

Groupware and Collaborative Interaction
Collaborative Virtual Environments

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Outline

Virtual Reality

Collaboration in Virtual Reality

Awareness

Communication

Collaborative Interaction

Navigation

Co-manipulation

Virtual Reality

Collaboration in Virtual Reality

Awareness

Communication

Collaborative Interaction

Navigation

Co-manipulation

Virtual Reality

Virtual environment (VE)

3D virtual world

Simulated by computers



Interaction in real time

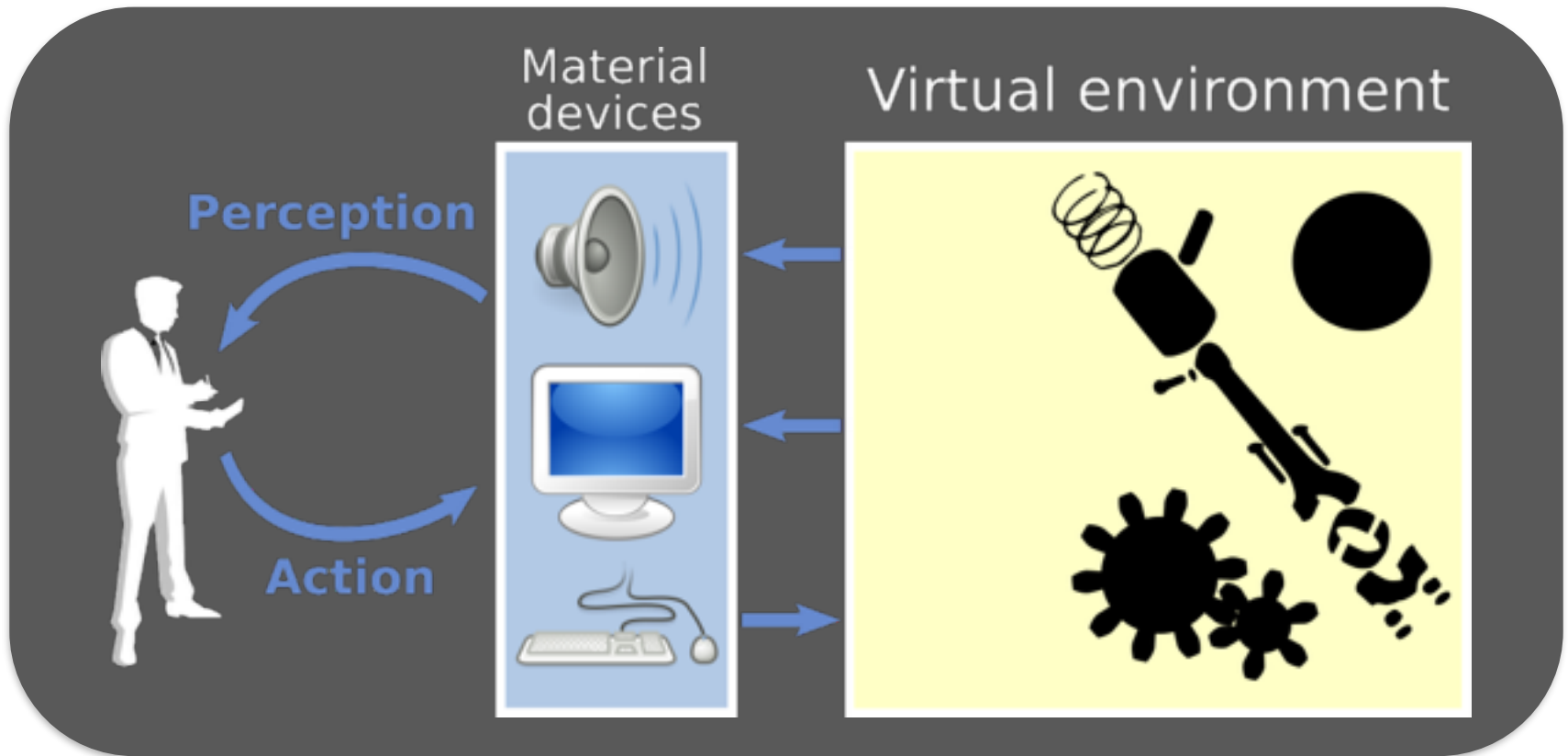
Trough various material devices

Immersion

Multi-sensorial perception of the VE

Virtual Reality

Action/perception loop



Interaction

3 kinds of interaction techniques [Hand, 1997]

Object manipulation (interaction)

Viewpoint manipulation (navigation)

Application Control

[Bowman et al., 2004]

Bowman D. A., Kruijff E., LaViola J. J. et Poupyrev I. (2004).
3D User Interfaces : Theory and Practice. Addison Wesley.

Navigation

Move the viewpoint + Modify the scale [Hand, 1997]

Manipulate its own viewpoint

or

Manipulate the viewpoint of the others

Include path finding [Bowman et al., 2004]

Navigation

Classical techniques

Egocentric

Walking metaphor

Flying metaphor

Driving metaphor



Exocentric

Navidget [Hachet et al., 2008]

Grabbing the air
[Mapes et Moshell, 1995]

Video



[Hachet et al., 2008]

Navigation

Classical techniques : assisted navigation

Select the destination

Pointing

World In Miniature (WIM)
[Stoakley et al., 1995]

List of defined path



[Stoakley et al., 1995]

Move to destination

Teleportation [Ruddle et al., 2000]

Interpolation [Mackinlay et al., 1990]

“Guided visit” metaphor [Elmqvist et al., 2007]

Video

Navigation

Multi-scale techniques

Manuel scale modification

An additional DoF

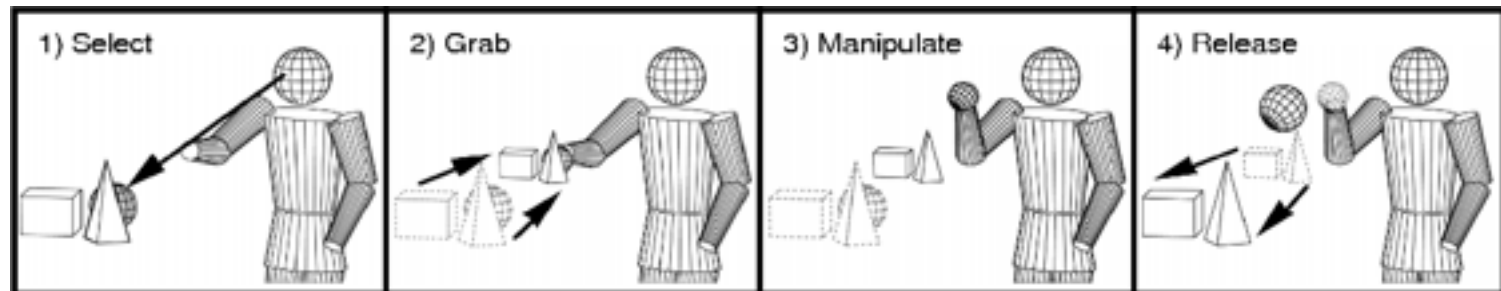
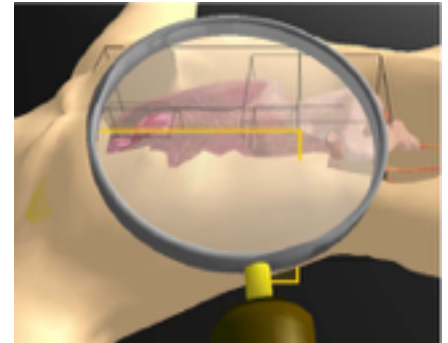
Head-butt Zoom [Mine et al., 1997]



Automatic scale modification

Bounding Boxes [Kopper et al., 2006]

Scaled-world grab [Mine et al., 1997]



Object Manipulation

Egocentric

vs

Exocentric

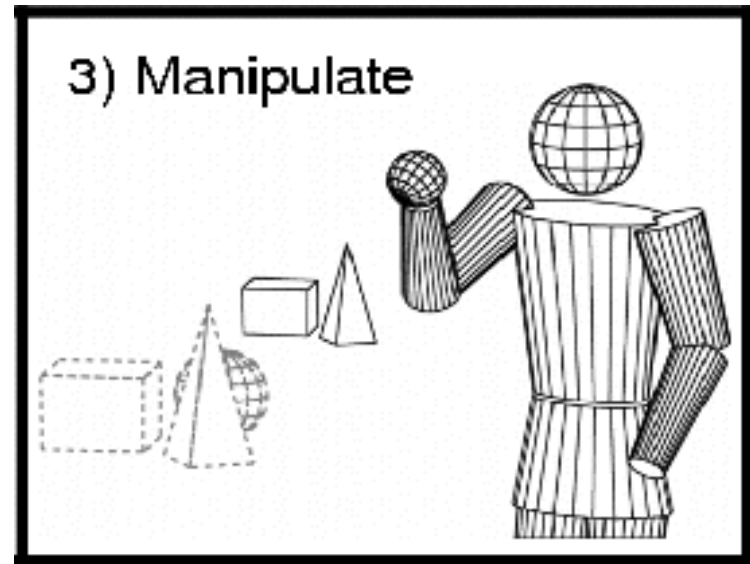
Scaled-world grab

WIM

2 main tasks

Selection

Manipulation



Object Manipulation

Virtual Hand [Jacoby et al., 1994]

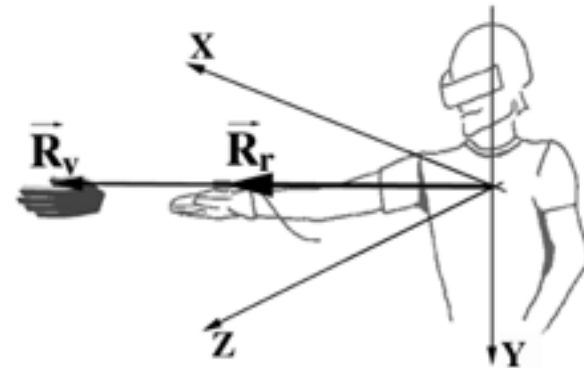
Select and manipulate by touching

“Go-Go” metaphor

[Poupyrev et al., 1996]

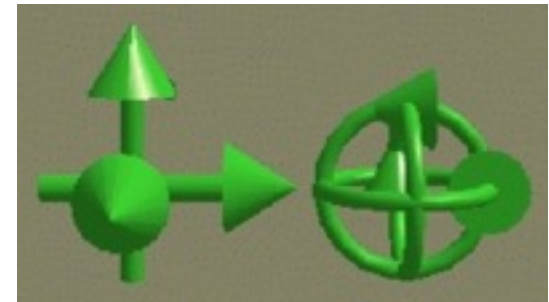
Extend the virtual hand

Move exponentially



3D cursor [Zhai et al., 1994]

Position or speed control



Object Manipulation

Virtual Ray [Mine, 1995]

