IMGD 5100:
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

- **2-3 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

Assignments

- ☐ Can be done in teams
  - ■ Clearly define what each member will be responsible for

- ☐ Can use any software/language you like

- ☐ Samples
  - ■ OpenGL, DirectX, Java3D, OpenSceneGraph, OpenSG, FreeVR, Android, iphone
  - ■ Game-engine code

- ☐ Resources
  - ■ HIVE has many devices for you to use.
  - ■ Field trip later in the semester
  - ■ Android phones

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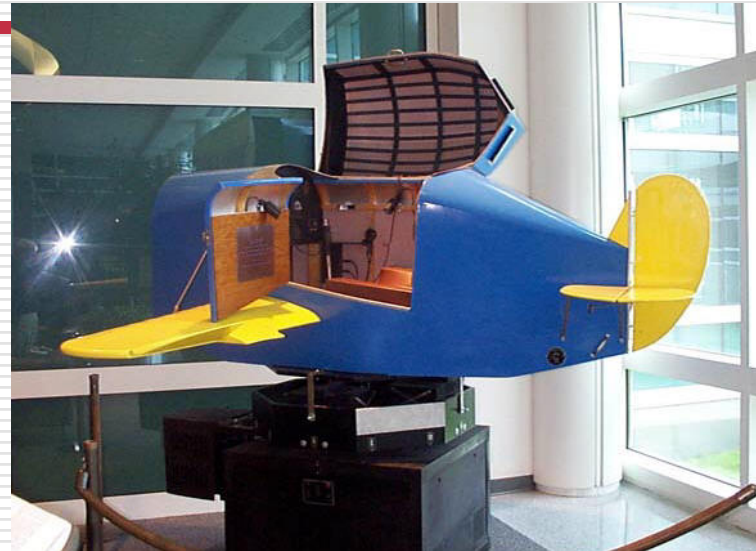
Instrument panel of the Link on display
The Link trainer was donated by Simulation Products Division, The Singer Co., Binghamton, NY.

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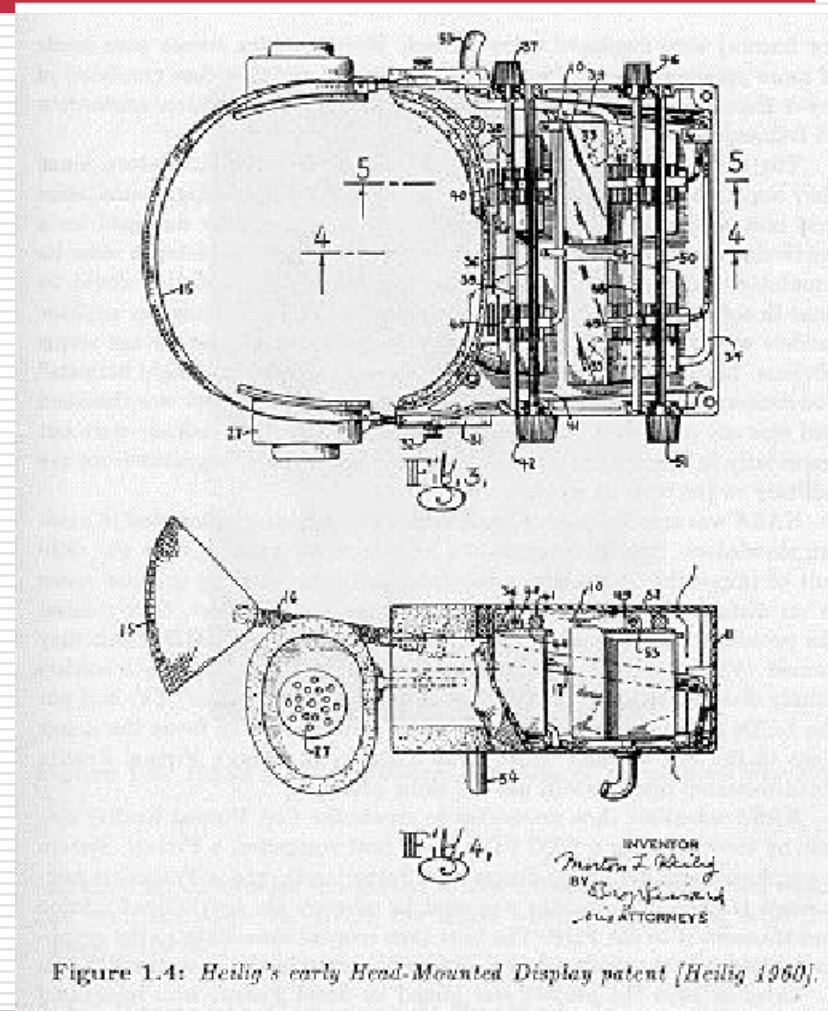
Figure 1.4: Heilig's early Head-Mounted Display patent [Heilig 1960].

