# Navidezna resničnost

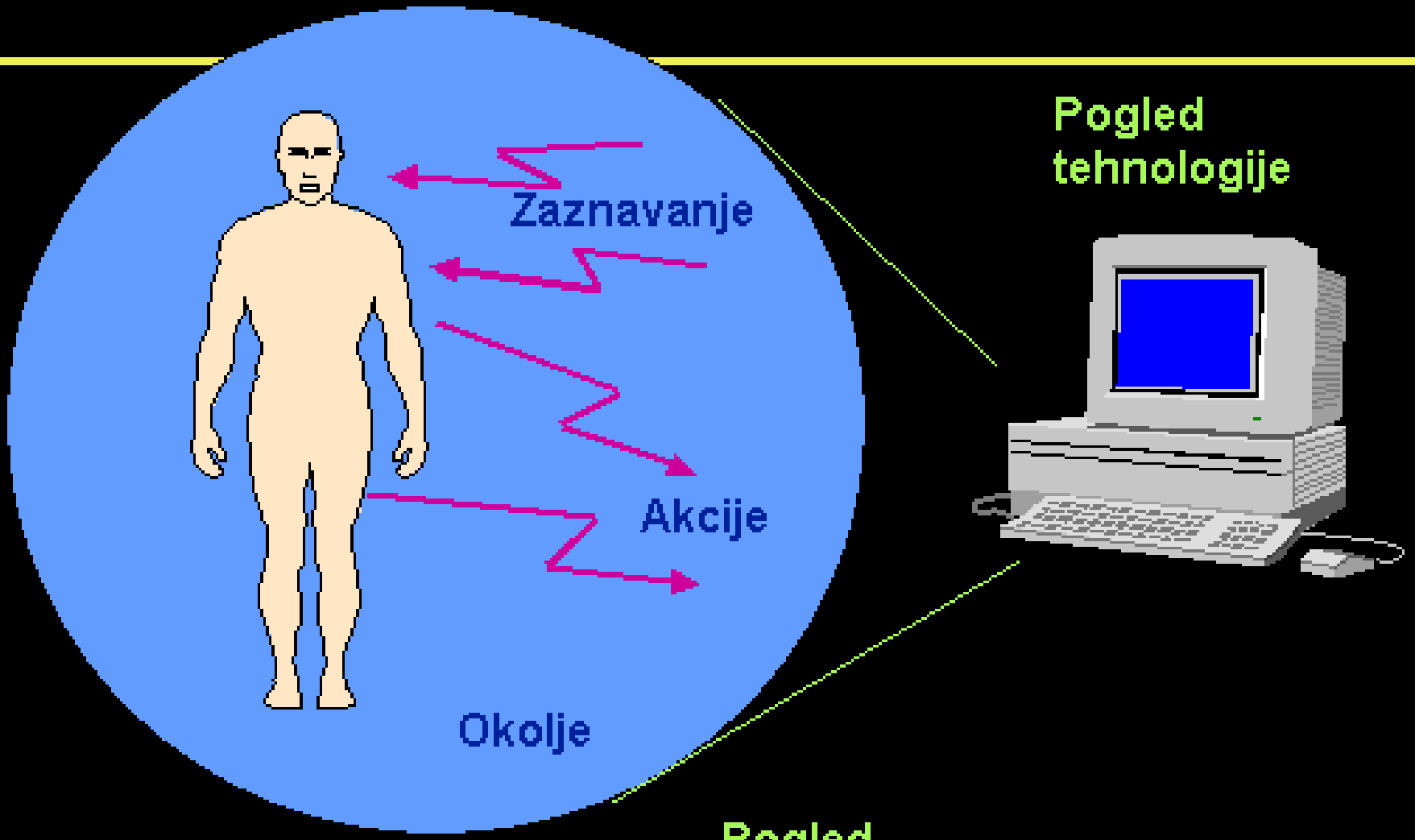
# Kaj je navidezna resničnost?

# Kaj je navidezna resničnost

Artificial computer-generated worlds that “feel” real, that respond to your every move much as the real world does.

Simulated environment into which a user “enters”, moves around and interacts with objects.

# Koncept navidezne resničnosti

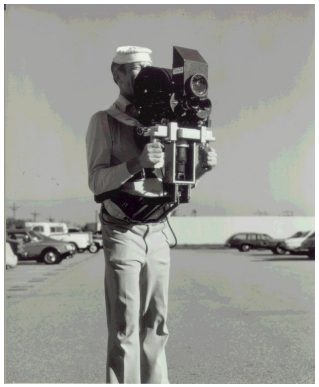


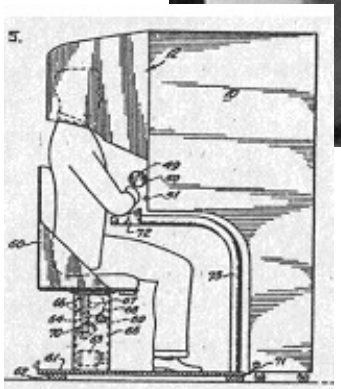
# Malo zgodovine

# Malo zgodovine


1956

- Stereo Film
- Vibration
- Smell
- Sound
- Wind
- Graphics
- (not interactive)



# Malo zgodovine

Flight Simulators (1930~ )

Stereo / Large Scale Movies (1930 ~)

Morton Heilig's Sensorama (First HMD, 1950's)

Visually coupled Tele-operated Environment and HUD's (60's ~)
(HMD + Trackers + Camera)

Modern Computer Graphics (Sutherland @ MIT, "Sketchpad", '63)

HMD + CG + Tracker + (Camera) (Sutherland @ Utah, '68)
"Ultimate Display / WOW", Augmented Reality)

UNC's Grope Project (Haptic Display, '69):
"Who wants his intelligence amplified ?"

Doug Englebart and ARC at Stanford: "Symbiosis" (60's ~ early 70's)
-> PARC -> ATARI -> APPLE -> … (70's ~ late 80's)

MIT ArchMac Group -> Media Lab (70's ~ today)
(Aspen Movie Map, "Put that there 등 )

# Malo zgodovine

1977 Sayre Glove (first glove with bend sensing device))

1981 DataGlove by Zimmerman (sold to VPL by Fisher and Lanier)

1979 Polhemus Navigation Trackers

1983 Myron Krueger's VideoPlace

- **3D interaction, 3D gesture recognized by vision, Multiple participants**

VIEW NASA Ames Research Center

- **BOOM, Convolvotron, RB2 (VPL) ...**

VCASS Visually Coupled Airborne System Simulator (SuperCockpit)

90's: VR emerging ...

- **Fish Tank VR: Desktop VR with Head Tracking**
- **AutoDesk’s WorldToolKit**
- **Projection based environments (CAVE / ImmersaDesk)**
- **91 Reality Engine**
- **94 Sensable Device's Phantom**

# Terminologija

Virtual / Synthetic Environments
Tele-presence
**Presence**
Cyberspace
**Immersion**
**Simulator / Motion Sickness**
**Lag time**
3D rendering / Graphics Engine
Polygons per second
Silicon Graphics (SGI)
CAD
**VRML**
Bodysuit
**Head Mounted Display (HMD)**

3D Mouse
Joystick
Roll, Pitch, Yaw
**Stereoscopic Display**
Liquid Crystal Shutterglasses
Ultrasonic / Magnetic / Optical Tracking
Cyber / Power / Data Glove
6 Degrees of Freedom (DoF)
Manipulation
**Haptic Display**
**Position Tracking**
Feedback

# Terminologija nadaljevanje

**Presence** - The feeling of ‘being there’.

**Immersion** - One is immersed if one perceives the environment on a 1 to 1 scale.

**Motion Sickness** - caused by time lags in head movement and what one sees.

**Lag time** – The time it takes for the computer to register a movement and show its consequence.

**Haptic Display** - feeling virtual objects.

**Position Tracking** - How the computer knows where you are and what you are looking at

# Navidezna resničnost in lažni svetovi (umetnost)

Recreating a “difficult to attain in real life” experience as realistic as possible using computer software/hardware and other devices (or even using drugs !?)

"synthetic sensory experience that communicate physical and abstract components to human participant”

Sensory information may include visual, haptic, tactile, auditory, olfactory, etc.

Note that the visual sense is very dominating. High degree of telepresence is still possible with just stereo graphics and strong depth cues (perspectives, lighting, shadows, motion parallax ...)

# Prisotnost in potopitev

One of the goals of directly influencing such various human senses is to create the feeling of "presence" ...

- feeling of being there (visitation) vs. just seeing
- ability to distinguish whether real or not
- relates to reflexive response of user (will you duck at an incoming missile, or feel dizzy at a virtual cliff ?)

Presence requires: Realism and Interaction

- “Immersive” environments
- First person viewpoint (exocentric vs. egocentric …)
- Involvement (degrees of control)
- LOD Control (visual and frame time variation)
- Collision response (latency)
- Peripheral vision and FOV
- *Measuring Presence : SSQ, PQ*

# Interakcija v realnem času

Well, interactivity has only been possible due to the recent increase and availability of powerful computers …

Many technical issues involved with VR is in implementing the artificial senses and control in "real" time (e.g. 10-20 frames of image for the visual senses, 1/10 sec of delay between natural interactions, 50-100 msec of latency, etc.)

# Interaktivnost

not static 3D images

not movies

moving within the world

manipulating objects in the world

# Vrste navidezne resničnosti

- desktop VR
  - ordinary screen,  mouse or keyboard control
  - polemous mouse,  steering wheel,  joystick
- immersive VR
  - helmet/goggles,  data glove
  - body suit,  trampoline!
- physical world/VR mixes

# “svetovi” navidezne resničnosti

- **Contain some or all “senses”**
  - sight
  - sound
  - motion
  - smell
  - feel and touch

# Klasifikacija navidezne resničnosti

- Simulatorji kabin
- Projicirana resničnost
- Obogatena resničnost
- Teleprisotnost
- Desktop VR
- Visual Coupled Displays
- Spatially Immersive Displays

# Simulatorji kabin

- similar to military simulators
- usually some sort of HUD
- airplane, tank, etc
- good for LBE
- BattleTech game

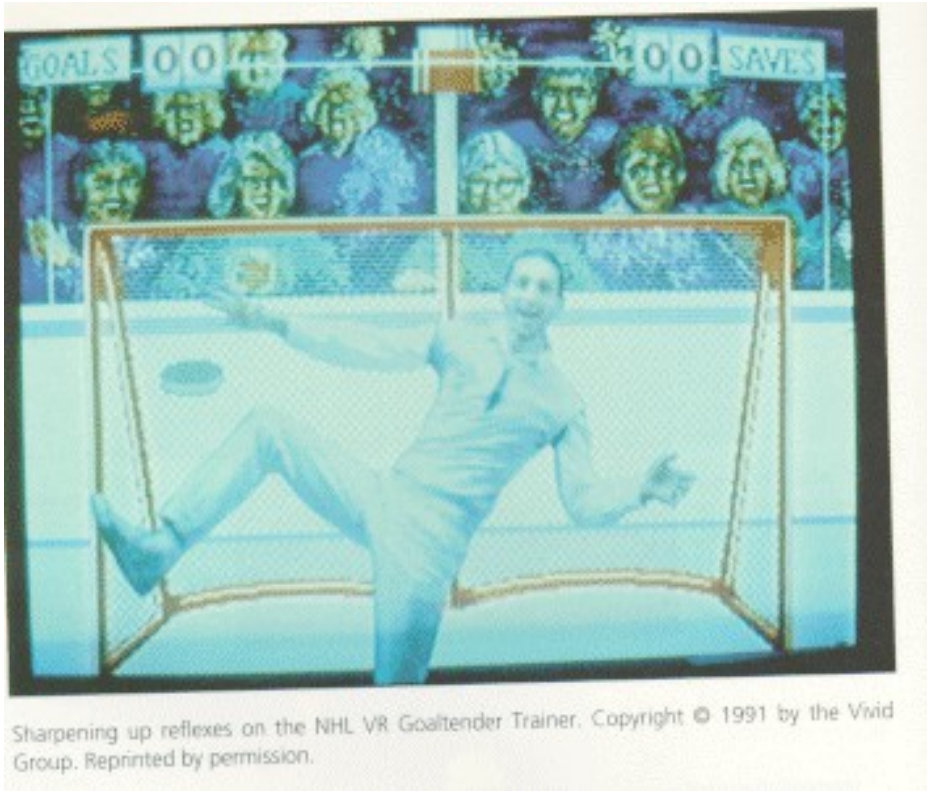
# Projicirana resničnost

projected environments

aka “mirrorworld”

Mandala systems most popular

many applications



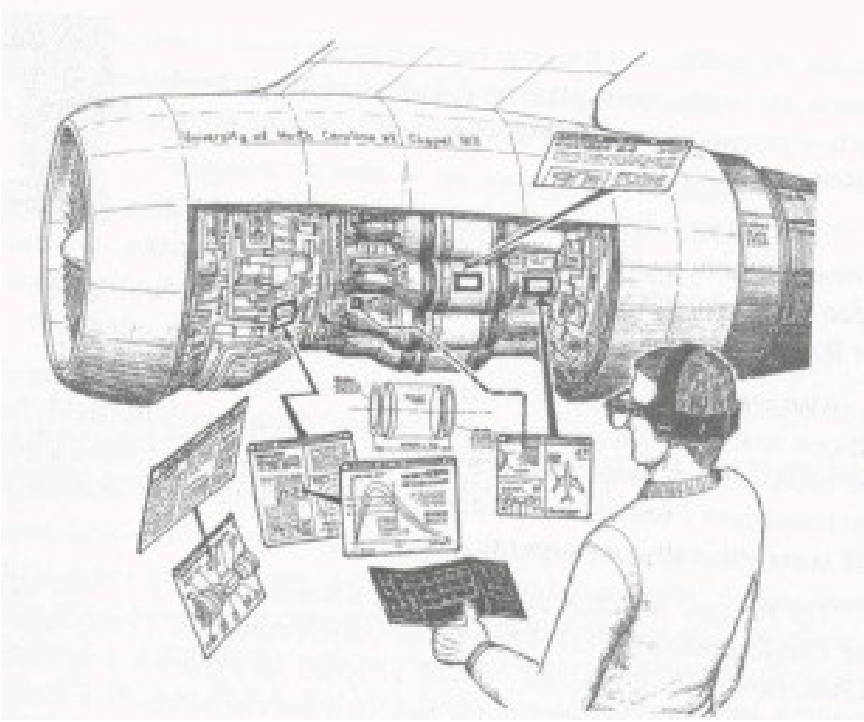

Sharpening up reflexes on the NHL VR Goaltender Trainer. Copyright © 1991 by the Vivid Group. Reprinted by permission.

# Obogatena resničnost

uses head displays

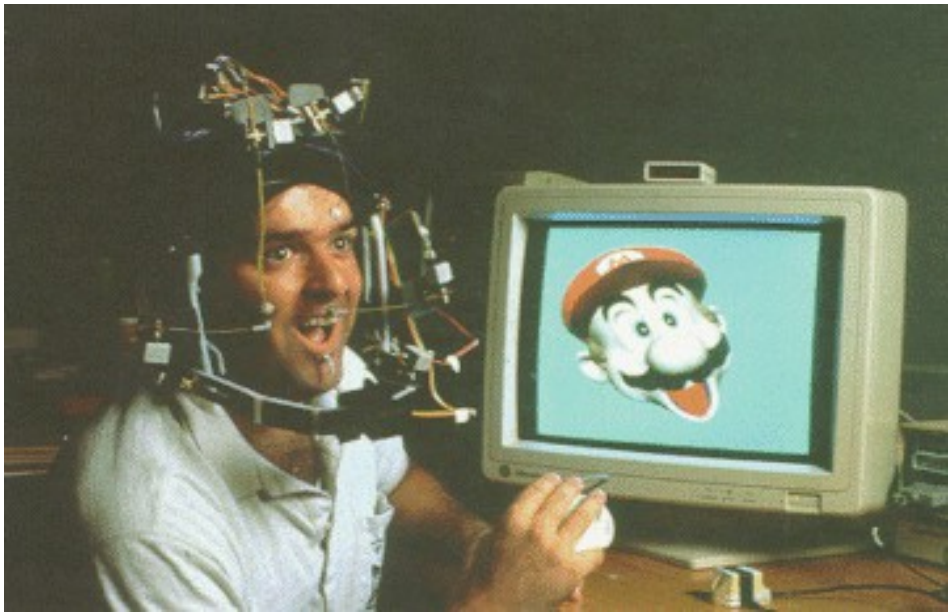
access to diagrams, parts lists, etc.

