CS-525H: Immersive HCI

Introduction

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Course Goals

- Learn about designing, building, and evaluating immersive interfaces
- Look at how humans function
- Look at application areas
- Look at usage environments
- Understand the main problems/sub-fields
- Build something cool!

Assignments

- Three Programming Assignments
  - Each uses different technologies
- Paper summaries
  - You will write short summaries for several papers
- Final Project
  - Done in groups of two
  - Go deeper into one application/technology
  - Evaluate your system with a user study

Final project

- Choose
  - User population
  - Application
  - Usage environment (e.g., mobile)
- Choose I/O devices/techniques
- Design the application
- Design the interface & interaction
- Build the system
- 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, Android, iphone
  - Game engine code
- HIVE resources
  - We have many devices for you to use.
  - Field trip later in the semester

What is Virtual Reality?

- You tell me!

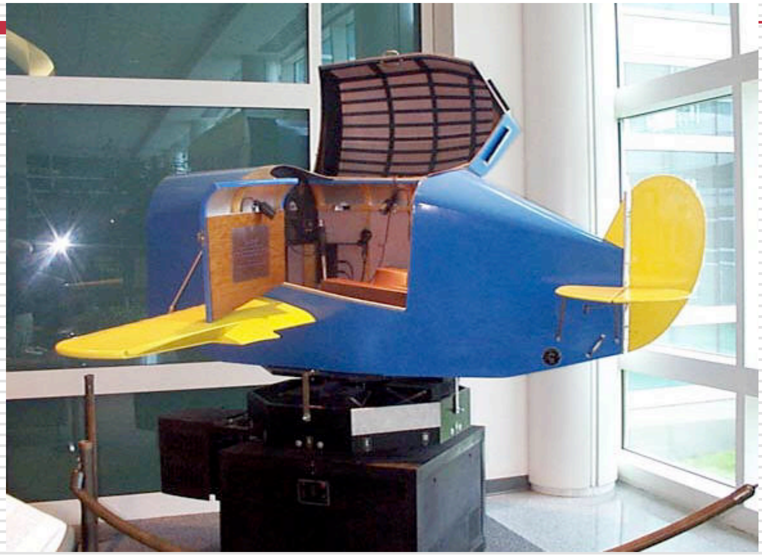
Virtual Reality Systems

- 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

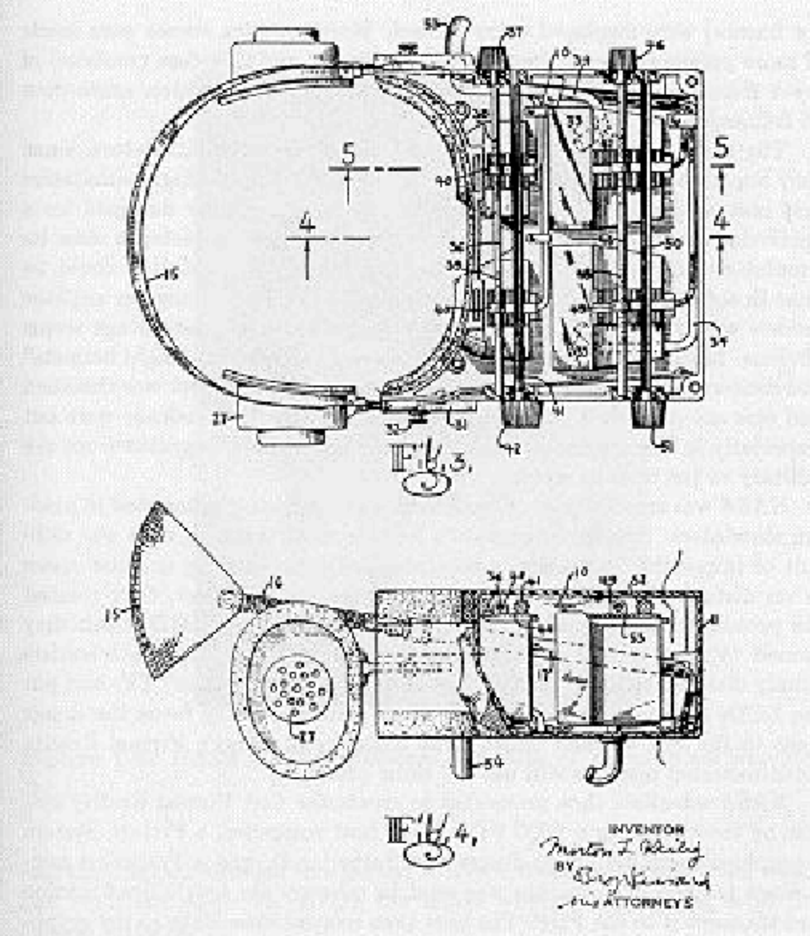


Figure 1.4: *Heilig's early Head-Mounted Display patent [Heilig 1960].*

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.)

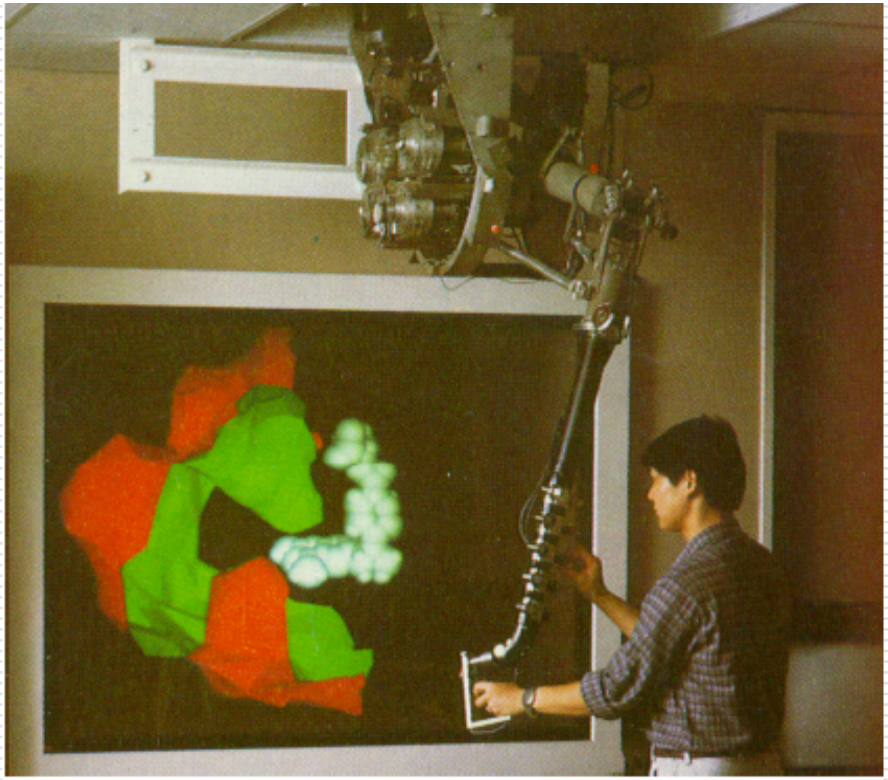
- Virtual Environments that mimic real environments: "A chair display in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal."
- VEs that go beyond reality: "There is no reason why the objects displayed 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

