



CS-525V: Building Effective Virtual Worlds

Introduction

Robert W. Lindeman

Worcester Polytechnic Institute
Department of Computer Science
gogo@wpi.edu

Course Overview

□ Goals

- Separate the hype from the potential
- Understand the main problems/sub-fields
- Build something cool!

Assignments

- Two Main Assignments
 - Survey paper
 - Programming assignment
- These don't need to be on the same topic

What Makes a Good Survey?

- What do you think?
- Not a laundry list!
- A classification scheme
 - Get up to speed on the main issues
 - See what others have done
 - Map out a design space
 - Dense/sparse areas
 - Find a potential thesis topic :-)

Programming Assignment

- ❑ Choose a target application area
- ❑ Design the application
- ❑ Put together a basic skeleton
- ❑ Populate the world with things
- ❑ Connect I/O devices
- ❑ Design the interaction
- ❑ Assess the result

Programming Assignment (cont.)

- Can be done in teams
 - Clearly define what each member will be responsible for
- Can use any software/language you like
 - You must program the experience though, so don't use tools that are too high-level
- Samples
 - OpenGL, DirectX, Java3D, OpenSceneGraph, OpenSG, FreeVR, others
 - Game engine code
- HIVE resources
 - We have many devices for you to use.
 - Field trip next week

What is Virtual Reality?

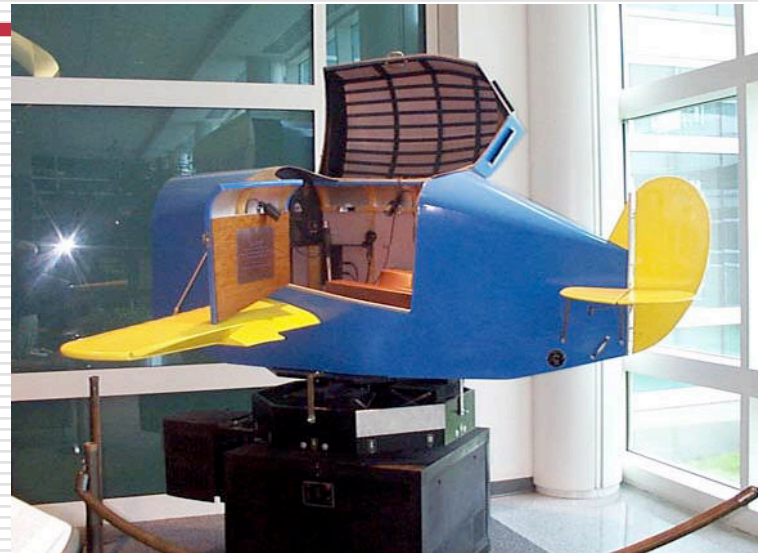
□ You tell me!

Virtual Reality Systems

- 1929 – Link Flight Simulator
- 1946 – First computer (ENIAC)
- 1956 – Sensorama
- 1960 – Heileg's HMD
- 1965-68 – The Ultimate Display
- 1972 – Pong
- 1973 – Evans & Sutherland Computer Corp.
- 1976 – Videoplace
- 1977 – Apple, Commodore, and Radio Shack PCs
- 1979 – First Data Glove [Sayre] (powerglove -89)
- 1981 – SGI founded
- 1985 – NASA AMES
- 1986-89 – Super Cockpit Program
- 1990s – Boom Displays
- 1992 – CAVE (at SIGGRAPH)
- 1995 – Workbench
- 1998 – Walking Experiment

Link Flight Simulator

- ❑ 1929 - Edward Link develops a *mechanical flight simulator*
- ❑ Train in a synthetic environment
- ❑ Used mechanical linkages
- ❑ Instrument (blind) flying
- ❑ http://www.wpafb.af.mil/museum/early_years/ey19a.htm



Instrument panel of the Link on display
The Link trainer was donated by Simulation Products Division, The Singer Co., Binghamton, NY.

