project

Physical Therapy/ Rehabilitation

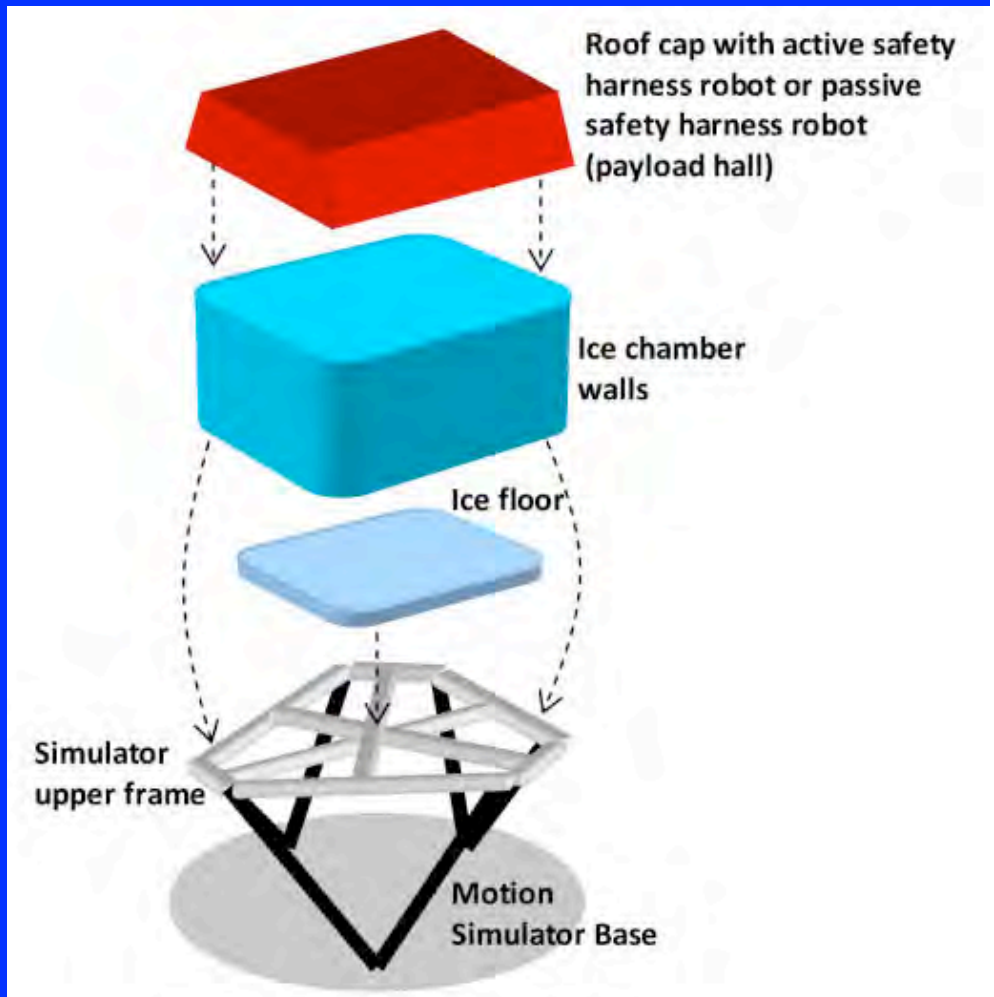
Fig. 2. Icy road condition, shown here in patches but presented continuously in the study. © Rutgers University and UMDNJ. Reprinted by permission.

