Groupware and Collaborative Interaction
Collaborative Virtual Environments

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slides based on lecture by Cédric Fleury

Housekeeping

Form groups &

add your project description on spreadsheet !!!

Do this early so we can confirm your topic.

Dec 1st you'll present your **progress**

project proposal / feedback session

In-person

Official (marked) milestone

Project Proposal/Feedback: Programming

5 min to present (~3 slides)

    Send in pdf format on Mon 29/11

    Present in class on Dec 1st

(i) your concept,

(ii) the features you plan to implement in order of priority,

(iii) the tools you'll use to develop it.

    IF you have anything implemented you can demo

3

Project Proposal/Feedback: Design

5 min to present (~3 slides)

      Send in pdf format on Mon 29/11

      Present in class on Dec 1st

(i) your concept,

(ii) related papers/systems you have reviewed,

(iii) what is novel about your concept.

      IF you have early designs you can show them

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Collaborative Virtual Environments

Today

Introduction to Mixed Reality (MR)

Overview of Interaction in MR

Collaboration in MR

    Remote Collaboration

    Co-located Collaboration

Awareness and Communication

Collaborative Interaction

    Navigation

    Co-manipulation

Collaborative
Virtual
Environments

Today

Introduction to Mixed Reality (MR)

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Collaborative
Virtual
Environments

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Virtual Reality

Virtual environment (VE)

    3D virtual world

    Simulated by computers

Interaction in real-time

    Through various material devices

Immersion

    Multi-sensorial perception of the VE

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Augmented Reality

Real environment + Virtual environment

Add virtual information on the real environment

How can we define the boundary between virtual reality and augmented reality ?
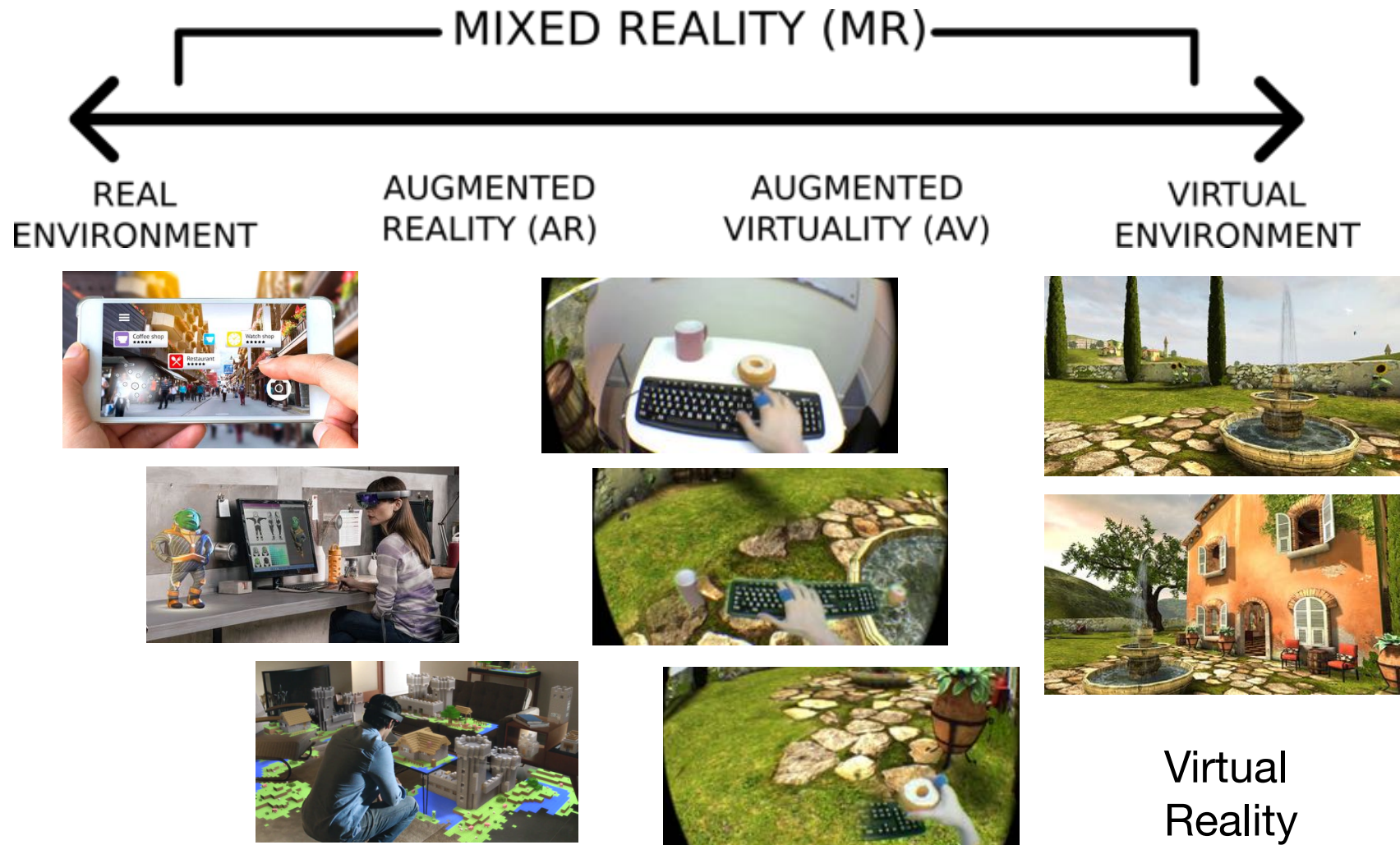
Mixed Reality

