



History of Virtual Reality

(based on a talk by Greg Welch)

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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.

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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**

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Sensorama (1956)

Morton Heilig

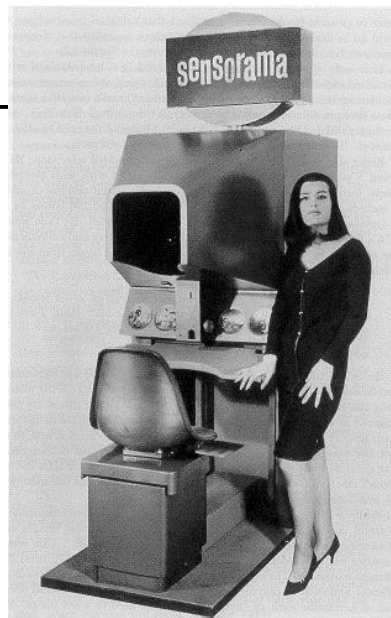
- **cinematographer/director of documentaries**

Motorcycle simulator - all senses

- **visual (city scenes)**
- **sound (engine, city sounds)**
- **vibration (engine)**
- **smell (exhaust, food)**

(not a big commercial success)

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*from Virtual
Reality
Technology,
Burdea & Coiffet*

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Heilig's HMD (1960)

“Simulation Mask”

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

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From Heilig's
1960 patent

from *Virtual Reality
Technology*, Burdea
& Coiffet

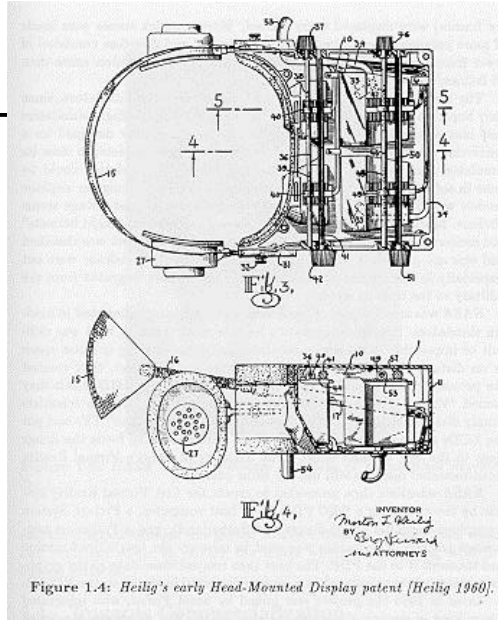


Figure 1.4: Heilig's early Head-Mounted Display patent [Heilig 1960].

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Philco Headsight TV Surveillance System (1961)

Comeau & Bryan

Components

- Remote closed-circuit TV
- HMD

Custom magnetic tracking

- measured head orientation

Head-sight camera linkage

Suggested HMD resolution matching

- match display to eye's resolution

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Ivan Sutherland and The Ultimate Display (1965)

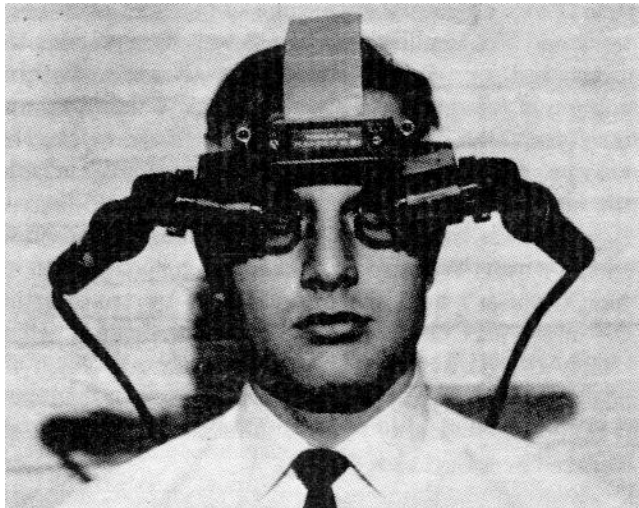


- Suggested HMD as a window into a virtual world
- Inspired many of the great achievers in interactive computer graphics

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Sutherland's HMD (1968)



**First HMD
driven by
computer
graphics**

**Wireframe
images
superimposed
on world**

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Sutherland's Tracking Systems