Toronto Rehab CEAL

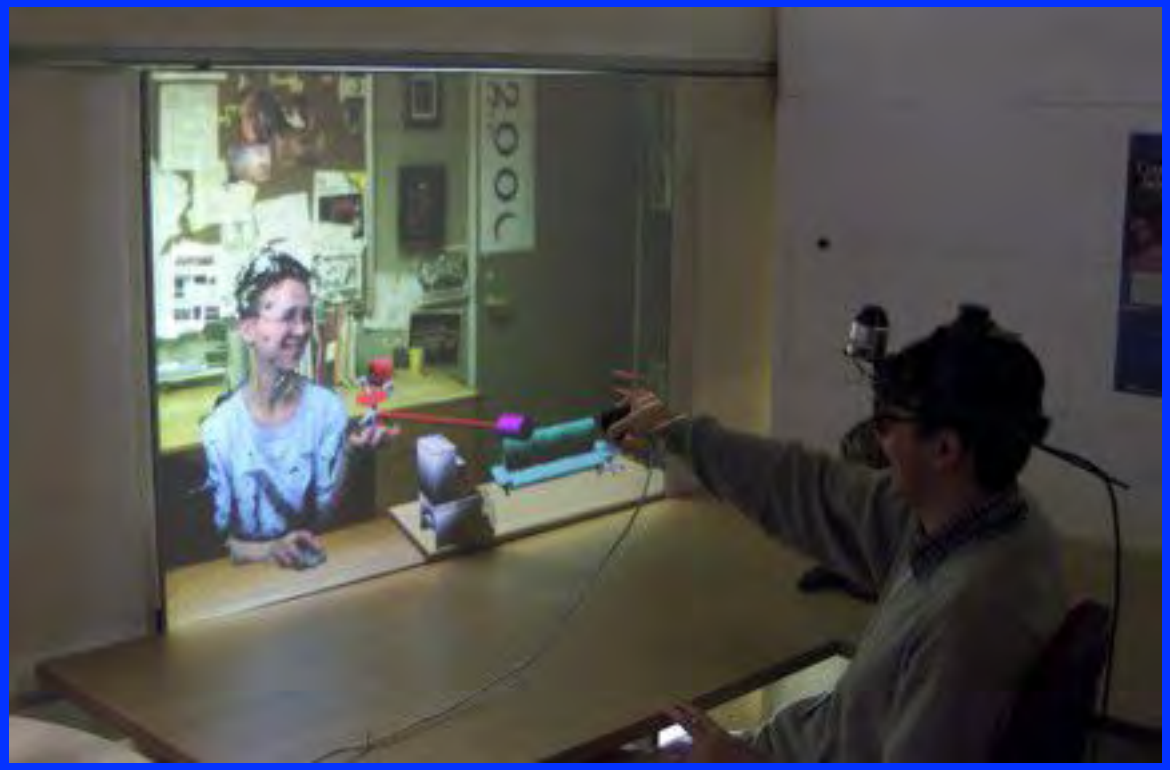




Overhead view of Winter Payload interior



Winter Payload schematic



UNC office of the future

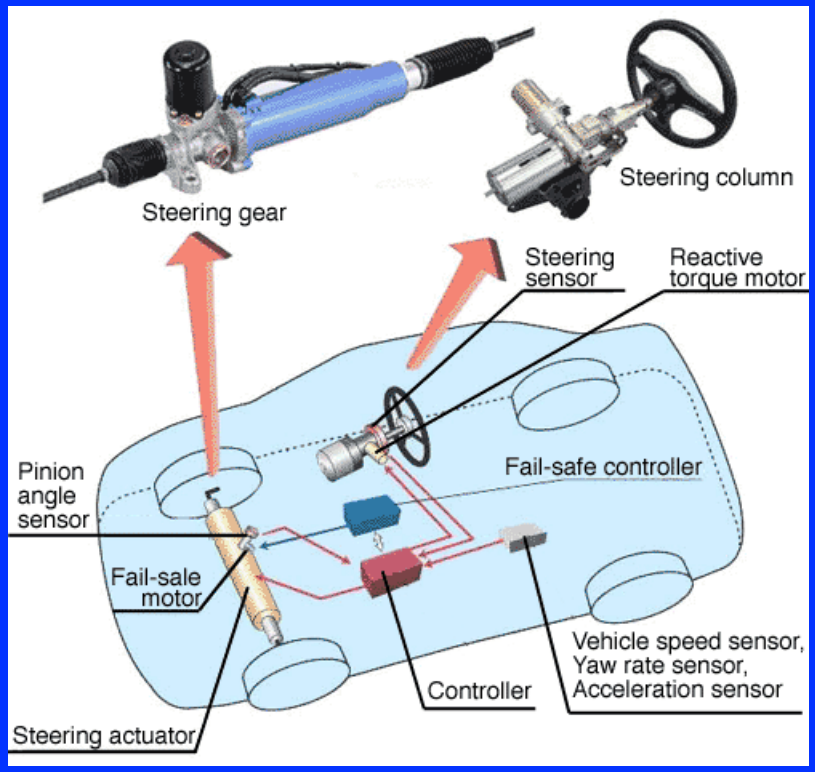
7 .Vehicular Applications- Heads up displays