Boundary between real and virtual can be fuzzy

Augmented virtuality

Integrated elements from the real world in the virtual environment

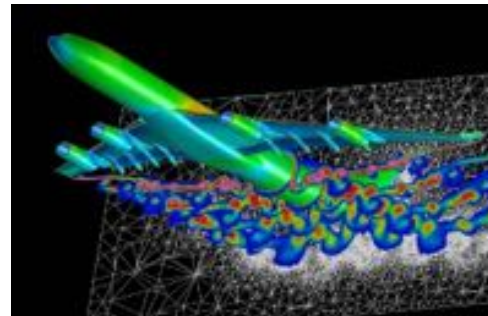Ex: video feeds, tangible interaction, user's real position, …

Milgram Continuum

MIXED REALITY (MR)

REAL ENVIRONMENT — AUGMENTED REALITY (AR) — AUGMENTED VIRTUALITY (AV) — VIRTUAL ENVIRONMENT

Virtual Reality

Applications of Mixed Reality

Scientific data analysis

Industrial applications

  Design, conception

  Fabrication

Training, education
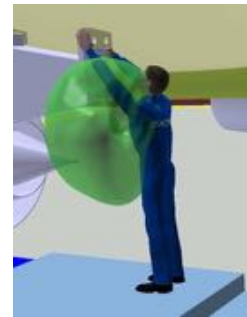
Phobia therapy, rehabilitation

Entertainment

  Video games

  Virtual visits of museums

  Social communication (telepresence)

today

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Collaborative Virtual Environments

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Interaction

3 kinds of interaction techniques [Hand, 1997]

Viewpoint manipulation (navigation)

Object manipulation (interaction)

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.