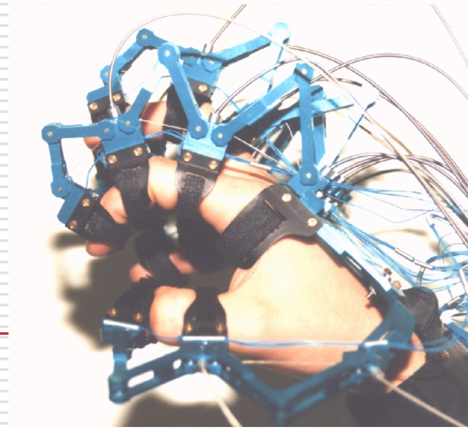
Molecular Docking Simulator

- Incorporated force feedback
- Visualize an abstract simulation



Data Gloves

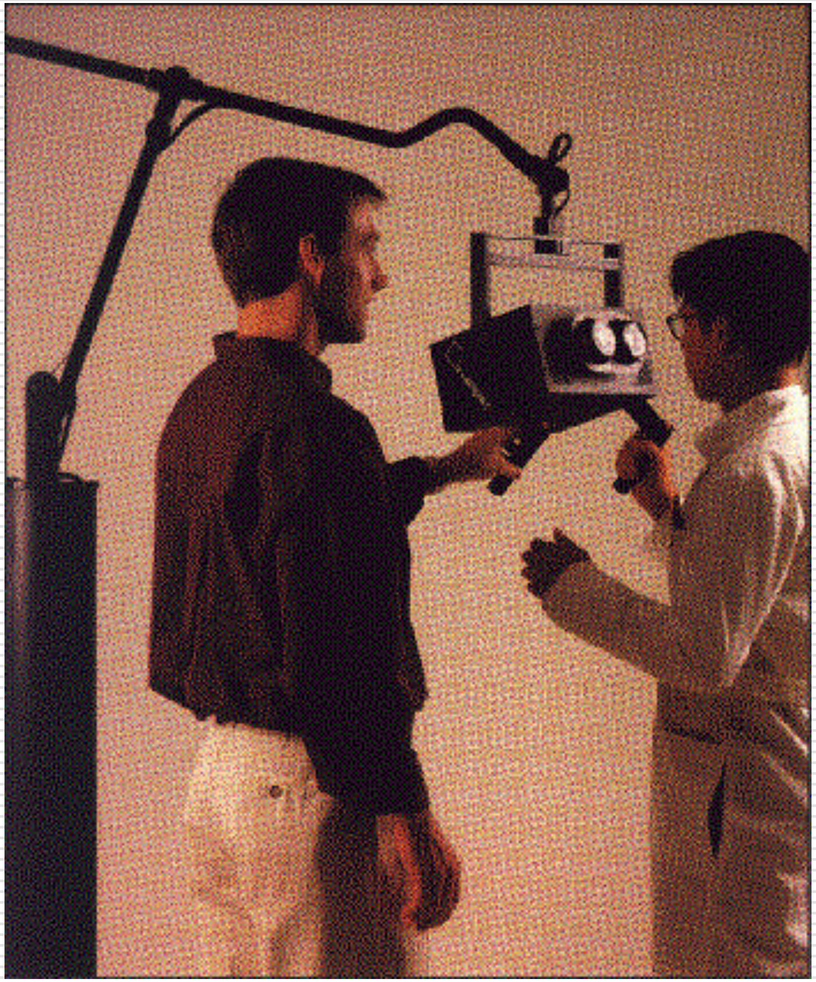
- Light, electrical or metal detectors compute “bend”
- Electrical sensors detect pinches
- Force feedback mechanical linkages