Sensorama

Morton Heilig, 1956

Motorcycle simulator - all senses

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

Extend the notion of a 'movie'



Heilig's HMD (1960)

Simulation Mask from Heilig's 1960 patent

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

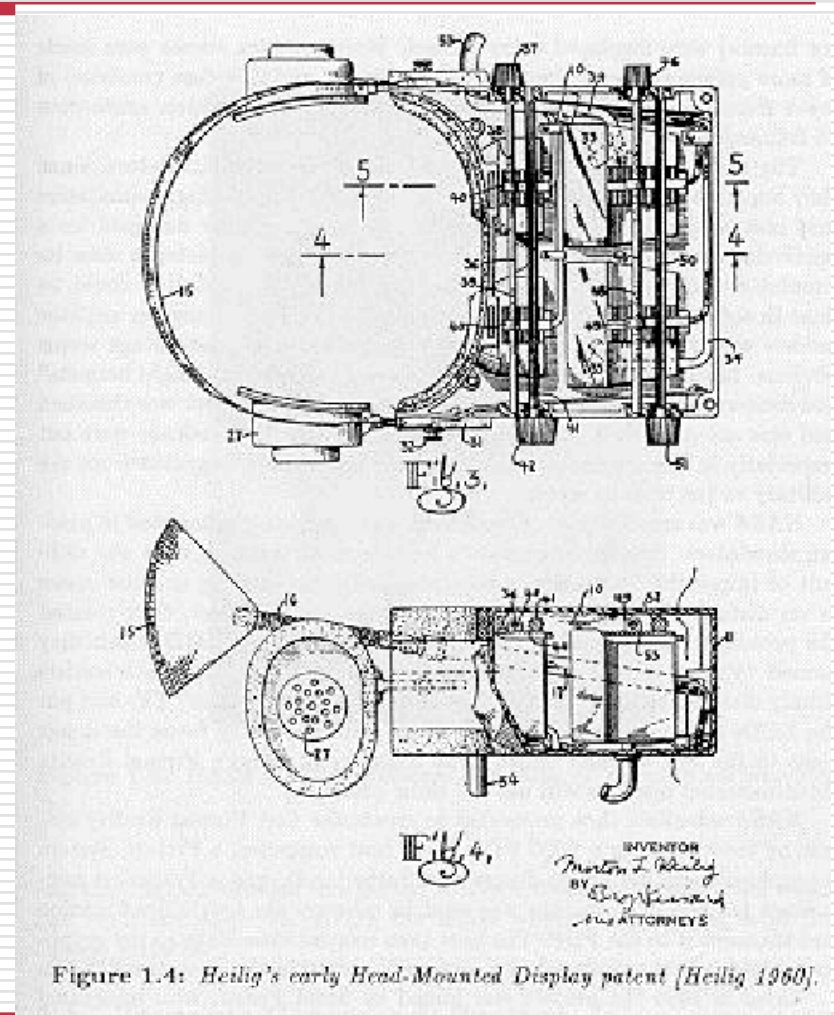


Figure 1.4: Heilig's early Head-Mounted Display patent [Heilig 1960].

Ivan Sutherland

□ The Ultimate Display (FIPS 1965)

- Data Visualization: "A display connected to a digital computer...is a looking glass into a mathematical wonderland."
- Body Tracking: "The computer can easily sense the positions of almost any of our body muscles."

Ultimate Display (cont.)

- Virtual Environments that mimic real environments: "A chair display in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal."
- VEs that go beyond reality: "There is no reason why the objects displayed by a computer have to follow ordinary rules of physical reality with which we are familiar."