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Navigation

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

Manipulate its own viewpoint

     or

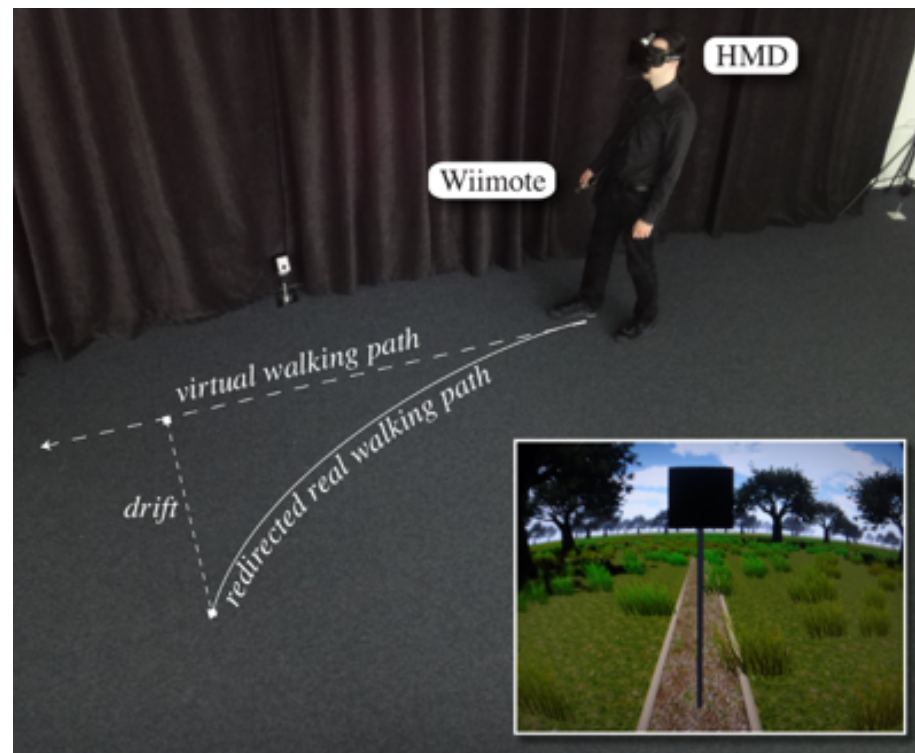Manipulate the viewpoint of the others

Includes path finding [Bowman et al., 2004]

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Navigation

Egocentric techniques

    Walking metaphor

    Flying metaphor

    Driving metaphor

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Navigation

Exocentric techniques

  Navidget [Hachet et al., 2008]

  Grabbing the air [Mapes et Moshell, 1995]

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Navigation

Choose occlusion free view
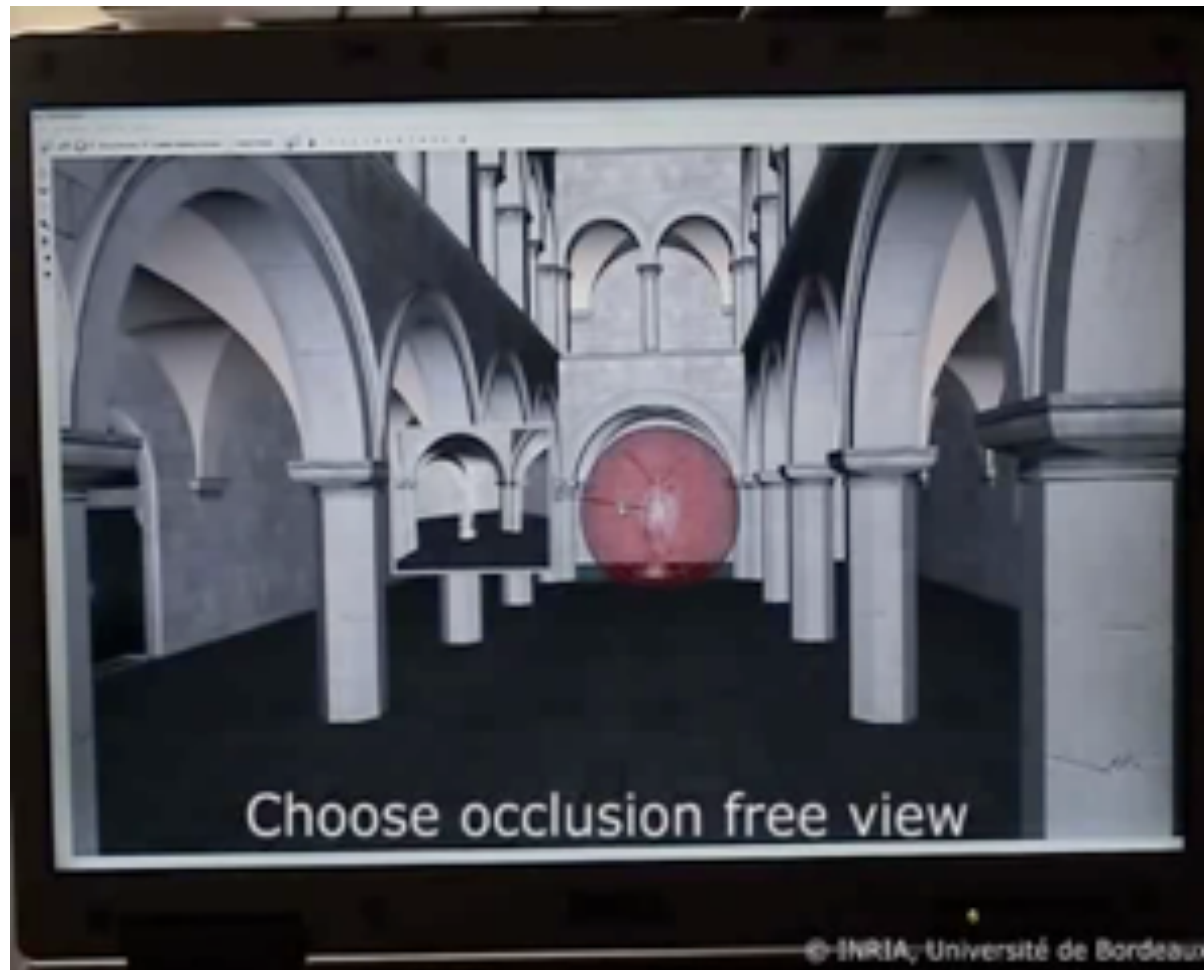
Navidget [Hachet et al., 2008]