Tracked both position and orientation

Developed two separate systems

- Mechanical - heavier
- Ultrasonic - more subject to accumulated errors

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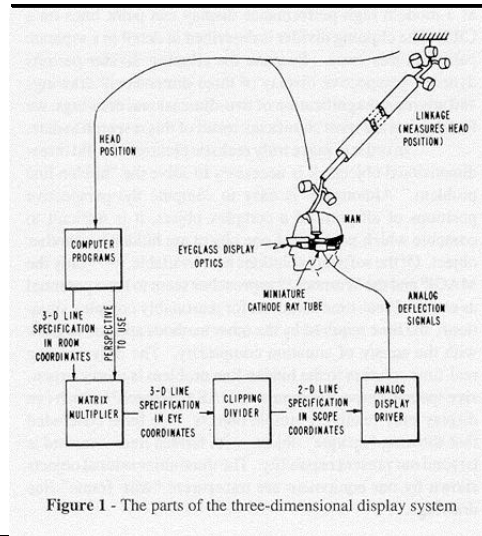


Figure 1 - The parts of the three-dimensional display system

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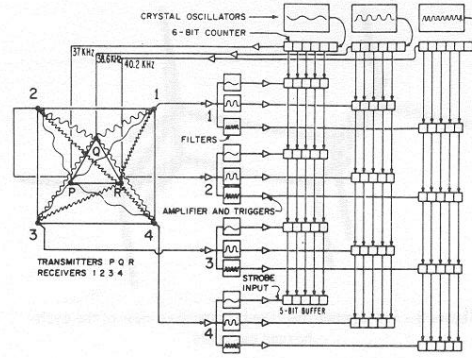
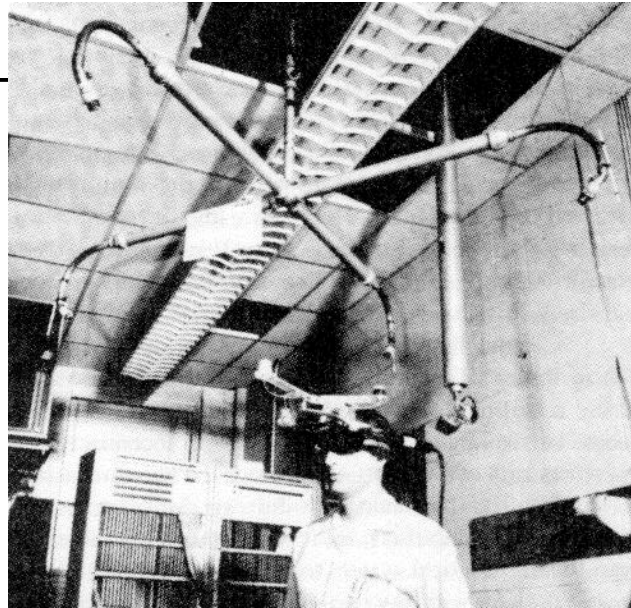


Figure 5 - The ultrasonic head position sensor logic

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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

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**Molecular docking with the
Argonne Remote
Manipulator (ARM)**



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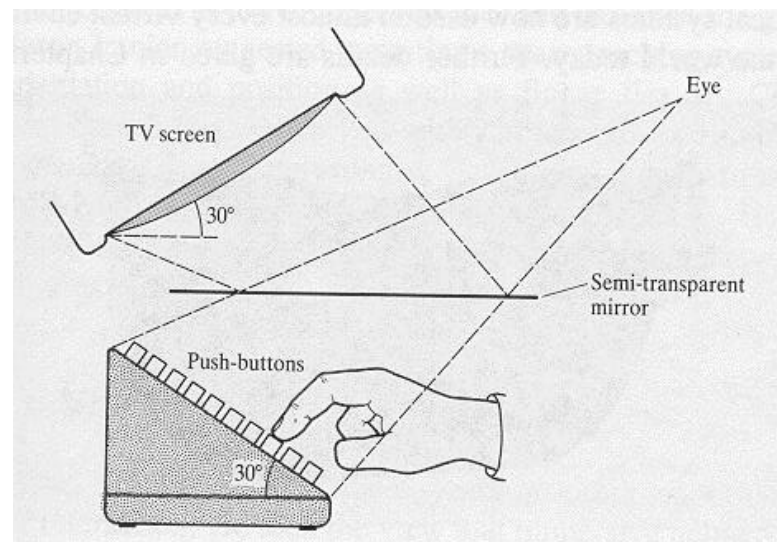
Knowlton's Virtual Pushbuttons (1975)

Partially-silvered mirror over keyboard

Programmable labels

Tactile feedback (real thing!)