Mimic a laser pointer

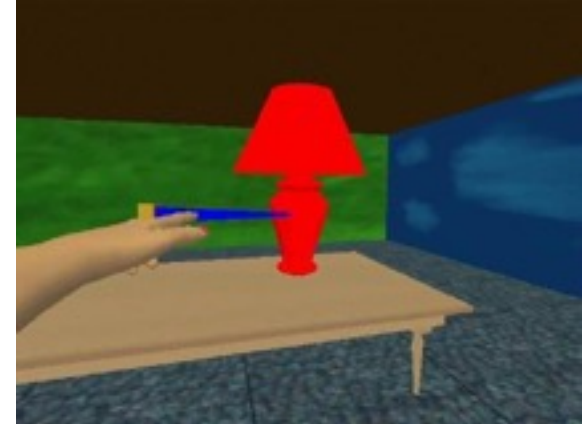
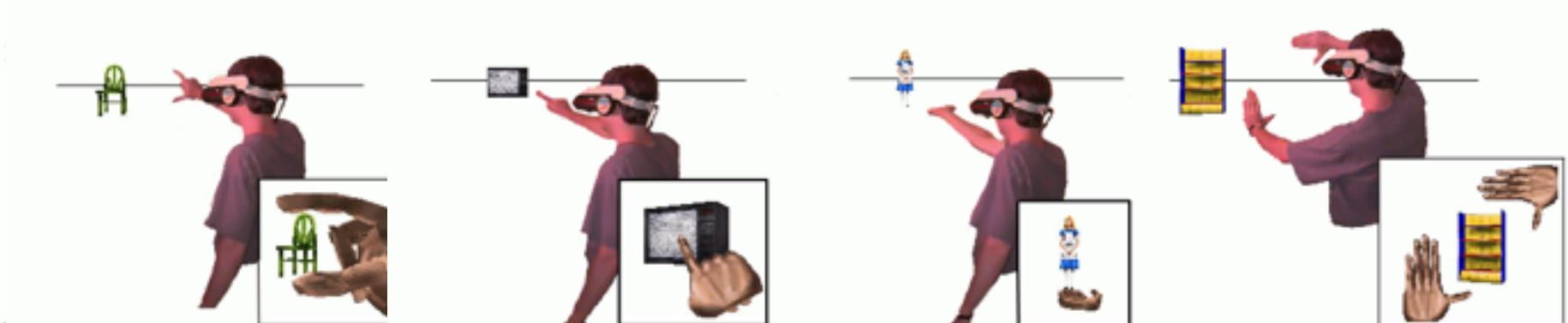


Image plan Interaction [Pierce et al., 1997]

Select by pointing with one part of the body

Video



Object Manipulation

Selection techniques not always suitable for manipulation

Ex: virtual ray for rotations

Combining several interaction tools

HOMER [Bowman et Hodges, 1997]

Move the manipulated object close to the user

Attached the interaction tools to the objects

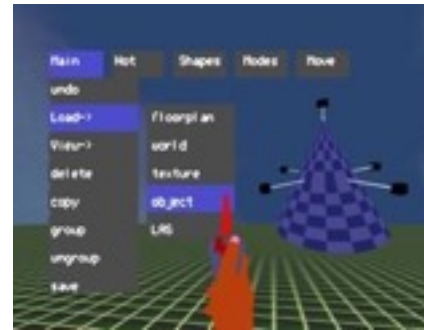
Application Control

Control

- Application (exit, pause,...)
- Rendering parameters
- Tools/actions selection

Techniques used

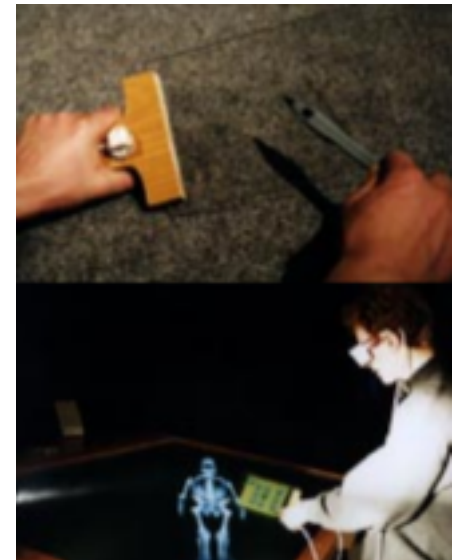
- 2D menus
- 3D menus
- Control on a tablet/smartphone



[CDS - Bowman et al., 1991]



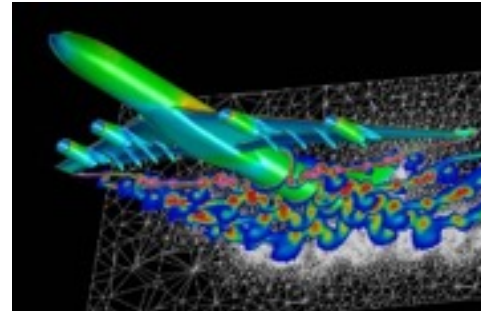
[CHIMP - Mine et al., 1997]



[Coquillart et al., 1999]

Applications of Virtual Reality

Scientific data analysis



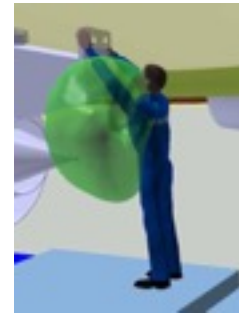
Industrial applications

Design, conception

Fabrication process



Training, education



Phobia therapy, rehabilitation



Entertainments

Video games

Virtual visits of museums

Social communication (telepresence)



Virtual Reality

Collaboration in Virtual Reality

Awareness

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Collaborative Interaction

Navigation

Co-manipulation

Collaboration in Virtual Reality



Several users work/play together in a VE

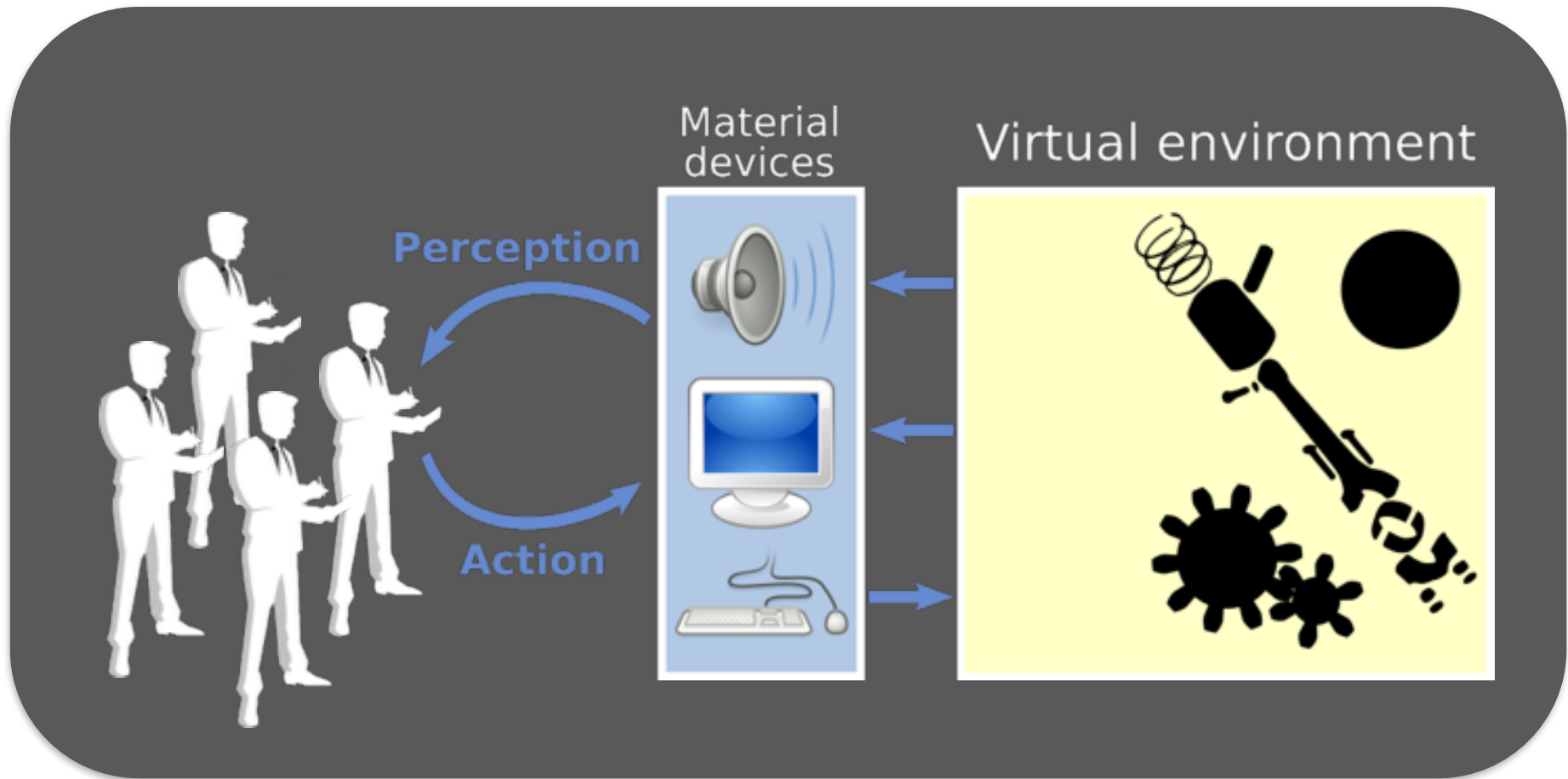
- Co-expertise of 3D data

- Complex manipulation (real or virtual)

- Training

- Social presence (telepresence)