Navigation

Assisted navigation techniques

Select the destination

Pointing

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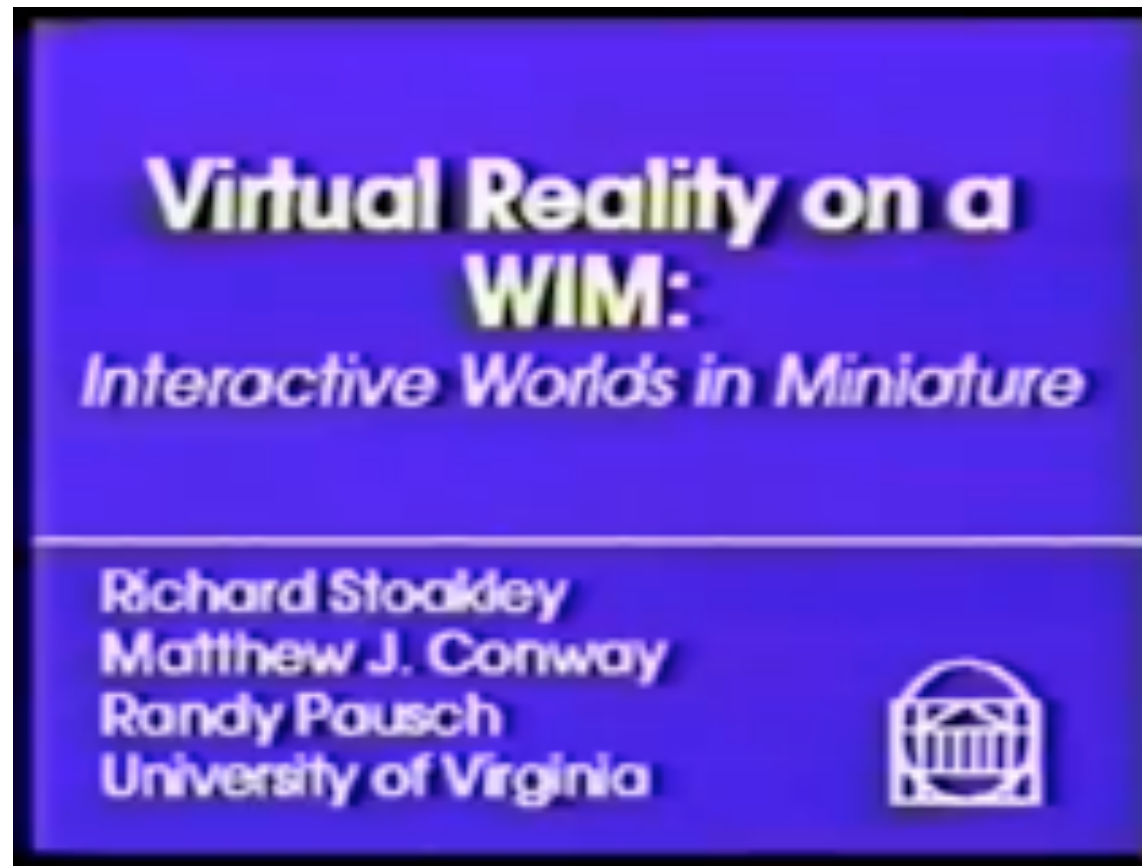[Stoakley et al., 1995]