Boeing a prime example



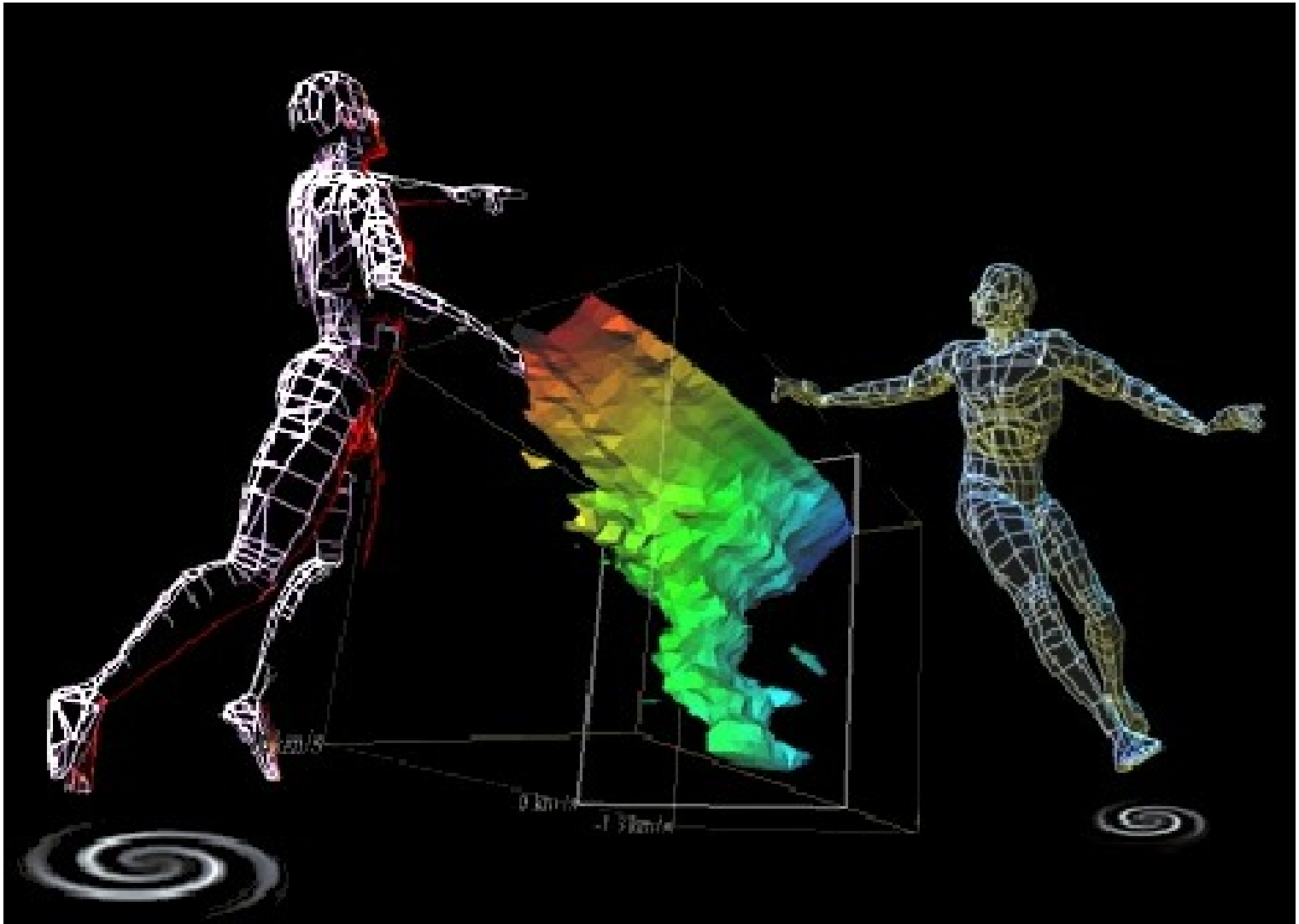
# Teleprisotnost

- project to a different place
- operate equipment or robots
- medicine apps
- exploration apps



# Tele Prisotnost :

Geografsko ločeno sodelovanje v simuliranem in prikazanem okolju

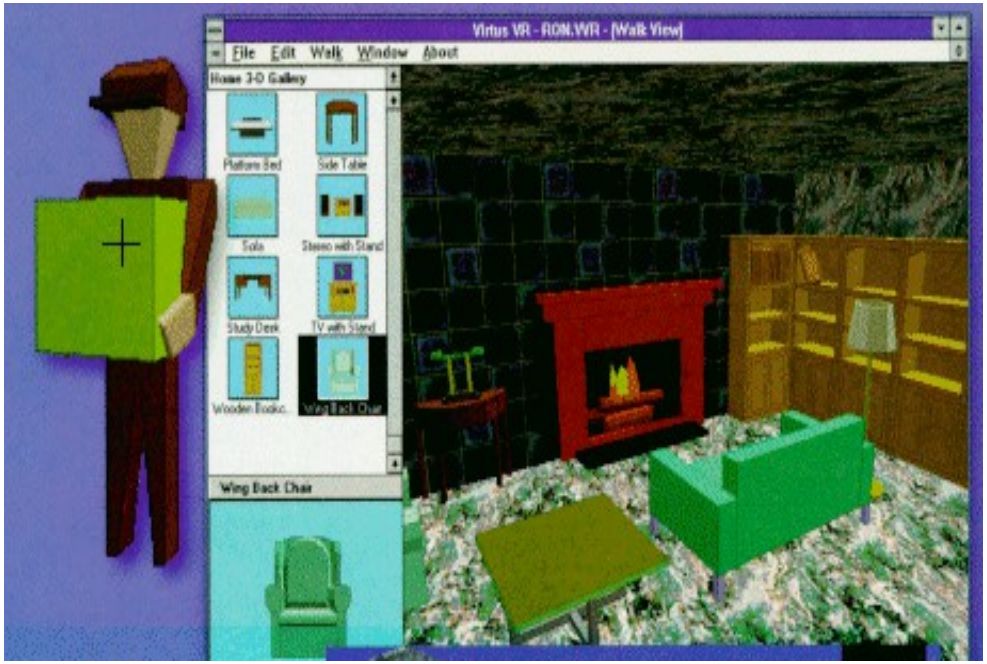


# Tele prisotnost

Občutek, da si
fizično prisoten
v računalniško generiranem
ali oddaljenem okolju

# Namizna navidezna resničnost (Desktop VR)

- uses personal computers
- usually cheaper
- immersive or not
- good for walkthroughs
- several software packages available



# Izhodne naprave

Visual

- Computer Screen, Head Mounted Display, Active Stereo, Passive Stereo (Imax), Cyberscope, Immersive Workbench, CAVE, Spherical Projection, Big Screen Technology, Visiondome, Reality Centre.

Audio (Stereo)

- Speakers, Earphones, Speech, Music

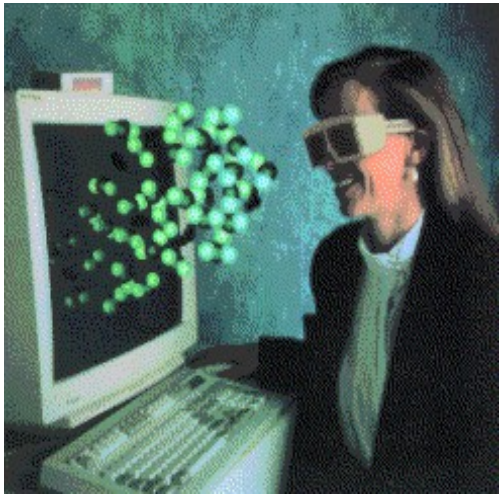
Tactile

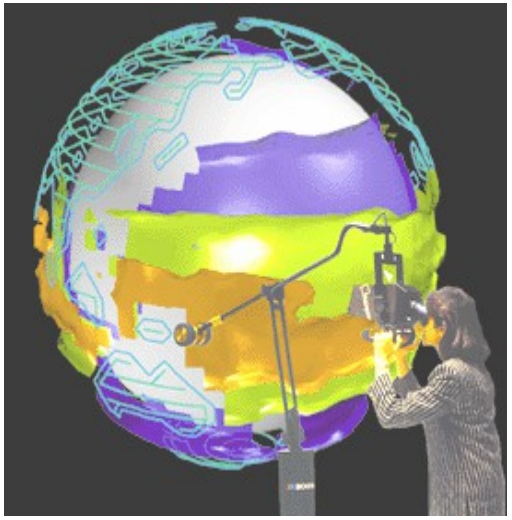
- PHANToM, ReachIn, Tactile Gloves

Motion

- eg. Flight Simulators and “rollercoaster” machines using pneumatic motion simulators

# Prikazovalniki





# Izhodne naprave-stereoskopska očala

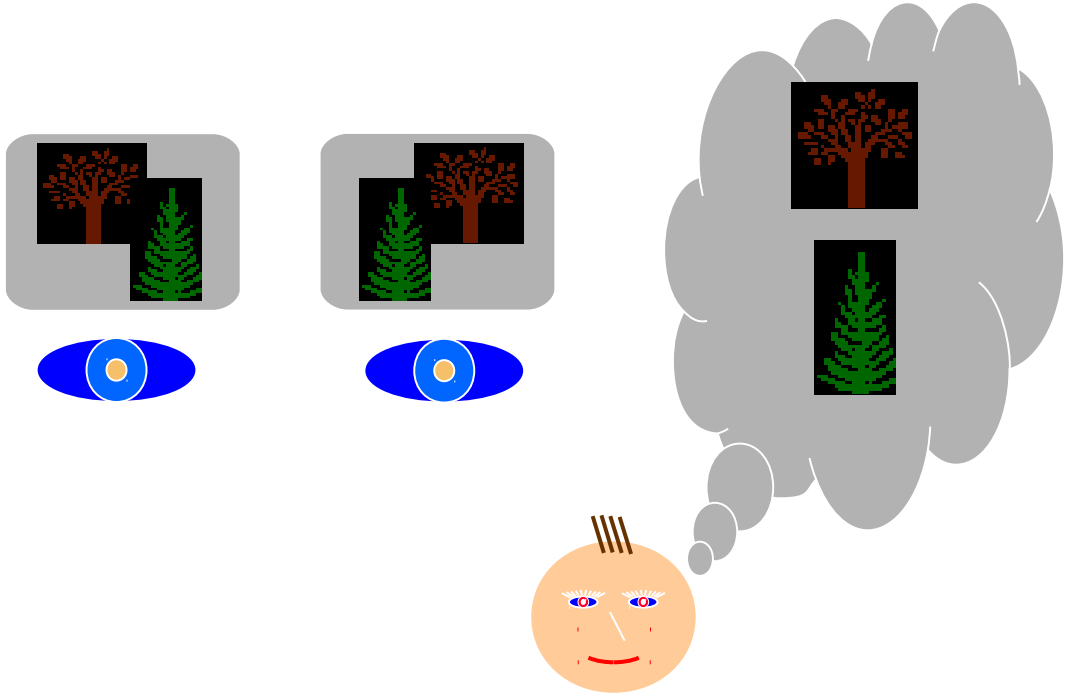
# Visual Coupled Displays

- most popular version
- various types of HMD
- gives immersive sensation
- includes head tracking often

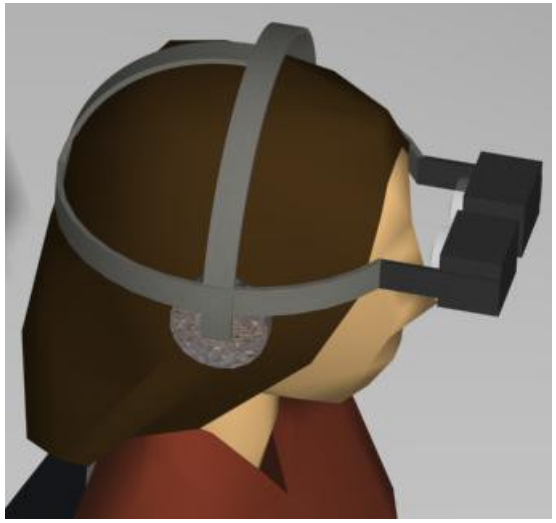
# Stereoskopska očala

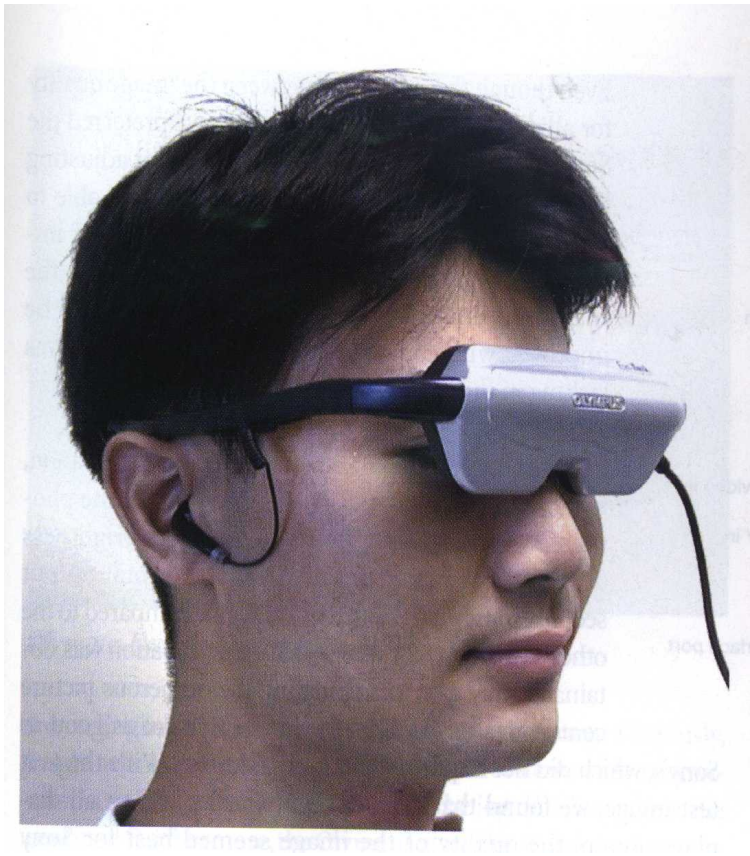
slightly different angles

3D effect



# Head Mounted Displays



# Vhodno-izhodne naprave -boom

# Karakteristike prikazovalnikov

FOV (Field of View): Angle subtended by the viewing surface from a given observer location

- Humans: 120H x 180V
- Related to Spatial Resolution
  (No. of Pixels that can be displayed in unit area)
- Related to Angular Resolution
  (Visual angle a pixel subtends from a particular location)

Refresh Rate

Brightness

Color

# Stereoskopija in občutek globine

We want Auto Stereoscopy

Occulo-motor Cues

- **Accommodation: changing shape of eye lens to focus Convergence: rotate eyes to fixate on object**
- **Accommodation and Convergence work together … but ...**

Binocular Disparity: Difference in retinal images due to projection of objects at different depth

- **Depth is felt with respect to an object in focus**
- **Screen Parallax must be (re) computed based current fixation poi t to get right disparity feeling**

Motion Parallax: Differential angular velocity of objects at different depth from observer (close objects move more rapidly than far objects)