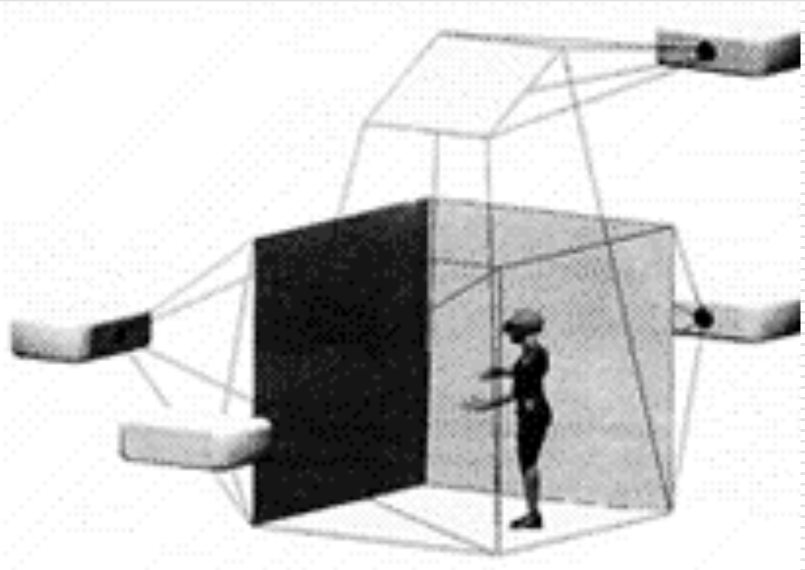
1985 - NASA Ames HMD

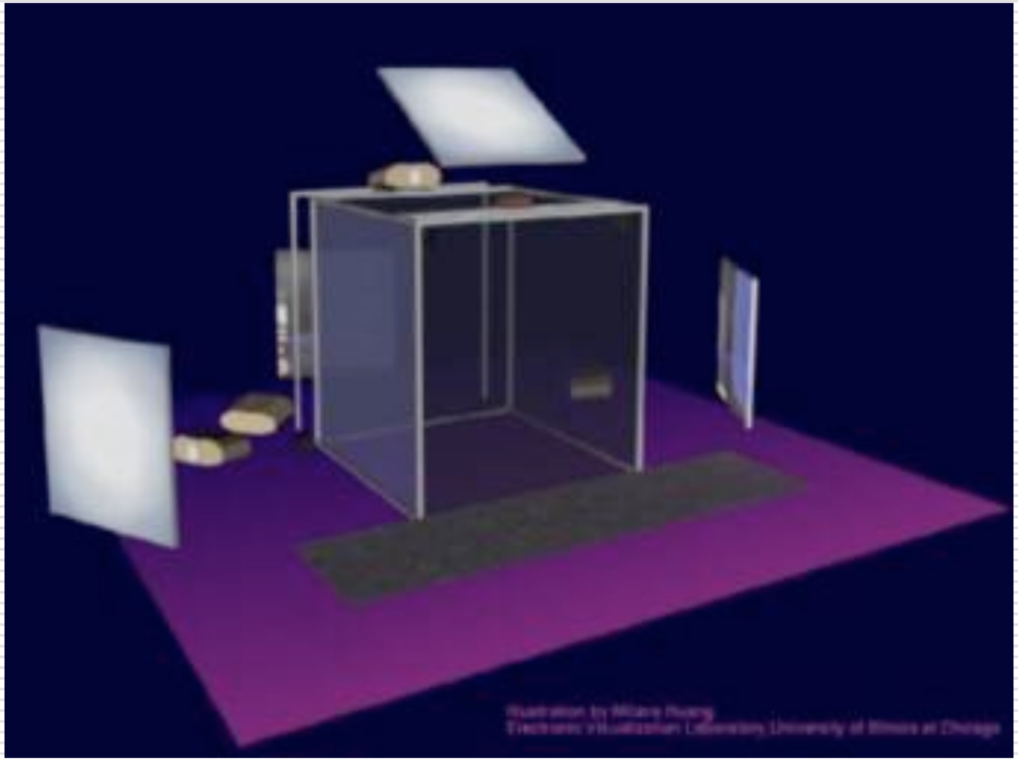
- McGreevy and and Humphries
  - Wearable immersive HMDs
  - LCD "Watchman" displays
  - LEEP Optics
- Led to VIVID, led by Scott Fisher

FakeSpace Boom Display: Early 1990s



CAVE - 1992



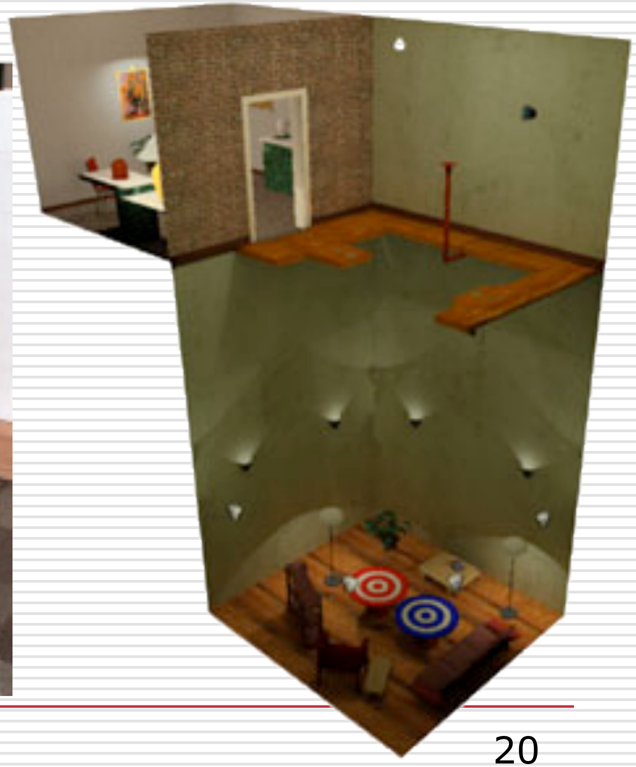


Virtual Workbench-1995

(Responsive Workbench, Immersidesk, etc.)