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
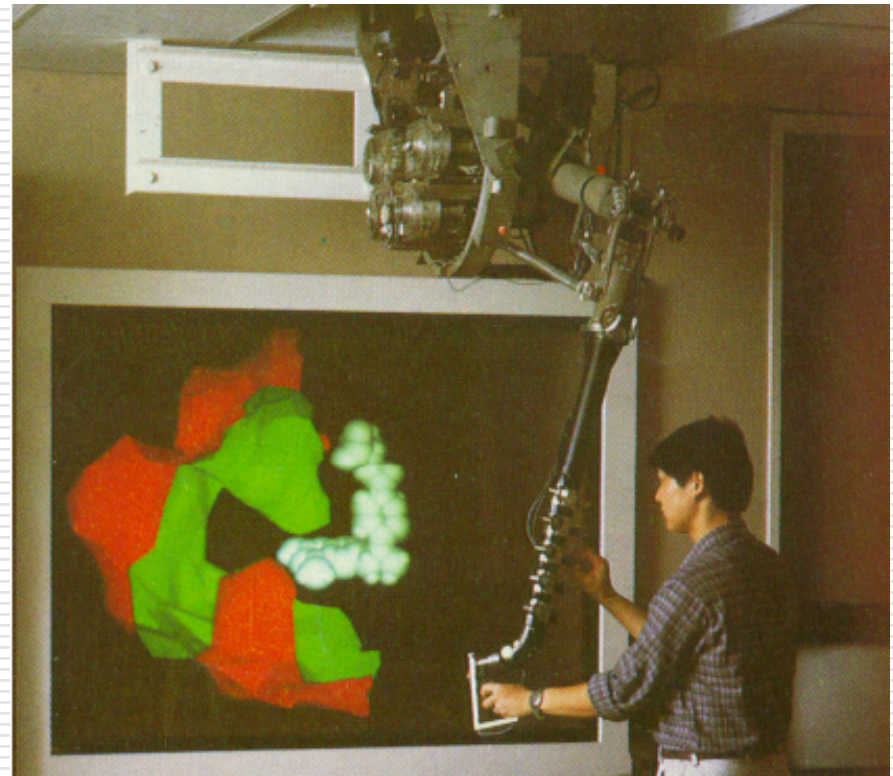
Data Gloves

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

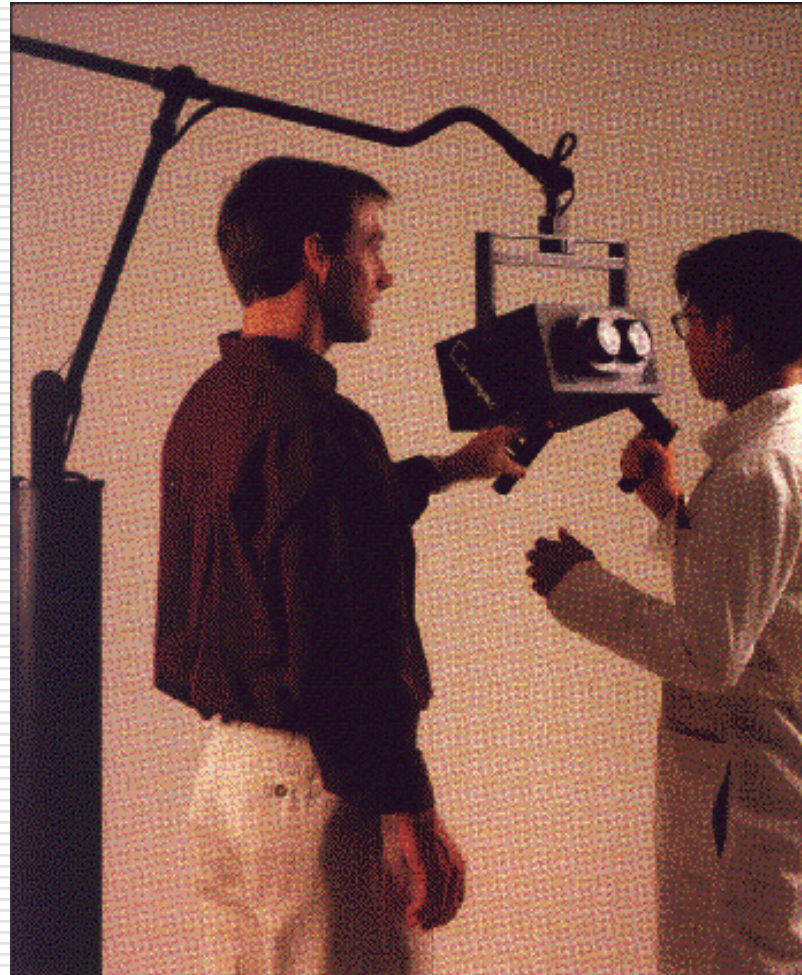Interactive Media & Game Development
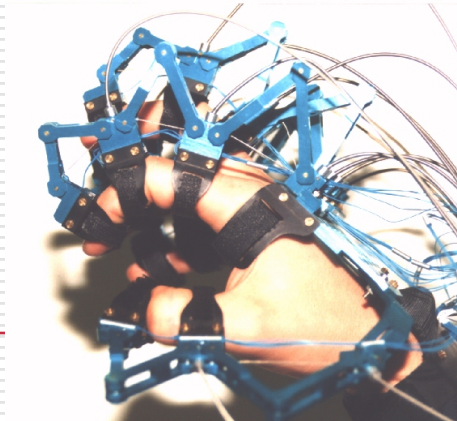
1985 - NASA Ames HMD

- McGreevy and and Humphries
  - Wearable immersive HMDs
  - LCD "Watchman" displays
  - LEEP Optics
- Led to VIVID, led by Scott Fisher
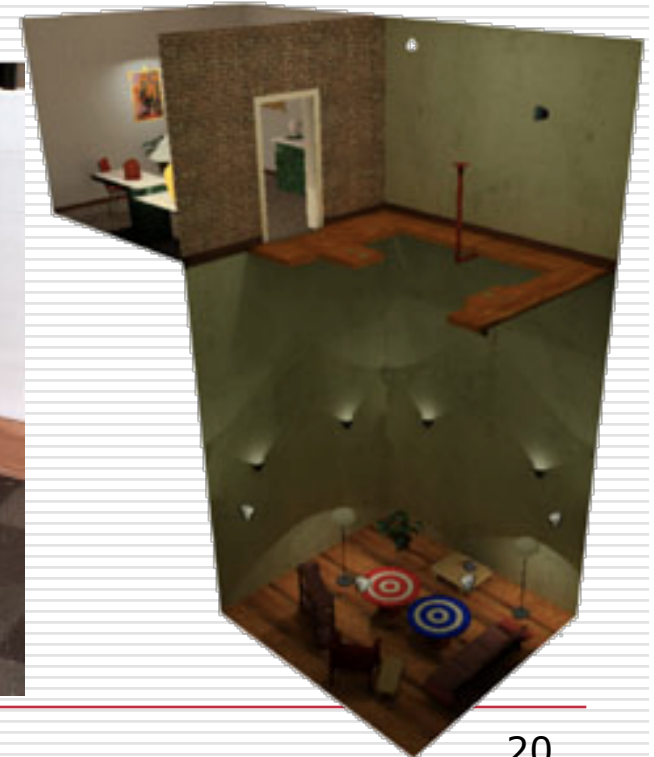
FakeSpace Boom Display: Early 1990s