List of (pre-)defined paths

[Stoakley et al., 1995]

Move to destination

Teleportation [Ruddle et al., 2000]

Interpolation [Mackinlay et al., 1990]

"Guided visit" metaphor [Elmqvist et al., 2007]

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Navigation

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

Navigation

Multi-scale techniques
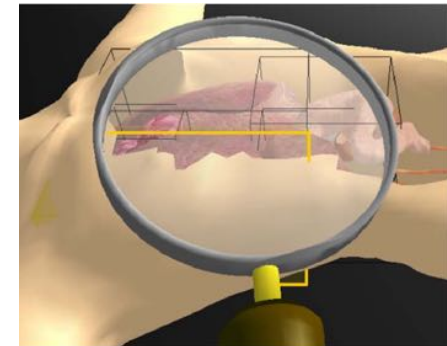
Manual scale modification

Scale the world

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

Automatic scale modification

Bounding Boxes [Kopper et al., 2006]

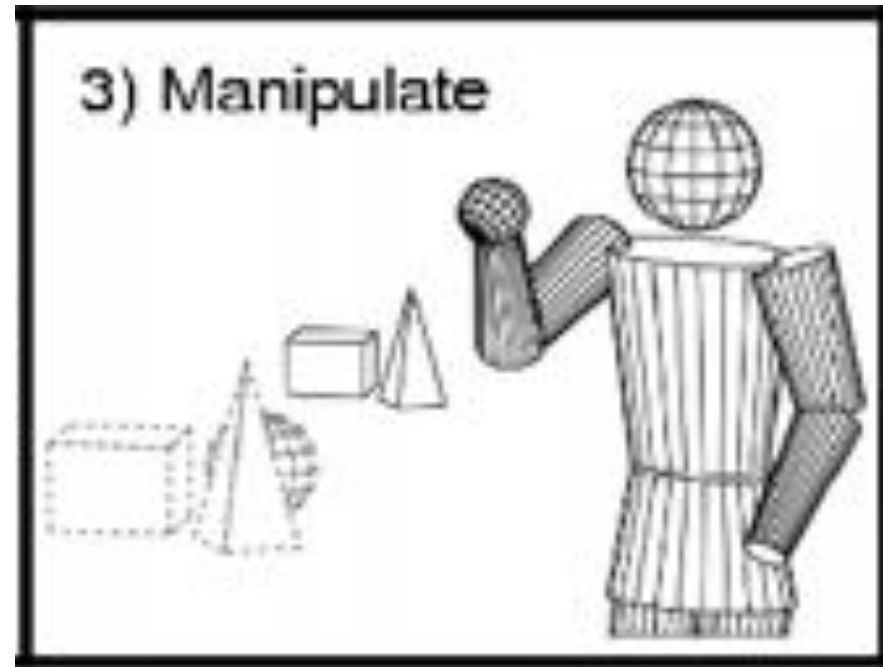Scaled-world grab [Mine et al., 1997]