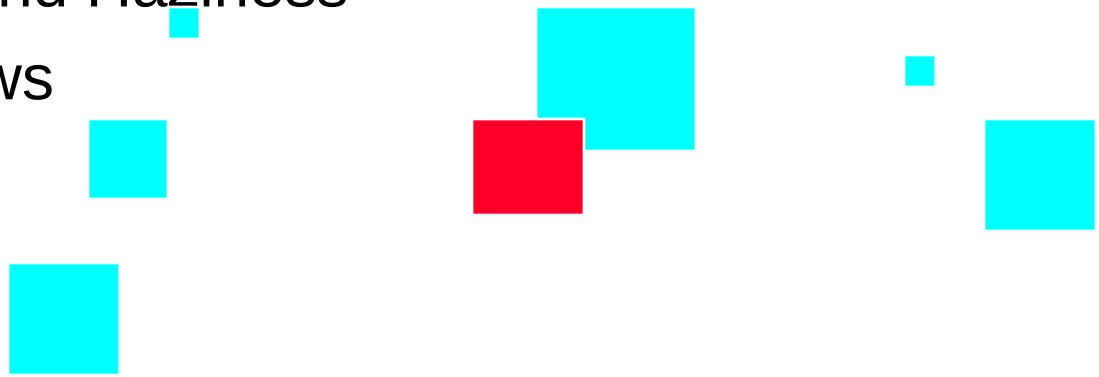
Perspective

Occlusion

Height in Field of View and Relative Size

Color and Haziness

Shadows



Cues are usually additive

# Display Systems

Anaglyphs / Polarized Glasses

HMD: Accommodation / Convergence Conflict

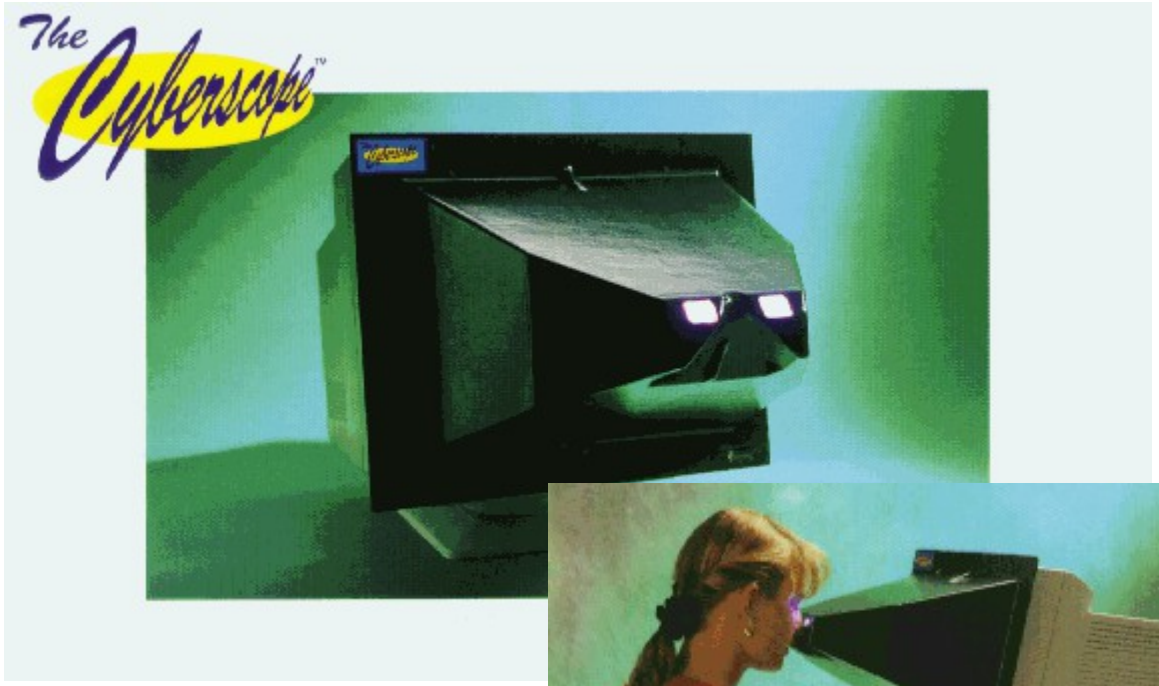
Time Multiplexed (Crystal Eye): Front Object Clipping

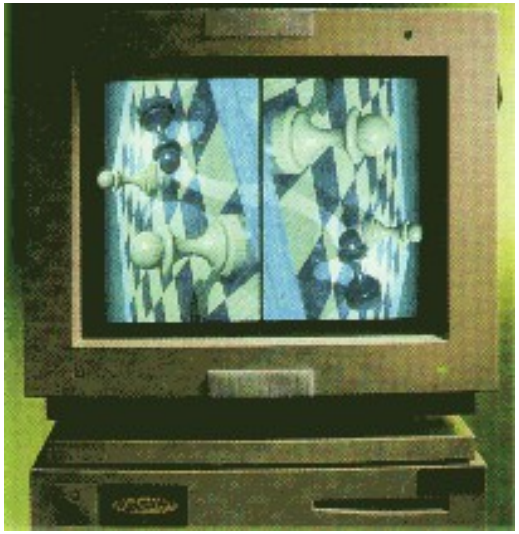
Boom: Hand(s) Occupied

Retinal Display

Fully / Semi / Non Immersive

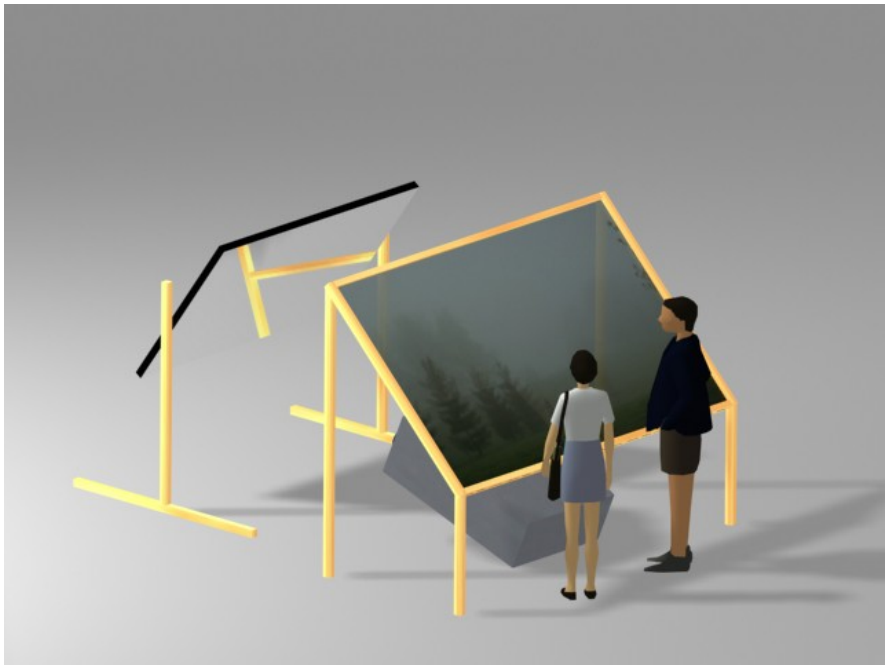
# Cyberscope



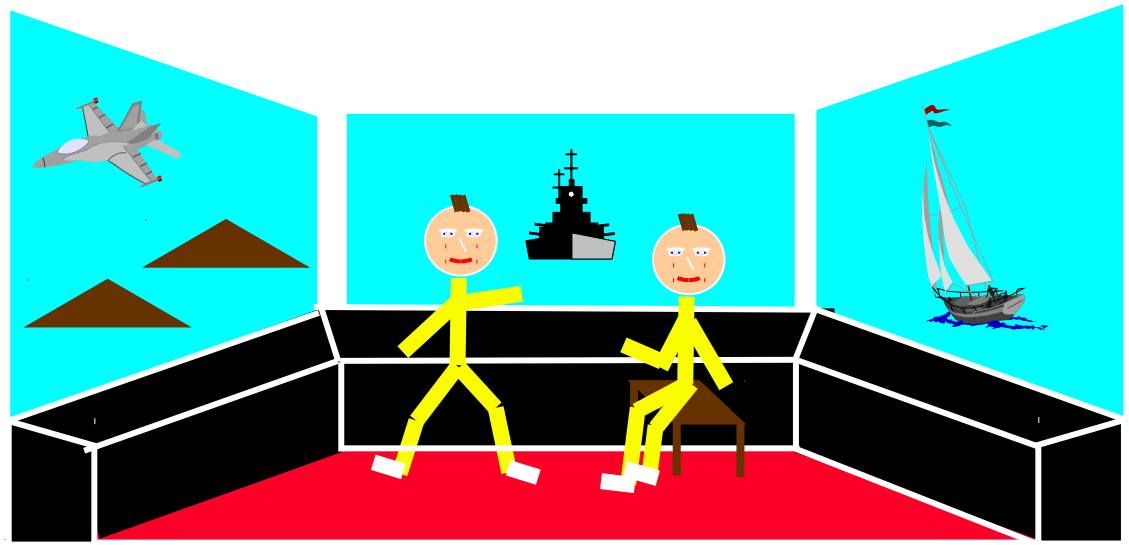
GO BAC

# Immersive Workbench



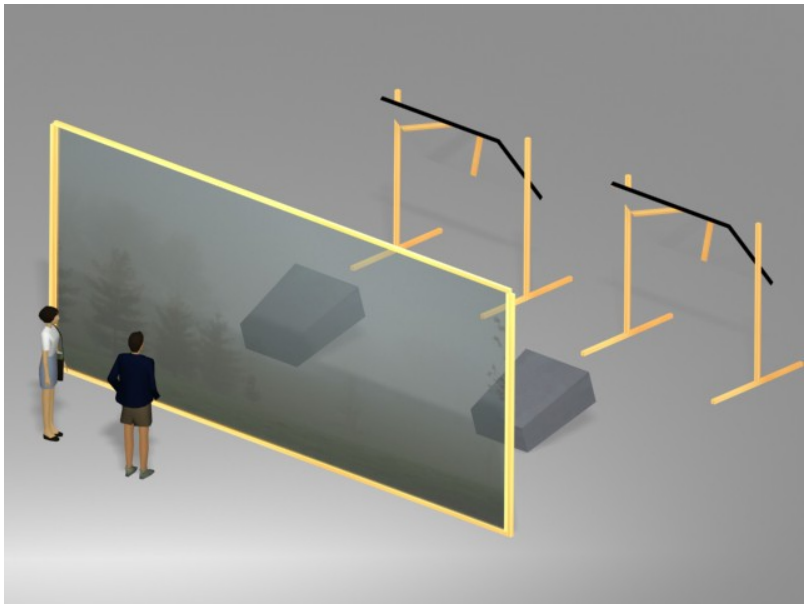
# inside VR

- scenes projected on walls
- realistic environment
- hydraulic rams!
- real controls
- other people