- Operator information optically super-imposed on view of real world
- Aircraft, navigation and instruments for automobiles (GPS, maps)

www.simlabs.arc.nasa.gov/

8. Vehicular Applications- Drive or Fly by Wire

- Controls and interfaces increasingly computer mediated
- Role of intelligent highways/automobiles
- Steer by wire, brake by wire, X by wire
- Need for feedback: haptic, visual, auditory displays



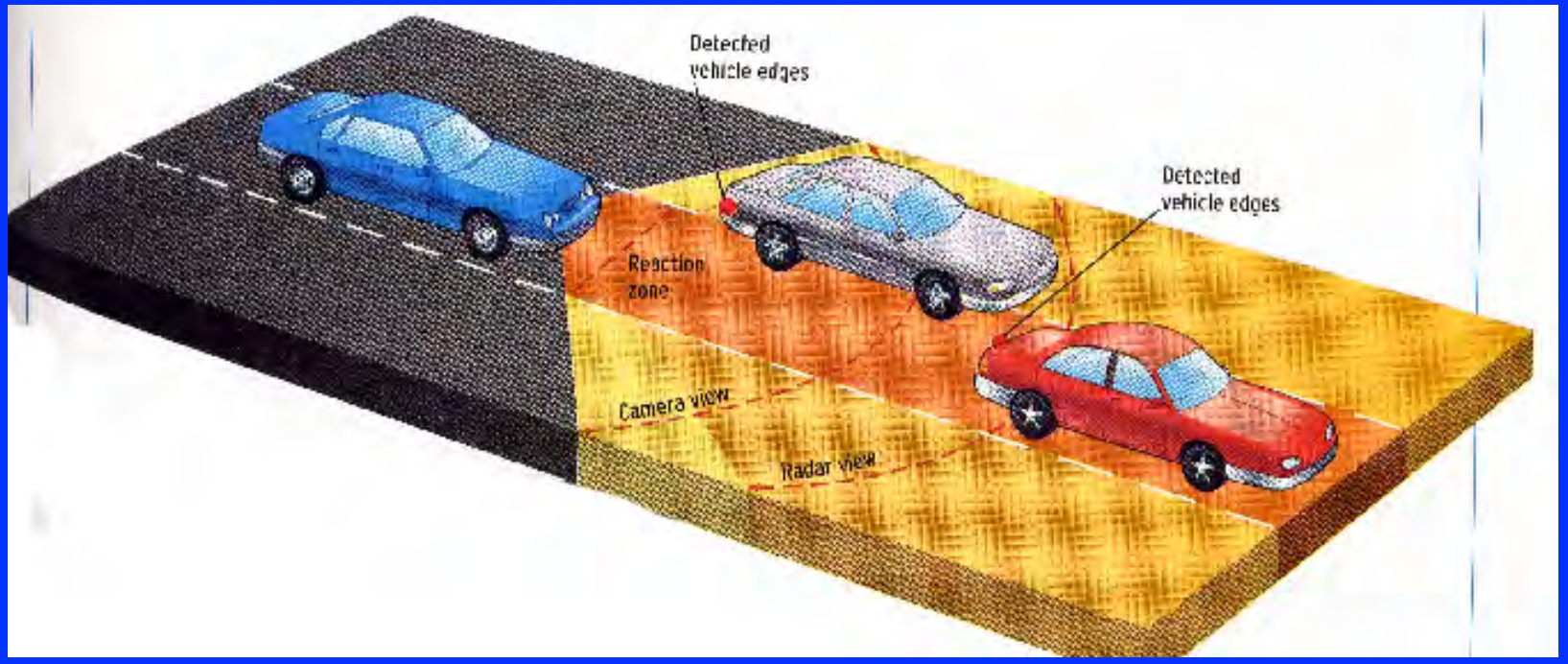
www.koyo-seiko.co.jp/.../www.koyo-seiko.co.jp/

