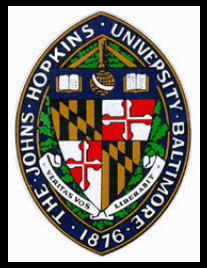
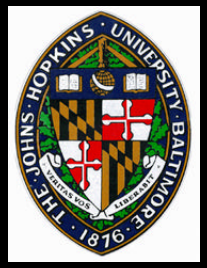


History of Virtual Reality

(based on a talk by Greg Welch)

Johns Hopkins Department of Computer Science
Course 600.460: Virtual Worlds, Spring 2000, Professor: Jonathan Cohen



Trends & Milestones

Displays (head-mounted)

- video only, CG overlay, CG only, mixed video
- CRT vs. LCD

Tracking

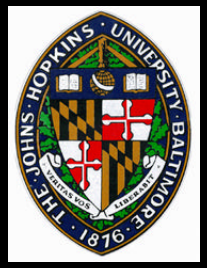
- magnetic, mechanical, ultrasonic, optical
- local vs. wide area

Haptics

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

Systems, Applications

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



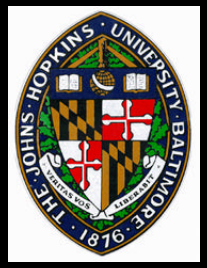
Visually Coupled Systems

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)

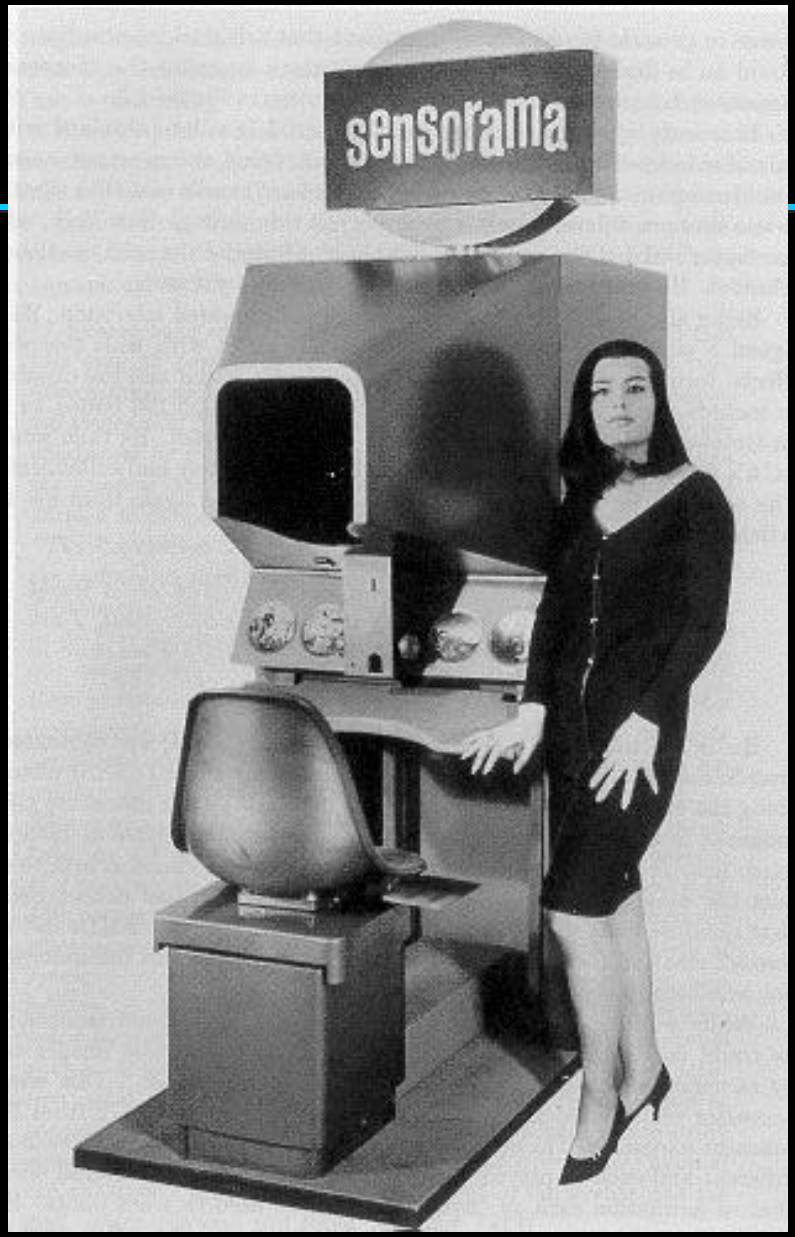
Morton Heilig

- cinematographer/director of documentaries

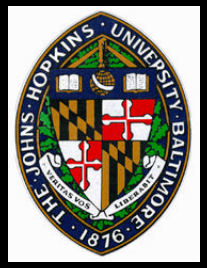
Motorcycle simulator - all senses

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

(not a big commercial success)