Co-located collaboration



Multi-stereoscopic display

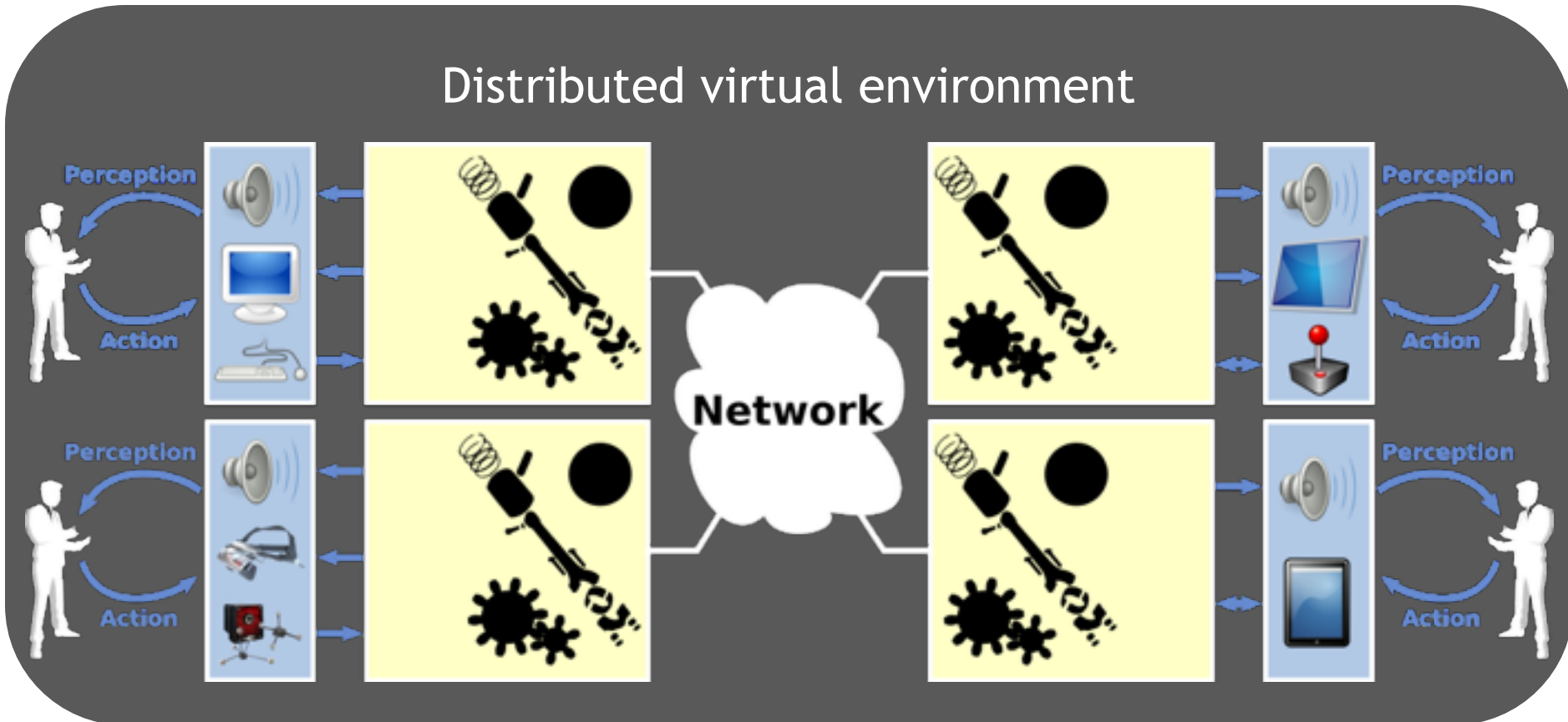
Integrate several users in the same devices



Video

Remote Collaboration

Distributed virtual environment



Immersive VR Telepresence



Social presence

Animated avatars

Shared virtual environment

Collaborative interaction

Video facilities

Video

Immersive Group-to-Group Telepresence



Social presence

Real 3D video integration

Shared virtual environment

Collaborative interaction

Specific tools for collaboration

Video

Outline

Virtual Reality

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Awareness

Perception of the other users

Where are they?

What are they doing?

What are they looking?

Are they looking at me?

What could they do ?

Can they see me?

Could they see what I am showing to them?

Could they do what I am asking them to do?

Awareness

Improve the mutual understanding

Just next to me... But where are you?

Just in front of me ... But where are you looking at?

Etc.

Multi-sensorial restitution

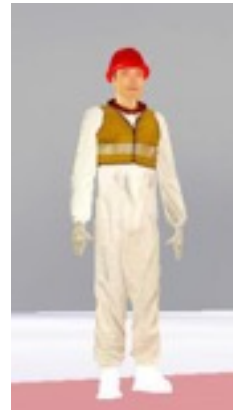
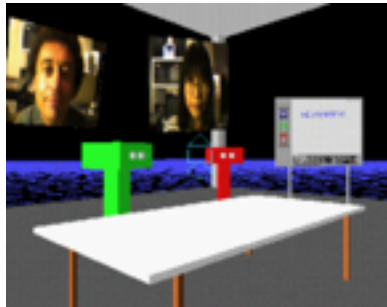
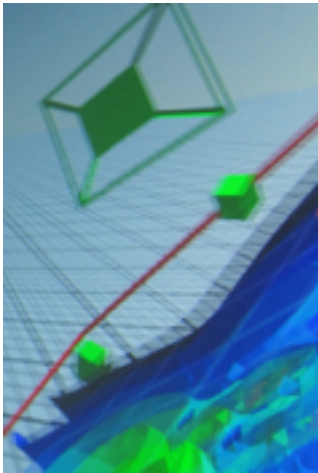
Visual awareness

Audio awareness

Haptic awareness

Visual Awareness

Avatar: representation of users in the VE



Visual Awareness

Animation of the avatars



Kinect Avatar



Body tracking

Video

Telepresence in virtual reality

Animated virtual characters



Real 3D video integration

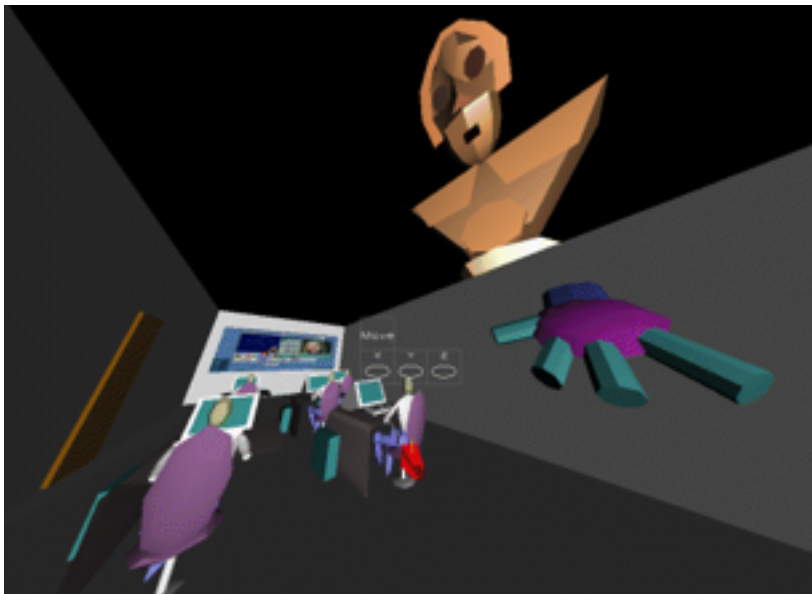


Video facilities

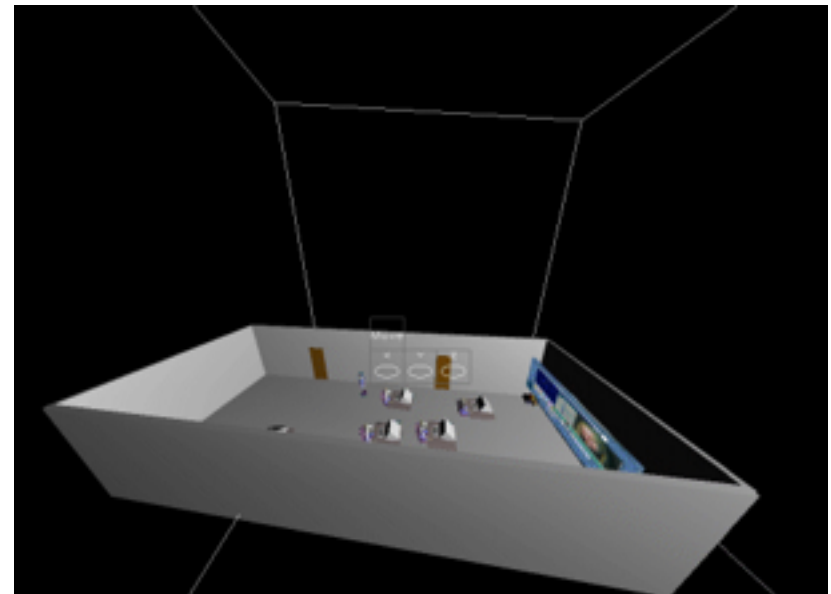


Visual Awareness

Use of a WIM [CALVIN, 1996]



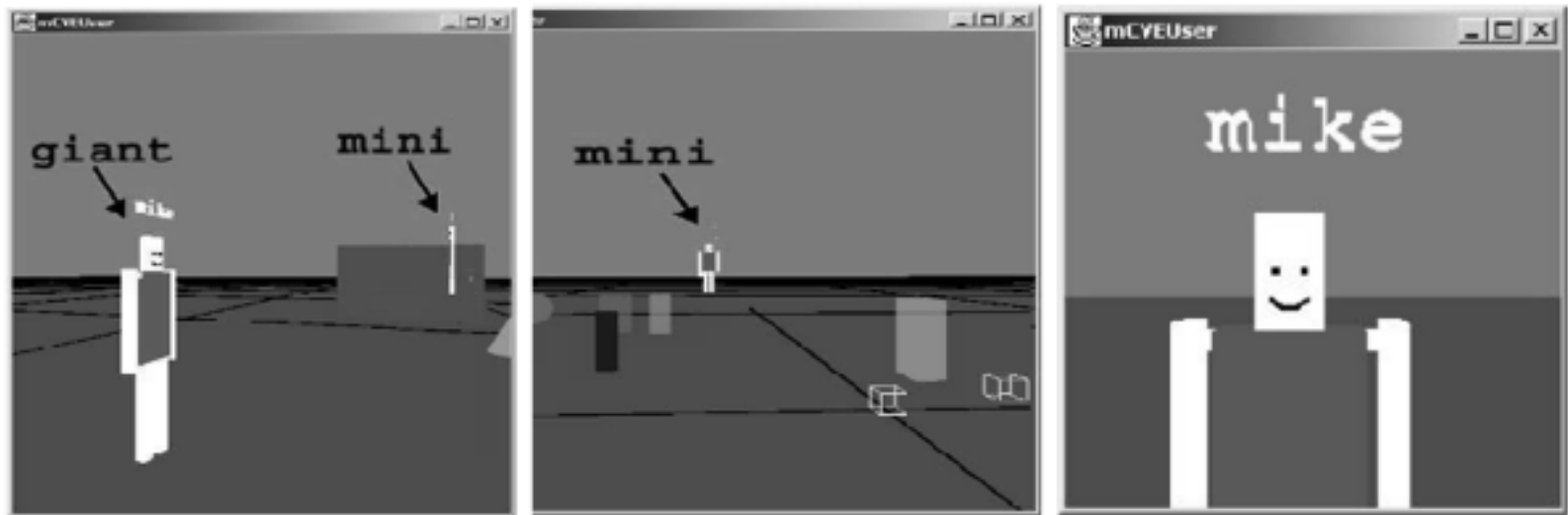
Mortal's view



Deity's view

Virtual Awareness

Multi-scale collaborative virtual environment



(a)

(b)

(c)

[Zhang et Furnas, 2002]