Current Best VE

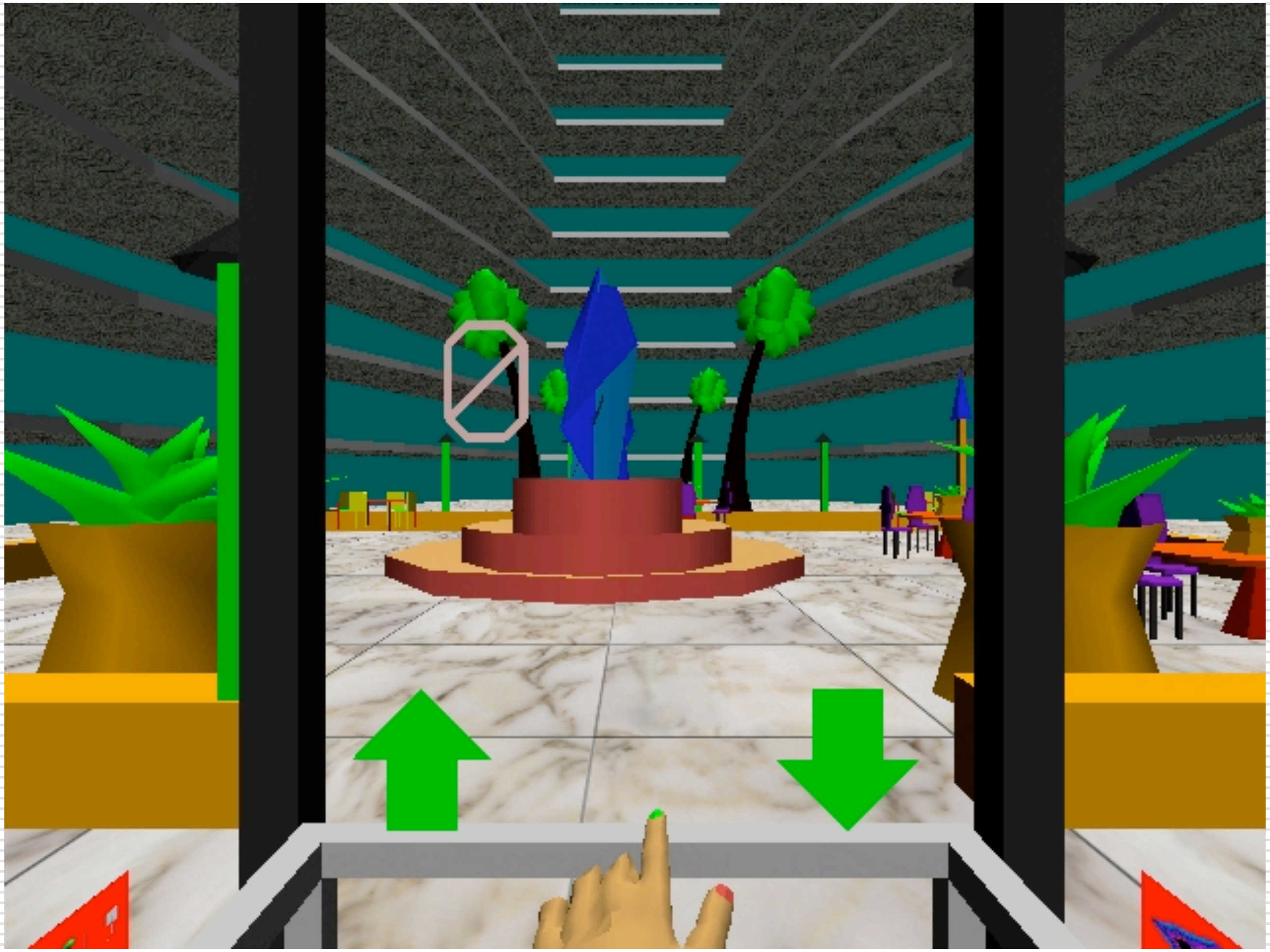
- UNC Pit Experiment
- Fear of Heights a Strong Response
- Thousands of visitors
- Compelling Experience
  - Haptics
  - Low Latency
  - High Visual Quality



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)
  - WiiMote/MotionPlus
  - Sony MOVE (SHOW MOVIE!)
  - MS Kinect (SHOW MOVIE!)
- Large LCDs are "cheap"
- 3D displays are here
  - Useful?

Why Study Immersive HCI?

- Relevant to real-world tasks
  - Can use familiarity to ease adaptation
  - Can increase realism of experience
- Mature technology
  - Cheap, robust solutions
  - Need to create interface mappings
- 3D interaction is difficult
  - Many VR/gaming systems lack necessary cues
  - Adapting WIMP techniques is not adequate

Why Study Immersive HCI? (cont.)

- Current approaches are either too simple or unusable
  - Since users have problems, dumb it down!
  - Need to be able to perform all actions though!
- Ripe area for study
  - Very hot area of HCI
  - We know *a lot* about doing things in 2D
  - And also about doing things in the real world

A Brief History (cont.)

- HCI draws on
  - Perception
  - Cognition
  - Linguistics
  - Human factors
  - Ethnography
  - Graphics design
  - Computer science
  - …

A Brief History (cont.)

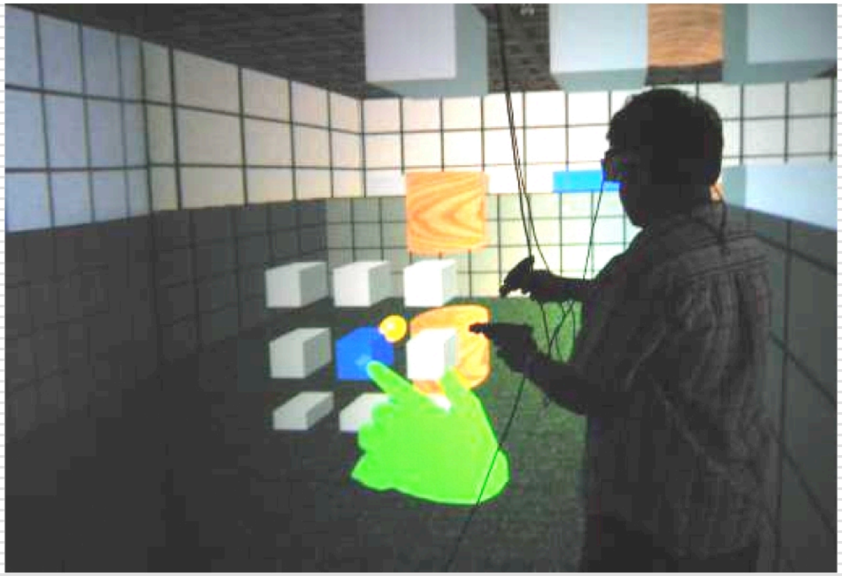
- Technology developments also drove growth
  - Flight simulators
  - 3D Graphics
  - Augmented Reality (AR)
  - Virtual Reality (VR)
  - Flight

Basic Interaction Tasks in VR (Bowman *et al.*)

- Object Selection
  - What do I want to manipulate?
- Object Manipulation
  - How can I manipulate it?
- Navigation
  - Wayfinding: How do I know where I am, and how to get where I am going?
  - Travel: How do I get there? (locomotion)
- System Control
  - How do I change system parameters?
- Symbolic Input
  - Inputting text and numbers

Dealing with Objects

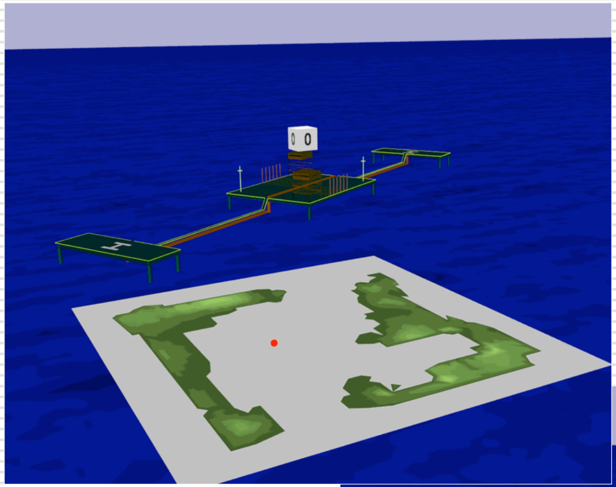
- Problems
  - Ambiguity
  - Distance
- Selection Approaches
  - Direct / enhanced grabbing
  - Ray-casting techniques
  - Image-plane techniques
- Manipulation Approaches
  - Direct position / orientation control
  - Worlds in miniature
  - Skewers
  - Surrogates