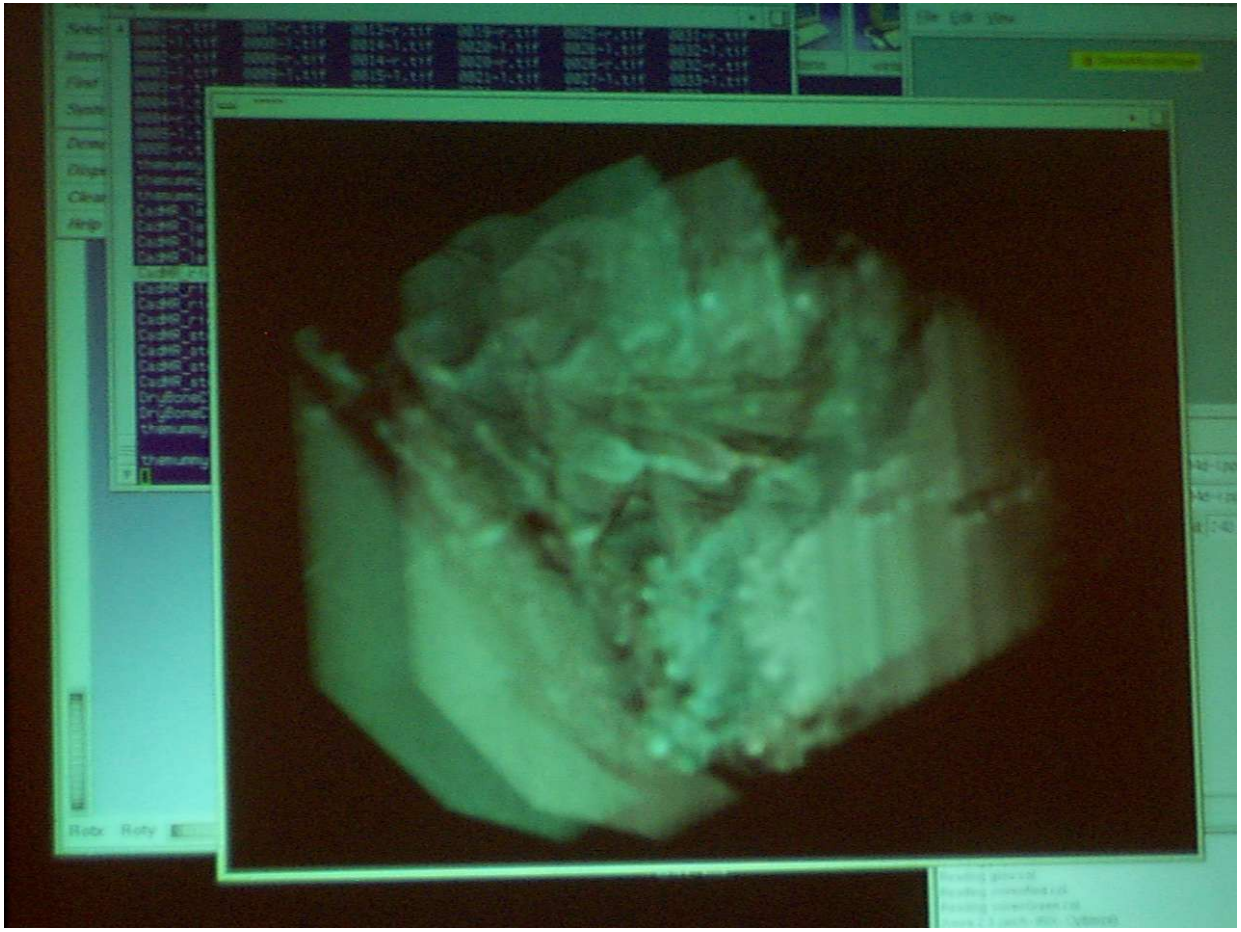


Demo

# Immersive Work Wall

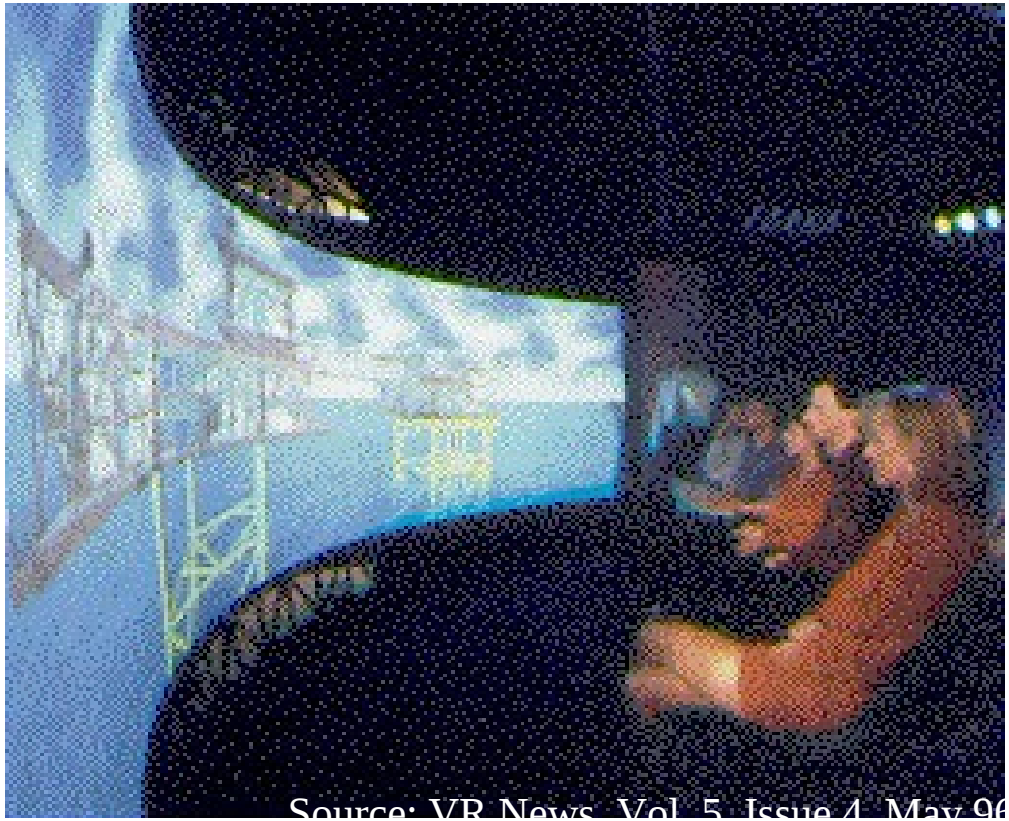


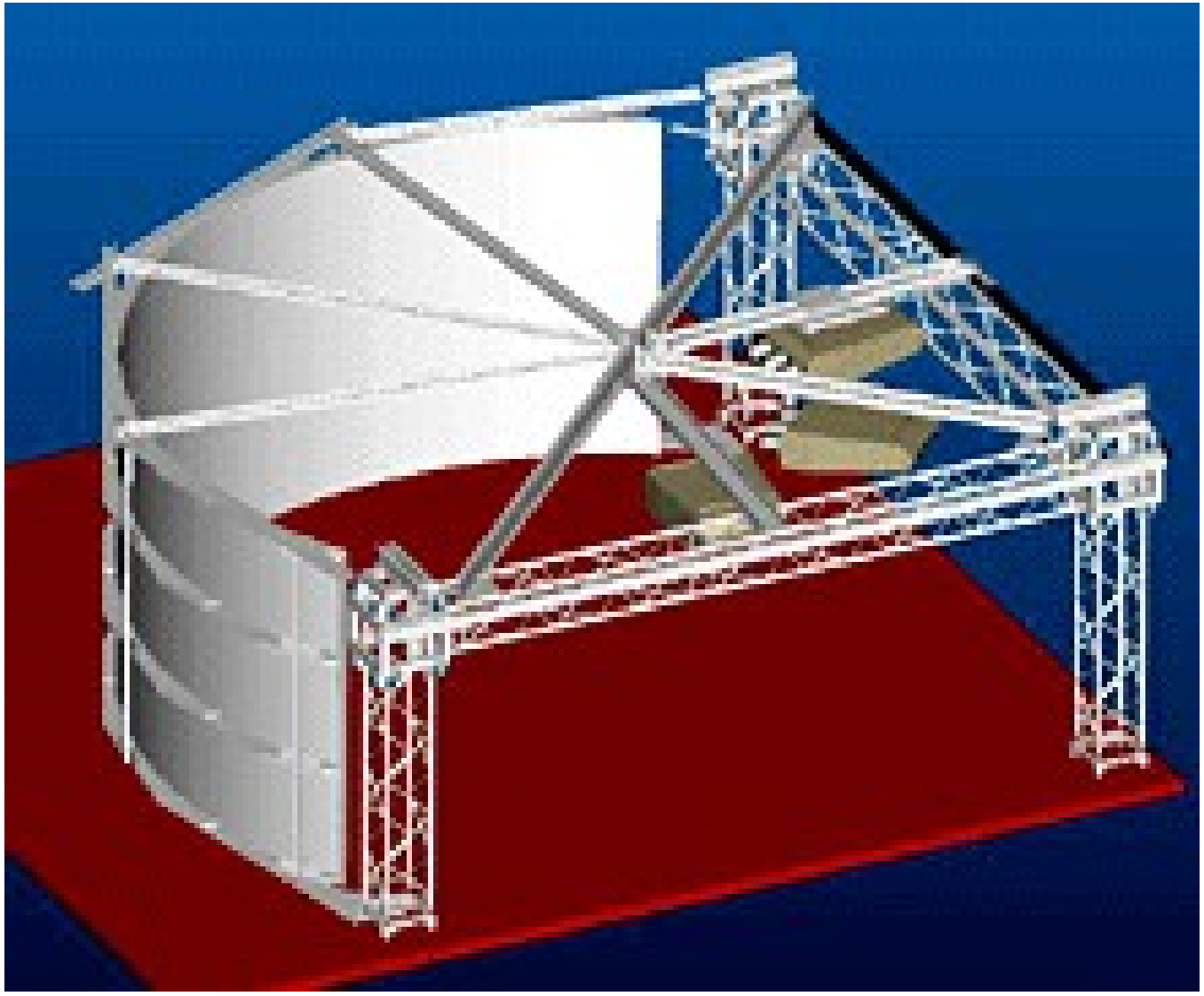
# Stereoskopska projekcija



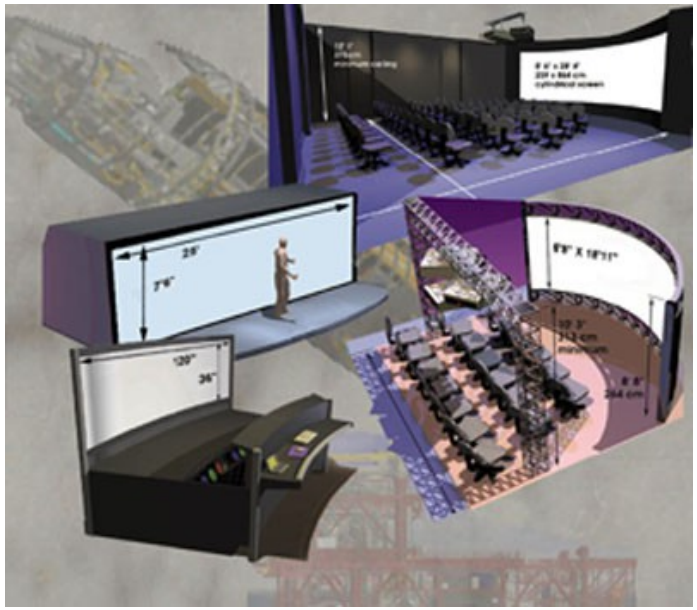
# Spatially Immersive Displays

- theater environment
- designed for large groups
- non-immersive or immersive
- most popular is the “CAVE”