CAVE - 1992
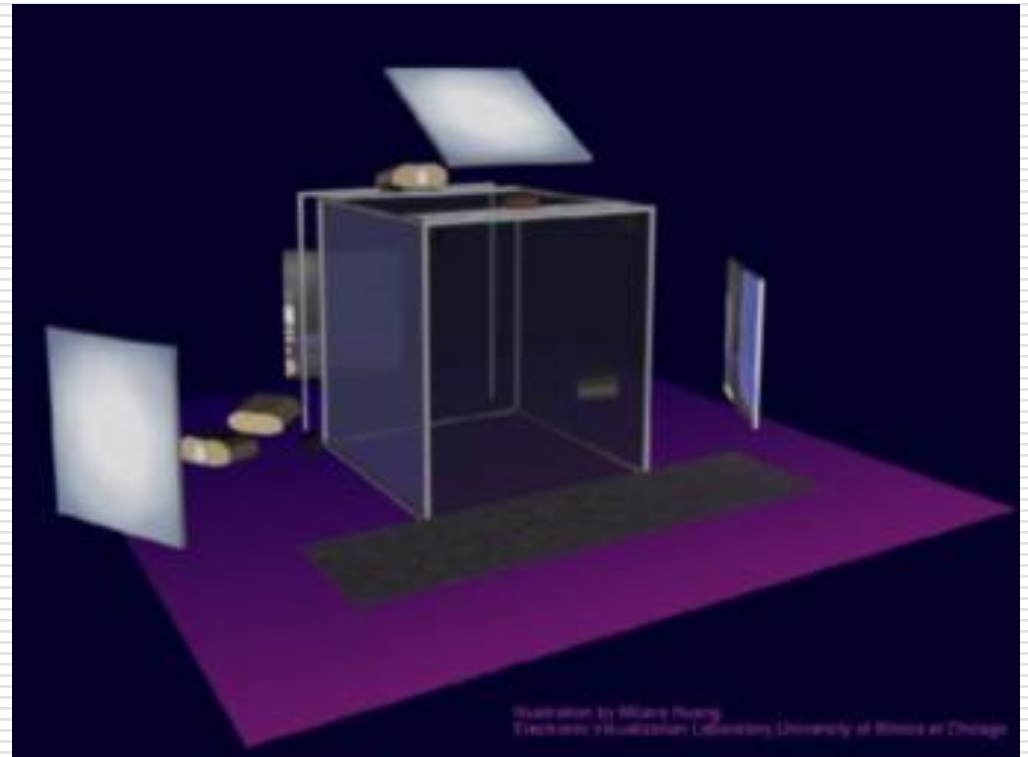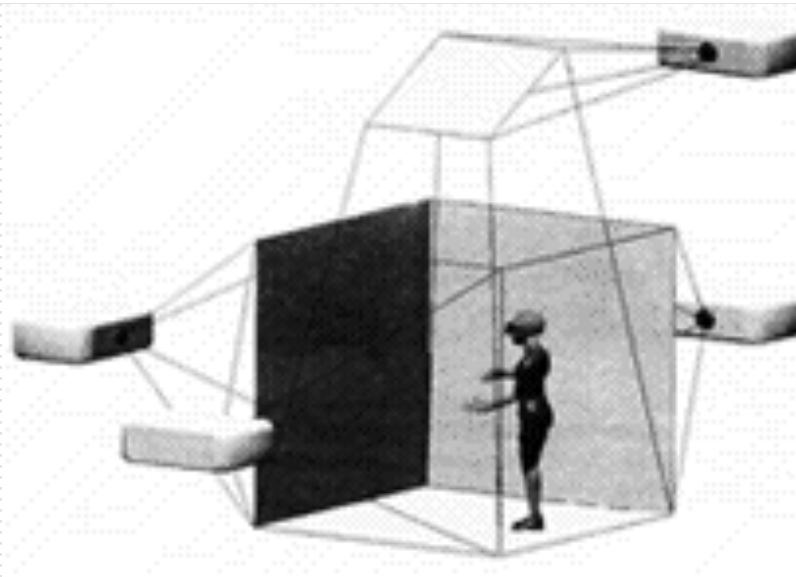
Virtual Workbench-1995
(Responsive Workbench, Immersidesk, etc.)