from 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

from *Virtual Reality Technology*, Burdea & Coiffet

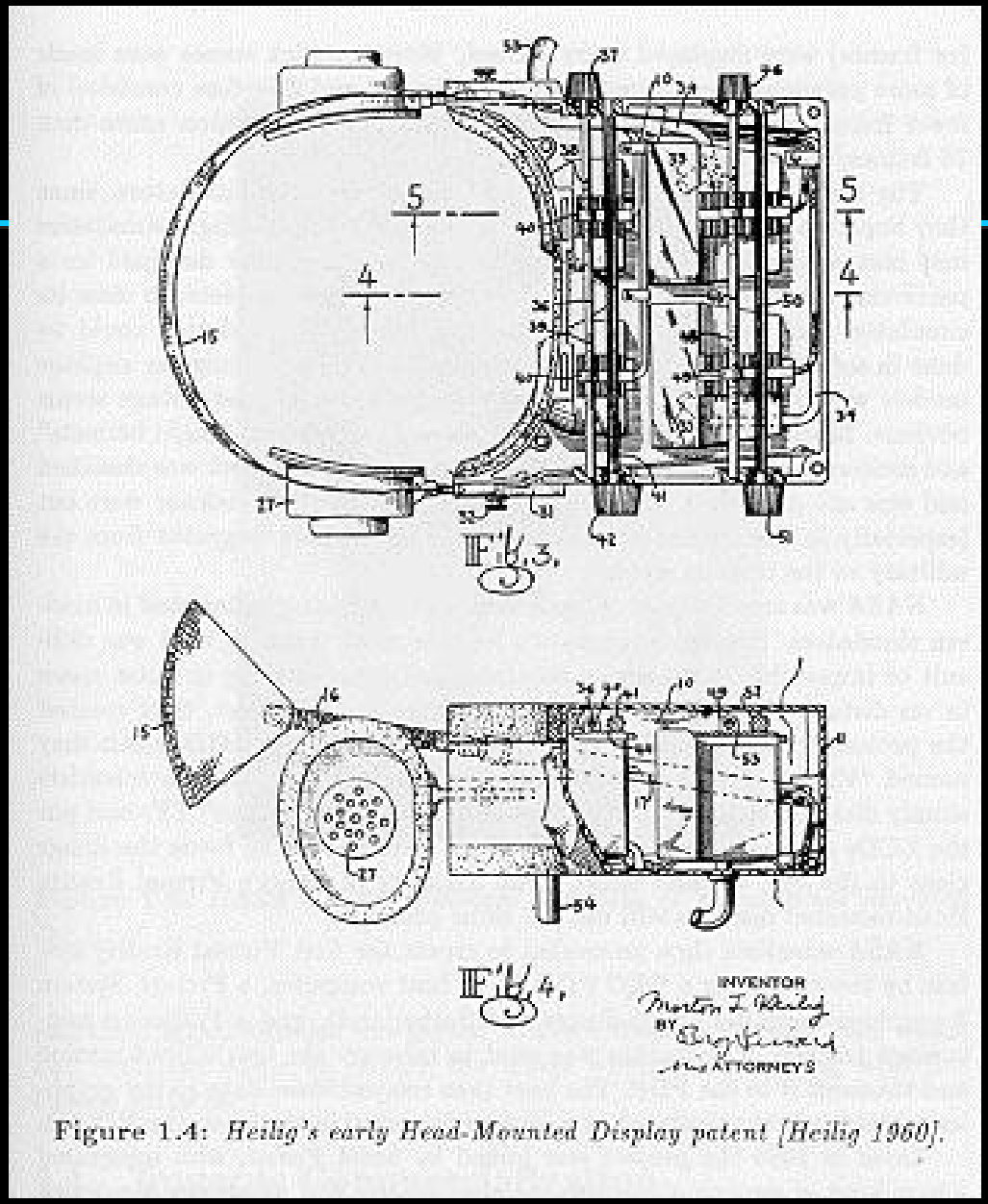
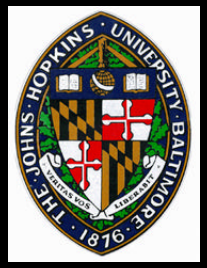


Figure 1.4: *Heilig's early Head-Mounted Display patent [Heilig 1960].*



Philco Headsight TV Surveillance System (1961)