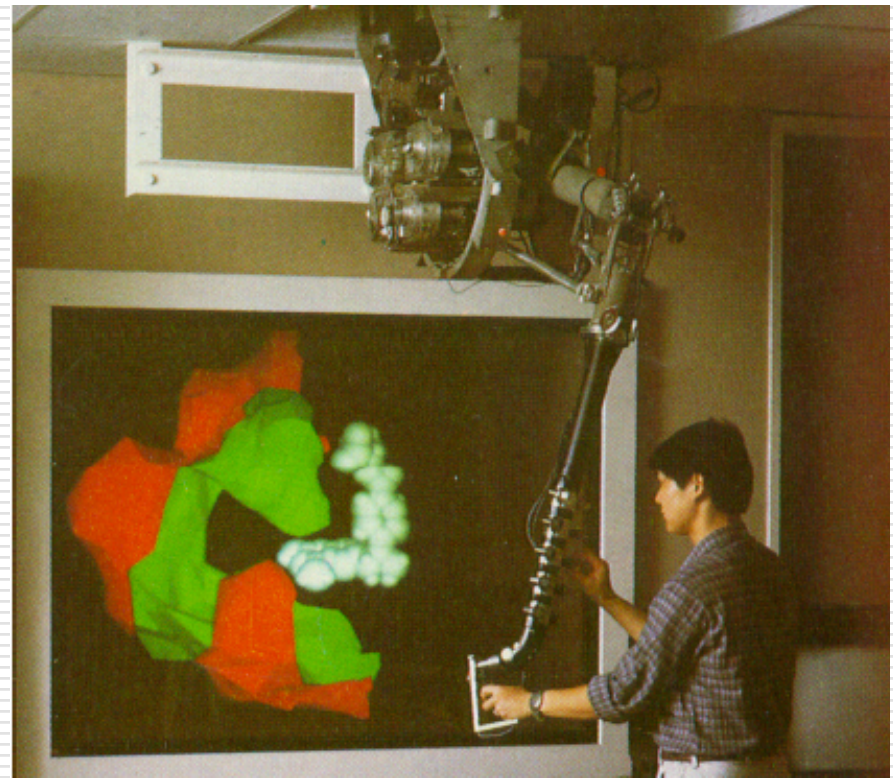
First HMD-Based VR



1965 - The Ultimate Display
paper by Sutherland
1968 - Ian Sutherland's HMD

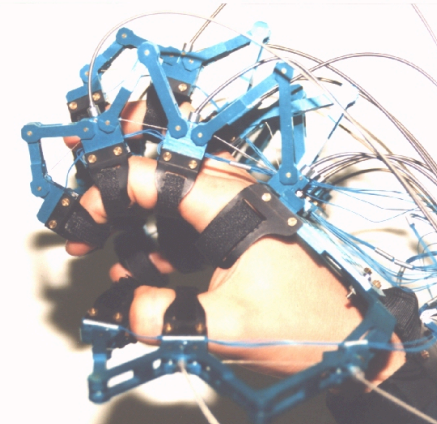
Molecular Docking Simulator

- ❑ Incorporated force feedback
- ❑ Visualize an abstract simulation



Data Gloves

- ❑ Light, electrical or metal detectors compute “bend”
- ❑ Electrical sensors detect pinches.
- ❑ Force feedback mechanical linkages