22
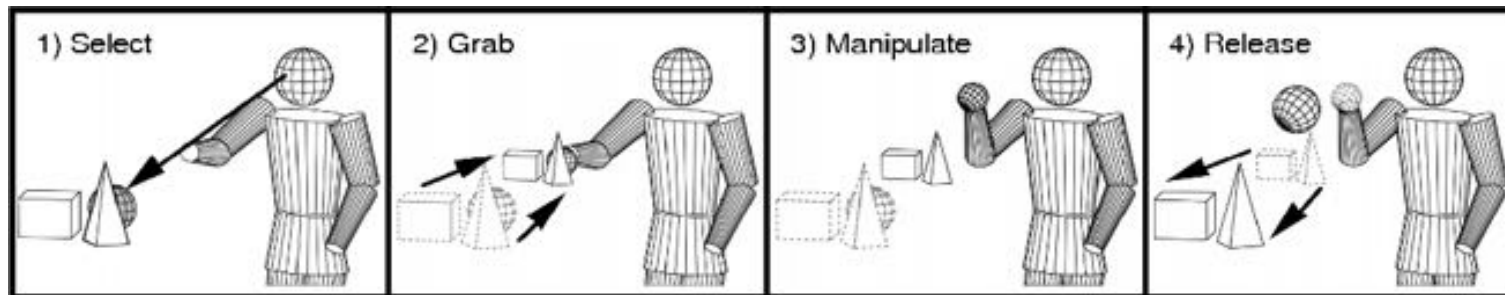
Object Manipulation

2 main tasks

    Selection

    Manipulation

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Object Manipulation

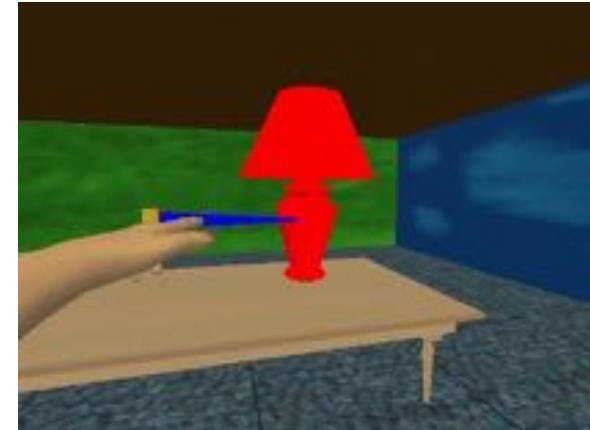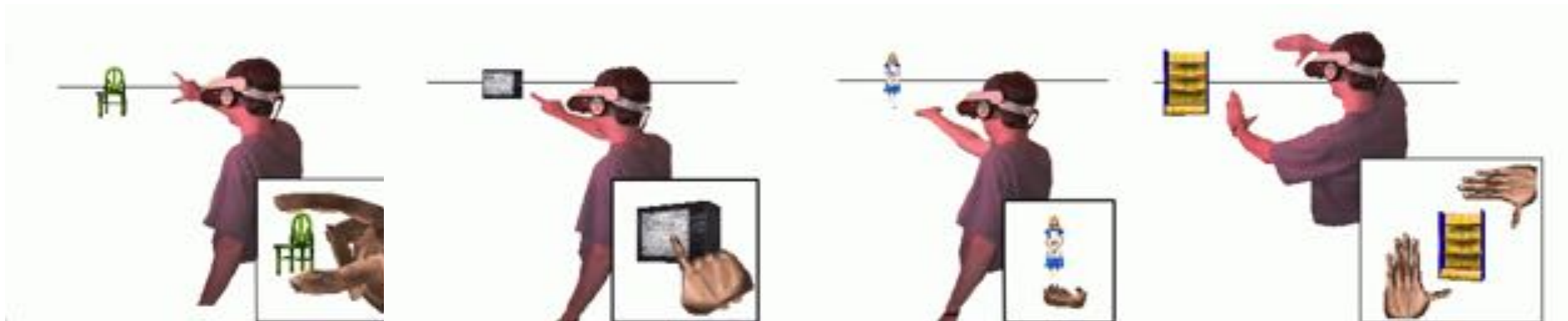Virtual Ray [Mine, 1995]

Mimics a laser pointer

Image plan Interaction [Pierce et al., 1997]