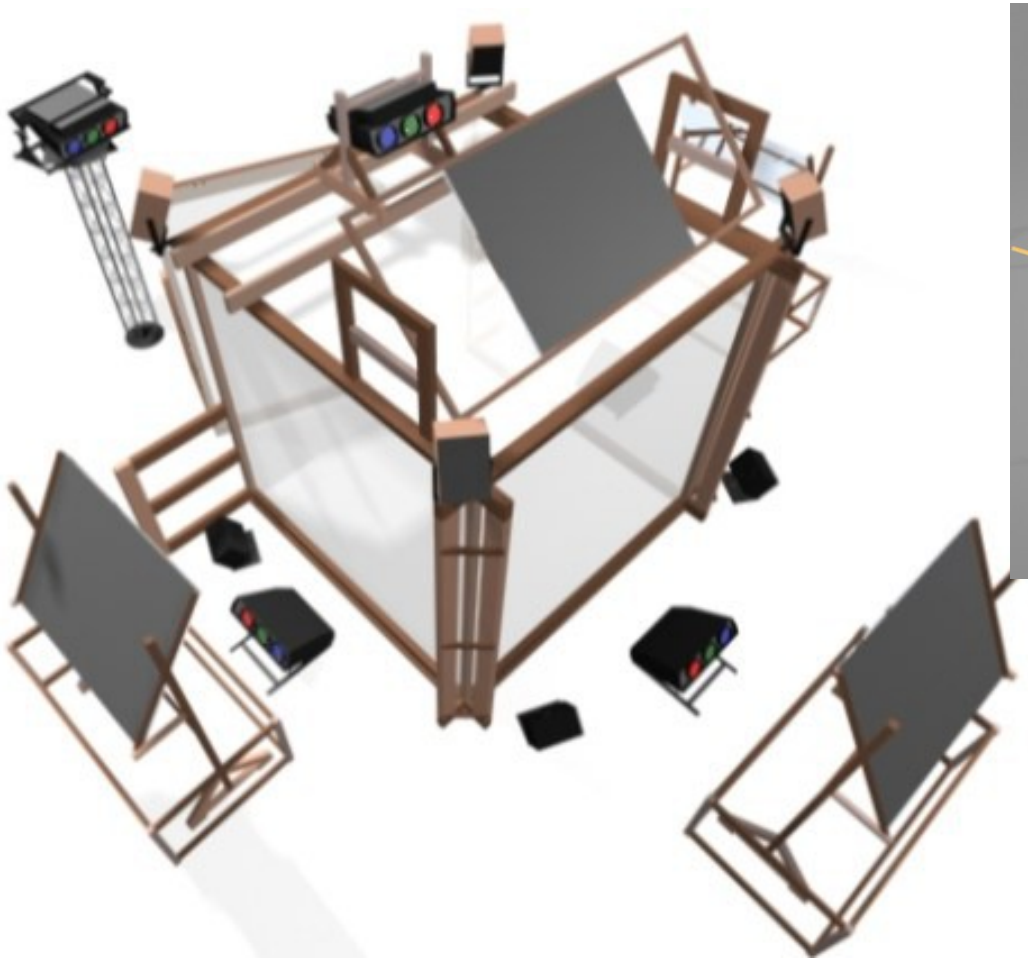


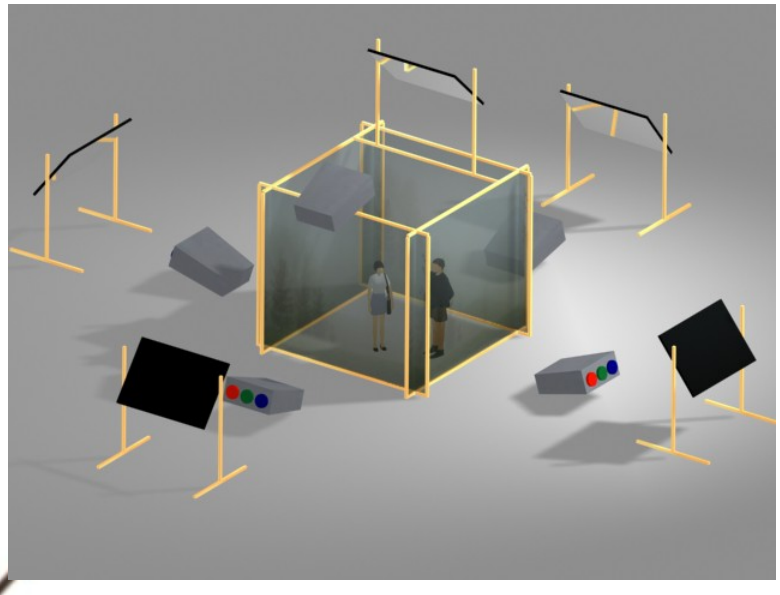
# Reality Center



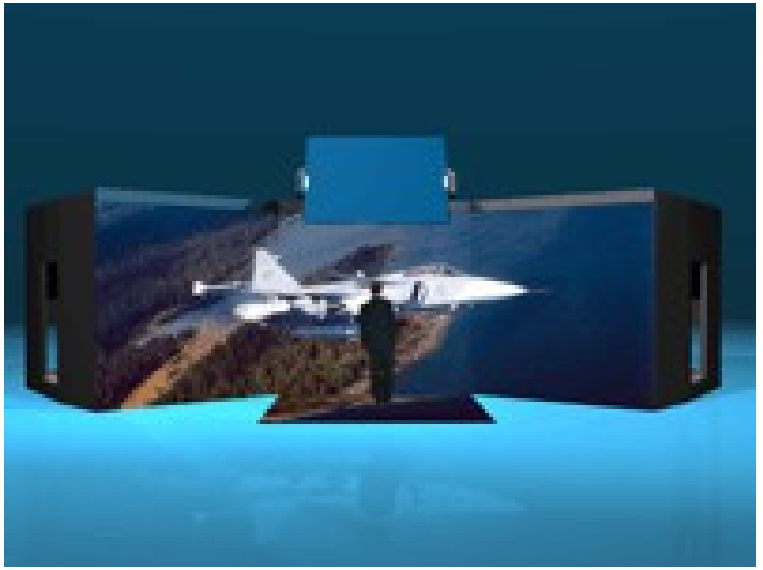

Video

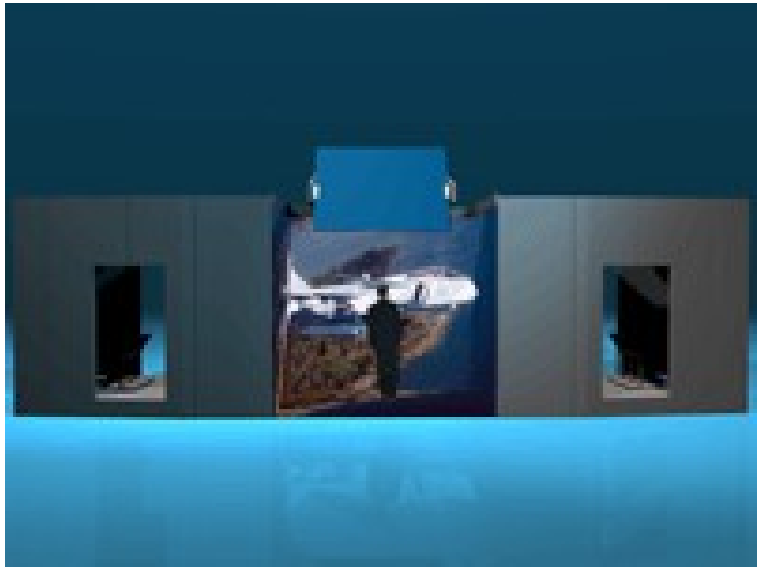
# CAVE oziroma CUBE

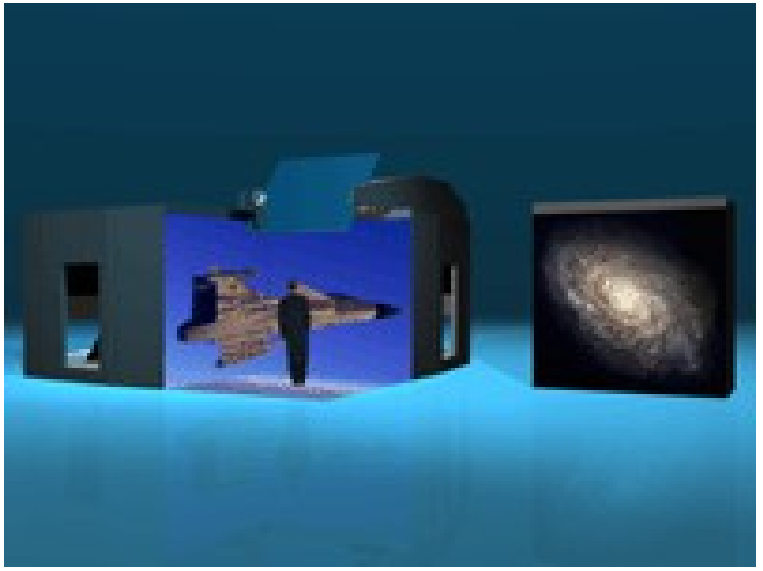




# RAVE

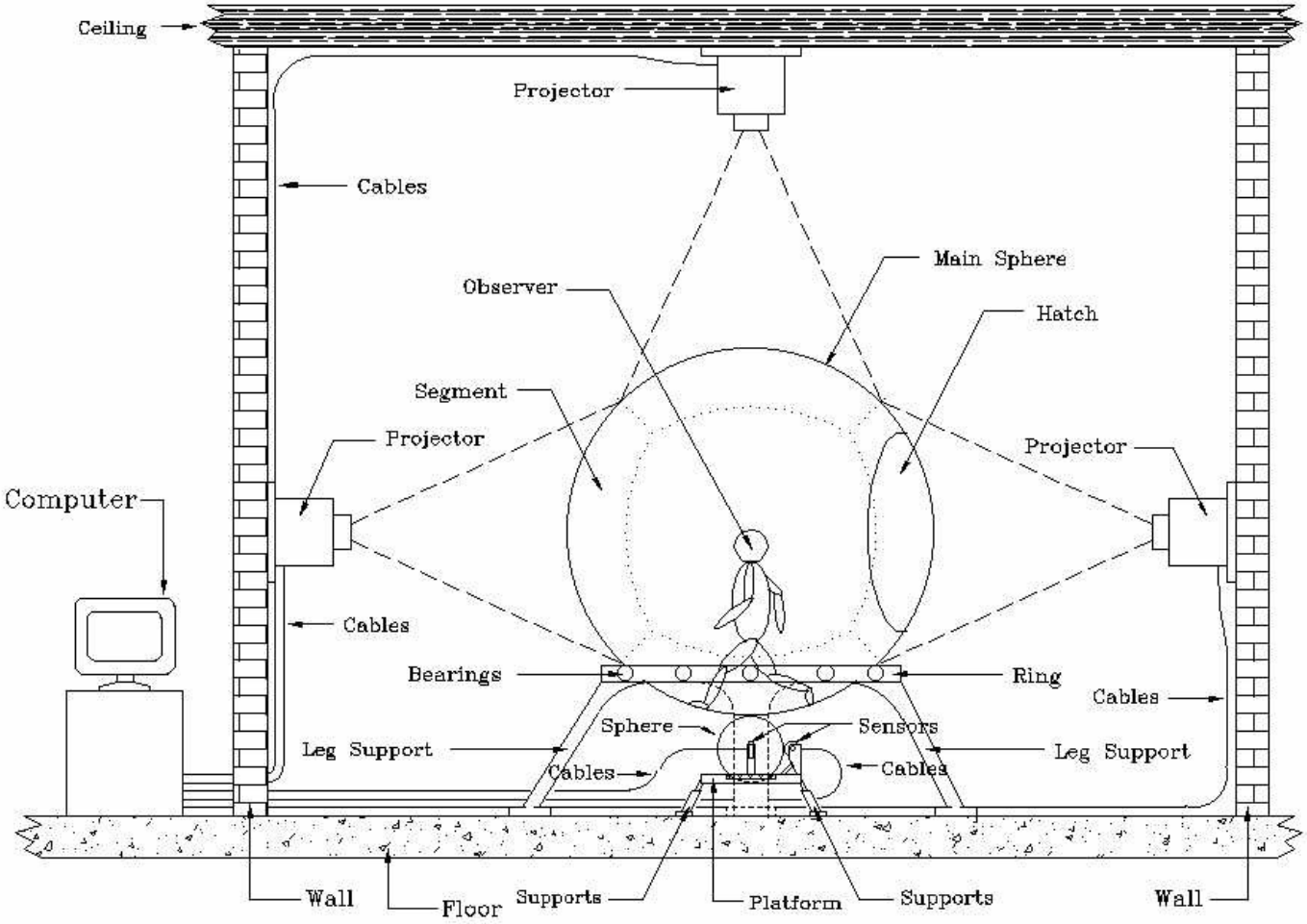




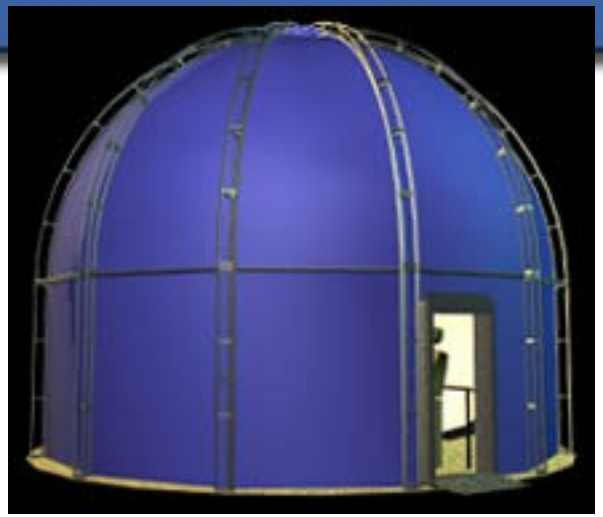


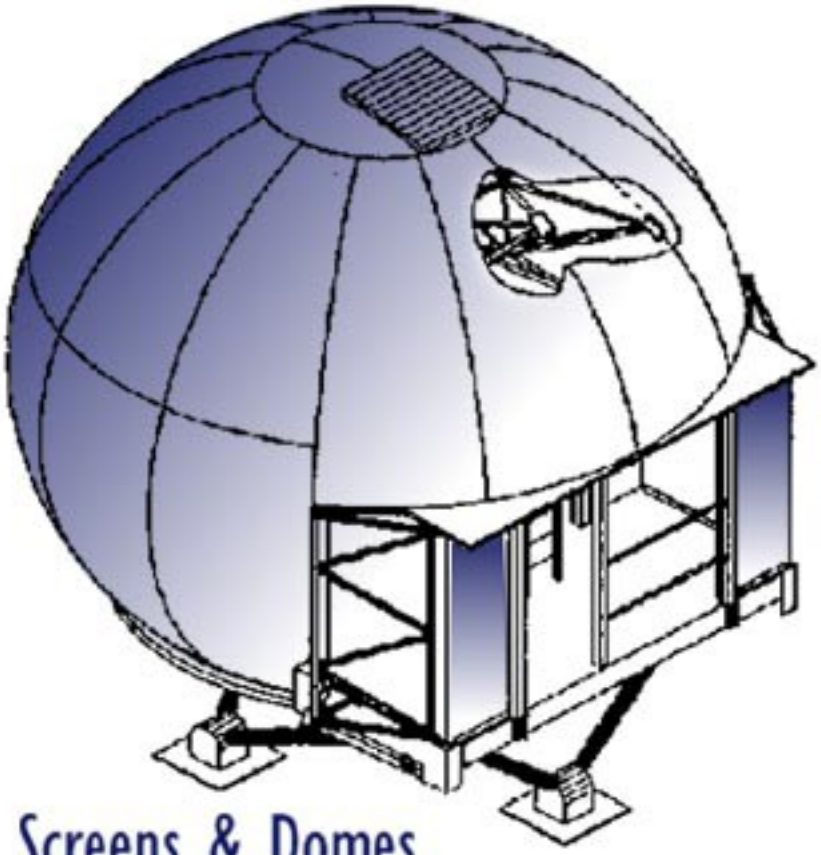
# RAVE

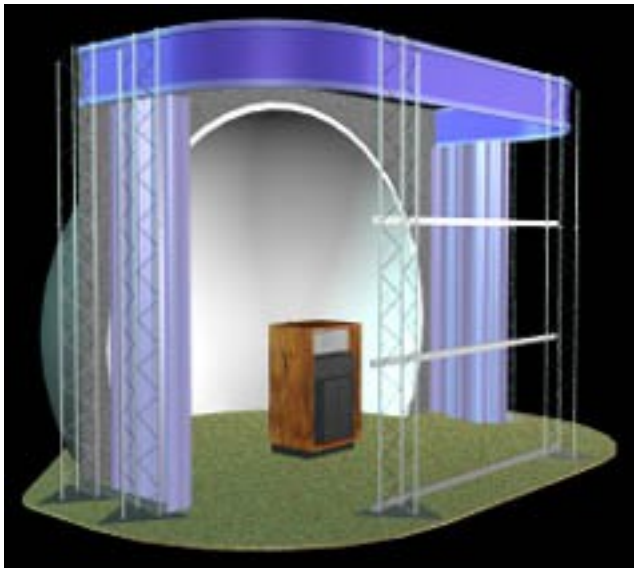
# Sferična projekcija



# VisionDome





# Skalabilne in porazdeljene aplikacije

- Individual (1-2)
  - *Desktop*
  - *Head Mounted Display (HMD)*
- Small Group (3-8)
  - *Workspace (e.g. ImmersaDesk)*
- Moderate Sized Course (25-35)
  - *Fakespace RAVE*
  - *Reality Center*
- Auditorium (200-500)
  - *Stereoscopic Projection*

# Uporabimo vsa čutila

sight:

- visual realism,  3D effects: shadows, etc.,

sound:

- surround sound, sub-seat woofers etc.

touch:

- haptic and force feedback,

and more … wind, … burning rubber!

# PHANToM (http://www.sensable.com)

# ReachIn

(http://www.reachin.se)

# Prikaz zvoka

Types

- **simple : beep sound**
- **iconic : simple wave sound**
- **natural sound : recorded and synthesized (sound rendering)**

Issues

- **localization and sonification**

  **3D/stereo sound, HRTF (Head Related Transfer Functions)**
- **graphics and audio synchronization**
- **setup methods : headphone, speakers …**

# Tactile/Haptic Display

Main types

- **ground referenced : Phantom**
- **body referenced : CyberGrasp**
- **tactile : CyberTouch**

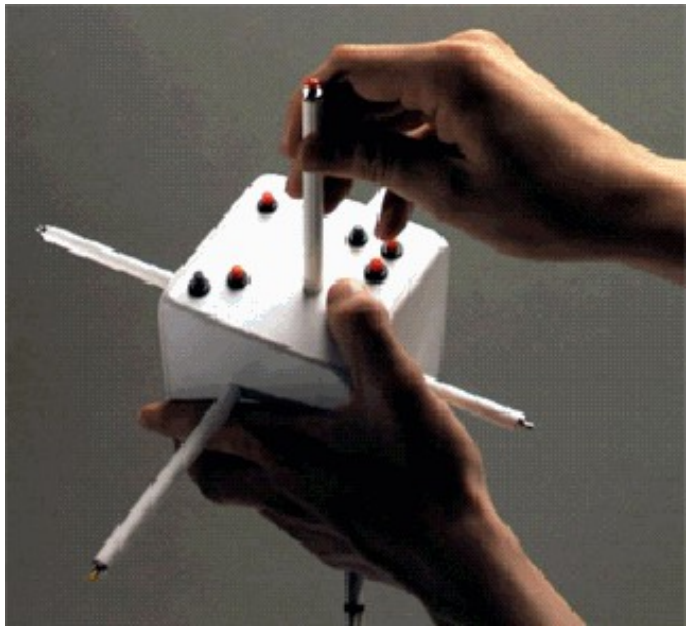
Issues

- **producing the mechanical device**

Interface design

- **must be useful for manipulation**
- **make it non intimidating**
- **mimic real world interaction**

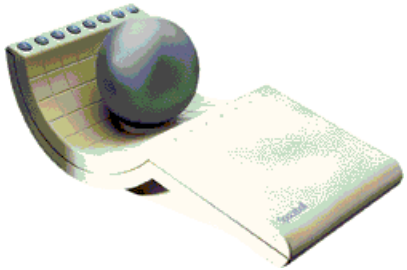
# Vrste navigacijskih naprav



# Vhodne naprave

DataGlove and Bodysuit

Mouse, Joystick, Keyboard, 3D Mouse



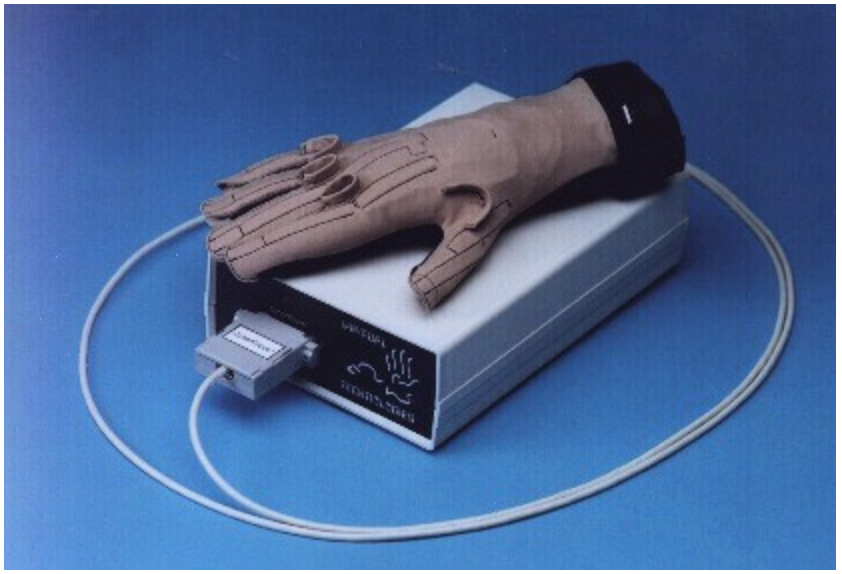
Movement Trackers (eg Polhemus)

Gesture Recognition (with DataGlove)

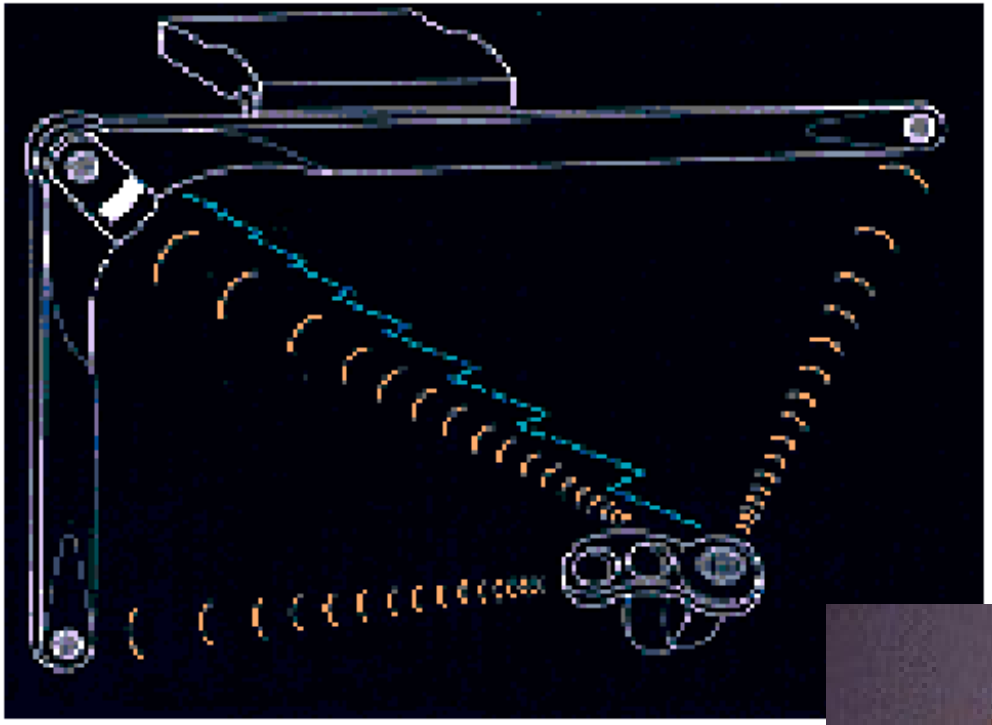
Speech Recognition

# Rokavica

# Cyberglove (http://www.virtex.com)

# Ultrazvočni naprstnik (ringMouse)



# Tracker Systems - Polhemus

(http://www.polhemus.com/)


# Diskretne vhodne naprave

Main features

- **generate one event at a time based on the user**
- **examples**

  **keyboard, Pinch Glove**

Interface design

- **useful for discrete command interface**

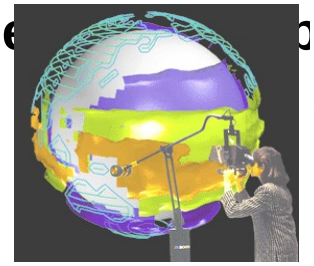
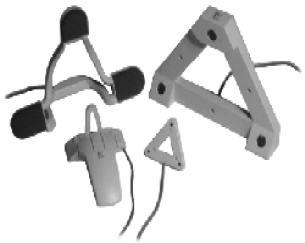
# Zvezne vhodne naprave

Trackers

- **types : magnetic, mechanical, acoustic, inertial, vision/camera, hybrids**
- **interface design**

  **correspondence between physical and virtua worlds**

Dataglove


# Kombinacija naprav in govora

Combination/Hybrid devices

- **mouse, joysticks, tablets, space mouse, ring mouse, fly mouse, BAT, Wand, Flex and Pinch …**
- **interface design**

  **consider DOF for users interaction**


Speech input

- **requires more stable recognition technology**

  **word-level : user-independent**

  **sentence-level : more training, noise**
- **interface design**

  **very convenient input**

  **ideal for “multimodal” interaction**

# Napotki za izbiro vhodnih-izhodnih naprav

Think about what interaction techniques are required

Think about inter-restriction of input devices and output devices

Practically money is a big factor

- **designing restricted interaction techniques with given devices Vs. buying more advanced devices**
- **Or, make new devices for accomplishing interaction techniques?**
- **Also can we assume that**

  **constraints of VR devices will practically disappeared in near future ?**

  **3D devices will become basic like the mouse ? (Space ‘2050)**

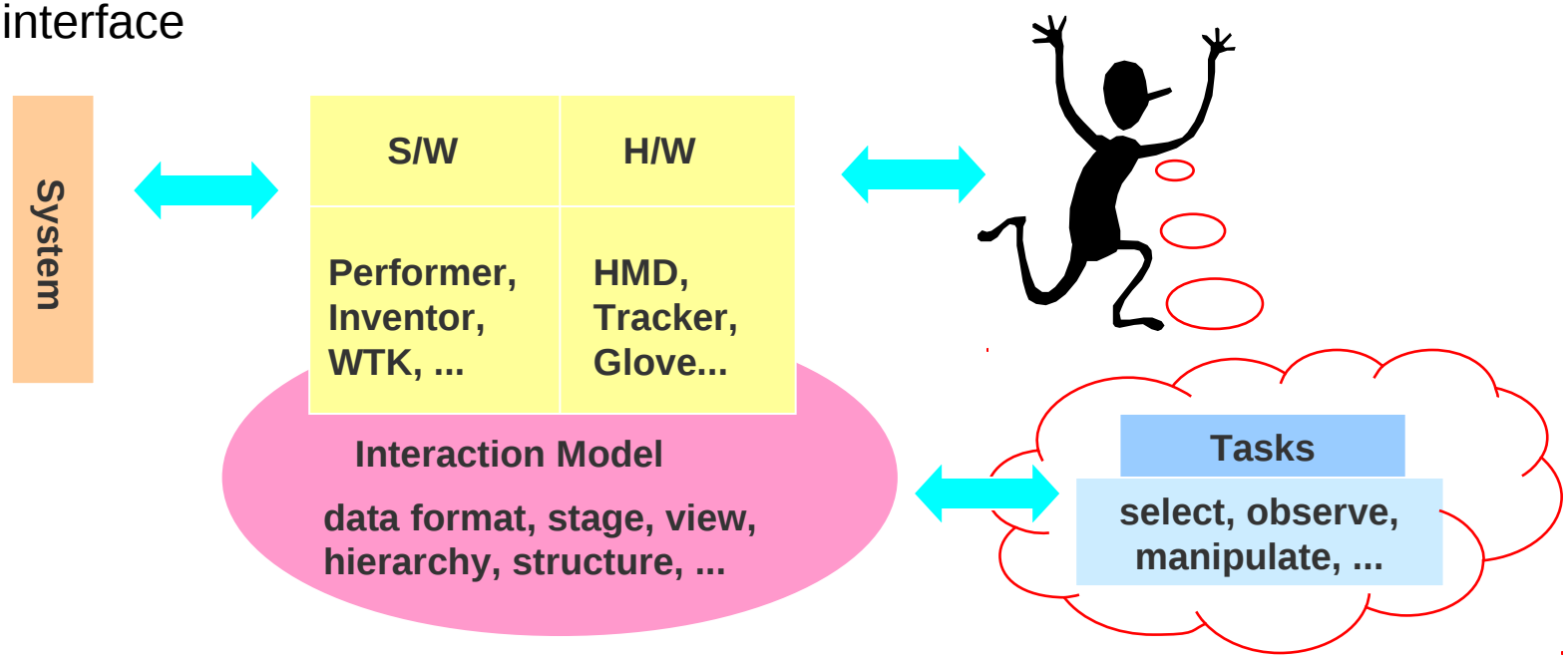
# 3D Multimodalna interakcija

Why 3D / Multimodal ?