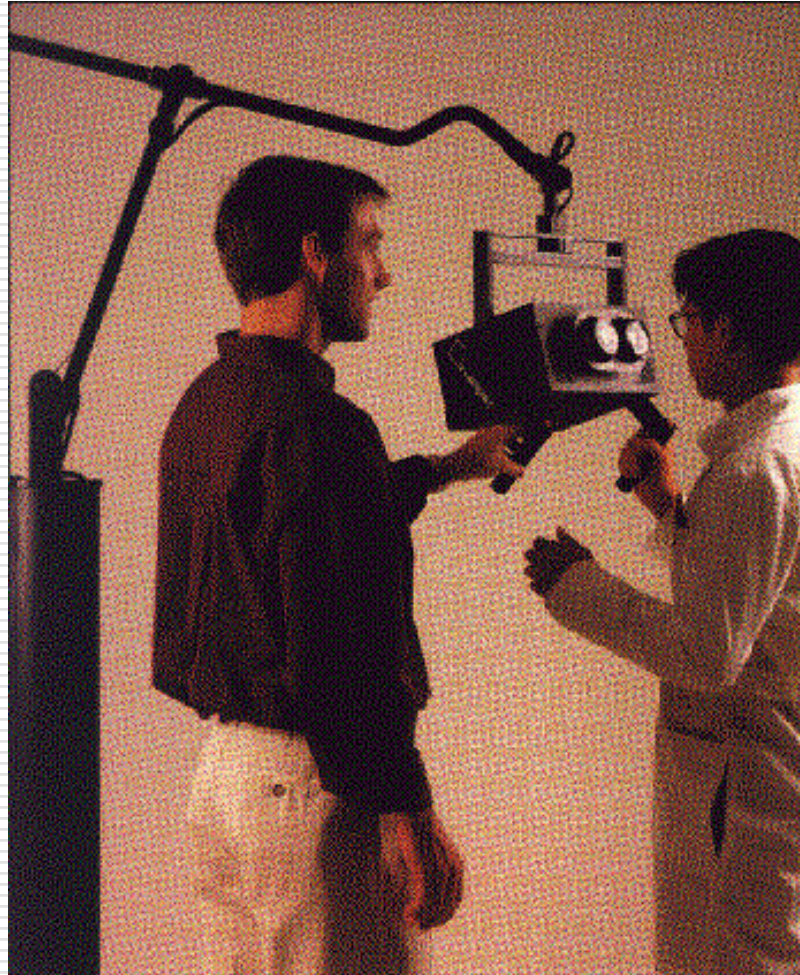


1985 - NASA Ames HMD

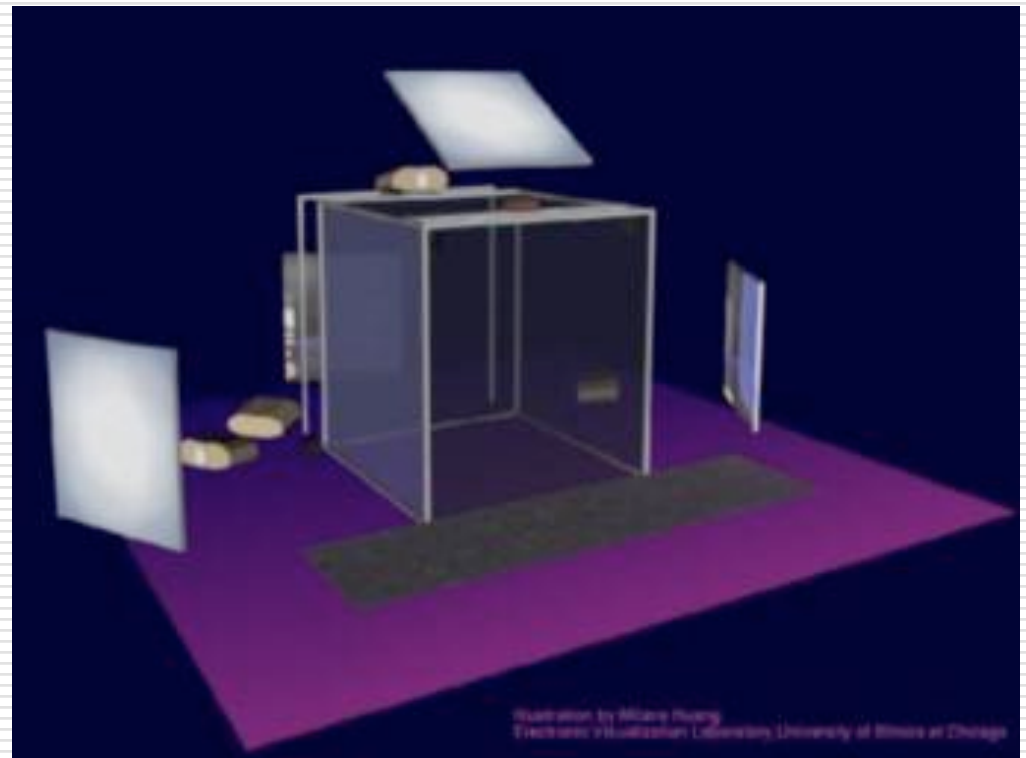
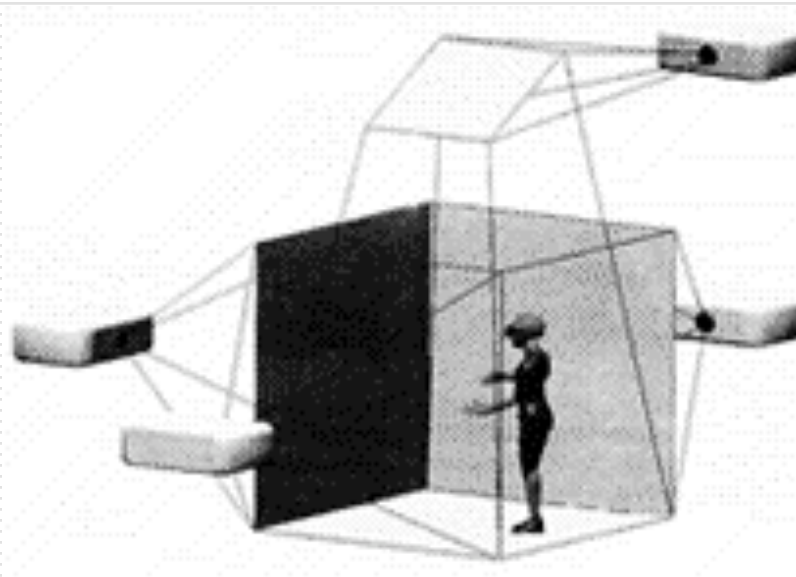
- ❑ McGreevy and and Humphries
 - Wearable immersive HMDs
 - LCD "Watchman" displays
 - LEEP Optics
- ❑ Led to VIVID, led by Scott Fisher