Audio Awareness

Spatialized voice restitution

Remote users' noises

Give a lot of information

Where they are

What they are doing

Add some sounds to describe the actions

Need to be spatialized sounds

Haptic Awareness

Force feedback of the others

Direct

Touch the others through haptic devices

Virtual handshake

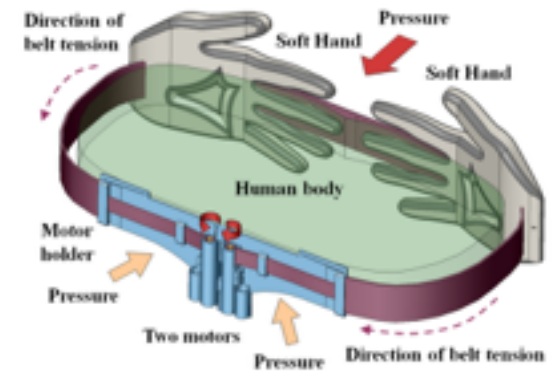
affective haptic

Can be asymmetrical

Indirect

Manipulate an object together

Feel the force apply by the other on the object



Awareness Model

Spatial Model of Interaction [Benford et al., 1994]

Compute which users can interact with others

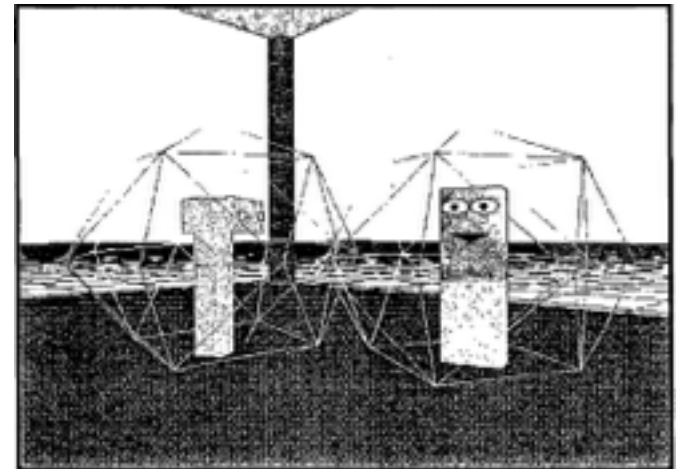
Medium

A typical communication medium
Ex: audio, visual, haptic, etc.

Aura

Sub-space bounding the presence
in a particular **Medium**

Interaction is possible between
two users with colliding **Aura**



[Benford et al., 1994]

Awareness Model

Spatial Model of Interaction [Benford et al., 1994]

Aura determines potential interactions
(on a technical point of view)

Users are responsible for controlling interactions

Measure of awareness between two users

Asymmetrical

Dependent of the **Medium**
(i.e. different for each **Medium**)

Introduction of the **Focus** and **Nimbus**

Awareness Model

Spatial Model of Interaction [Benford et al., 1994]

Focus

Area where a user perceives the others

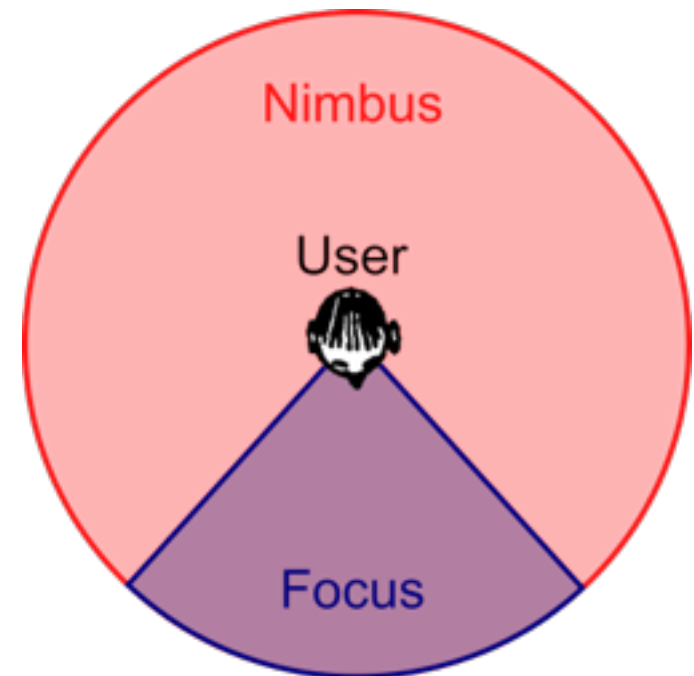
For each particular **Medium**

Nimbus

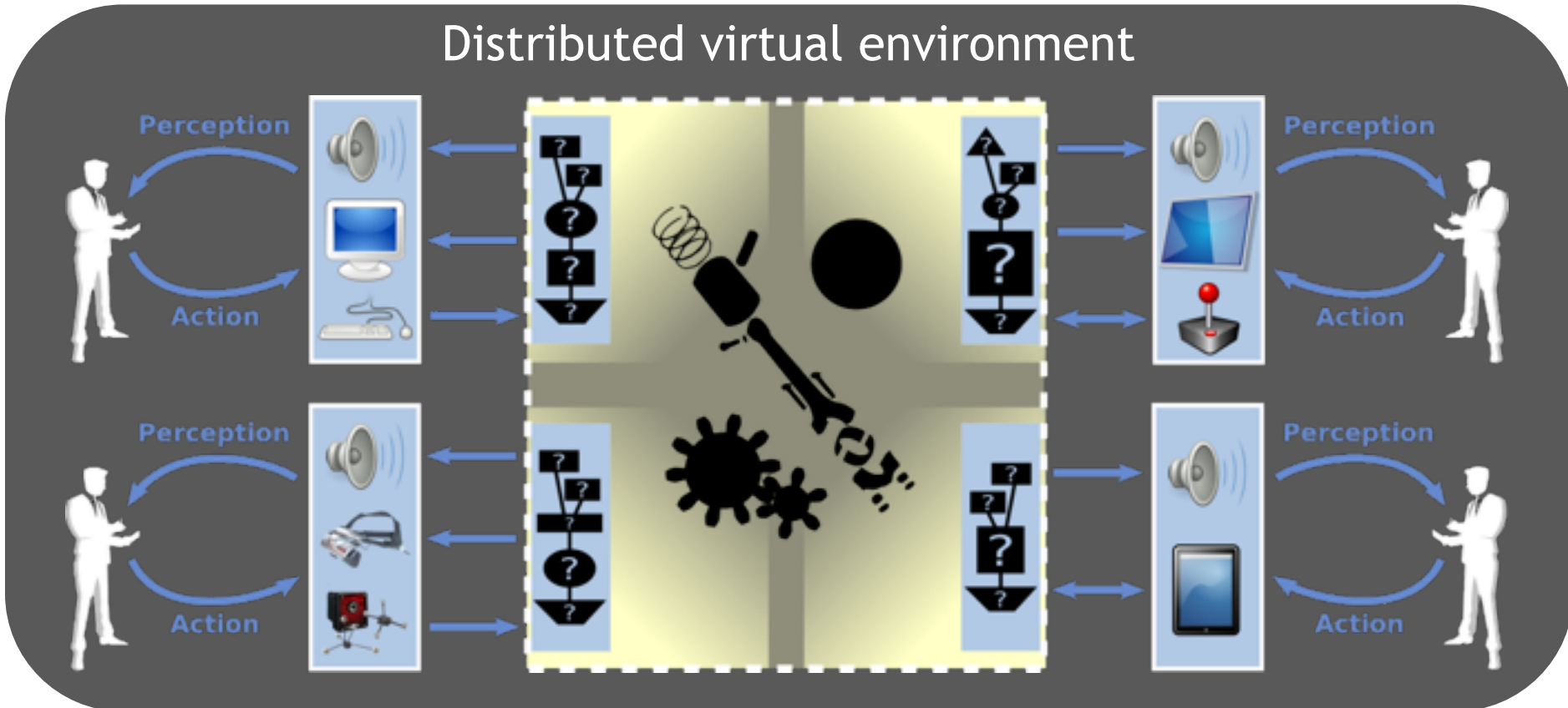
Area where the others can perceive a particular user

For each particular **Medium**

Different from the **focus**



Activities/Capabilities Perception



⇒ How can users understand what the others are doing?

⇒ How can they understand what the others can do?

Interaction Workspaces

3D space in the real world

Associated to a particular material device

Perceive or interact with the virtual world

Ex: visual, audio, haptic, physical displacement, etc.

Why integrating these interaction workspaces?

Each user can have different interaction workspaces

Take into account workspaces for users' interaction

Adapt the interaction techniques

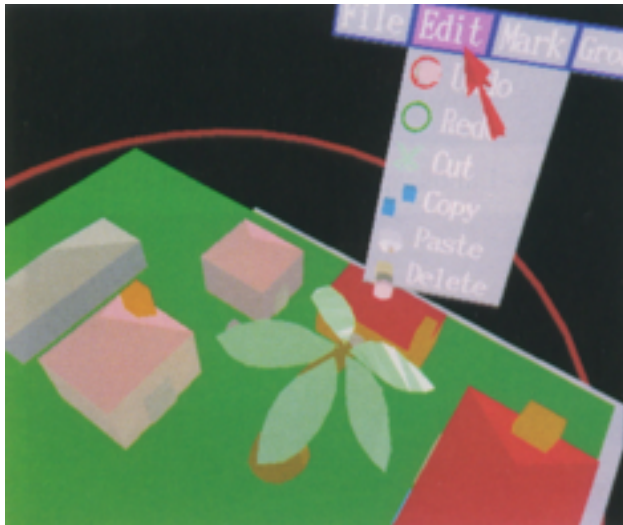
Capabilities perception

Examples of Interaction Workspaces

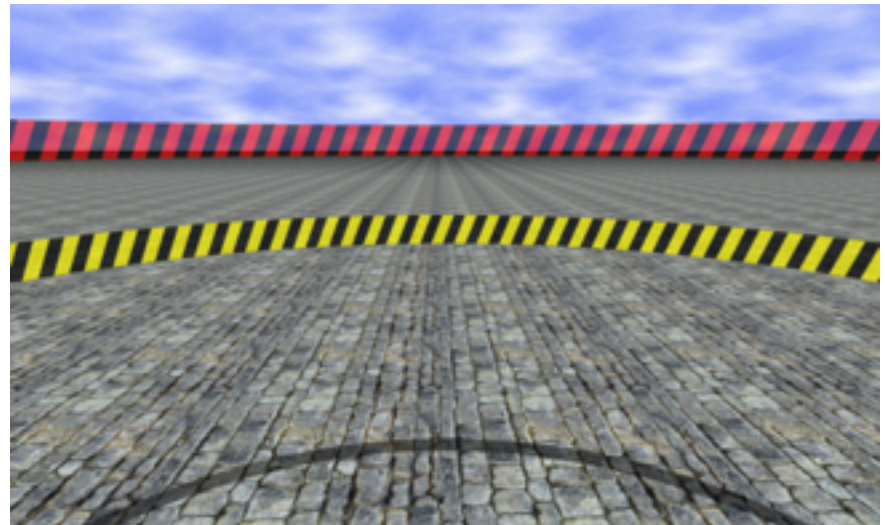
User's physical displacement workspace

Magic Carpet in 3DM [Butterworth et al. 92]