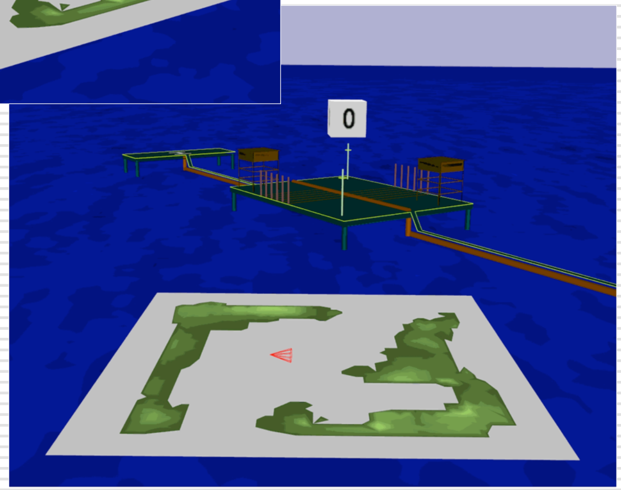


Courtesy: D. Bowman

Navigation: Wayfinding

- People get lost/disoriented easily
- Traditional tools
  - Maps (North-up vs. Forward-up)
  - Landmarks
  - Spoken directions
- Non-traditional
  - Callouts
  - Zooming





Images: http://vehand.engr.ucf.edu/handbook/Chapters/Chapter28/Chapter28.html

Navigation: Travel

- Problems
  - Limited physical space, unlimited virtual space
  - Cables
- Approaches
  - Fly where you point/look
  - Treadmills
  - Walking in place
  - Big track ball

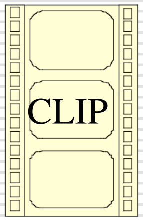


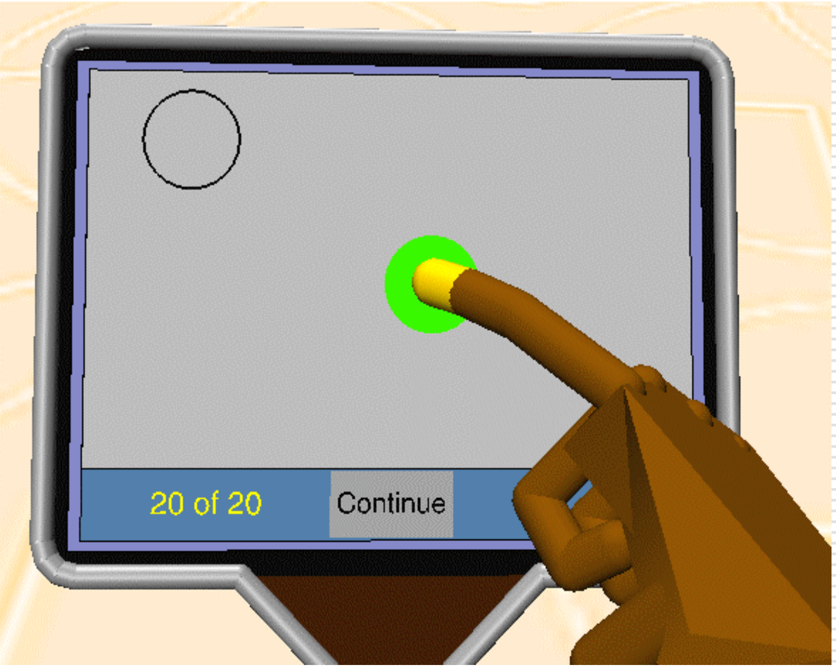
Image: www.virtusphere.com

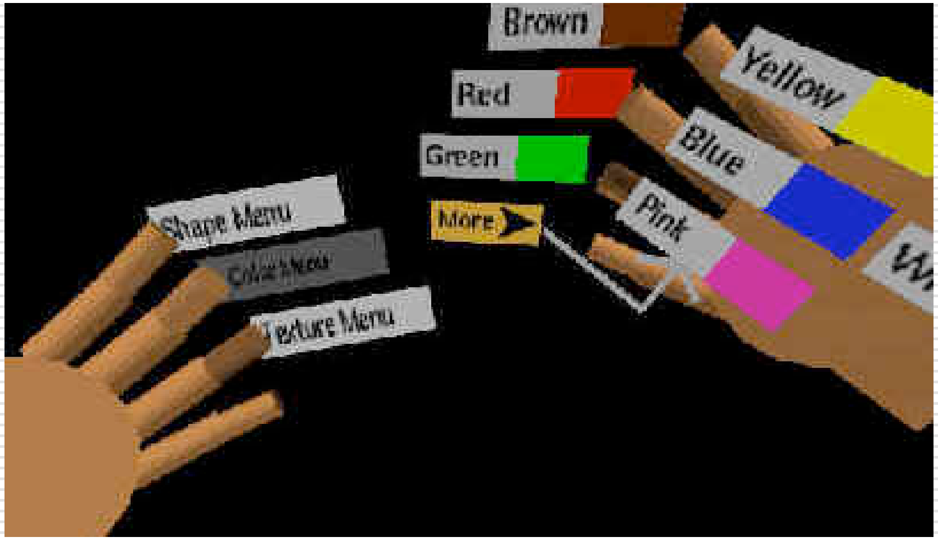
System Control

- Need to manipulate widgets
  - Lighting effects
  - Object representation
  - Data filtering
- Approaches
  - Floating windows
  - Hand-held windows
  - Gestures
  - Menus on fingers