FakeSpace Boom Display: Early 1990s

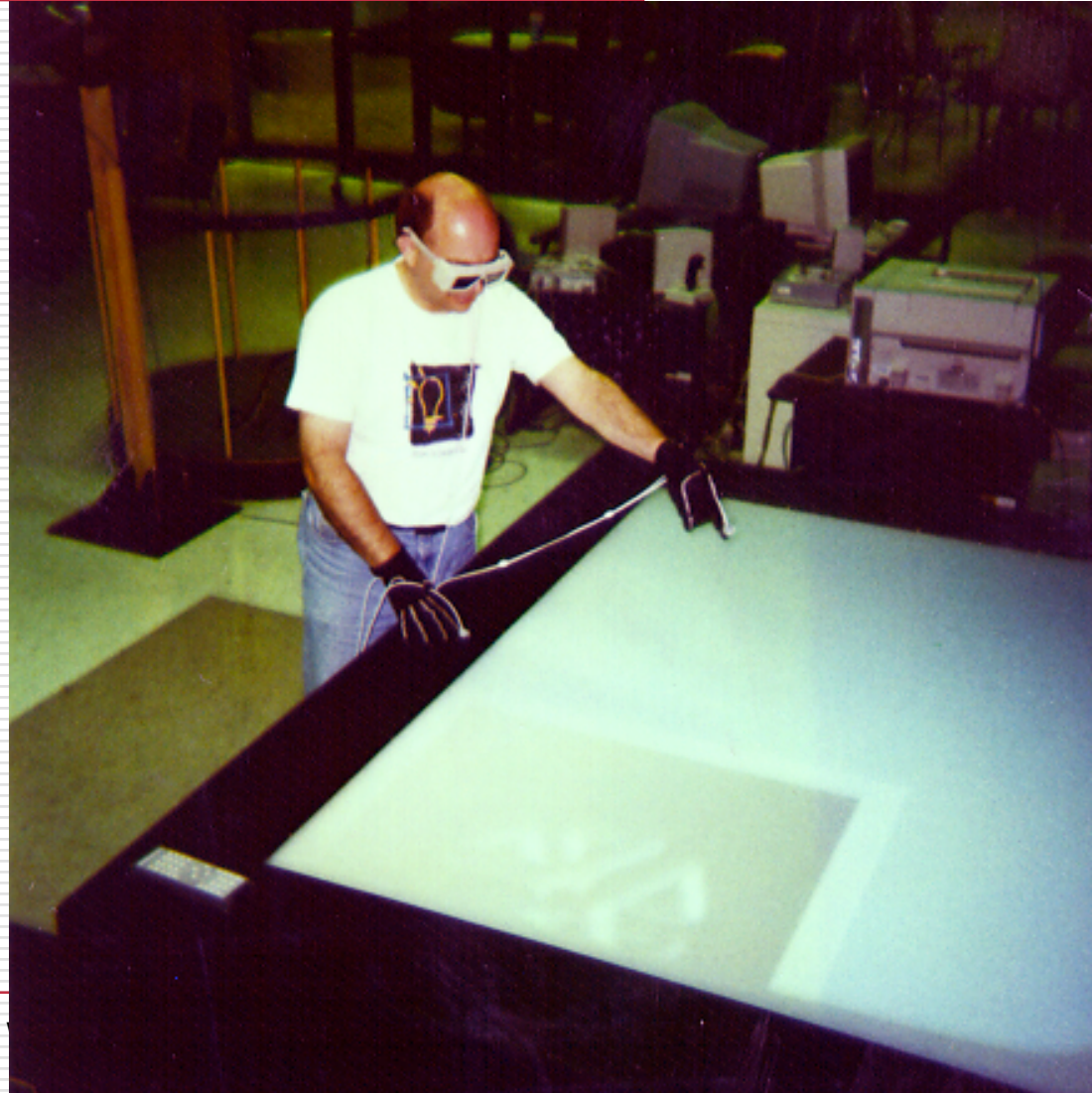


CAVE - 1992



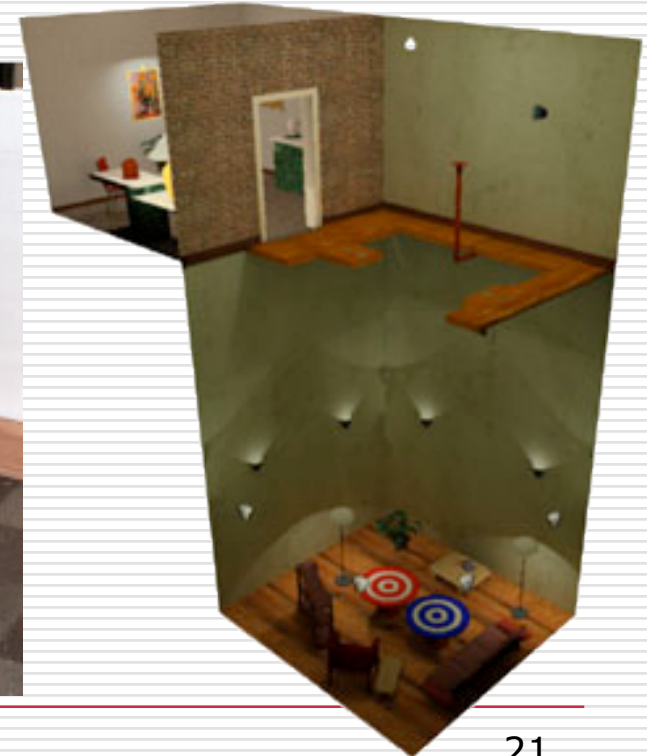
Virtual Workbench-1995

(Responsive Workbench, Immersidesk, etc.)



Current Best VE

- ❑ UNC Pit Experiment
- ❑ Fear of Heights a Strong Response
- ❑ Thousands of visitors
- ❑ Compelling Experience
 - Haptics
 - Low Latency
 - High Visual Quality