Magic Barrier Tape [Cirio et al. 09]



Magic Carpet

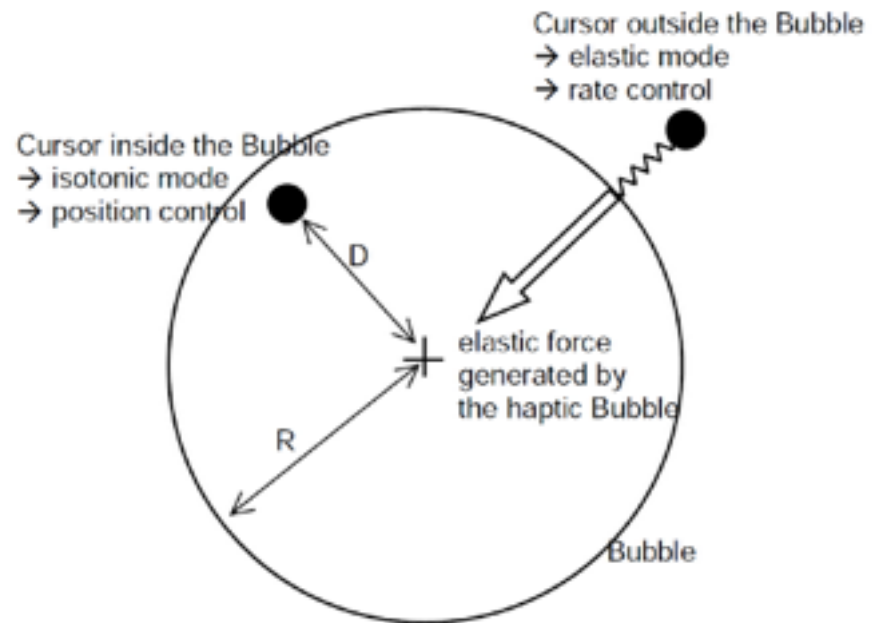
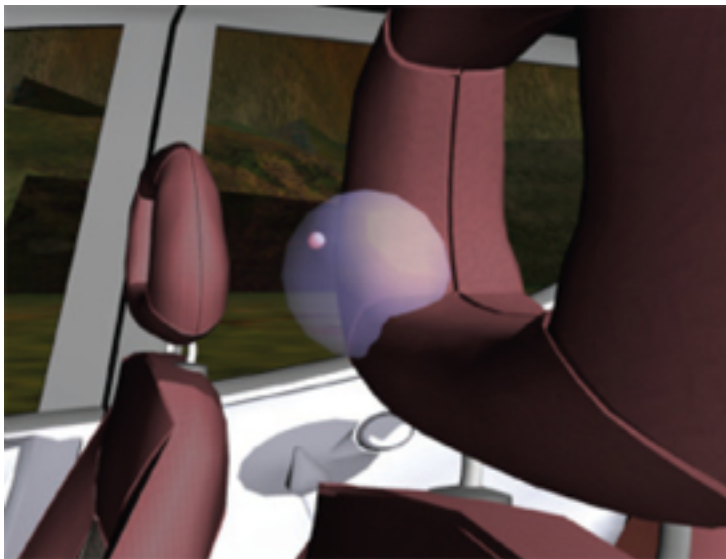


Magic Barrier Tape

Examples of Interaction Workspaces

Haptic interaction workspace

Bubble technique [Dominjon et al. 05]



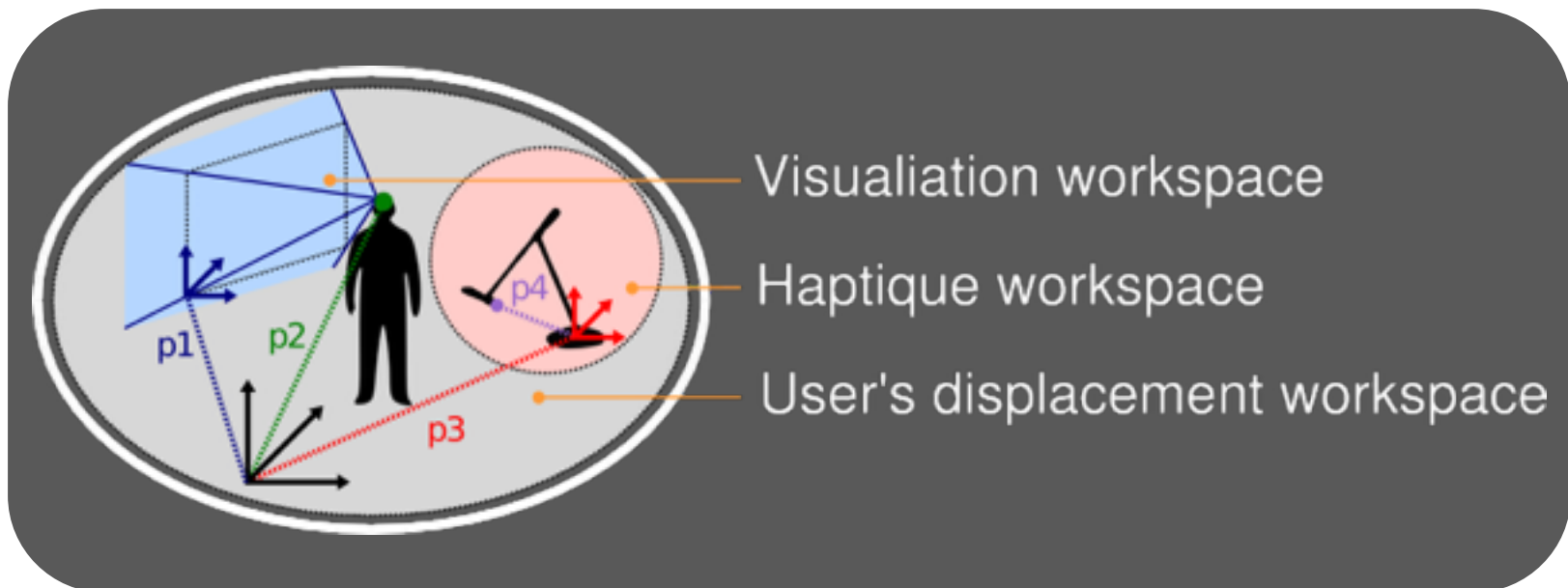
Immersive Interactive Virtual Cabin

[Fleury et al., 2011]

Organizes and integrates interaction workspaces

Users can carry them on the VE

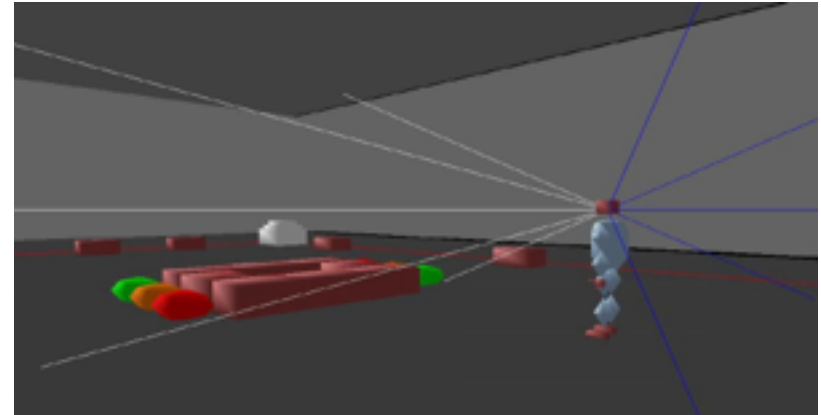
Based on a structured hierarchy



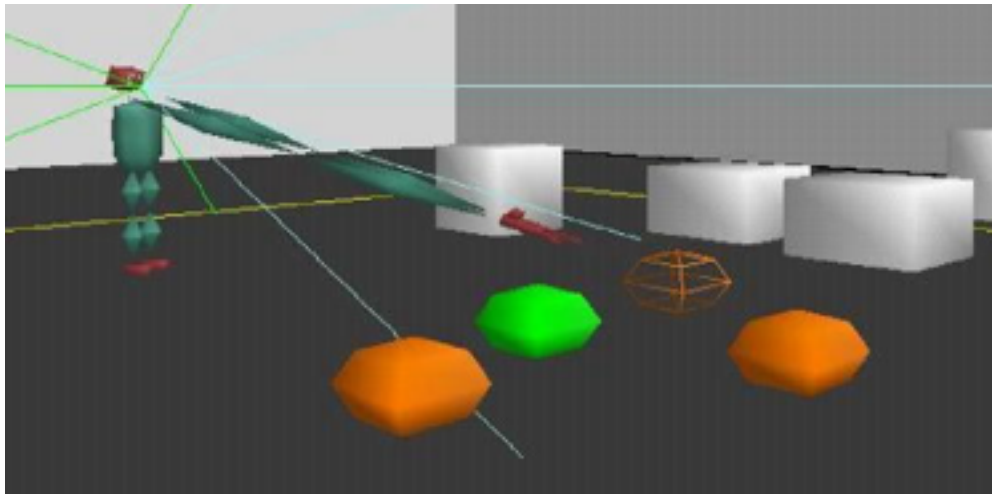
Activities Perception

[Fraser et al., 1999]

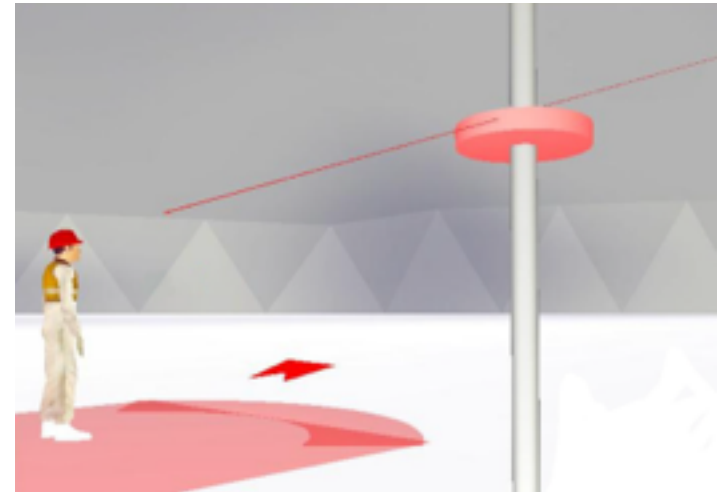
What is the user seeing?



What is the user doing?