System Control Examples

Courtesy: R. Lindeman



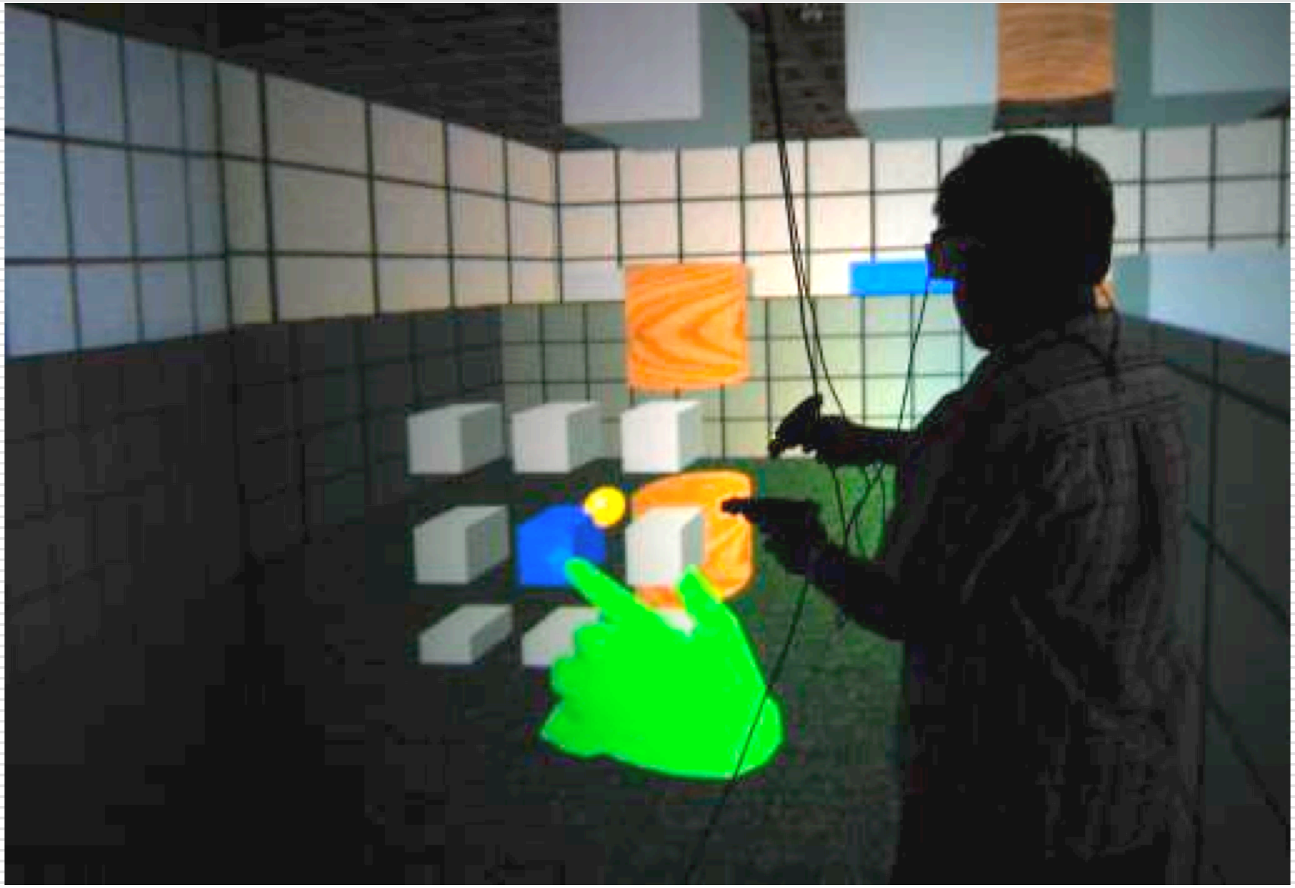


Courtesy: D. Bowman

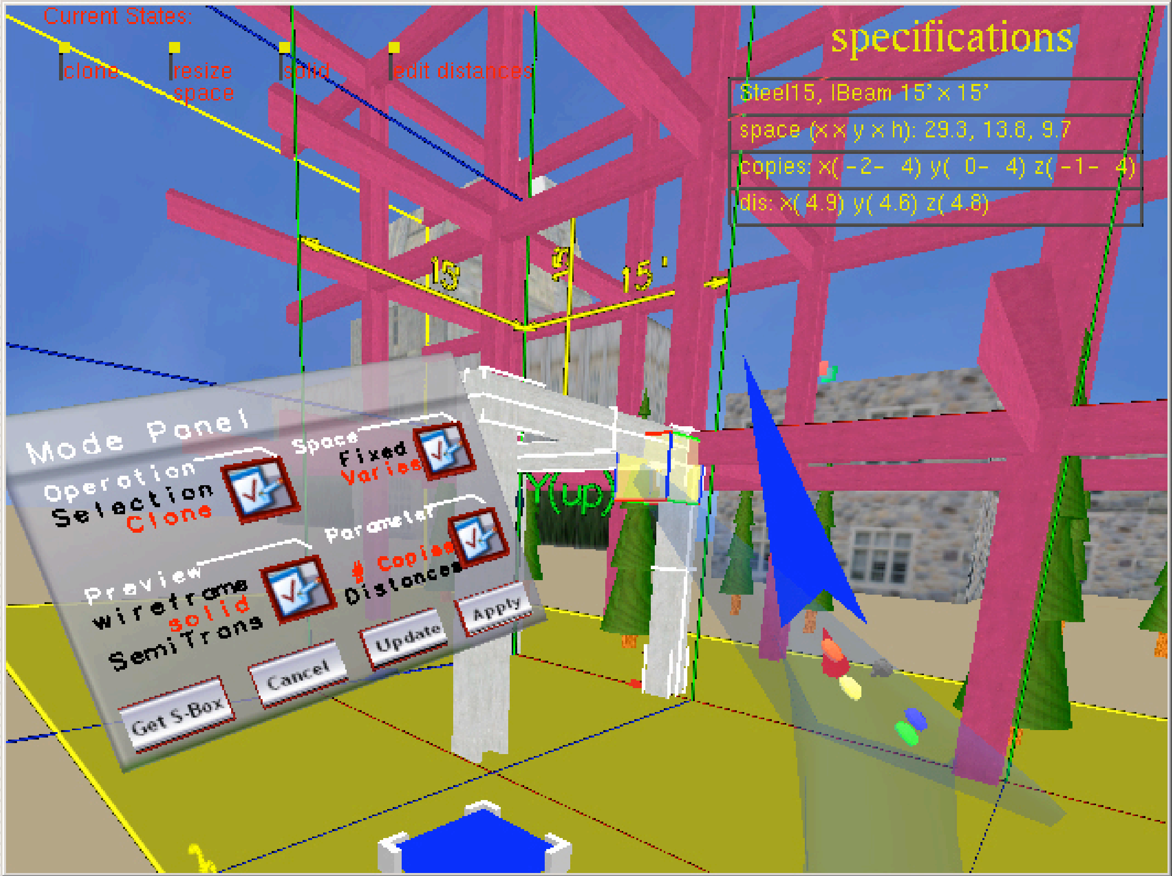
User, Task & Environment

- The "optimal" interface will depend on the capabilities of the *user*, the nature of the *task* being