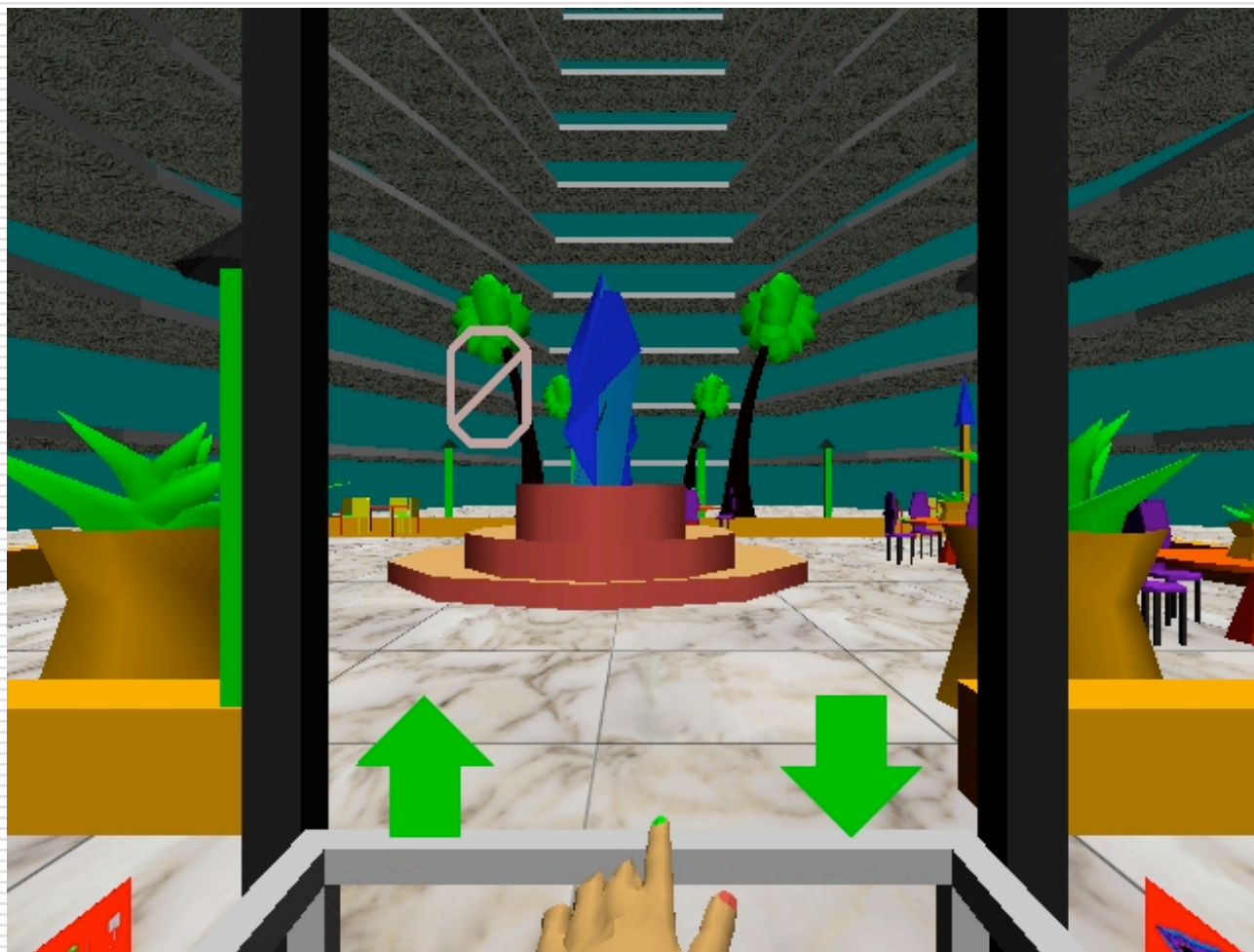


VPL Founded - 1985

- First VR Company
- VPL Research by Jaron Lanier and Thomas Zimmerman
 - Data Glove
 - Term: Virtual Reality



1995 - Effectiveness of computer-generated (VR) graded exposure
in the treatment of acrophobia in *American Journal of Psychiatry*



Major Reinvigoration: Hardware Evolution

- High expense
- PC performance surpasses Graphics supercomputers
 - SGI RealityEngine (300k tris – 1993)
 - XBOX (150 mil tri/sec - 2001)
 - XBOX360 (500 mil tri/sec - 2005)
 - Wii input device
- Large Volume Displays
- VR Estimated \$3.4 billion industry in 2005