- **Immersion (Presence), Naturalness(Cognitive Load), Speed/Efficiency**

Interface: specialized choice of hardware / software through which a user communicates with a computer system

Interaction: a model by which a user accomplishes some tasks via the interface



# Sodeluje naj celo telo

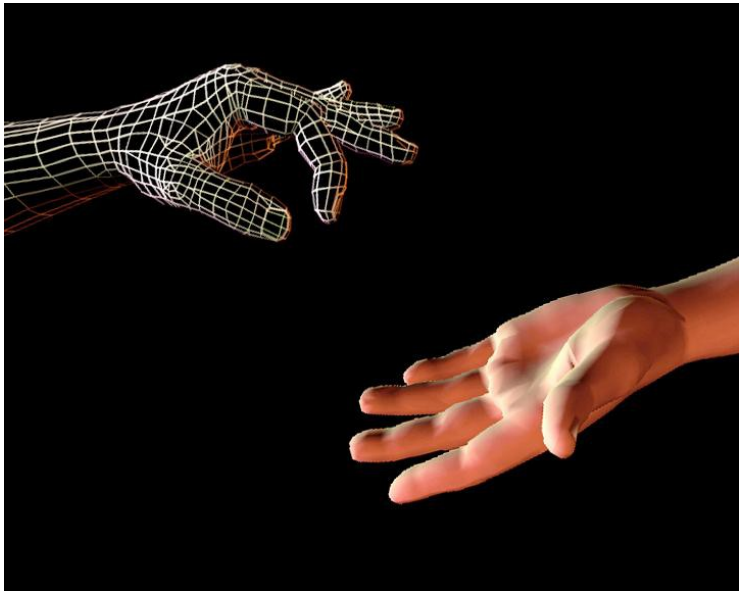
realistic devices

movement in the environment

interaction and control of objects,

rapid feedback …

more important than photo-realism



# Cilji in proiblemi pri načrtovanju vmesnikov

Performance
- **efficiency, accuracy and productivity**
- **quantitative measures**

Usability
- **easy to use and learn**
- **qualitative experience**

Applicability

Problems:
- **not enough Guidelines**
- **multimodal**
- **changing technologies**

# Naloge interakcije

Navigation: travel, walk, way-finding

Selection: choosing one or more objects

Manipulation: specification of object position, orientation, scale, shape, others
(Selection $\subset$ Manipulation ?, Menu Selection ?)

Others : almost atomic (chunked) tasks

- Visual information browsing
- Measurement
- Data input
- Following / Flow control

# Kaj je potovanje?

the motor component of navigation

movement between 2 locations, setting the position (and orientation) of the user’s viewpoint

the most basic and common VE interaction technique, used in almost any large-scale VE

# Naloge potovanja

## Exploration

- travel which has no specific target
- build knowledge of environment

## Search

- naive: travel to find a target whose position is not known
- primed: travel to a target whose position is known
- build layout knowledge
- move to task location

## Maneuvering

- travel to position viewpoint for task
- short, precise movements

# Metafore potovanja (navigacije)

steering: continuous specification of direction of motion
- gaze-directed
- pointing
- physical device (steering wheel, flight stick)

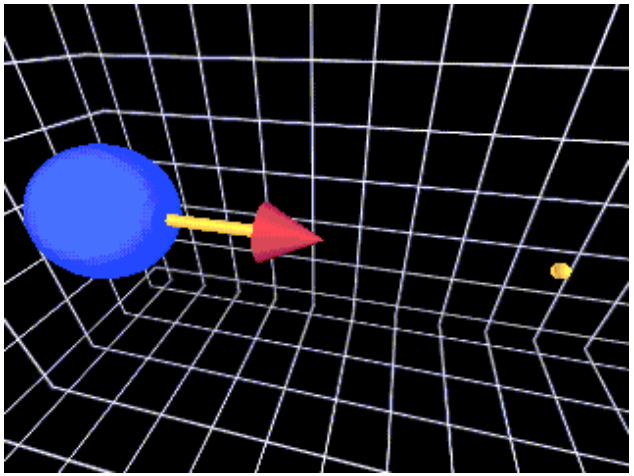
target-based: discrete specification of goal
- point at object
- choose from list
- enter coordinates

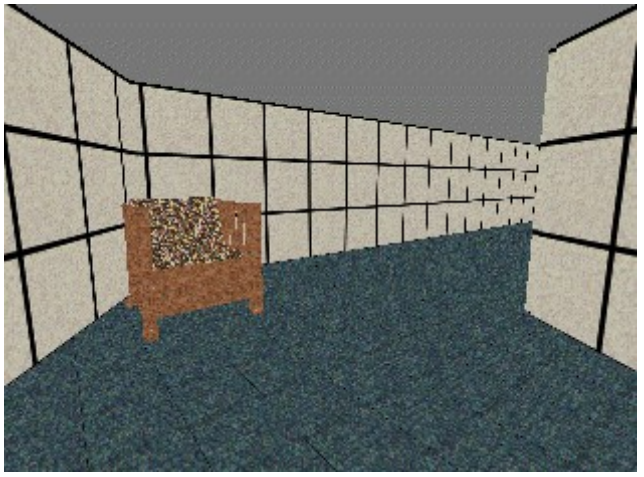
route planning: one-time specification of path
- place markers in world
- move icon on map

manual manipulation of viewpoint
- “camera in hand”
- fixed object manipulation

# Klasifikacija potovanja (navigacija)

- Direction/Target Selection
  - Gaze-directed steering
  - Pointing/gesture steering (including props)
  - Discrete selection
    - Lists (e.g. menus)
    - Environmental/direct targets (objects in the virtual world)
  - 2D pointing
- Velocity/Acceleration Selection
  - Constant velocity/acceleration
  - Gesture-based (including props)
  - Explicit selection
    - Discrete (1 of N)
    - Continuous range
  - User/environment scaling
  - Automatic/adaptive
- Input Conditions
  - Constant travel/no input
  - Continuous input
  - Start and stop inputs
  - Automatic start or stop





# Tehnike navigacije (2)

Steering : direction and velocity

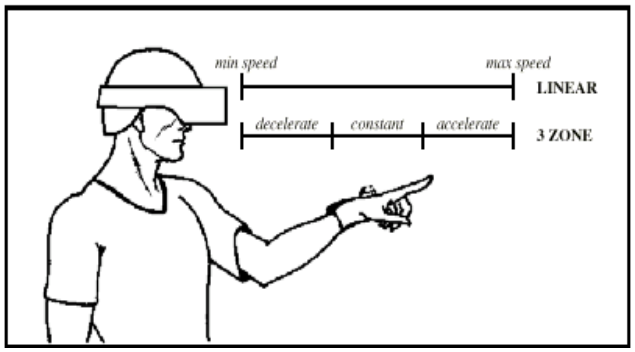
- **hand-directed**
- **gaze-directed *(boljščanje)***
- **physical devices (steering wheel, flight sticks)**

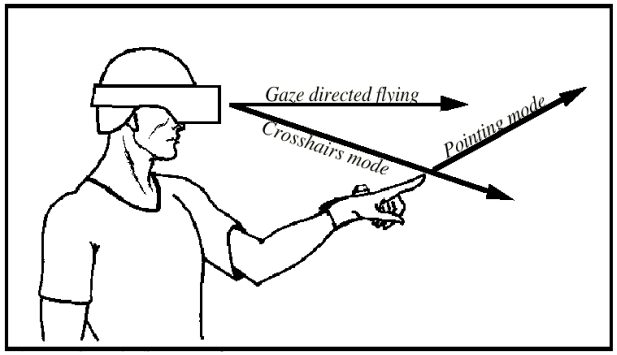
Target-based

- **point at object, list of coordinates**

Route planning

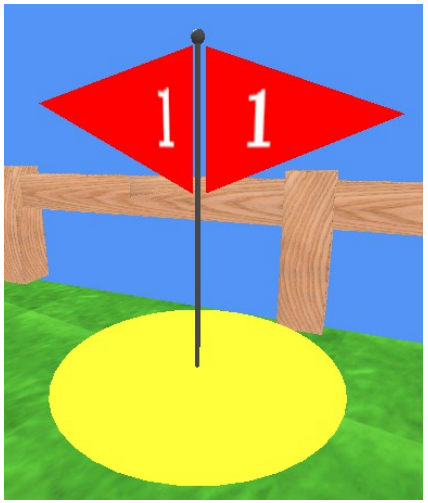
- **place markers in world**

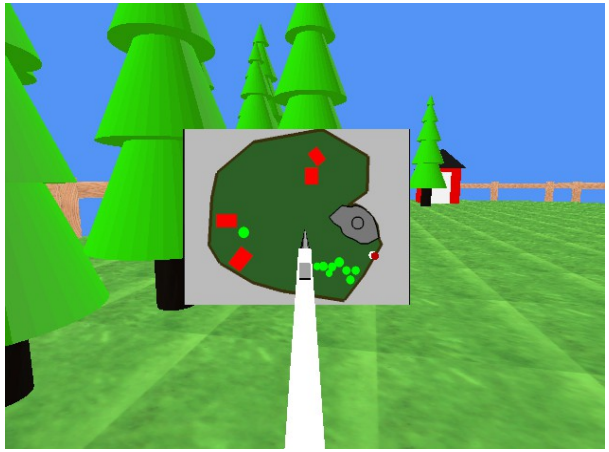


# Primernost tehnik

- Object manipulation-based techniques very efficient for relative motion
- Manipulation-based techniques not requiring an object efficient for search, but tiring
- Steering techniques best for naïve and primed search (both egocentric tasks?)
- Map-based techniques not effective in unfamiliar environments, or when any precision is required



# Miti

*There is one optimal travel technique for VEs.*

*A “natural” technique will always exhibit more performance, usability, and usefulness than another technique.*

*Desktop 3D, workbench, and CAVE applications should use the same travel ITs as HMD-based VEs.*

# Napotki za načrtovanje navigacije

*Make simple travel tasks simple (target-based techniques for motion to an object, steering techniques for search).*

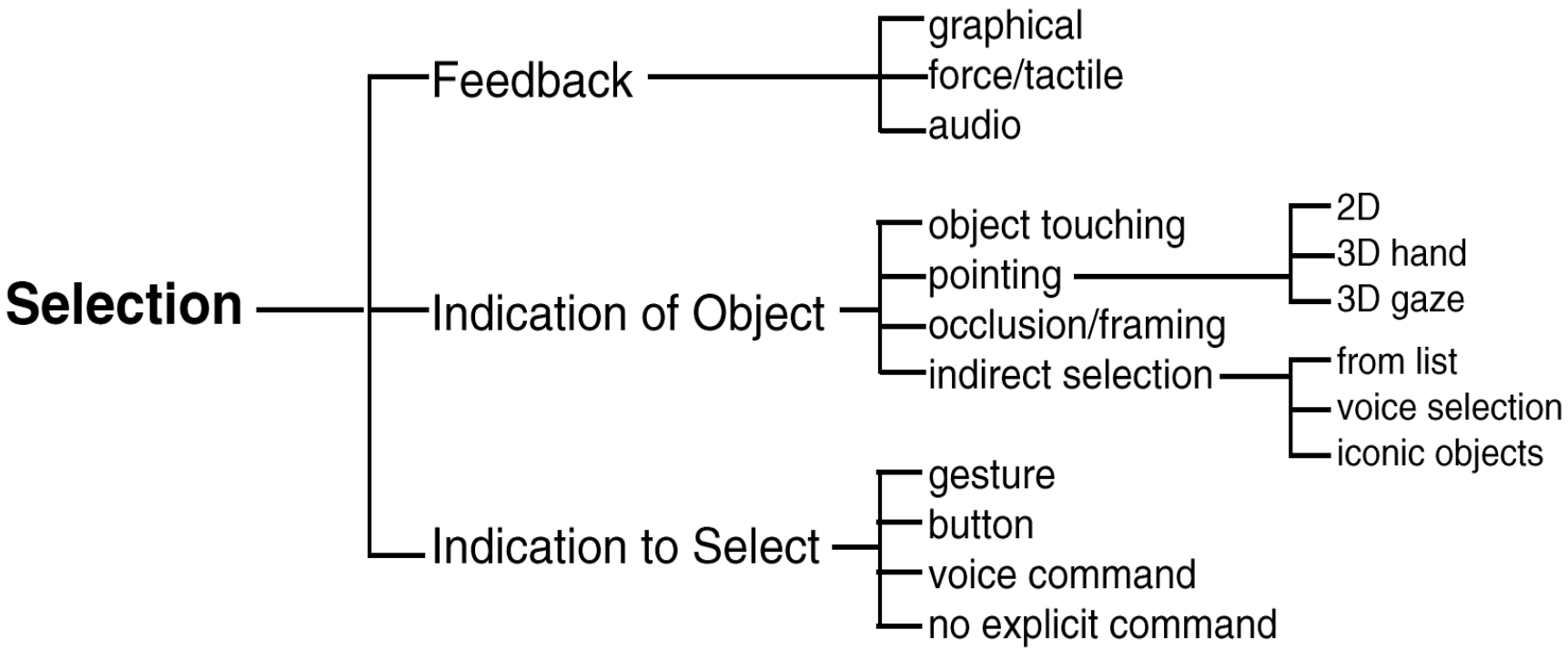
*Provide multiple travel techniques to support different travel tasks in the same application.*

*Use graceful transitional motions if overall environment context is important.*

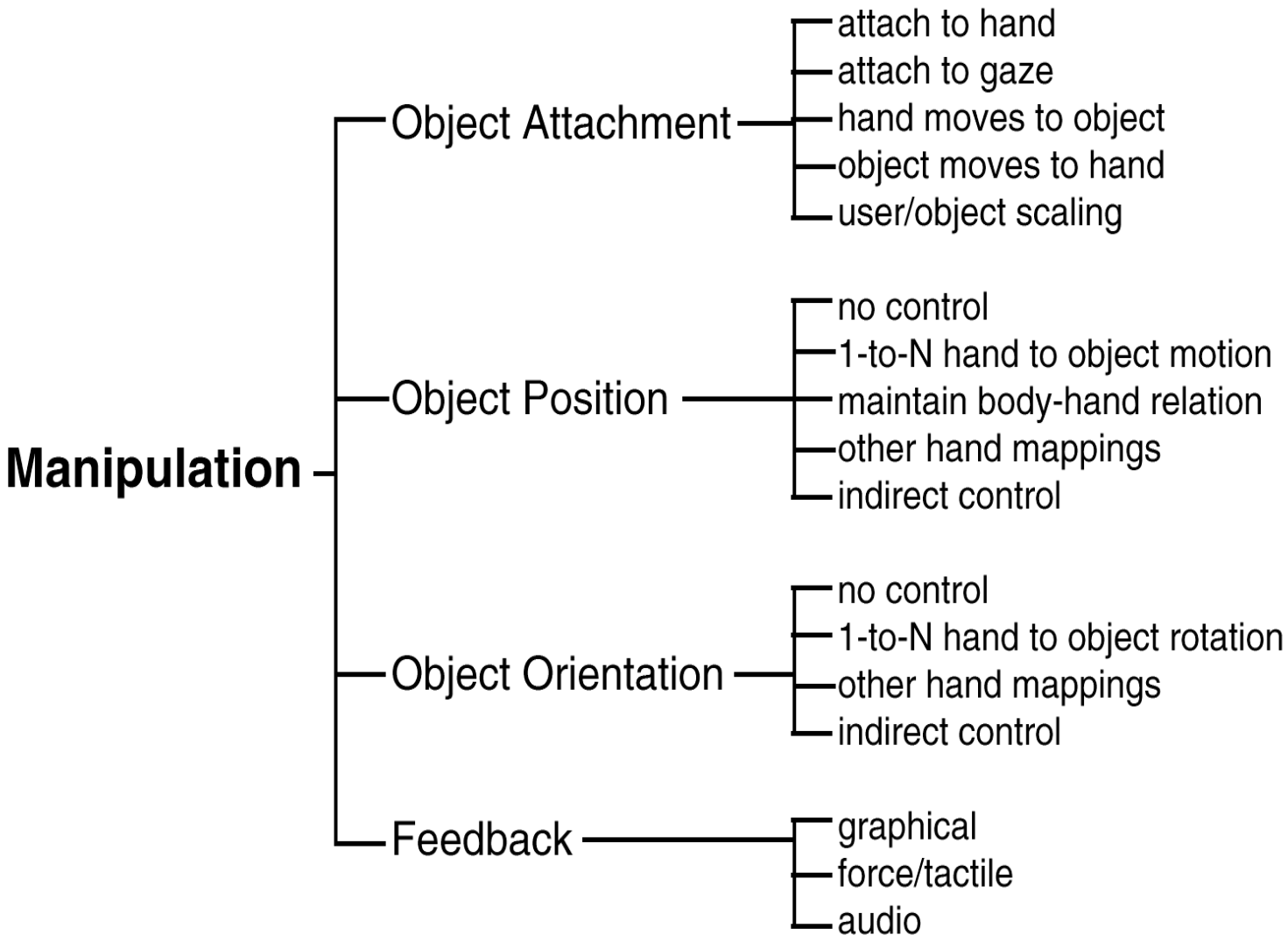
*Train users in sophisticated strategies to help them acquire survey knowledge.*