Current Best VE

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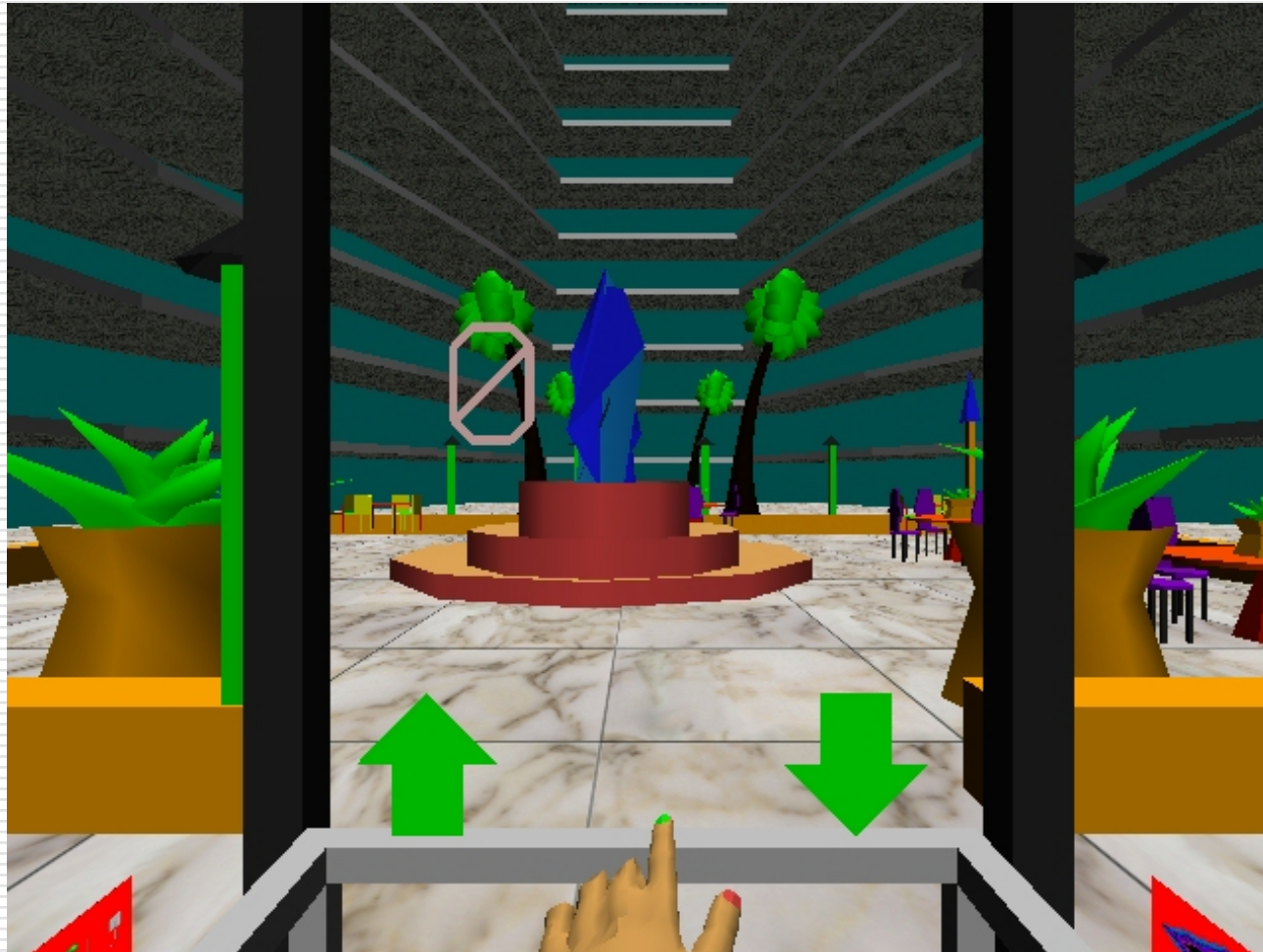 - ■ Low Latency
  - ■ High Visual Quality

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
  - Mobile wearable systems emerging

A Brief History (cont.)

- HCI draws on
  - Perception
  - Cognition
  - Linguistics
  - Human factors
  - Ethnography
  - Graphic 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

World Builder (Bruce Banit)

- ☐ Concept film
- ☐ Can you spot the different tasks?

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
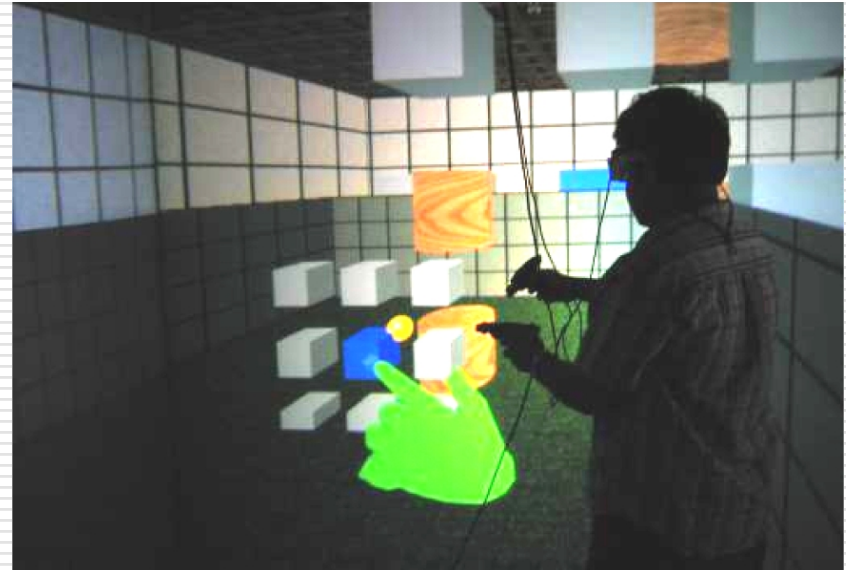
Courtesy: D. Bowman