Comeau & Bryan

Components

- **Remote closed-circuit TV**
- **HMD**

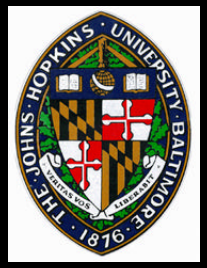
Custom magnetic tracking

- **measured head orientation**

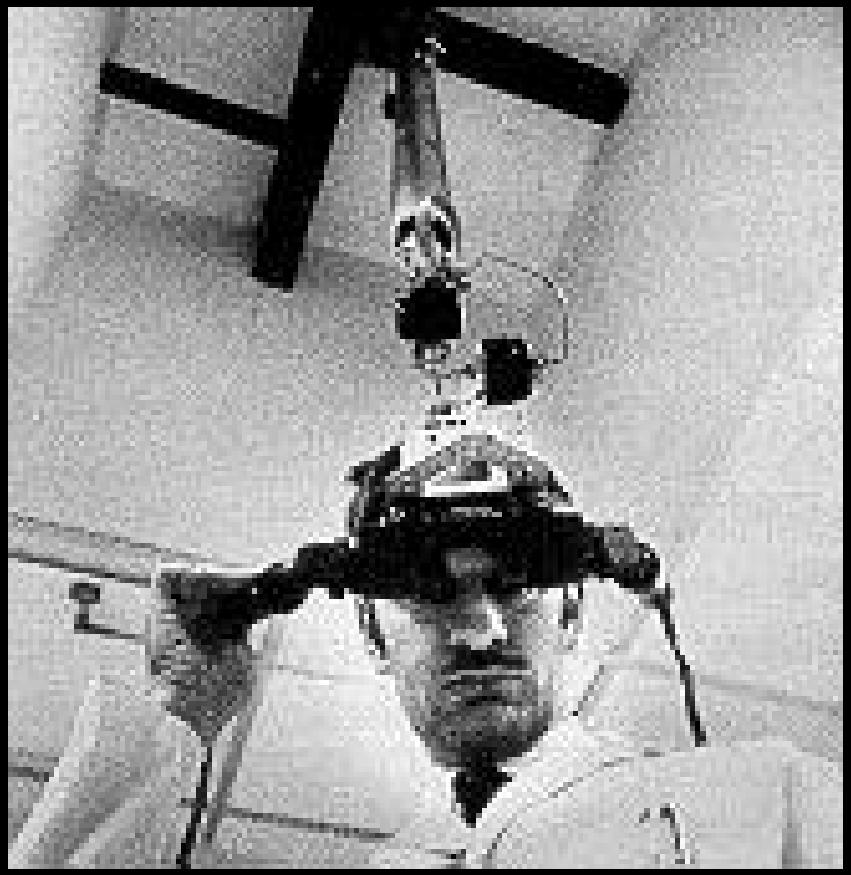
Head-sight camera linkage

Suggested HMD resolution matching

- **match display to eye's resolution**

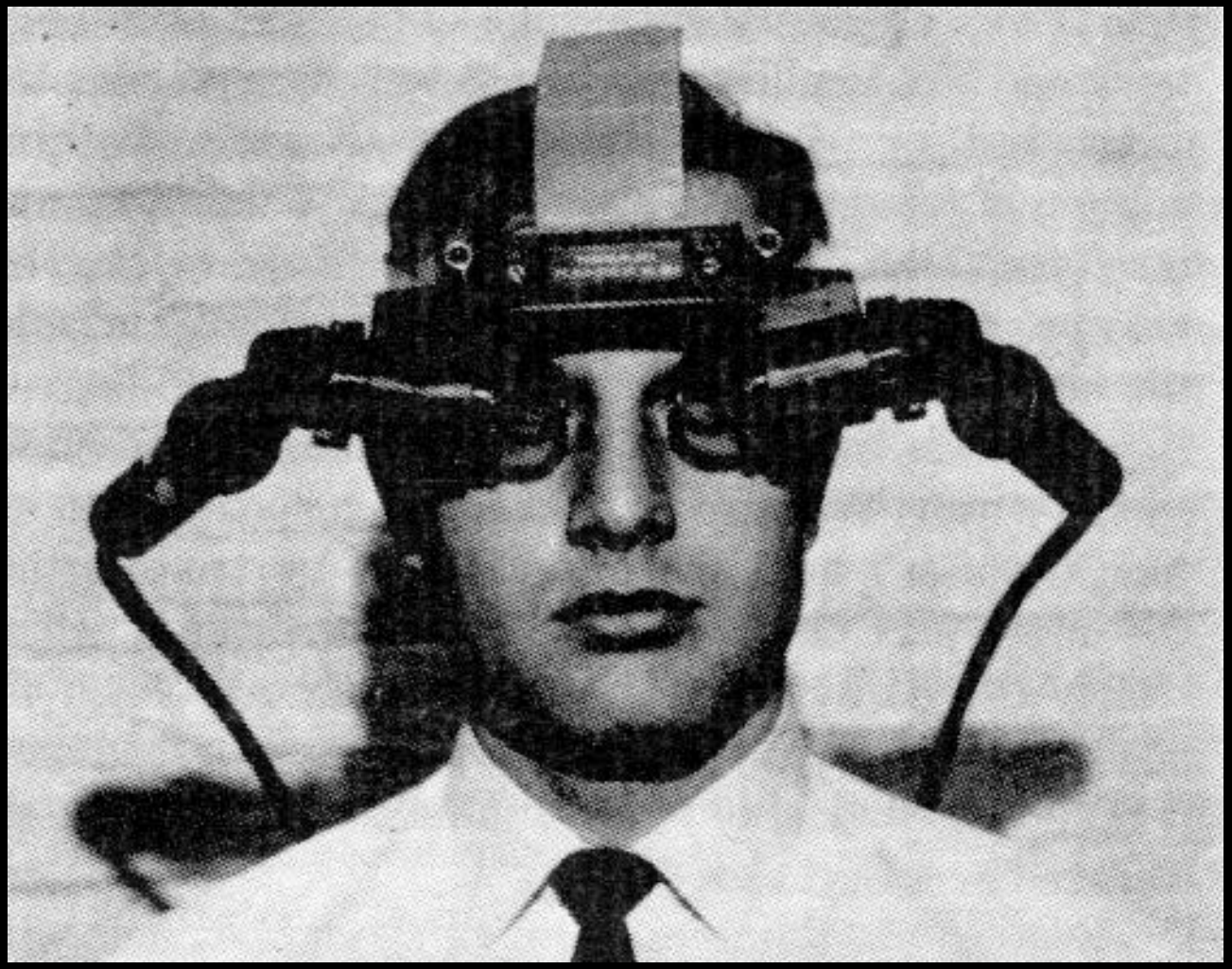


Ivan Sutherland and The Ultimate Display (1965)



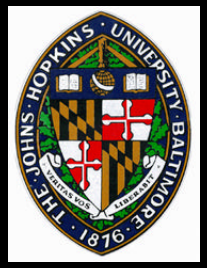
- Suggested HMD as a a window into a virtual world
- Inspired many of the great achievers in interactive computer graphics

Sutherland's HMD (1968)