[Fraser et al., 1999]



[Duval et al., 2008]

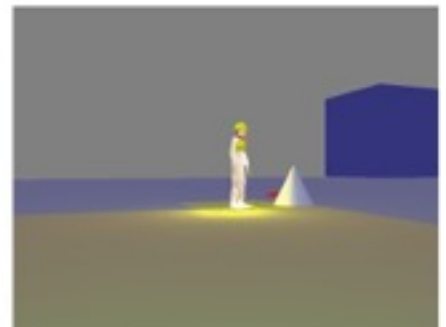
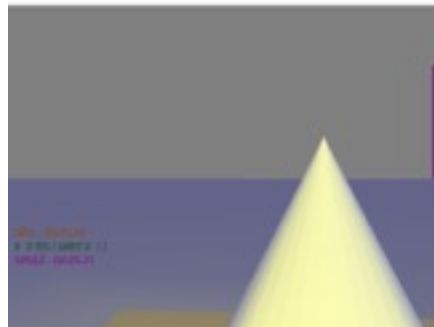
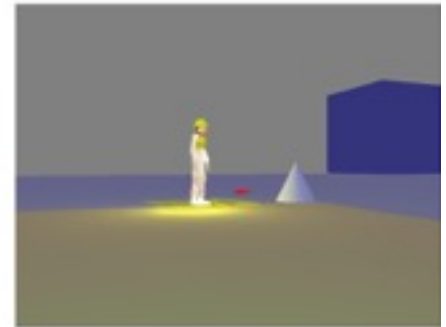
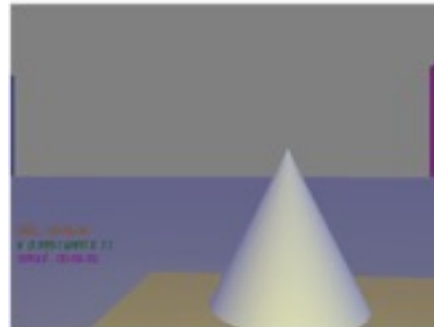
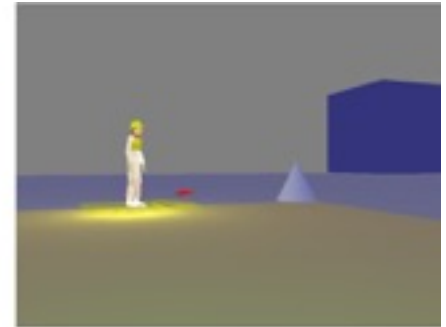
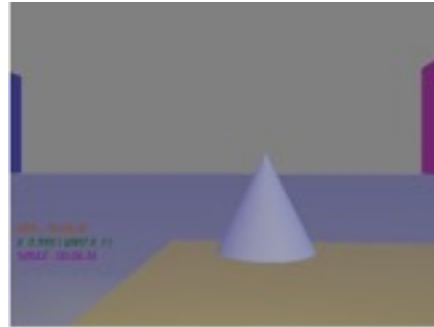
Capabilities Perception

Example for the user himself:
user's displacement workspace



Capabilities Perception

Example for another user:
interaction workspace



Outline

Virtual Reality

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Awareness

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Navigation

Co-manipulation

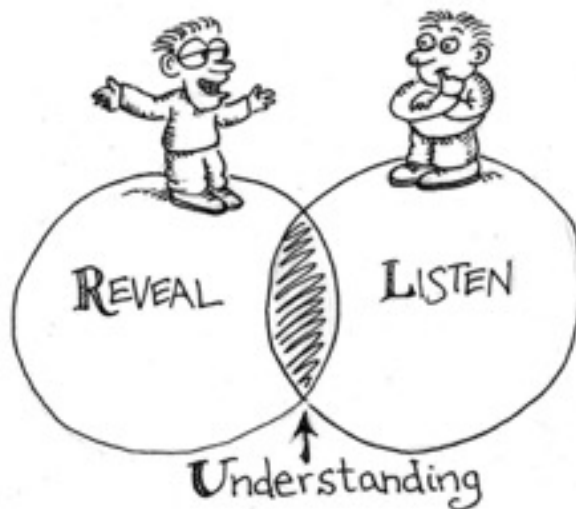
Voice communication

Essential for collaborative application

Compensate a bad perception of the VE
[Hindmarsh et al., 1998]

Share different point of view

However:



Voice communication induces also discontinuity in interaction

[Bowers et al., 1996]

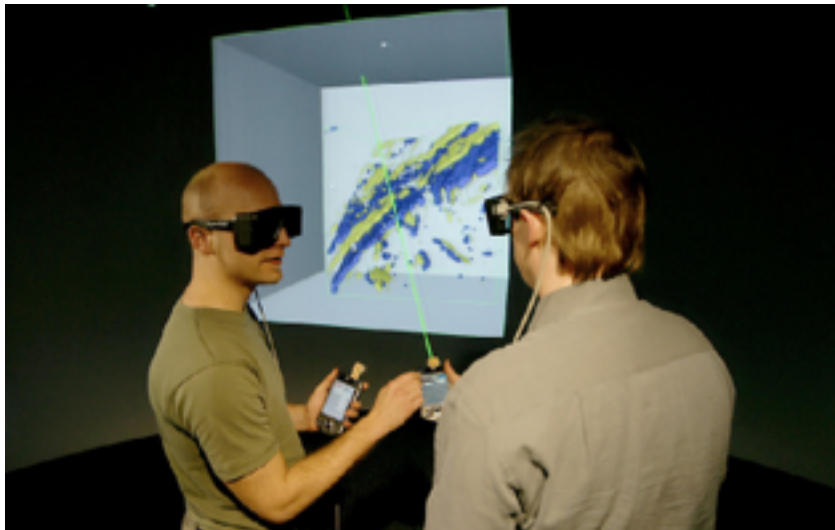
⇒ Users need specific tools for communication

Tools for communication

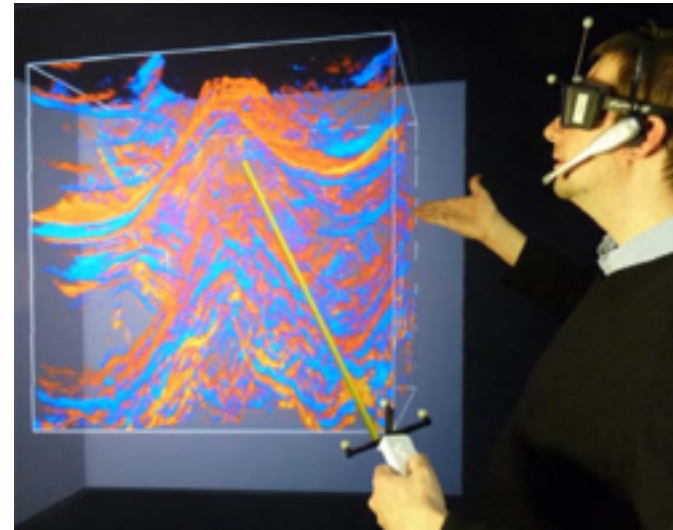
Virtual Ray

Laser pointer metaphor

Easy and intuitive manipulation



[Simon, 2005]



[Schild et al., 2009]

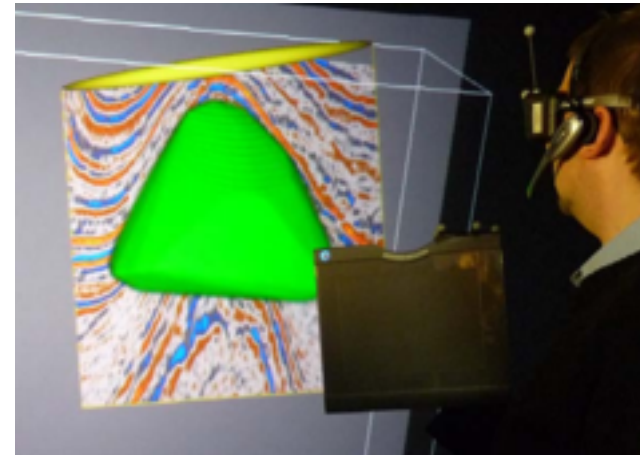
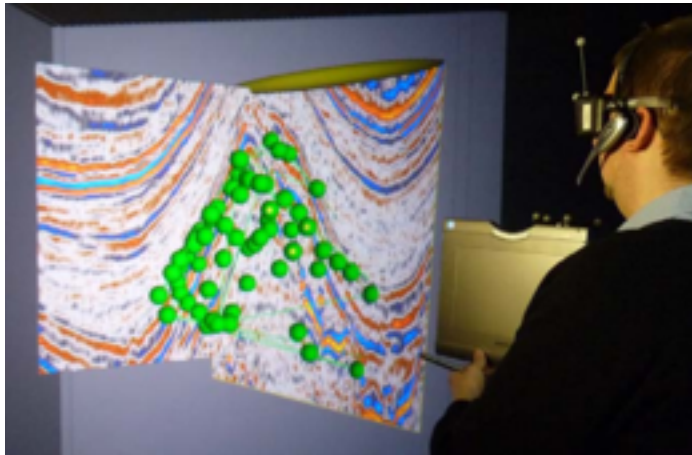
Tools for communication

Annotations

Sketching, text, audio, videos

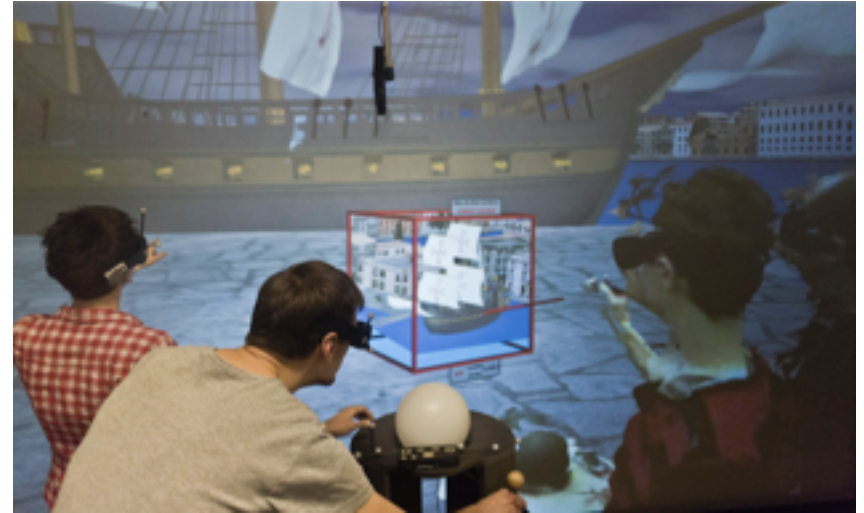
Especially relevant for scientific data analysis

Synchronous and asynchronous collaboration



[Schild et al., 2009]

Tools for communication



Photoportals

Shared 2D or 3D views

Annotations

Interaction with the shared views

Video

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Collaborative virtual environment

WYSINWIS (What Your See Is Not What I see)