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
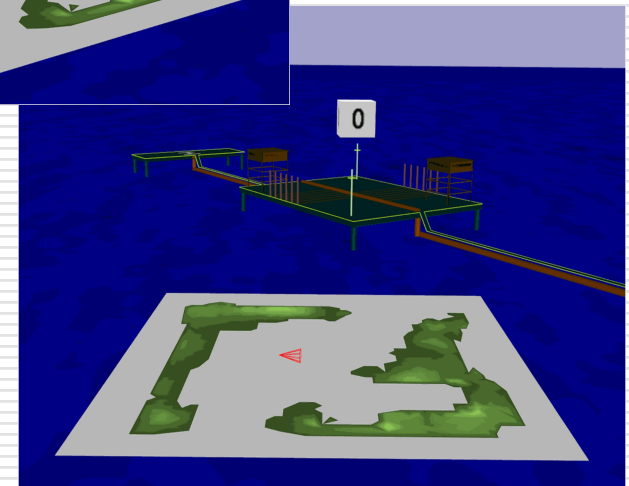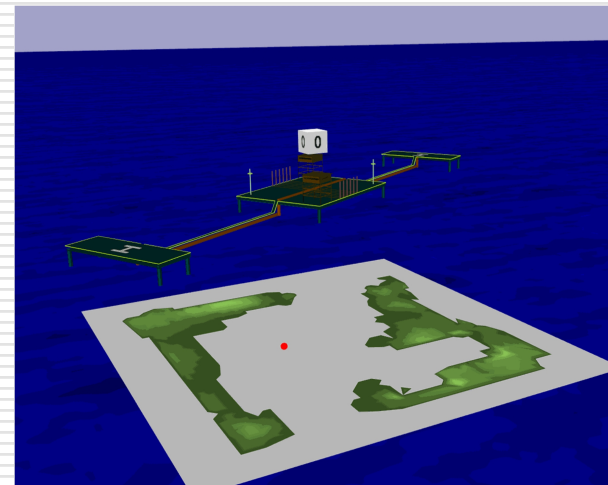
Navigation: Travel

- **Problems**
  - Limited physical space, unlimited virtual space
  - Cables

- **Approaches**
  - Fly where you point/look
  - Treadmills
  - Walking in place
  - Big track ball

CLIP
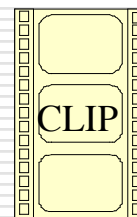
Image: www.virtusphere.com

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
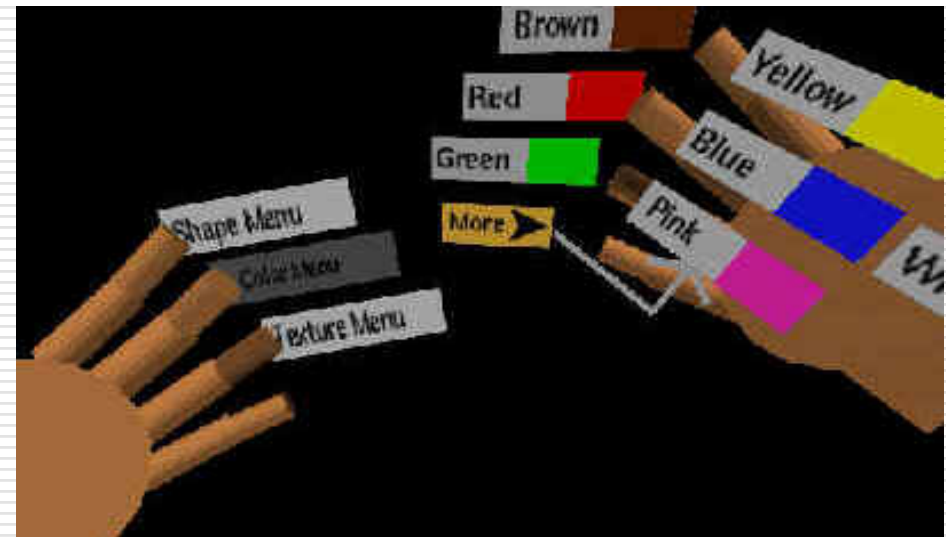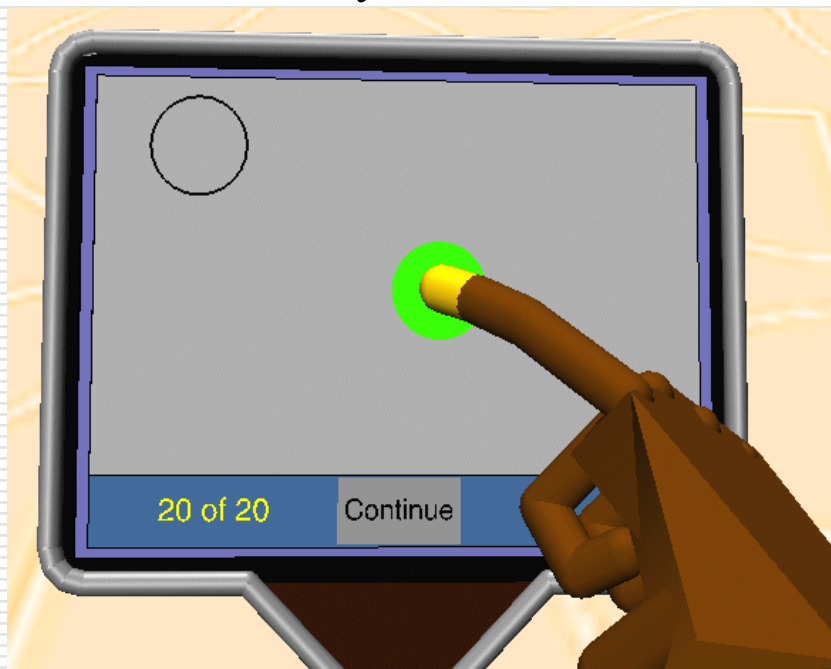
Courtesy: D. Bowman