*Consider integrated (“cross-task”) ITs if travel is used in the context of another task (e.g. manipulation).*

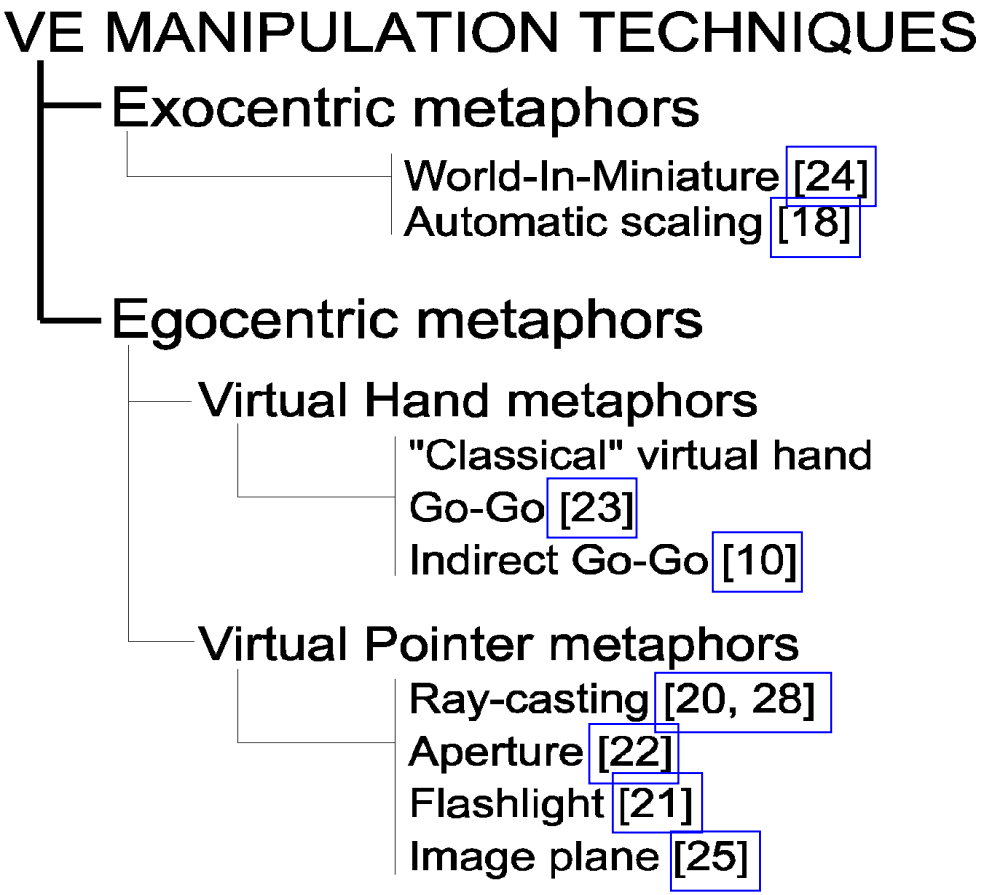
# Klasifikacija izbiranja



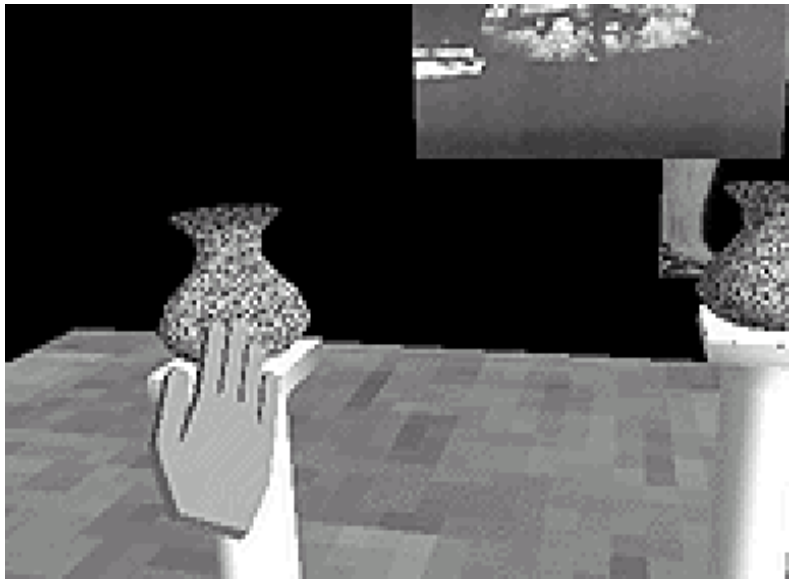
# Klasifikacija rokovanja (1)



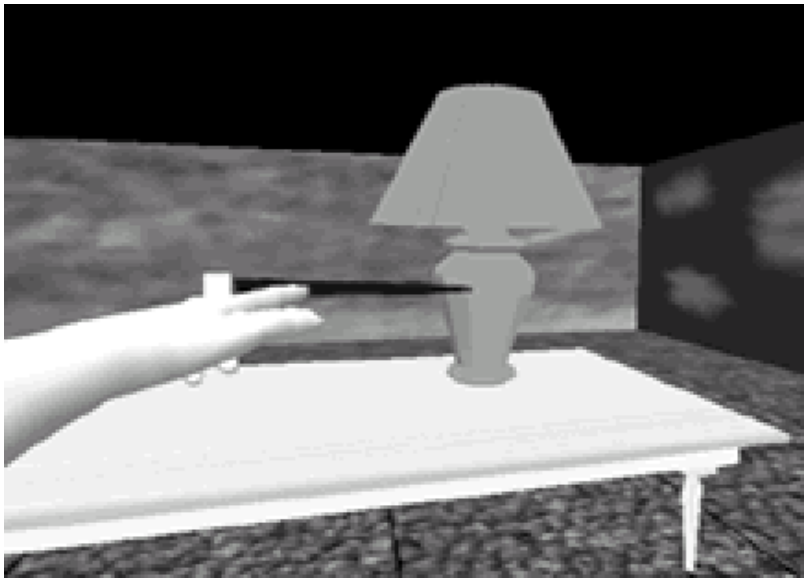
# Klasifikacija rokovanja (2)



# Tehnike izbiranja/rokovanja (1)



**“Simple” Virtual Hand**

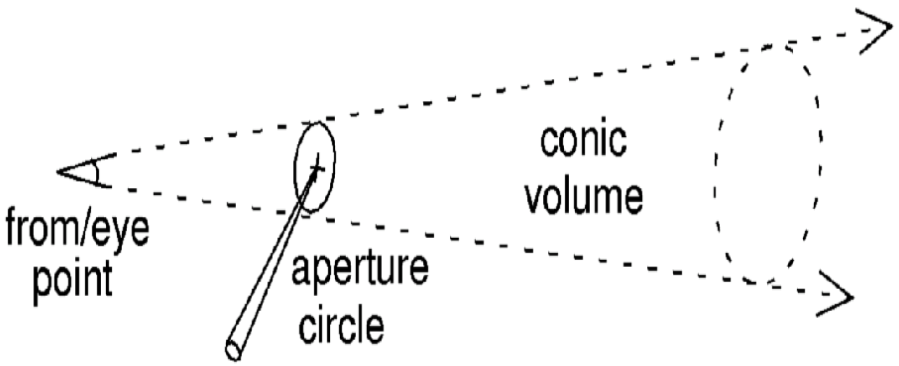


**Ray-casting (Bolt, 1980)**

Demo

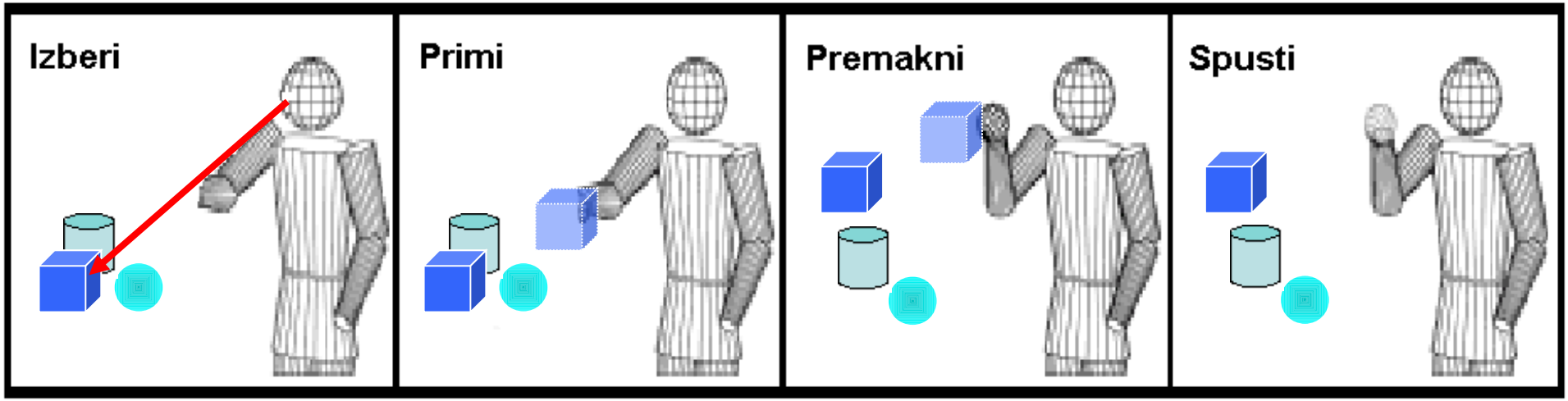
# Tehnike izbiranja/rokovanja (2)

**Spotlight (Liang, 1994)**



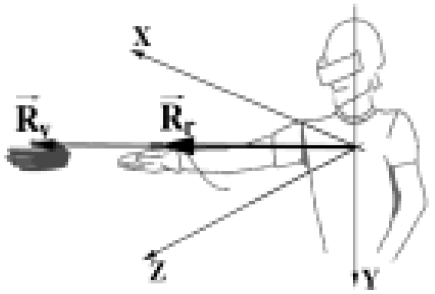

**Aperture (Forsberg, 1996)**

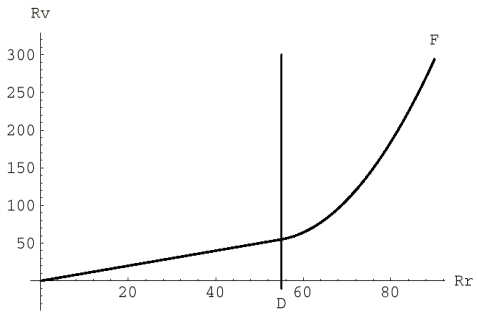
# Tehnike izbiranja/rokovanja (3)



# Tehnike izbiranja/rokovanja (4)

**World-in-Miniature (Stoakley, 1995)**




**Go-Go (Poupyrev , 1996)**

# Druge tehnike interakcije

Multimodal

Training: Ghost Metaphor

Music / Control:
e.g. Conducting, Dance, Instrument-based

Menu Selection

Composite Tasks

Display as Feedback Information

Passive and Active Haptics / Reduced Haptics

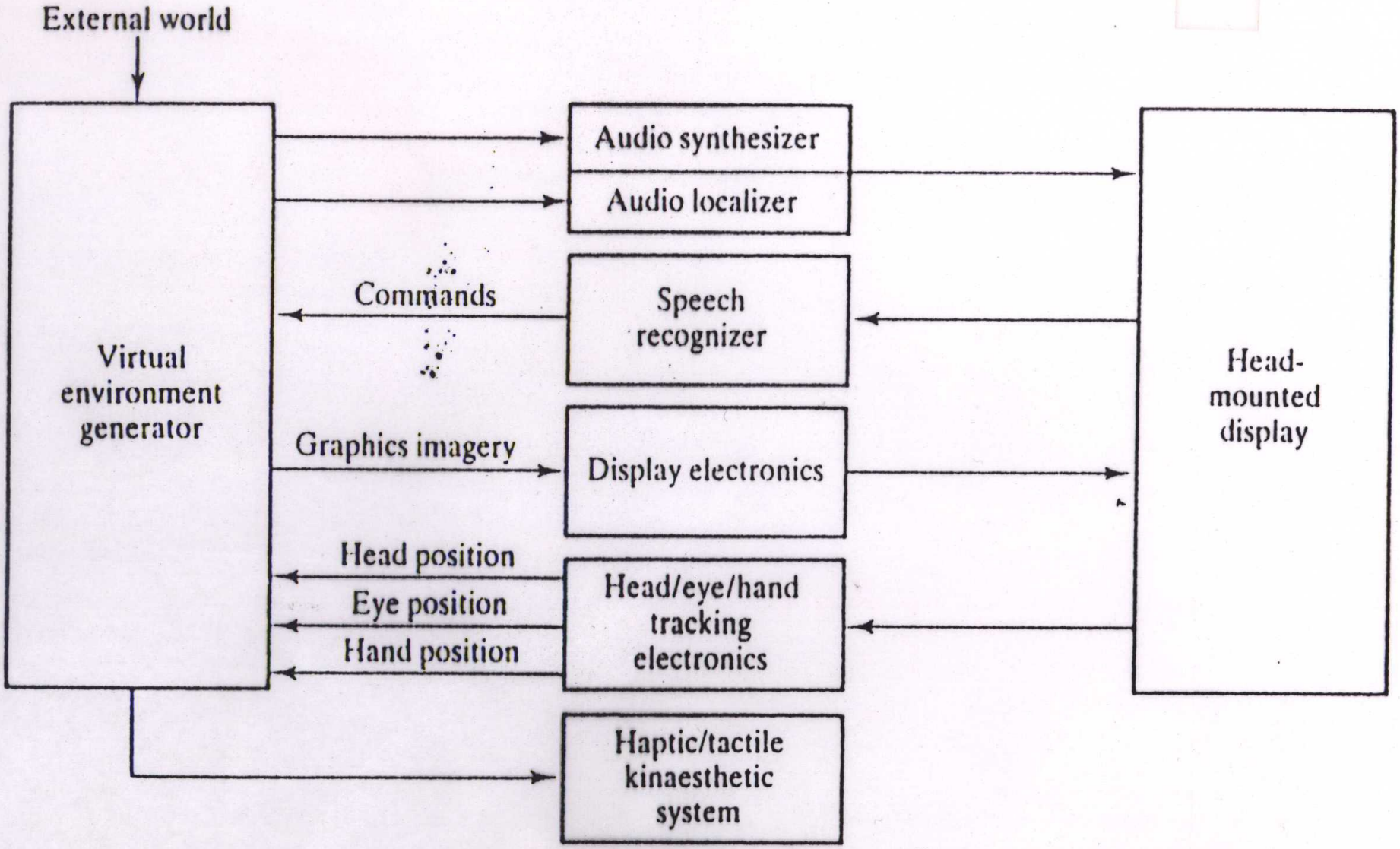



**Figure 1.6** Immersive virtual man–machine interface.

# Building a VE starts with Modeling

VR Software:
"Make specs, then design and code …"

- **Concurrent Consideration of Form / Function / Behavior**
  - **Form: Outer Appearance (Geometric Models) and their configuration**
  - **Function: Primitive things that objects do**
  - **Behavior: How primitive functions interact to achieve higher level tasks**
- **Real Time Properties**
- **Incremental and Hierarchical Development**
- **Generation of LOD's**
- **Reuse of VR Components**

# Internet in sodelavna navidezna okolja

Collaborative VirtualEnvironments (CVE)