performed, and the constraints of the *environment*.
- User
  - Dexterity, level of expertise
- Task
  - Granularity and complexity of task
- Environment
  - Stationary, moving, noisy, *etc.*

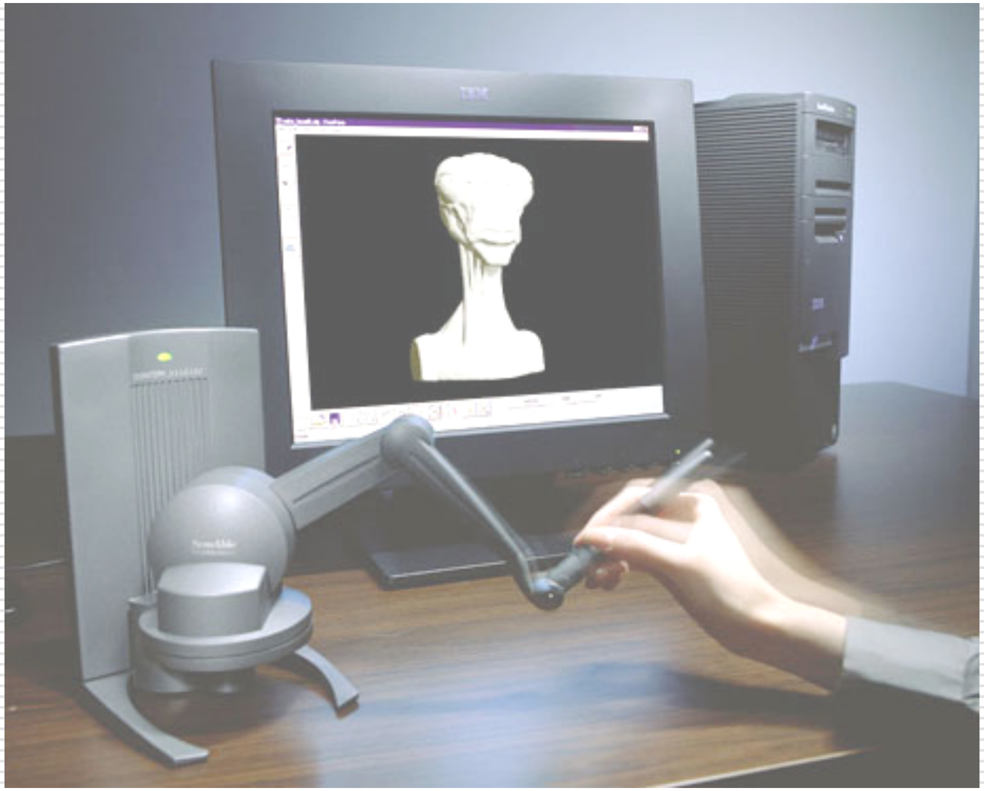
Direct Manipulation



Can We Do WIMP in VR?