Each user can have its own viewpoint

But, sometime users need:

To share the same viewpoint

To meet somewhere in the VE

To guide others in the VE

To follow each other

Collaborative Navigation

3 main modes of collaborative navigation

Share the same point of view

One user drives, the other follows

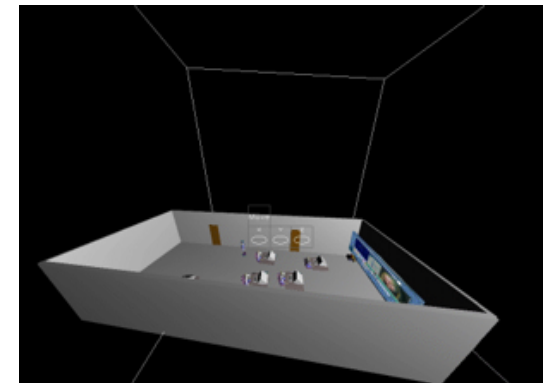
One move and the other follows with an offset

One user drives, the other can modify his offset

World in Miniature

Guide the others through the WIM

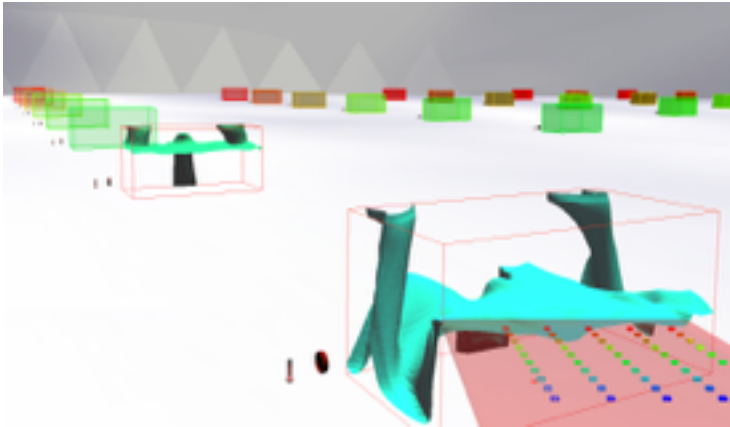
Move the others through the WIM



[CALVIN, 1996]

Viewpoints sharing

[Duval et al., 2008]



Context: scientific data analysis

Users can:

Save interesting viewpoints

Select on particular viewpoint

Travel cross of the saved viewpoints
of a particular user





Group Navigation

[Dodds et Ruddle, 2008]

Users are part of a predefined group

Each user can travel independently

Functionalities help to travel with the group

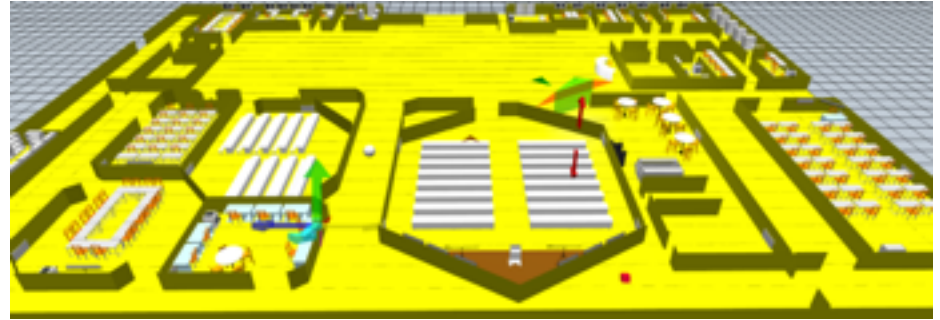
To follow the first member of the group

To come back at the middle of the group
(mean of member positions)



Guidance techniques

[Nguyen et al., 2013]



Context: collaborative navigation in a building

User 1 is in an immersive room

Find several targets in the building

User 2 is in front a desktop workstation

Guide the other user using a WIM

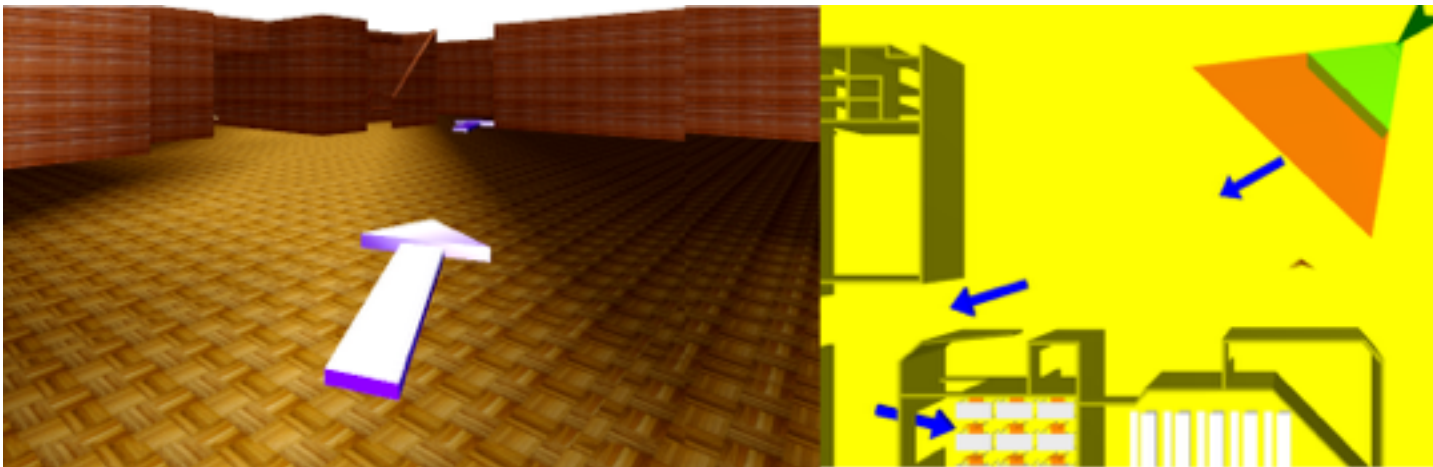
Not verbal communication

Guidance techniques

[Nguyen et al., 2013]

Technique 1:

Draw arrows in the virtual environment

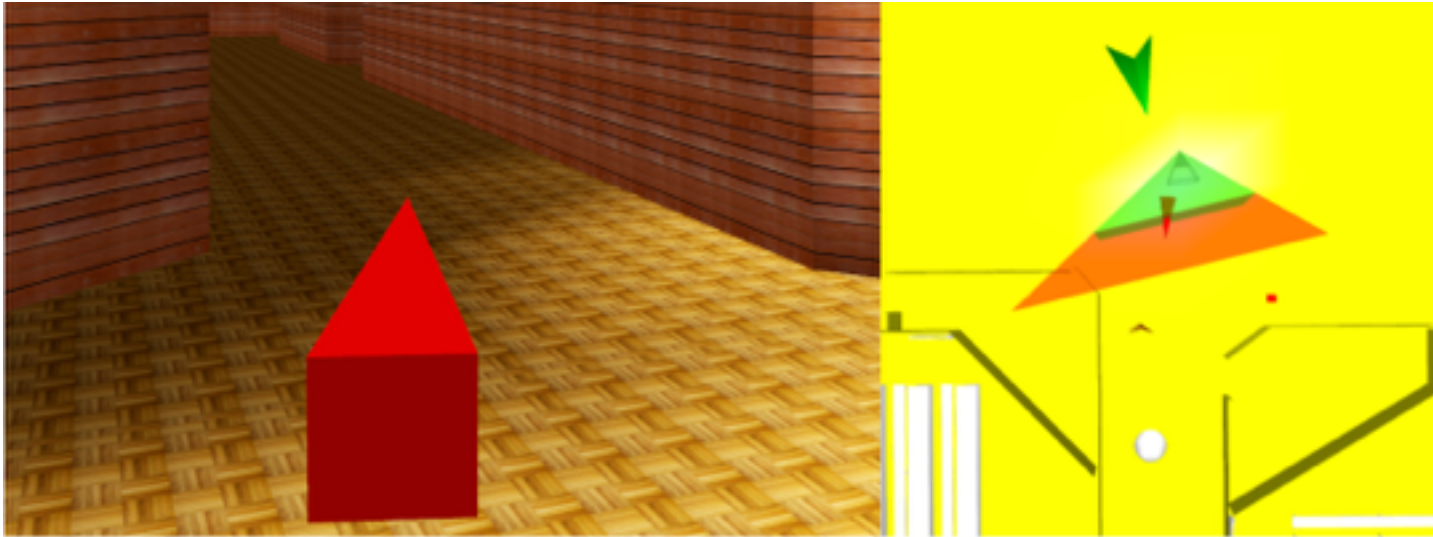


Guidance techniques

[Nguyen et al., 2013]

Technique 2:

Orient an arrow attached to the user (like a compass)

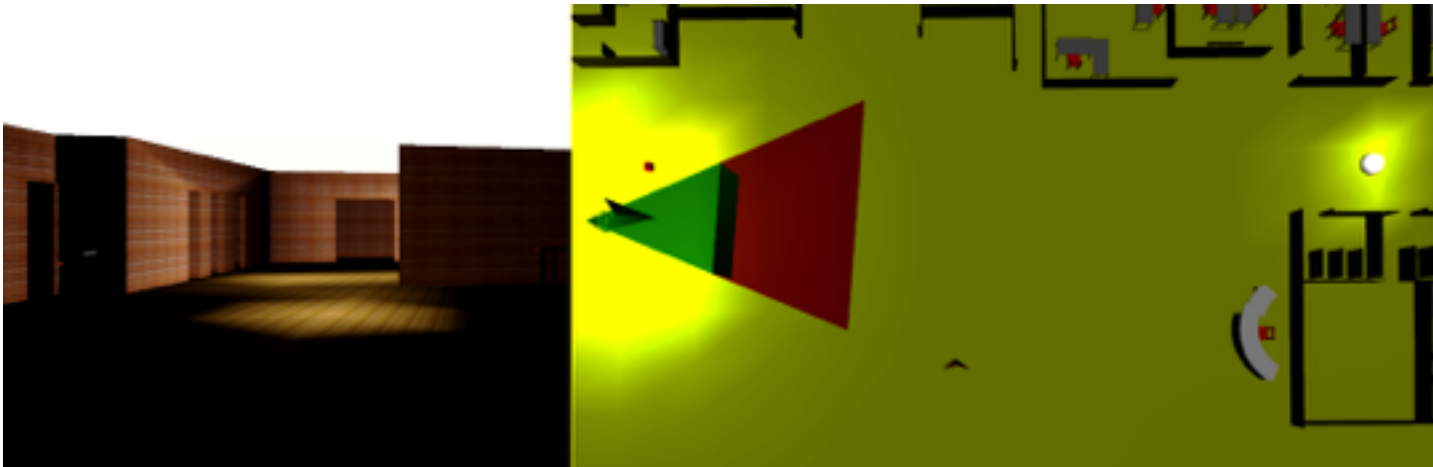


Guidance techniques

[Nguyen et al., 2013]

Technique 3:

Align the path in the virtual environment



Video

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Co-manipulation

Several users manipulate a same virtual object

Achieve a hard manipulation task in VE

Mimic the same task than in the real world (training)

2 solutions

Users manipulate different DoF of an object

Users can manipulate the same DoF of an object

DoF: Degree of Freedom

Usually 6 DoF (3 translations, 3 rotations) + the scale

Some other parameters (color, shape, etc.)