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
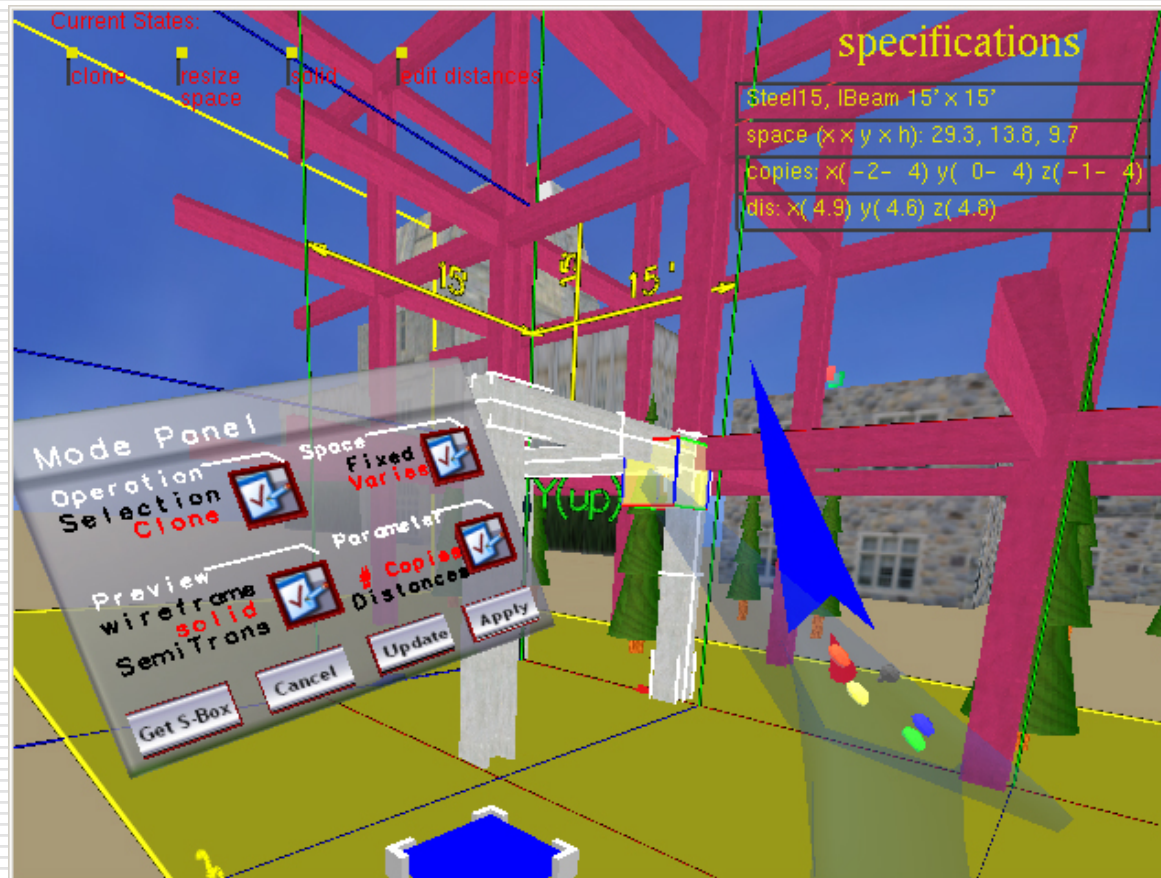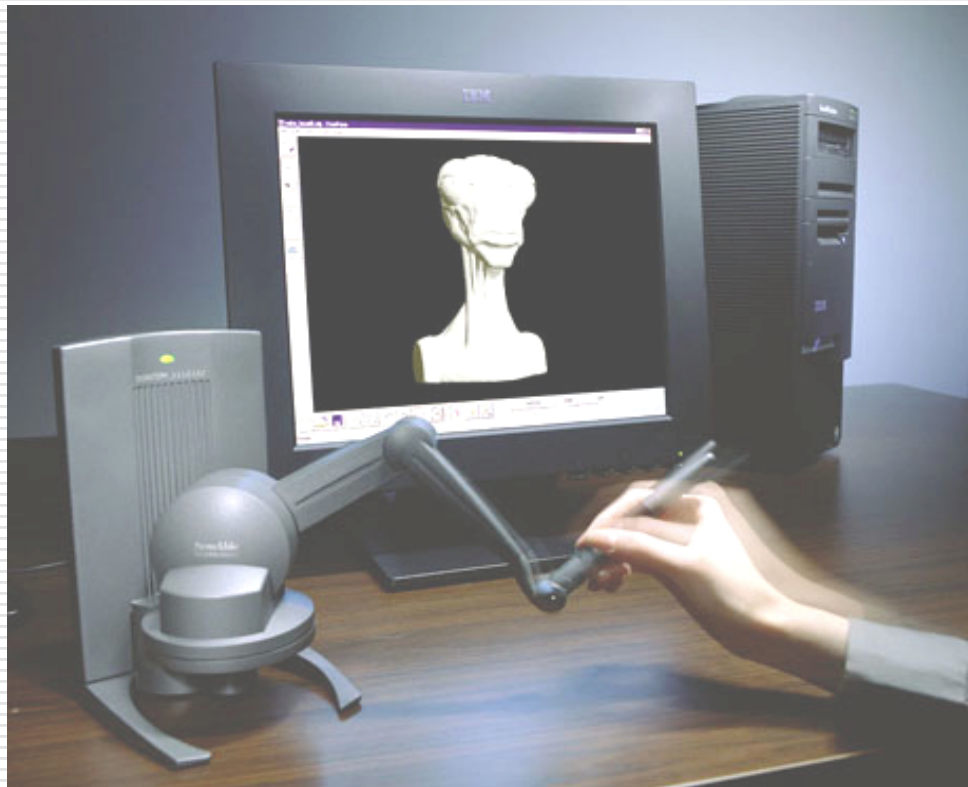 - Stationary, moving, noisy, *etc.*