Desktop Interaction: SensAble *PHANToM*

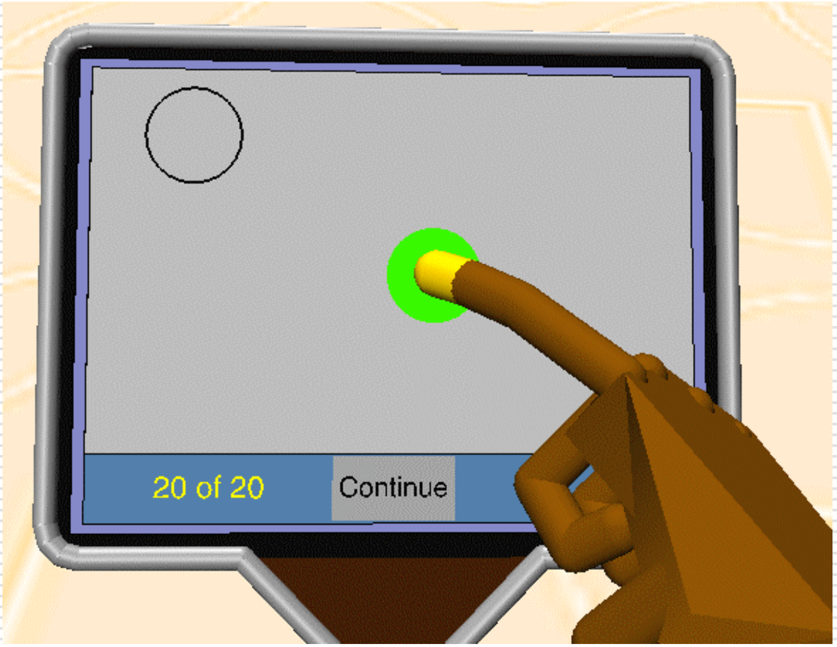


http://www.sensable.com/

Wearable Interaction with Haptics: Immersion *CyberGrasp*

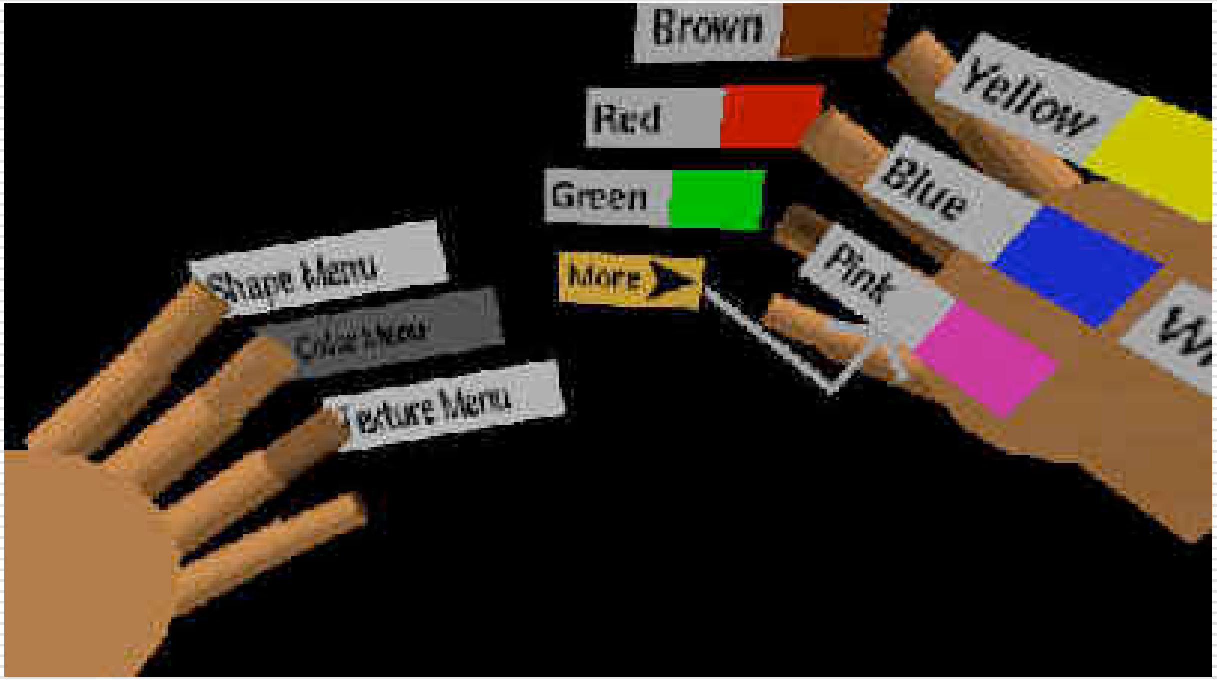
http://www.immersion.com/

Wearable Interaction: Rob's *Hand-Held Windows*

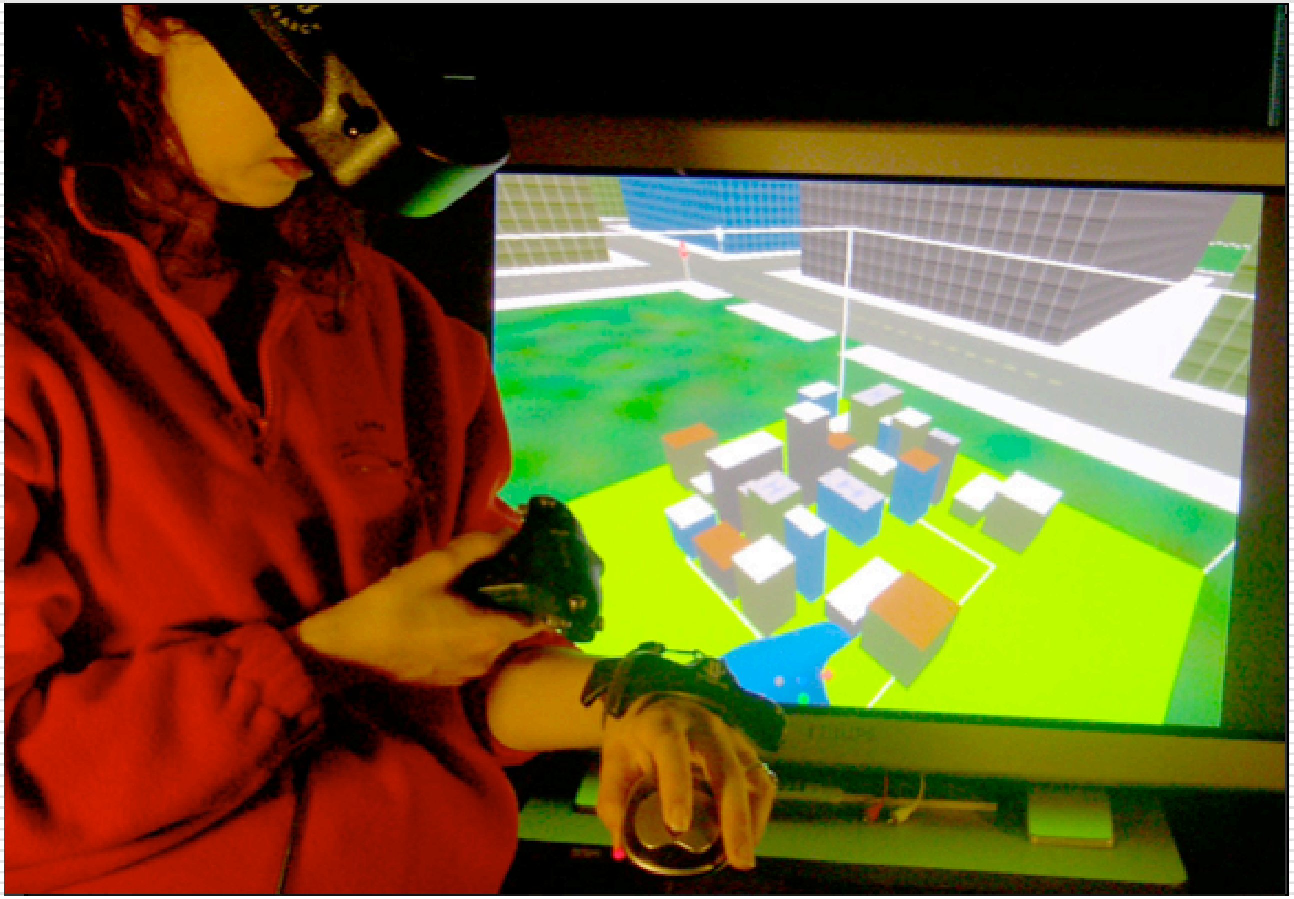


http://www.cs.wpi.edu/~gogo/

How Do We Do Menus?



Interface Devices



Courtesy: Virginia Tech

Augmented Reality (AR)