History of Virtual Reality

(thanks, Greg Welch)

Trends & Milestones

Displays (head-mounted)
- video only, CG overlay, CG only, mixed video
- CRT vs. LCD

Tracking
- magnetic, mechanical, ultrasonic, optical
- local vs. wide area

Haptics
- vibration, 2D fields, 6D fields
- Large vs. small working volume and forces

Systems, Applications
- Aerospace, surveillance
- Scientific, research
- Entertainment, telepresence, etc.

Visually Coupled Systems

Aerospace and Defense Requirements
- Cost-effective and safe training
- Put heads-up-display (HUD) in pilot s view

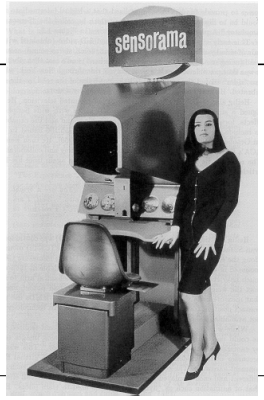
Other Applications
- Off-boresight weapons aiming
- Steerable night vision aids

Sensorama (1956)

Morton Heilig
- cinematographer/director of documentaries

Motorcycle simulator - all senses
- visual (city scenes)
- sound (engine, city sounds)
- vibration (engine)
- smell (exhaust, food)

(not a big commercial success)



Virtual Reality Technology, Burdea & Coiffet

Heilig s HMD (1960)

Simulation Mask
- 3D photographic slides
- WFOV optics with focus control
- Stereo sound
- Smell

From Heilig's 1960 patent

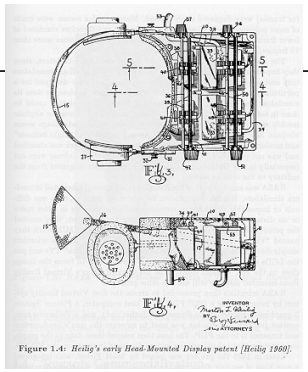


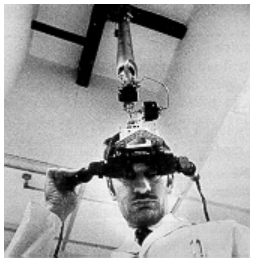
Figure 1A: Heilig's early Head-Mounted Display patent [Heilig 1960].

Virtual Reality Technology, Burdea & Coiffet

Philco Headsight TV Surveillance System (1961)

- **Comeau & Bryan**
- **Components**
  - **Remote closed-circuit TV**
  - **HMD**
- **Custom magnetic tracking**
- **Head-sight camera linkage**
- **Suggested HMD resolution matching**
  - **match display to eye s resolution**

Ivan Sutherland and The Ultimate Display (1965)



- **Suggested HMD as a a window into a virtual world**
- **Inspired many of the great achievers in interactive computer graphics**

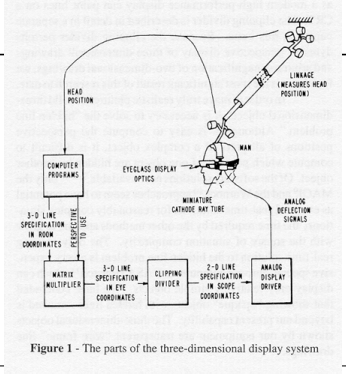
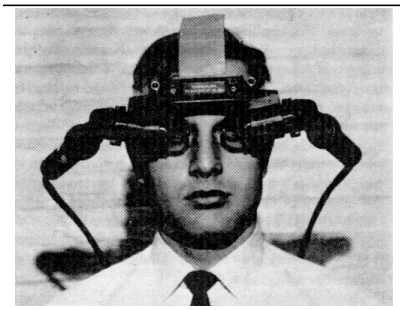


Figure 1 - The parts of the three-dimensional display system

Sutherland s HMD



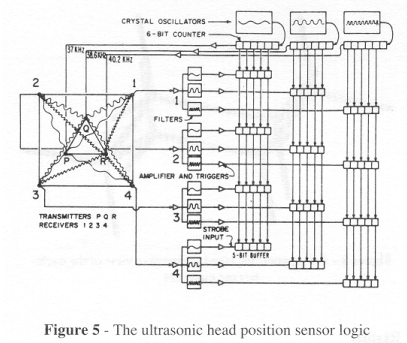
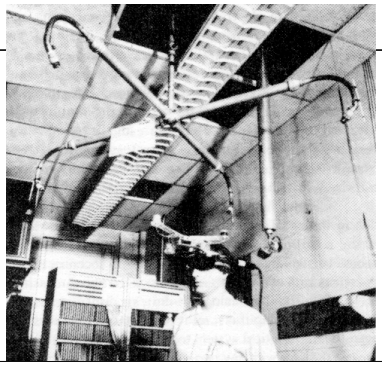


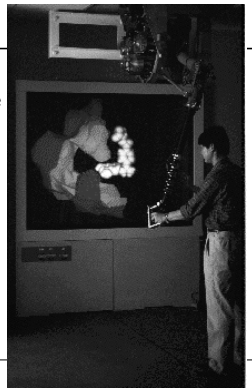
Figure 5 - The ultrasonic head position sensor logic



UNC Haptic Systems (1967-1980 s)