Direct Manipulation
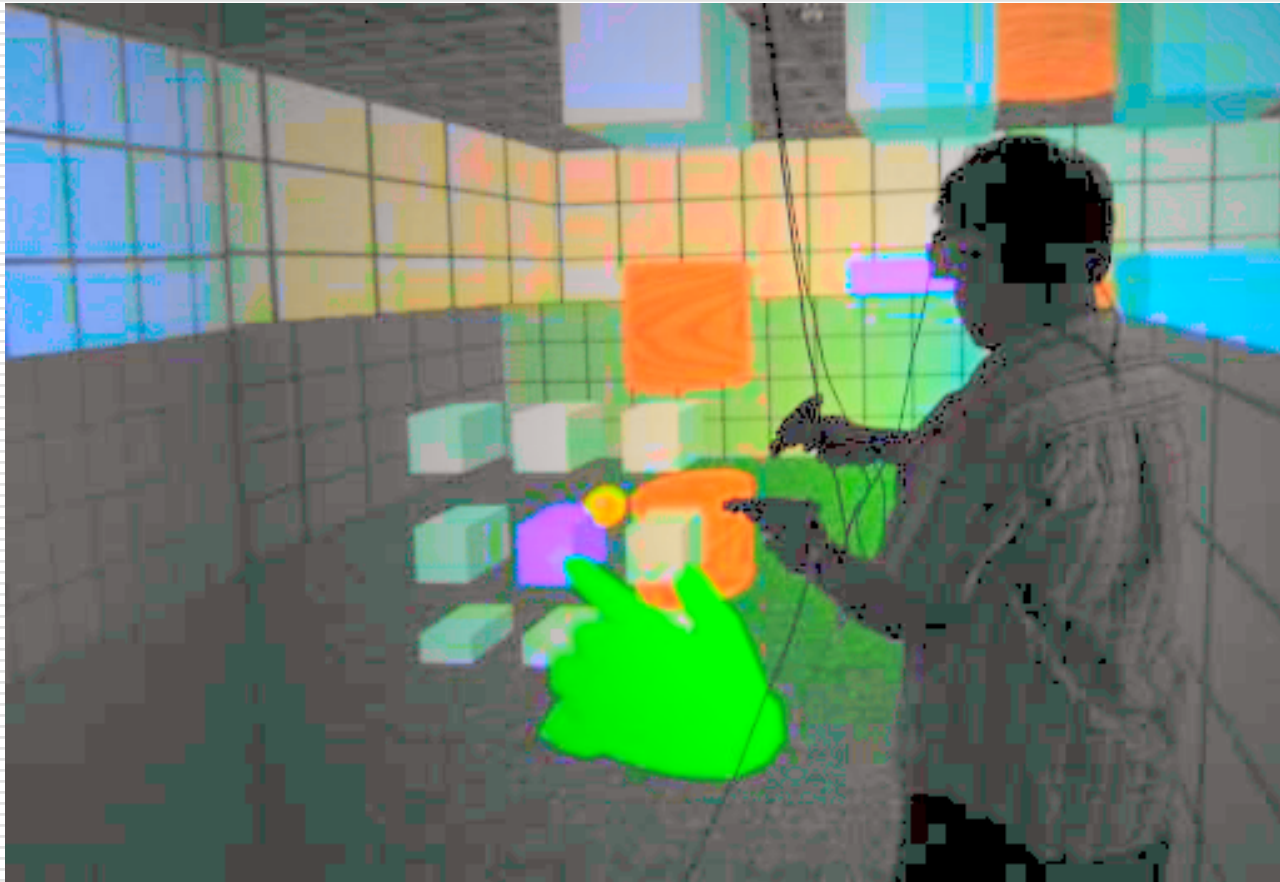
Can We Do WIMP in VR?