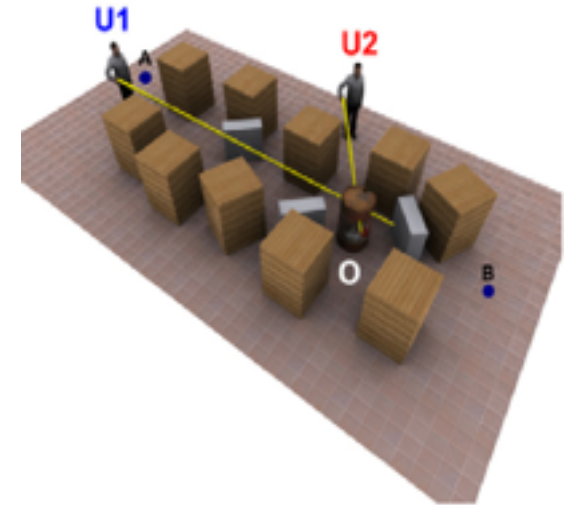
Manipulate different DoF

Users use the same tools

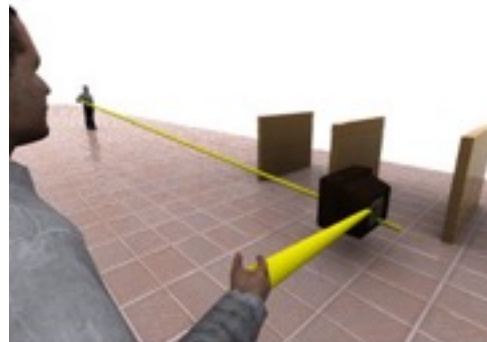
Ex: two virtual rays [Pinho et al., 2008]

Help with obstacles

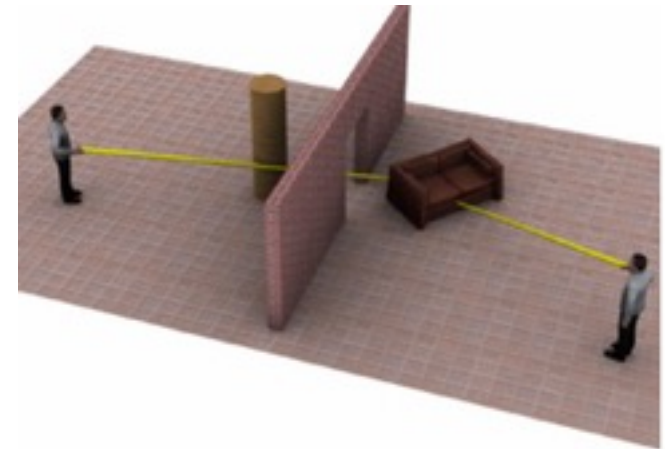
Help when the depth is hard to perceive



User U1's view



User U2's view



Manipulate different DoF

Users use different tools

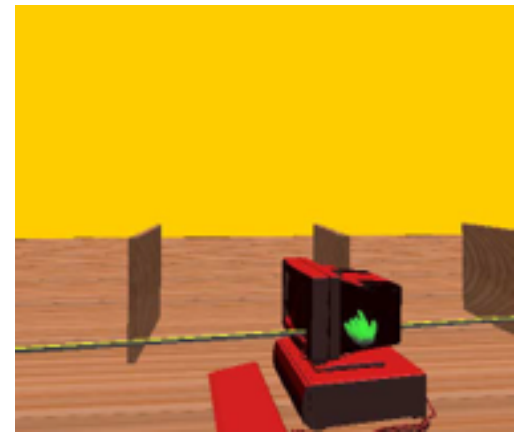
Ex: a virtual ray and a virtual hand

Virtual ray manages positions

Virtual hand manages rotations

User studies show [Pinho et al., 2002]

Faster, easier and more precise
than single user manipulations



[Pinho et al., 2002]

Manipulate the same DoF

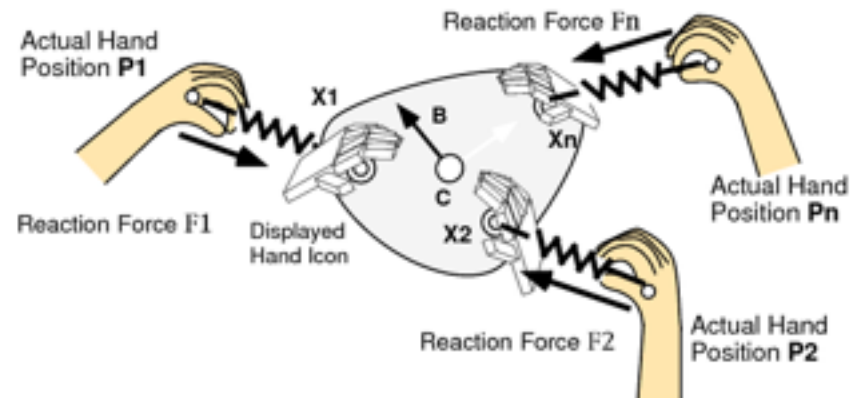
Manipulate together positions and orientations

Compute the mean of each user's actions

Use a physical engine [Noma et Miyasato, 1997]

Positions and orientations are the results of all the forces applied by the users

Add springs between users' hands and the object to avoid instability



Manipulate the same DoF

Holding together a virtual object

Need at least 3 control points

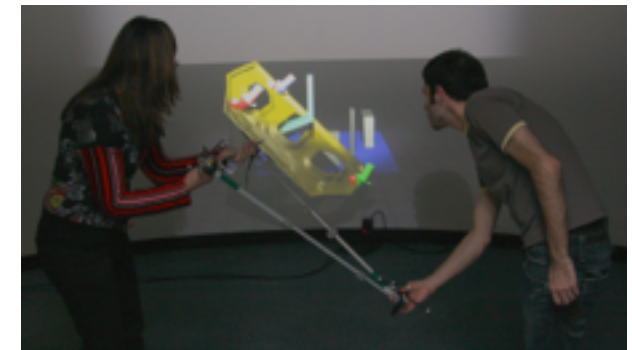
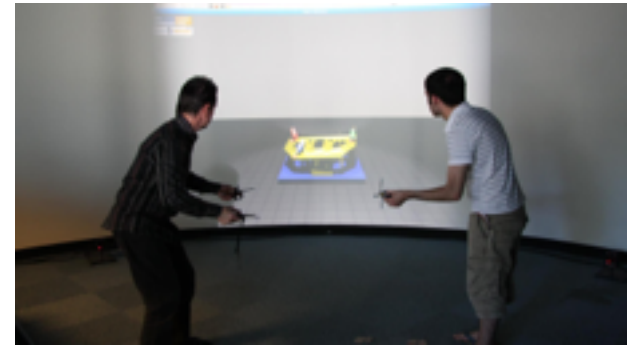
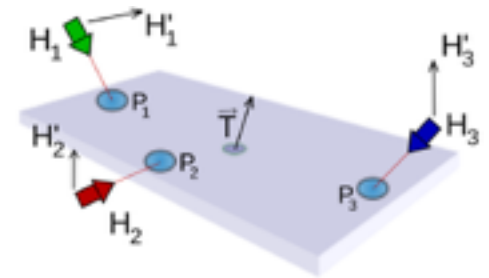
3 hand manipulation technique
[Aguerreche et al., 2009]

One user has 2 control points

The other has 1 control point

Co-located or remote collab.
[Fleury et al., 2012]

Implemented with a prop
(Reconfigurable tangible device)
[Aguerreche et al., 2010]



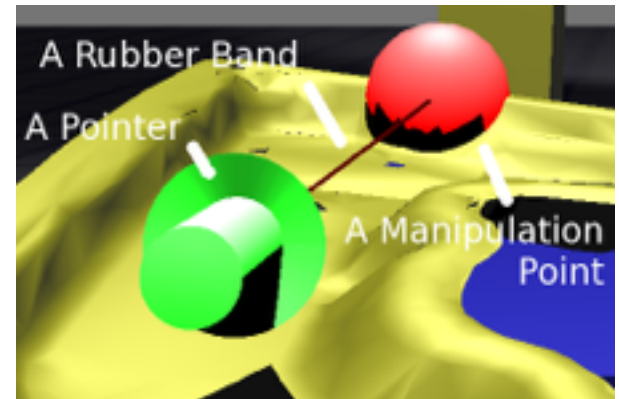
Manipulate the same DoF

Provide feedback to users about their actions

Force feedback with haptic devices

Springs or rubber bands

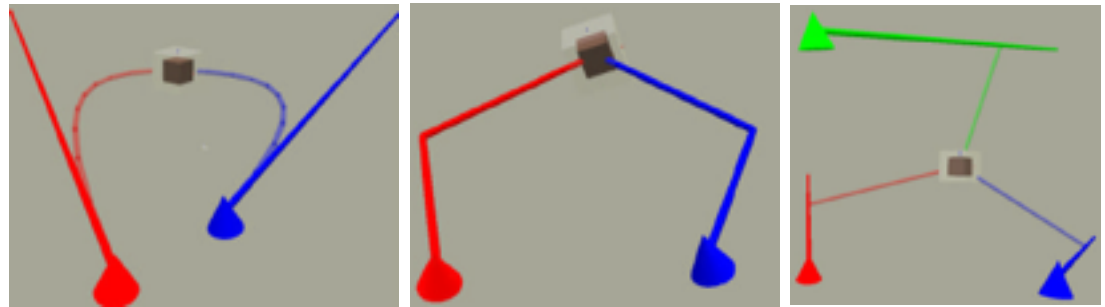
Curve virtual ray



[Aguerreche et al., 2009]



[Riege et al., 2006]



[Duval et Fenals, 2002]

Conclusion

Collaborative Virtual Environment (CVE)

Several solutions to represent users in a CVE

From realistic to simplified solutions

Activities/Capabilities perception

Usually voice communication

But not so much tools to improve the communication

Techniques for collaborative interaction

Navigation together or help the other to navigate

Move virtual objects together

Conclusion

Collaborative Virtual Environment (CVE)

Feedback of what the others are doing is very important
Especially for co-manipulation

Applications of CVE

Co-expertise, collaborative review or design

Training (learn a collaborative task or learn with a remote teacher)

Entertainment (video games, artistic performance, etc.)

Social presence (telepresence)