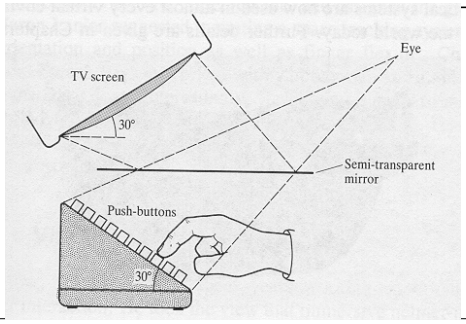
- Haptic/kinesthetic display system
- 6D force fields of molecular structures
- Progression
  - Grope I, simple fields, particle feedback
  - Grope II, 1978, children s building blocks
  - Grope III, late 80 s, Argonne Remote Manipulator (ARM)
- Sarcos arm

Molecular docking with the Argonne Remote Manipulator (ARM)



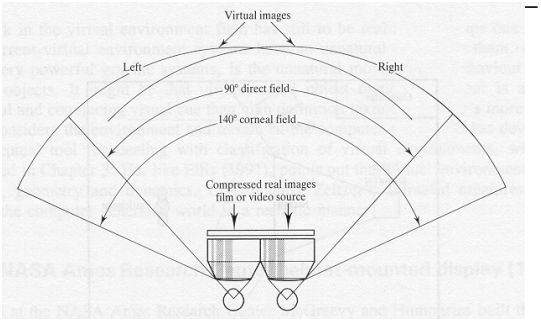
Knowlton s Virtual Pushbuttons (1975)

- Partially-silvered mirror over keyboard
- Programmable labels
- Tactile feedback (real thing!)



LEEP Optics (1975)

- Large Expanse, Extra Perspective (LEEP)
- Eric Howlett (Pop-Optix Labs)
- Originally for 3D still photo vieweing
- Lenses correct for camera distortion
  - Display optics matched to camera optics
  - Often uncorrected distortion for CG images
- Reported to have great realism for still images
- 90^{o} direct FOV, 140^{o} corneal FOV



The DataGlove (1981-1982)

Precurser, Sayre Glove (U of IL, ORD, 1977, NEA grant!)

1982 Thomas Zimmerman patented light-based bend sensors

VPL: Zimmerman, Jaron Lanier and Scott Fisher (all met at Atari Research Labs Sunnyvale, CA)

Lanier added 6 DOF tracking

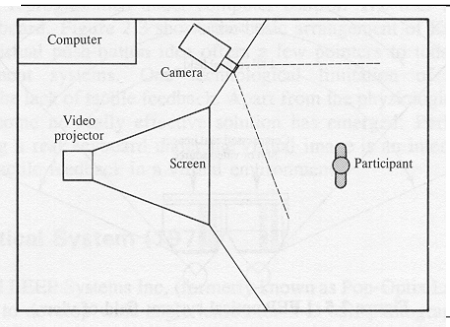
Krueger s Videoplace (1983)

Graphics and gesture recognition

University of Connecticut, 1970s-

VideoDesk

- **camera captures gestures**
- **relays to remote collaborator**
- **gestures control graphics**
- **paint, draw, menu selection**



Bishop s Self-Tracker Dissertation (1984)

Passive tracking in large, unstructured environments

Custom VLSI optical sensors with smarts

Linear array

Cube w/ multiple sensors

Difficult problem, step back and try ceiling

NASA Ames HMD (1981-1984)

McGreevy and Humphries, Scott Fisher

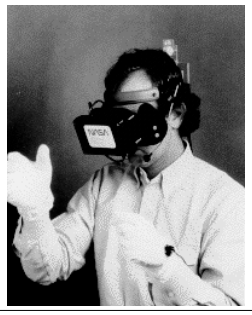
First *implemented* immersive HMDs

LCD Watchman displays

Led to VIEW (next slide)

NASA Ames VIEW or VIVID (1985)

- Virtual Interface Environment Workstation
  - Polhemus tracker
  - LEEP-based HMD
  - 3D audio, Crystal River s Convolvotron
  - Gesture recognition w/ VPL DataGlove
  - Book-mounted CRT (Sterling Software)
  - Remote Camera (Fake Space)



USAF Super Cockpit (1985)

- Wright Patterson Ait Force Base
- Visual, auditory, tactile
- Head, eye, speech, and hand input
- Designed to deal pilot information overload
- Research only
  - big system, not safe for ejecting

VPL Research (1985)

- Jaron Lanier, Jean-Jacques Grimaud
  - Lanier came up with term virtual reality
- Funding from NASA and Thomson-CSF
- DataGlove, EyePhone, AudioSphere
- Provided framework for complete systems
  - Components could be added piece-meal
  - Software infrastructure assisted in the creation of VR applications

British Aerospace (1987-1990 s)

- Virtual Cockpit (1987)
- Virtual Environment Configurable Training Aids (VECTA)
  - Fully immersive HMD
  - Inability to see hands disturbing
- Real and Virtual Environment Configurable Training Aids (RAVECTA)
  - Video see-through HMD
  - Blue screening (chroma keying) of outdoor environment

W Industries (1990 s)

Dr. Jon Waldron

Virtuality System

UK Entertainment market

Location-based entertainment

High volume use means dealing with human factors and safety issues

UNC Ceiling Tracker (1991-now)

Wide-area optical tracking system

- **Navigation by the stars**
  - **Infrared LEDs mounted in ceiling of room**
  - **CCD cameras mounted on HMD**

Rigid frame replaced by standard ceiling tiles

- **auto-calibration**

6 cameras shrunk into single small unit