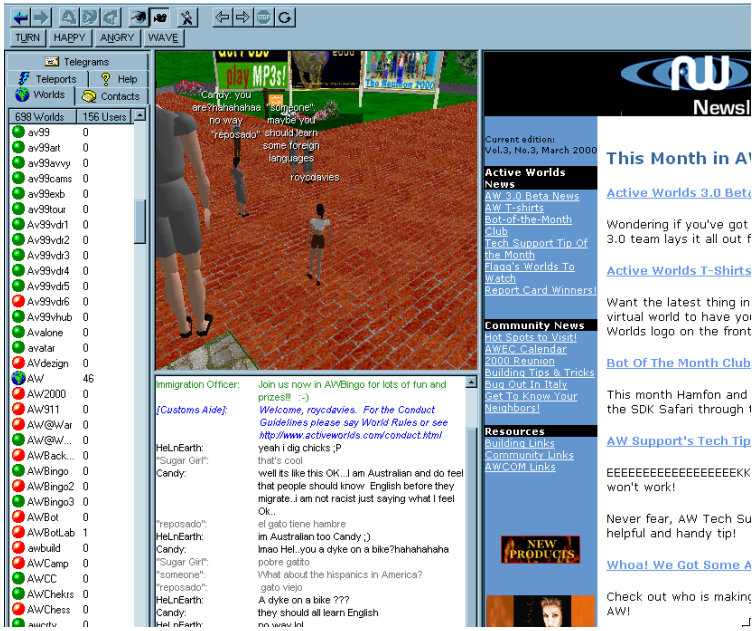
Shared WorldS
(http://www.activeworlds.com)

Sense8 WorldUp

Adobe Atmosphere

Quest3D

Cult3D

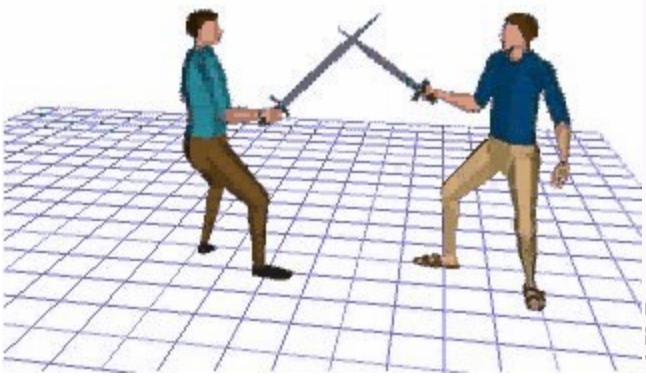


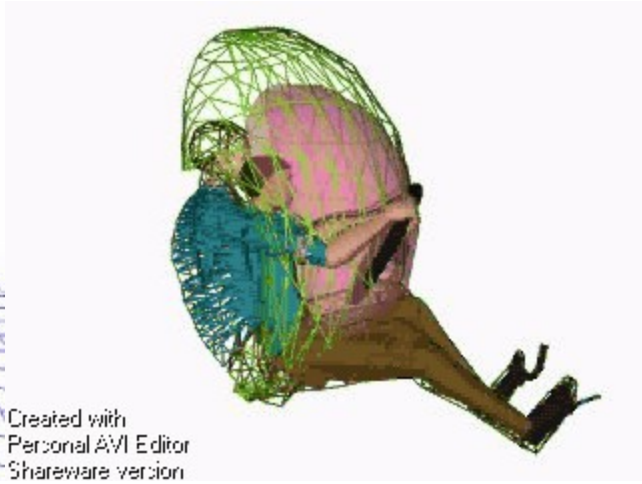
# Umetni ljudje

People can be represented in VEs by Virtual Humans, Mannikins, Avatars, etc.

These are sometimes even computer controlled (bots)– in CVEs, the person you are talking to may not even exíst...

Ergonomic Testing – reach envelopes, view, dynamics, loading, etc.






Virtual Reality puts real-time demands first
Defficiencies in rendering quality

Virtual Reality uses simple Reflectance Properties like
Phong Model
Textures
Simple BumpMapping
Simple Global Illumination
Radiosity Solution

# Increase Realism in Virtual Reality

- Accurate Materials
- Accurate Texturing
- Texture Mapping
- Texture Synthesis
- Accurate Global Light Simulation and Visualization
- Real-Time, High Quality Visualization

# aplikacije

- simulate dangerous/expensive situations
  - command and control,  virtual tourism
  - practising medical procedures,  treatment of phobia
- see hidden real world features
  - virtual wind tunnel
- visualise complex information
- fun  :-)

# Navidezna resničnost v medicini

# Sintetična naravna okolja

- Disaster site (school bus accident, plane crash)
  - *Acute care professionals*
  - *Psychiatric-mental health professionals*
  - *Public safety officers (EMS, fire, police, security)*
- Environmental assessment (home, community)
  - *Community health students*
  - *World Health Organization home care students*
  - *City of Cleveland Health Department*
- MDMA use by college student
  - *Psychiatric-mental health professionals*
  - *Public safety officers (EMS, police, security)*

# Aplikacije

M1A & Bradley Maintenance - USAR

Operation Sea Dragon - NRL & USMC

Battle of 73 Easting - DARPA

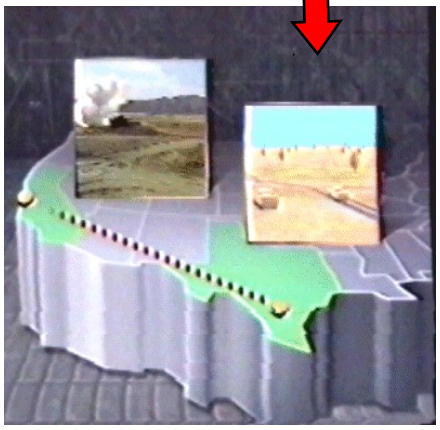
Embassy Defense - USMC

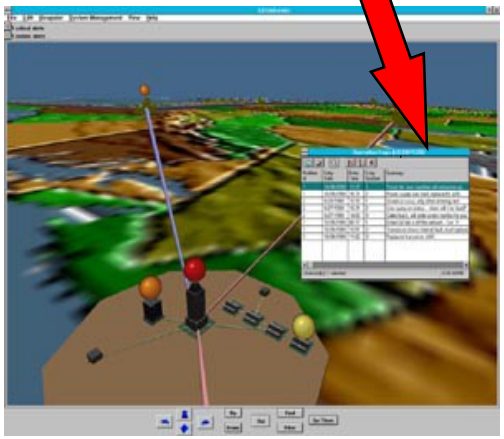
Bosnian Territorial Demarcation

START III Stockpile -DSWA

Network Management - USAF

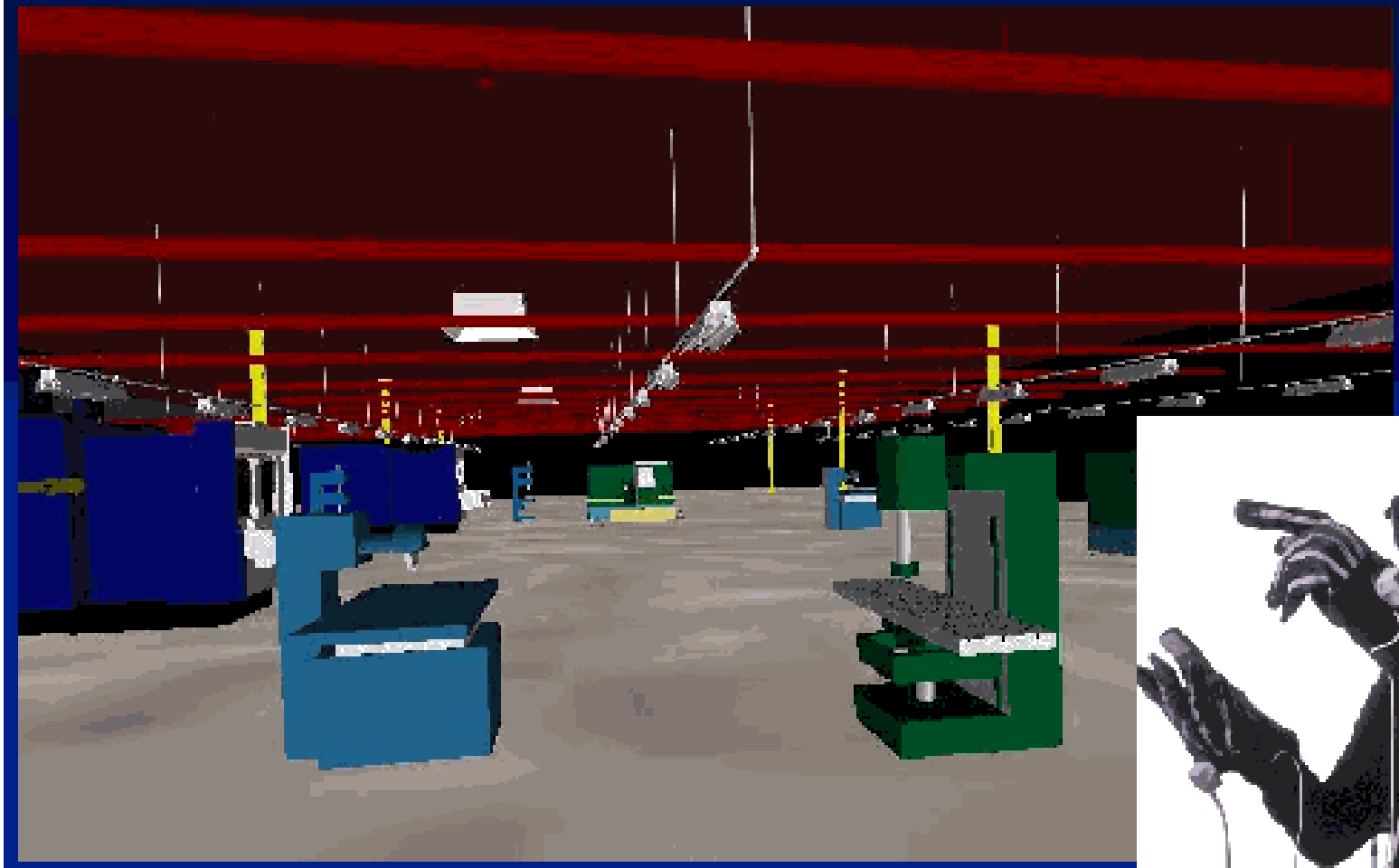
Distributed Interactive Simulation



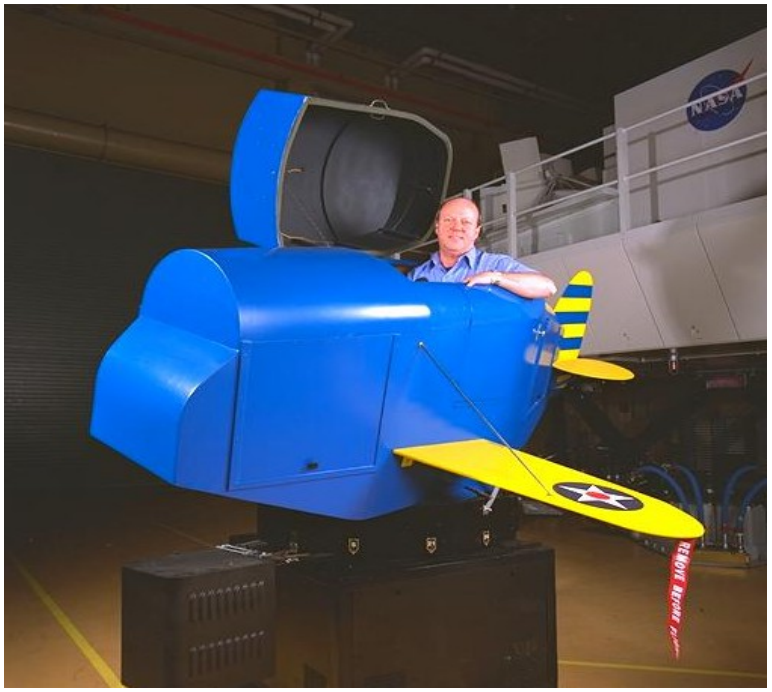
# Spletne aplikacije http://www.superscape.com

# Načrtovanje proizvodnih obratov



# Načrtovanje, arhitektura

# Navidezna resničnost in zabava

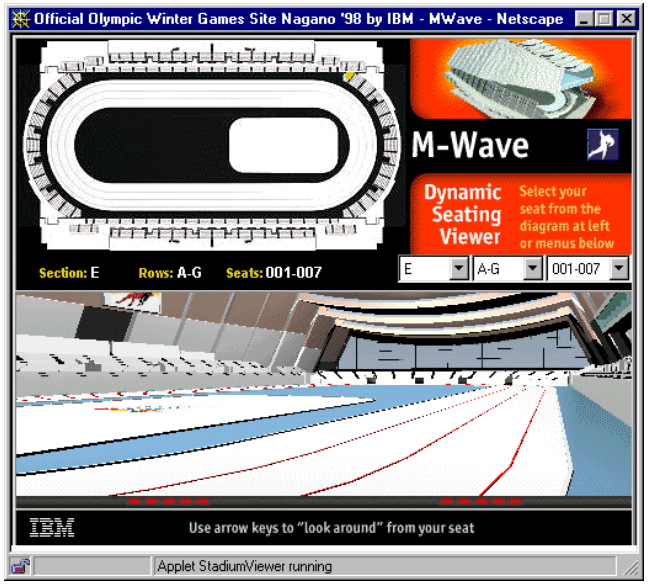



# Aplikacije


SUPERSCAPE
VISCAPE™


Installing a PC graphics card
By
Max Thornton, Alex Tearse and A. S. McNair
SUPERSCAPE
VISCAPE™
1-Remove ca
2-Remove fix screw
3-Remove blanking plat
4-Insert grap card
5-Connect graphics car
6-Insert fixing screw
7-Close casi
8-Load graph software
Complete installation


VIEWPOINTS
COMMANDS
MOVE/TURN UNITS
SUPERSCAPE
VISCAPE™


Official Olympic Winter Games Site Nagano '98 by IBM - MWave - Netscape
M-Wave
Dynamic Seating Viewer
Select your seat from the diagram at left or menus below
Section: E
Rows: A-G
Seats: 001-007
E
A-G
001-007
IBM
Use arrow keys to "look around" from your seat
Applet StadiumViewer running

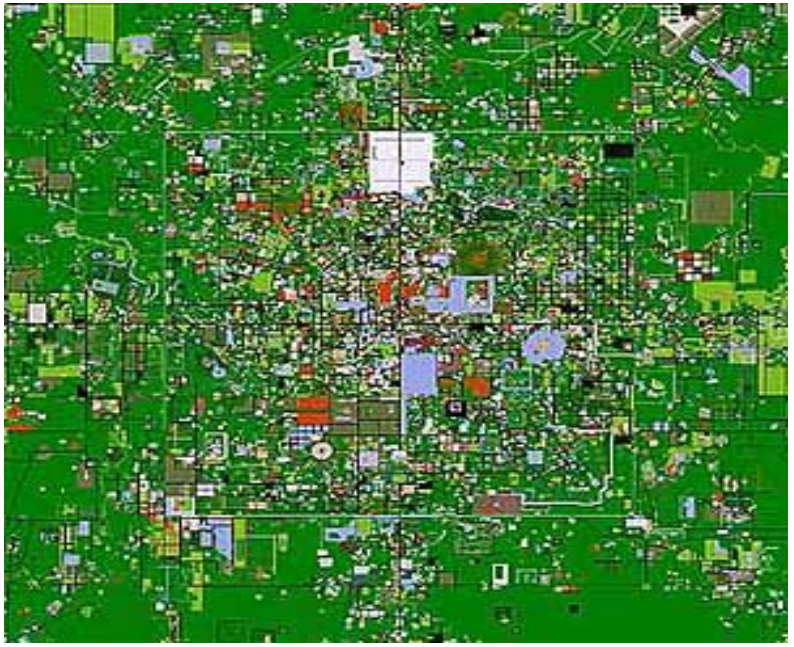
# Avatarji

## Onlive Traveler

- http://ok.actlab.utexas.edu/utopia/entrance.olv


## Activeworlds Universe

- www.activeworlds.com
- 100,000 + citizens
- Hundreds of  Portals
- Real Estate Claims
- $20 annual fee



# Avatarji

In online chat, your handle used to be the thing that distinguished you from everyone else. But as 3D chat worlds proliferate, the avatars are taking over.

An avatar is a graphical representation that you select to stand in for you; it can look like a person, an object, or an animal.

Since an avatar may look nothing like you (unless you happen to resemble a blue fish), you should choose one that fairly represents the way you'd like to be seen by the people you're chatting with.

# Problemi z navidezno resničnostjo

Hardware Limitations (field of view, tactile simulation, lag time, graphic resolution)

Simulator Sickness

Visual disturbances after using HMD.

Physical loading on the neck-muscles by heavy HMD.

No real information on long-term effects of VR usage.

# Za konec

Navidezna resničnost je kvečjemu
karikatura resničnosti