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LEEP Optics (1975)

Large Expanse, Extra Perspective (LEEP)

Eric Howlett (Pop-Optix Labs)

Originally for 3D still photo viewing

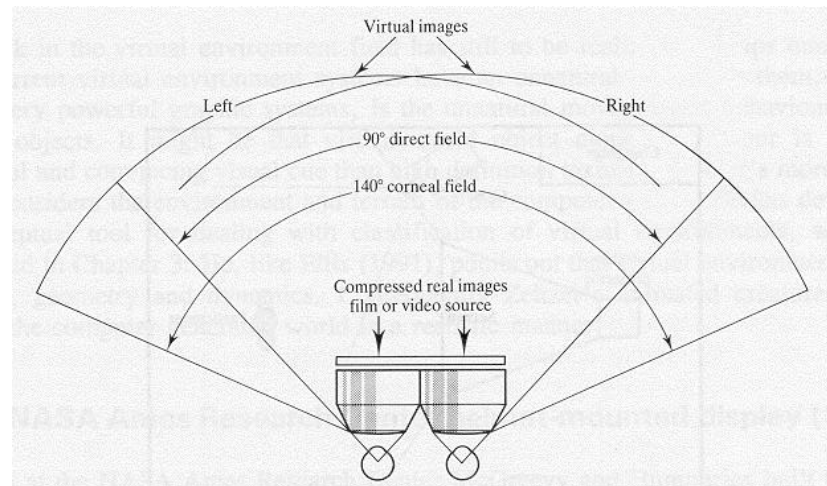
Lenses correct for camera distortion

- Display optics matched to camera optics
- Often uncorrected distortion for CG images

Reported to have great realism for still images

90° direct FOV, 140° corneal FOV

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The DataGlove (1981-1982)

Precursor, Sayre Glove (U of IL, ORD, 1977, National Endowment for the Arts 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

Featured in *Scientific American* in 1987

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Krueger's Videoplace (1983)

Graphics and gesture recognition

University of Connecticut, 1970s

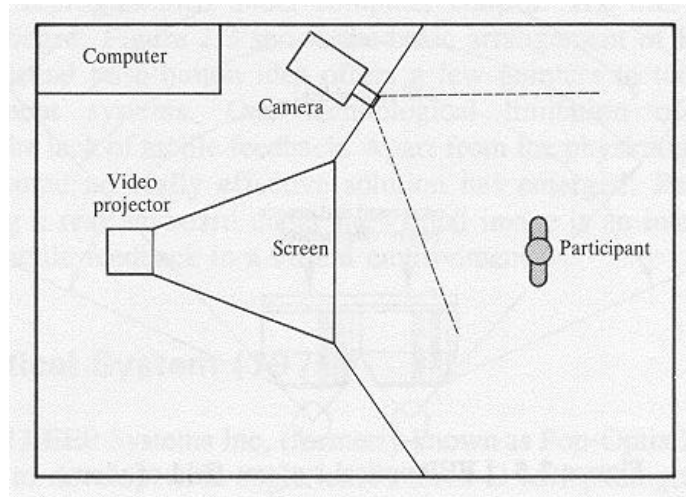
VideoDesk

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

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Videoplace



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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

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NASA Ames HMD (1981-1984)

McGreevy and Humphries

- **First *implemented* immersive HMDs**
- **LCD “Watchman” displays**

Led to VIEW, led by Scott Fisher

- **(next slide)**

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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**
- **BOOM-mounted CRT (Sterling Software)**
- **Remote Camera (Fake Space)**

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USAF Super Cockpit (1985)

Wright Patterson Air Force Base

Visual, auditory, tactile

Head, eye, speech, and hand input

**Designed to deal with problem of pilot
information overload**

- **Flight controls and tasks too complicated**

Research only

- **big system, not safe for ejecting**

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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

—“Reality Built for Two” - RB2

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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

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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**

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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

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