First HMD driven by computer graphics

Wireframe images superimposed on world



Sutherland's Tracking Systems

Tracked both position and orientation

Developed two separate systems

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

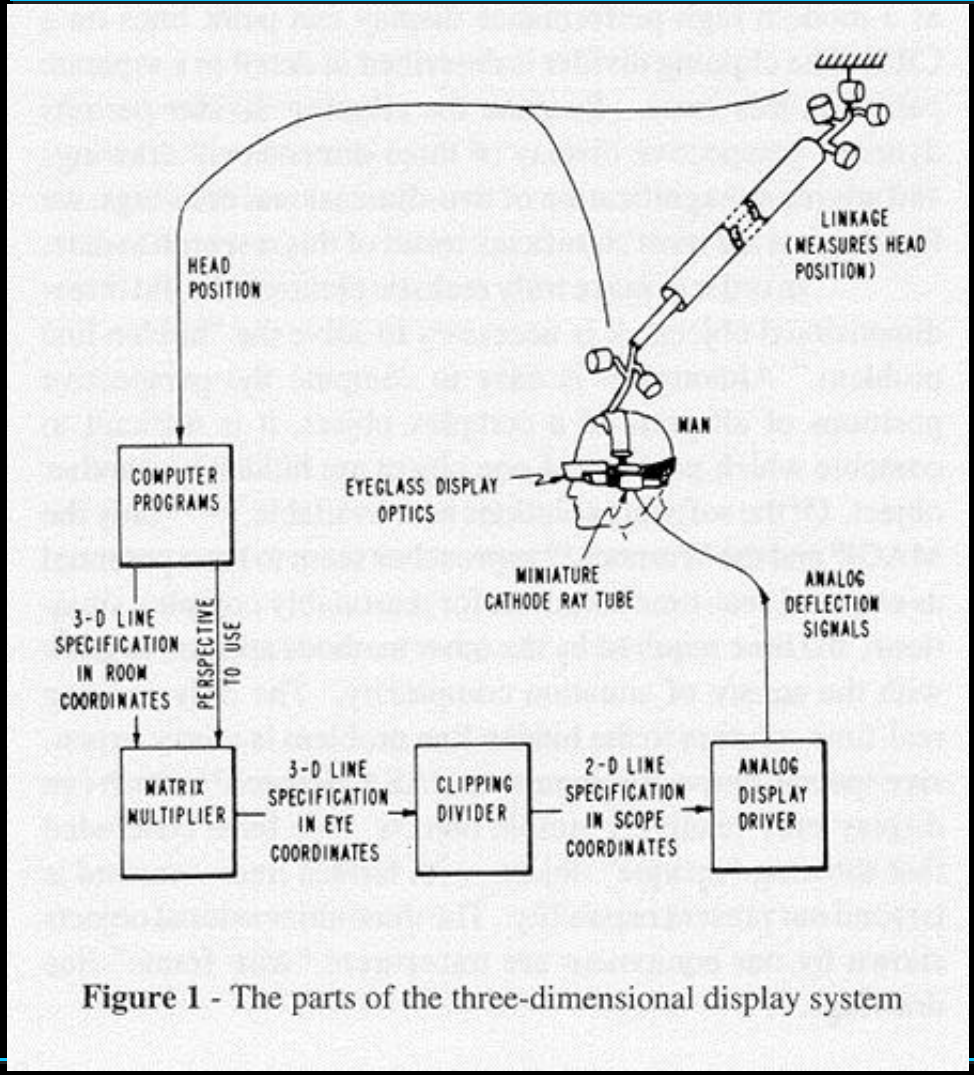


Figure 1 - The parts of the three-dimensional display system

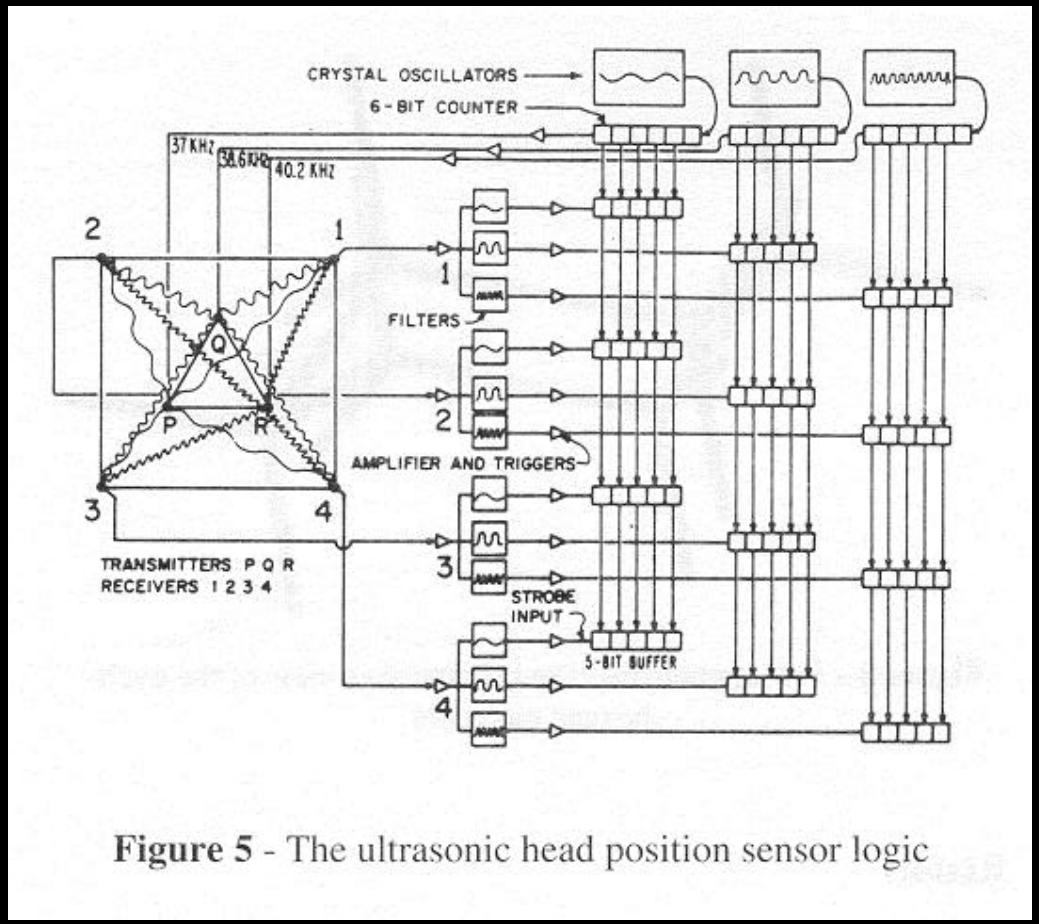
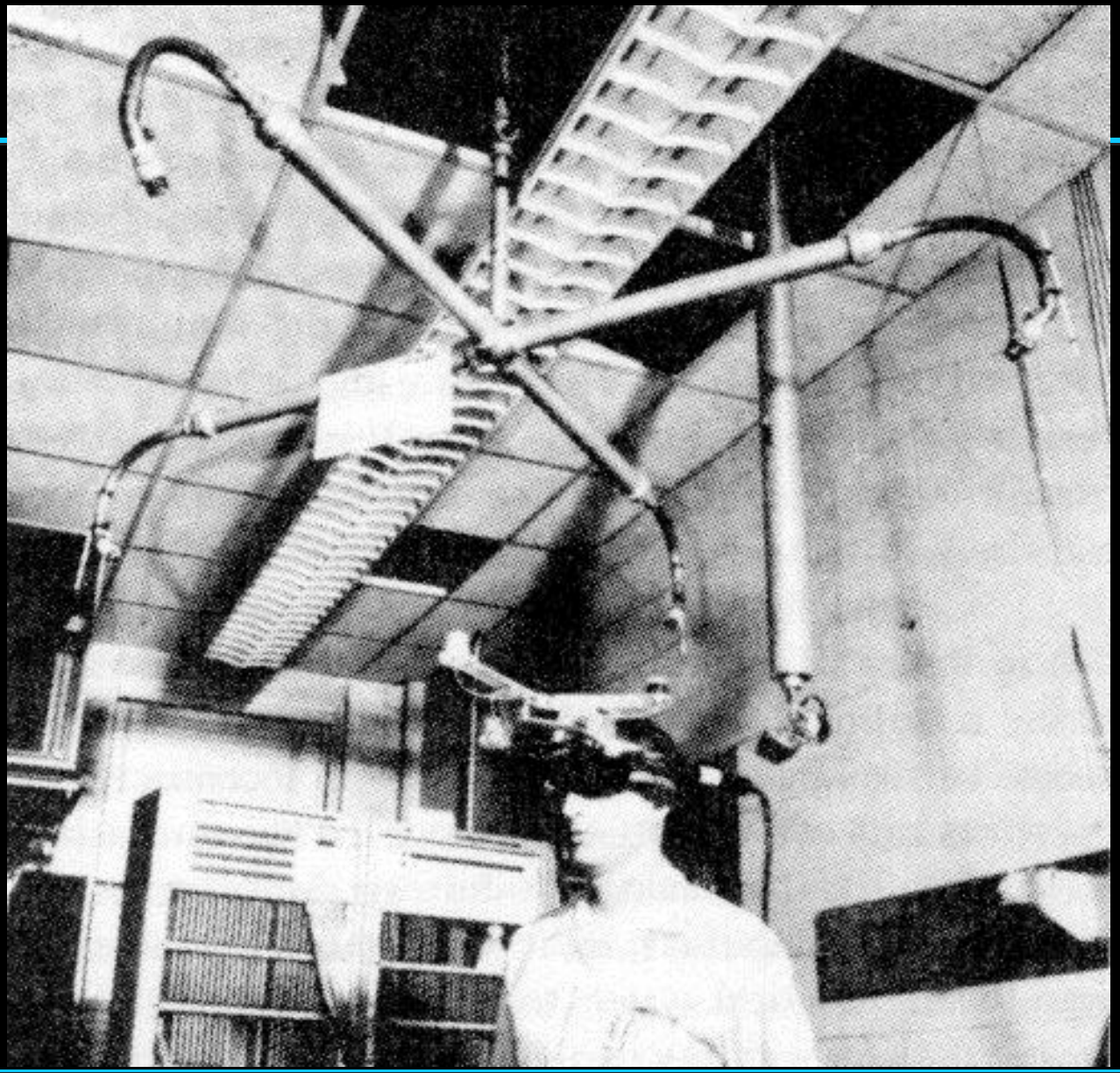
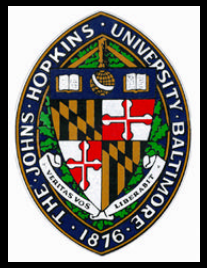