Desktop Interaction: SensAble *PHANToM*

http://www.sensable.com/

Wearable Interaction with Haptics: Immersion *CyberGrasp*
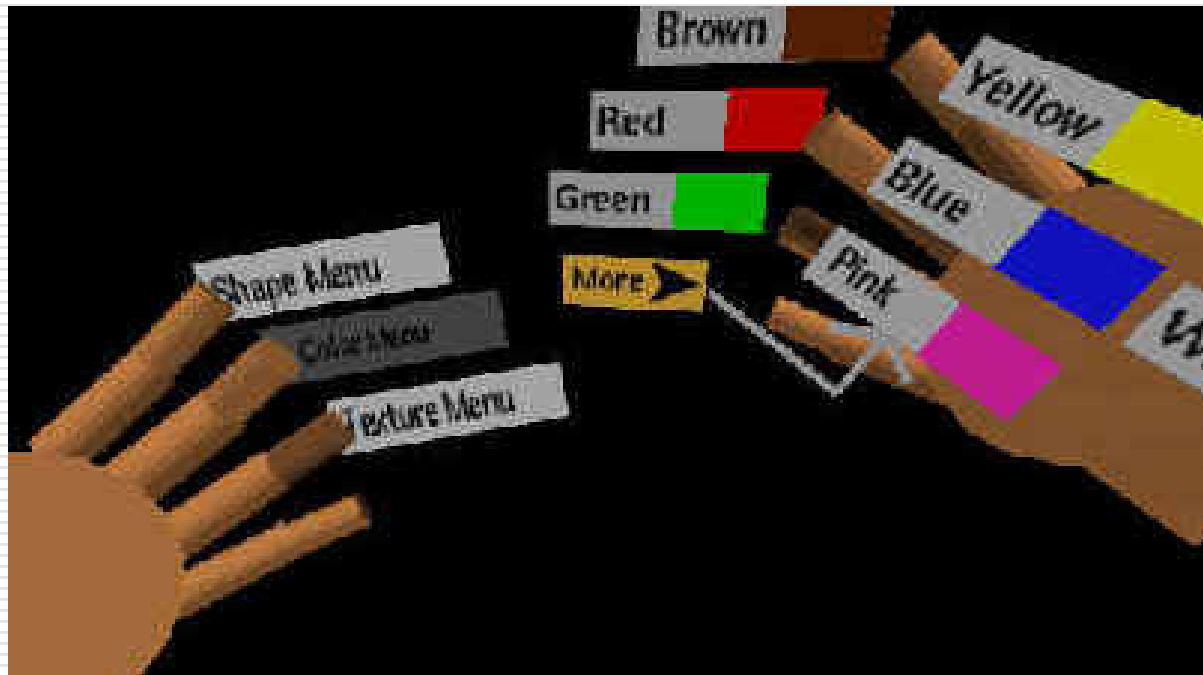
Wearable Interaction: Rob's *Hand-Held Windows*
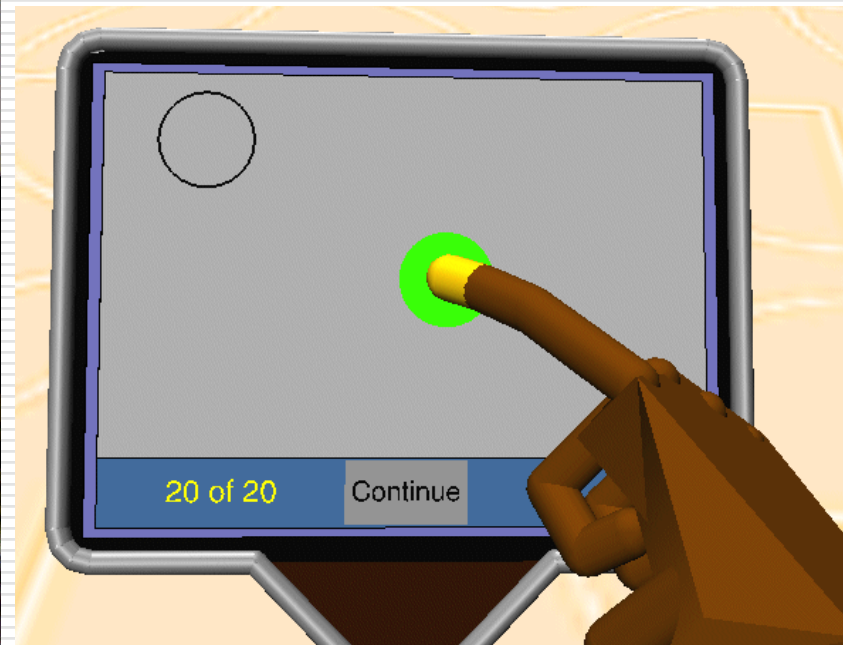
How Do We Do Menus?
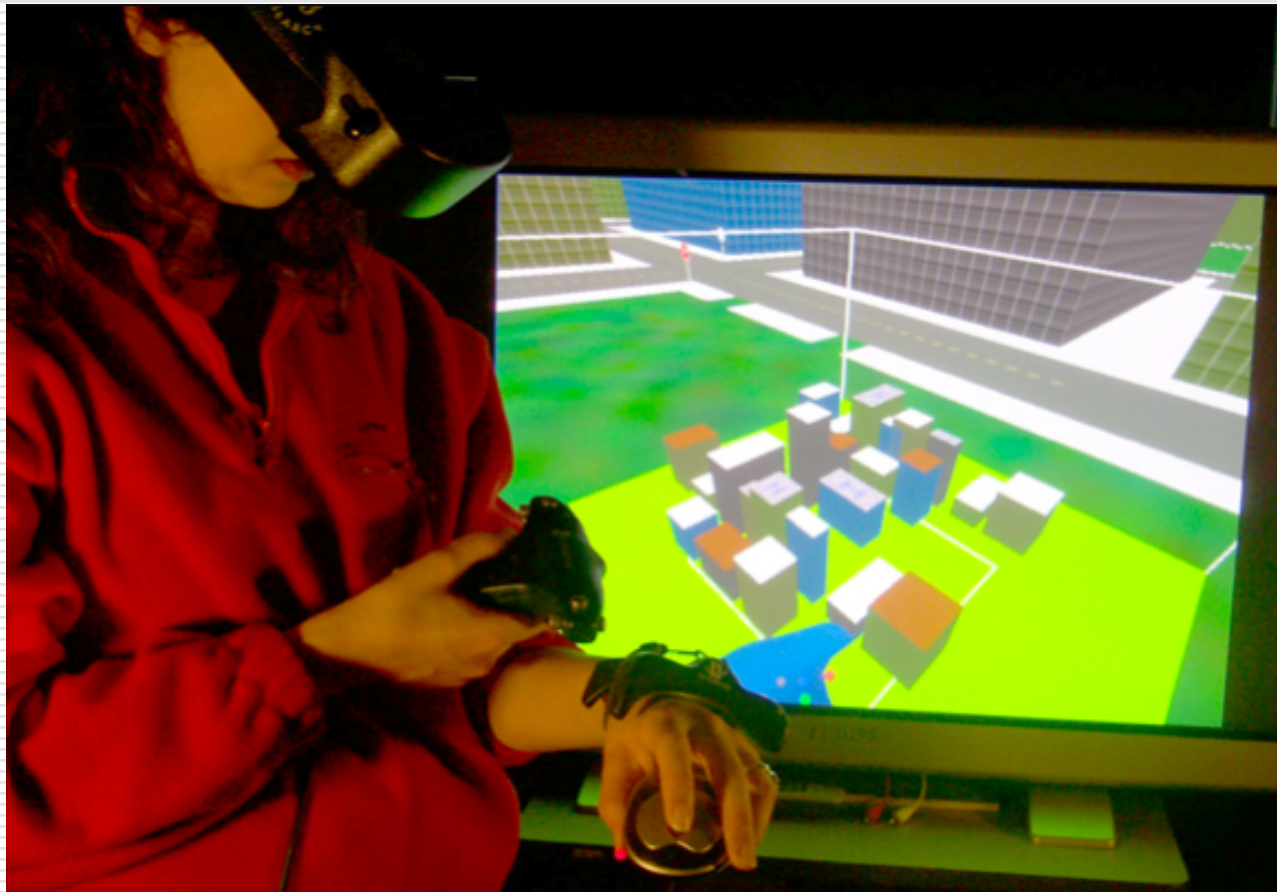
Interface Devices

Augmented Reality (AR)

AR (cont.)

☐ Wearable mobile systems emerging
- Google Glass
- Epson Moverio
- Just Android phones with special modifications
- iPhone 6?

Google Project Glass

☐ Concept videos

☐ How does the user interact?