GM Hy-Wire

http://popularmechanics.com/automotive/auto_technology/2002/8/hy_wire_hybrid/

Adaptive Cruise Control

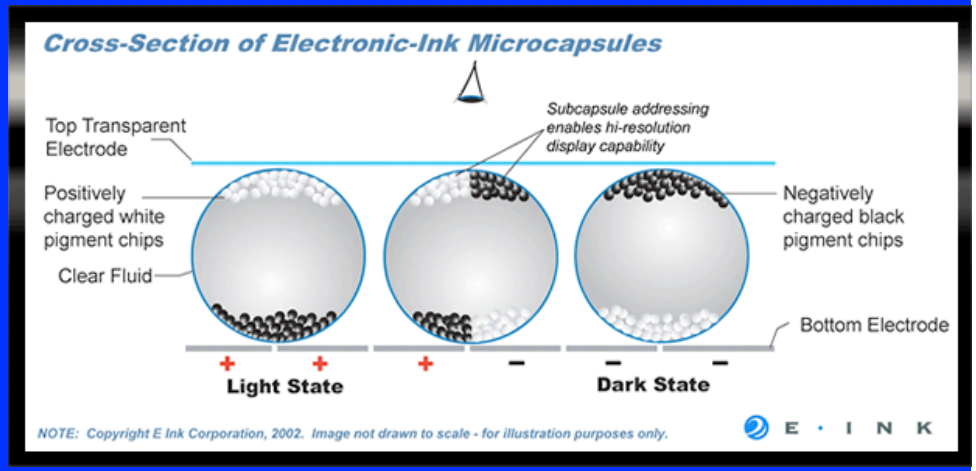
- Currently ‘driver aid’ for liability reasons – need to consider interaction with driver



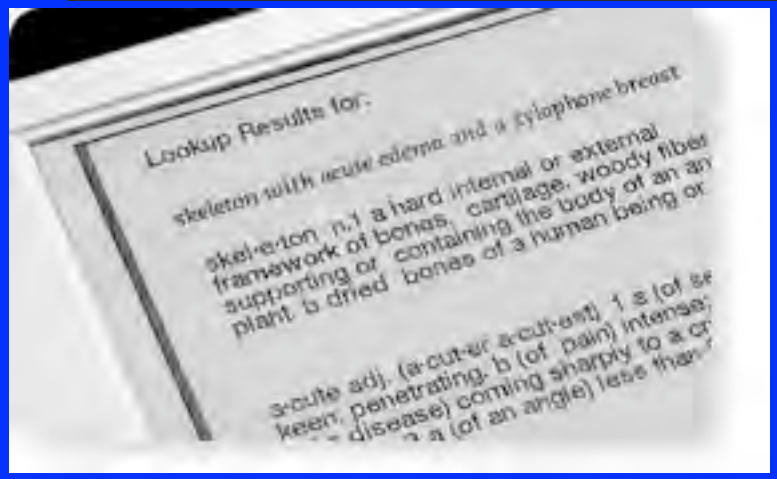
IEEE Spectrum, Sept 2001

9. Perception can be important in other technologies

- Electronic Ink (E-Ink) or reusable digital paper (Xerox, Amazon Kindle shown)



Giant e-ink clock from CES 2014 (phote theverge.com)



http://www.uk.research.att.com/spirit/

9. Perception can be important in other technologies

- Location-aware ubiquitous computing, pervasive computing, sentient computing
- Gaming, online virtual worlds, …