Figure 5 - The ultrasonic head position sensor logic





UNC Haptic Systems (1967-1980's)

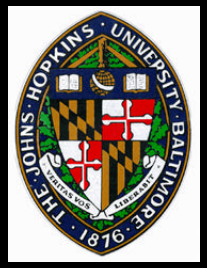
Haptic/kinesthetic display system

6D force fields of molecular structures

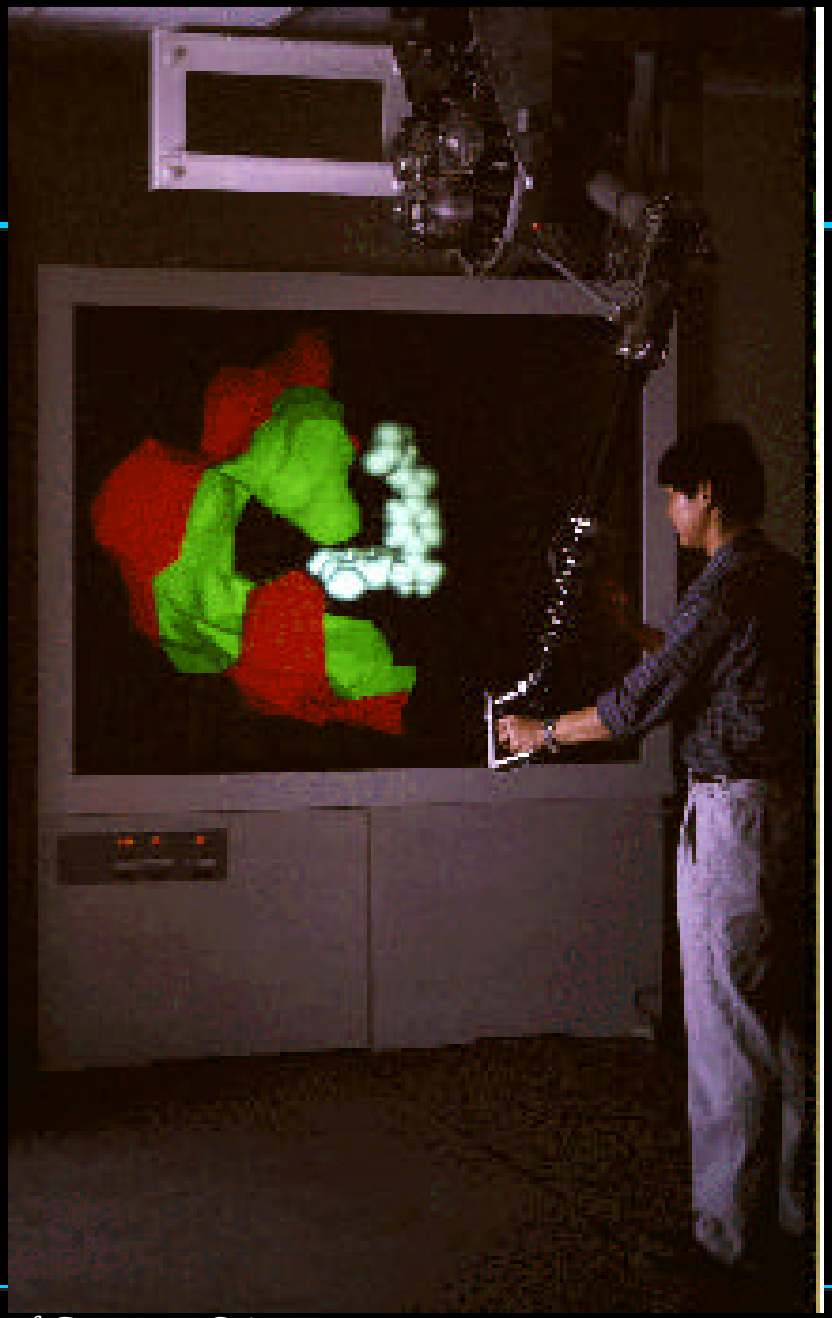
Progression

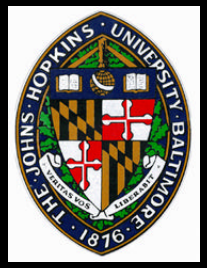
- **Grope I, simple fields, particle feedback**
- **Grope II, 1978, children's building blocks**
- **Grope III, late 80's, Argonne Remote Manipulator (ARM)**

Sarcos arm



Molecular docking with the Argonne Remote Manipulator (ARM)



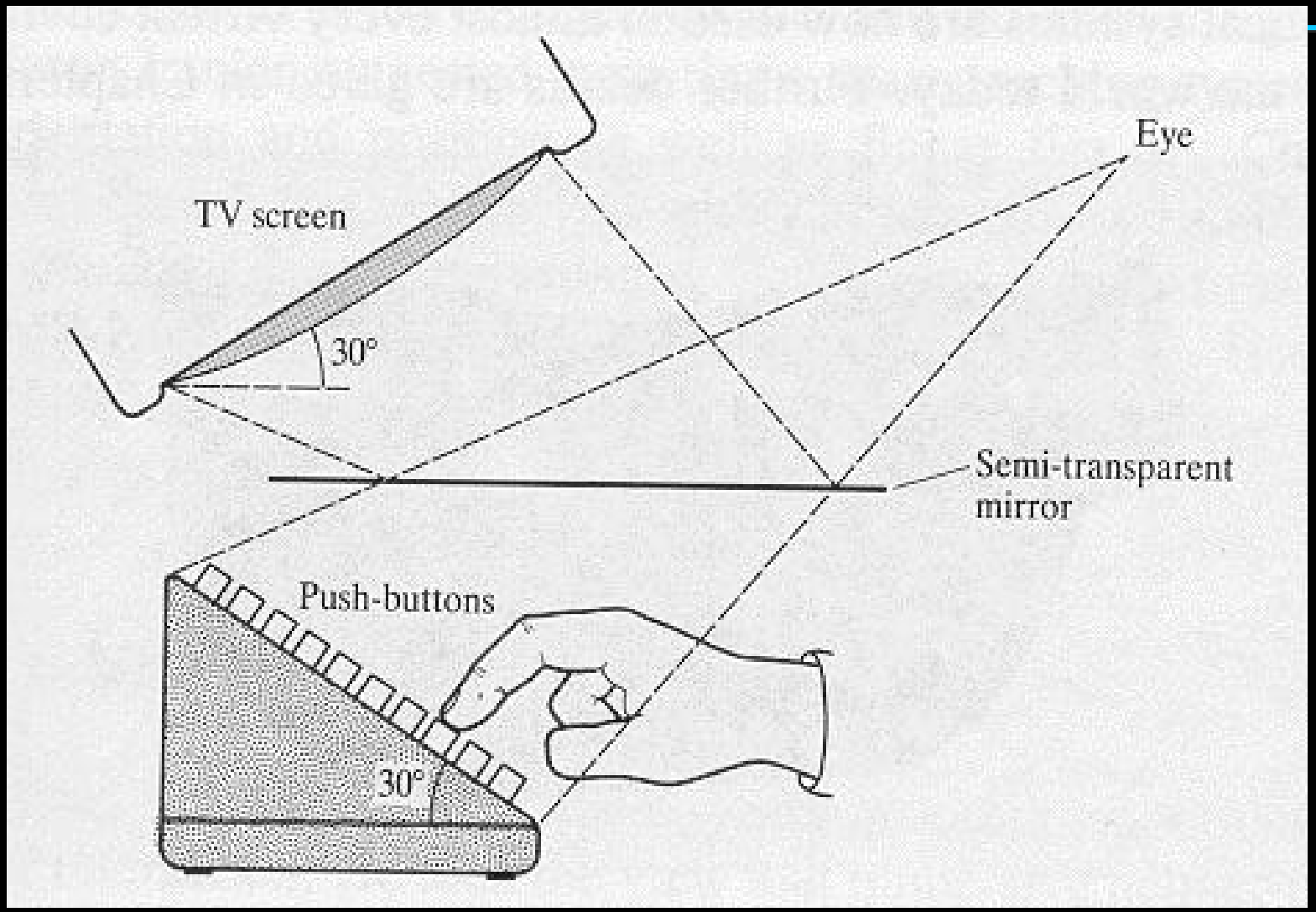


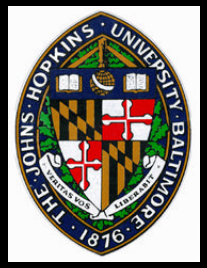
Knowlton's Virtual Pushbuttons (1975)

Partially-silvered mirror over keyboard

Programmable labels

Tactile feedback (real thing!)


Eye
TV screen
30°
Semi-transparent
mirror
Push-buttons
30°



LEEP Optics (1975)

Large Expanse, Extra Perspective (LEEP)

Eric Howlett (Pop-Optix Labs)

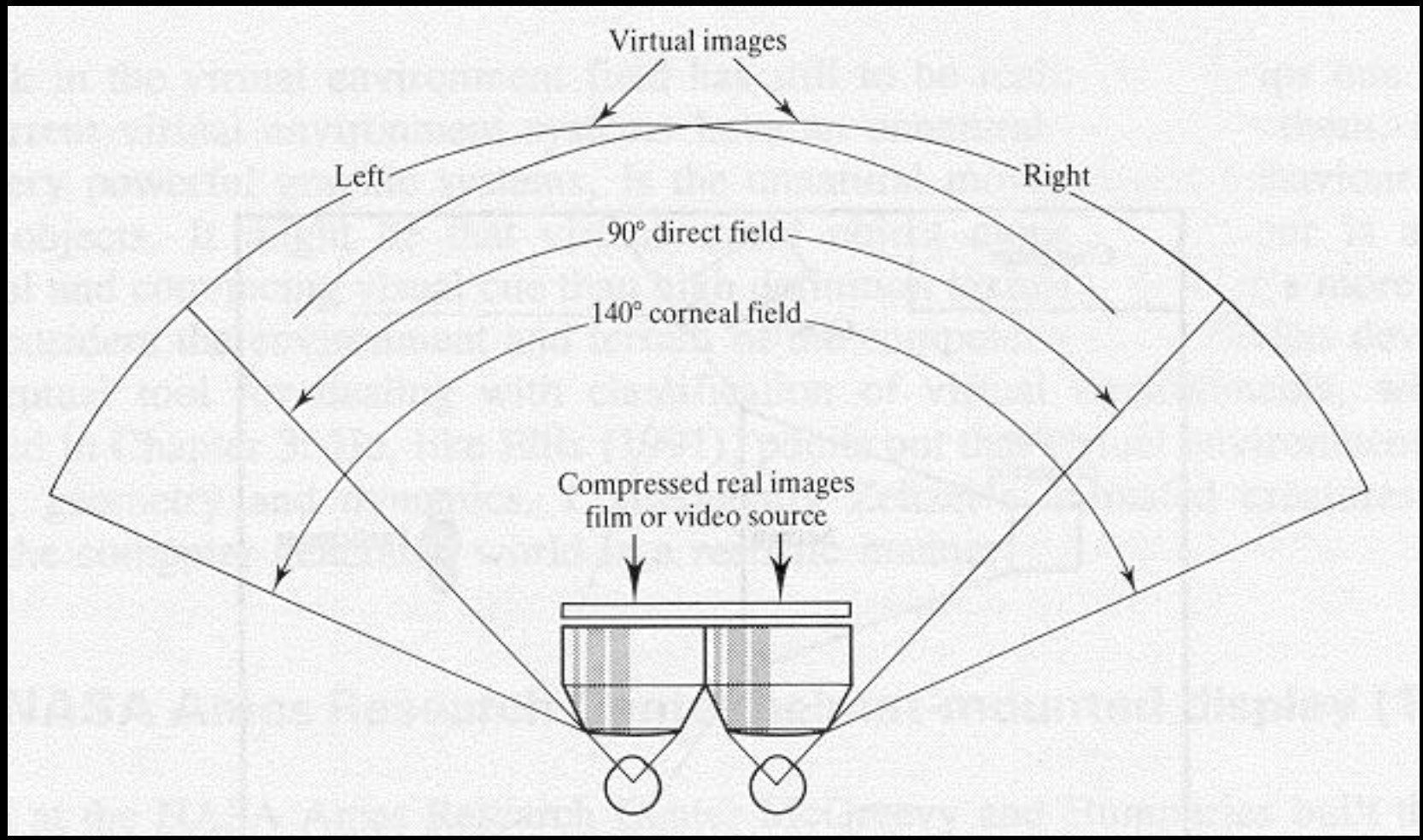
Originally for 3D still photo viewing

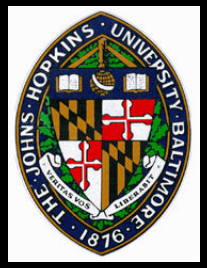
Lenses correct for camera distortion

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

Reported to have great realism for still images

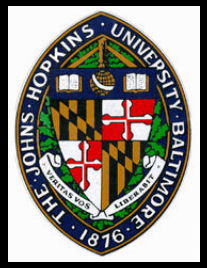
90º direct FOV, 140º corneal FOV


Virtual images
Left
Right
90° direct field
140° corneal field
Compressed real images
film or video source



The DataGlove (1981-1982)

- Precurser, 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



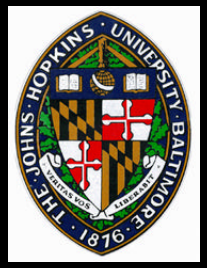
Krueger's Videoplace (1983)

Graphics and gesture recognition

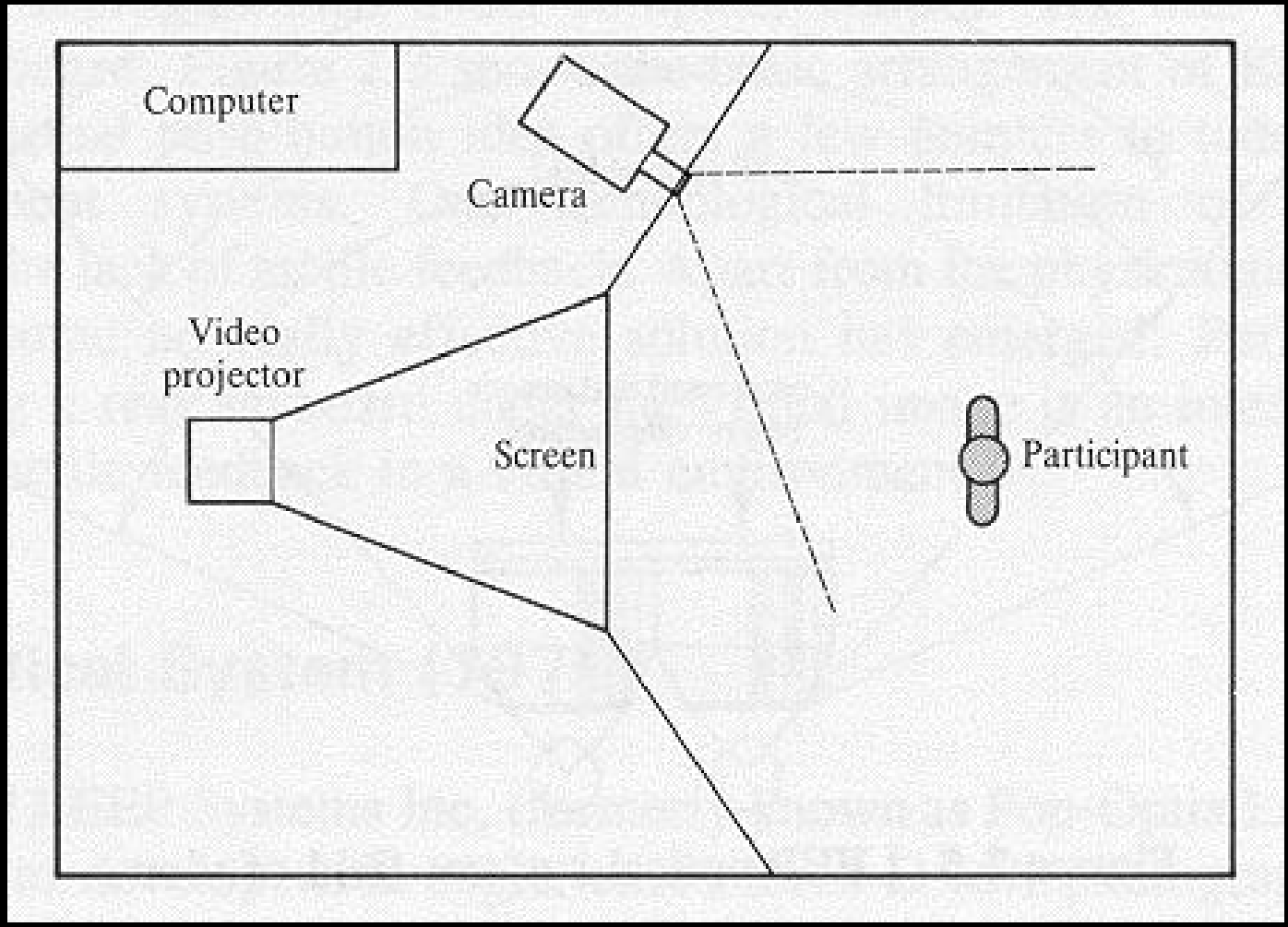
University of Connecticut, 1970s

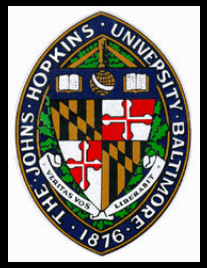
VideoDesk

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



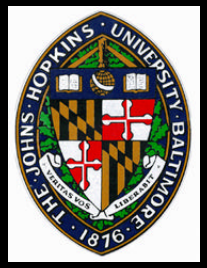
Videoplace





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



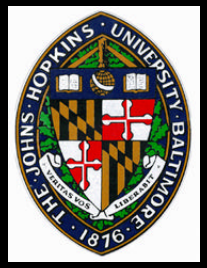
NASA Ames HMD (1981-1984)

McGreevy and Humphries

- **First *implemented* immersive HMDs**
- **LCD "Watchman" displays**

Led to VIEW, led by Scott Fisher

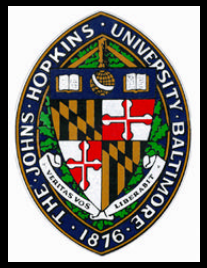
- **(next slide)**



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



USAF Super Cockpit (1985)

Wright Patterson Air Force Base

Visual, auditory, tactile

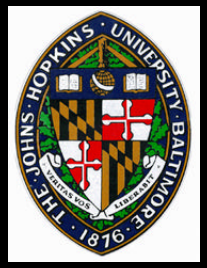
Head, eye, speech, and hand input

Designed to deal with problem of pilot information overload

- **Flight controls and tasks too complicated**

Research only

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



VPL Research (1985)

Jaron Lanier, Jean-Jacques Grimaud

- **Lanier came up with term “virtual reality”**

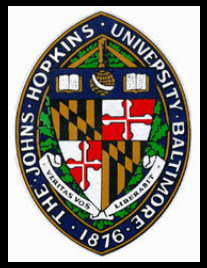
Funding from NASA and Thomson-CSF

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**



British Aerospace (1987-1990's)

Virtual Cockpit (1987)

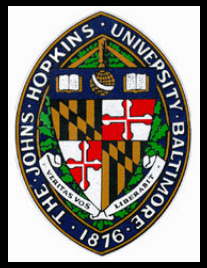
Virtual Environment Configurable Training Aids (VECTA)

- 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


DANGER



W Industries (1990's)

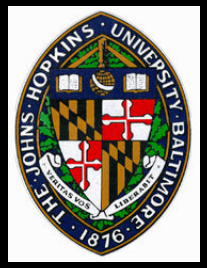
Dr. Jon Waldron

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