Select by pointing with one part of the body

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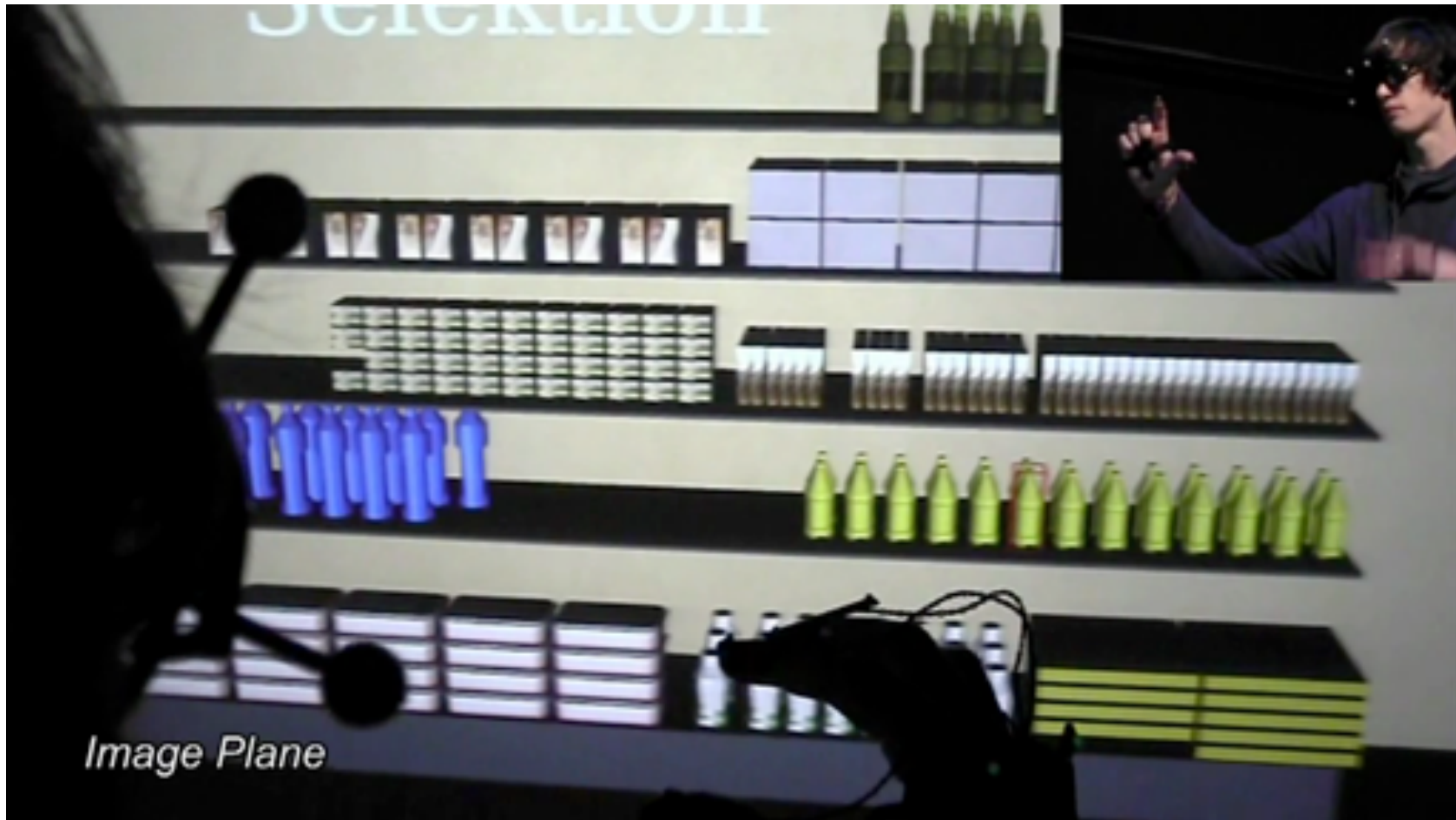
Object Manipulation

Image plan Interaction [Pierce et al., 1997]

Object Manipulation

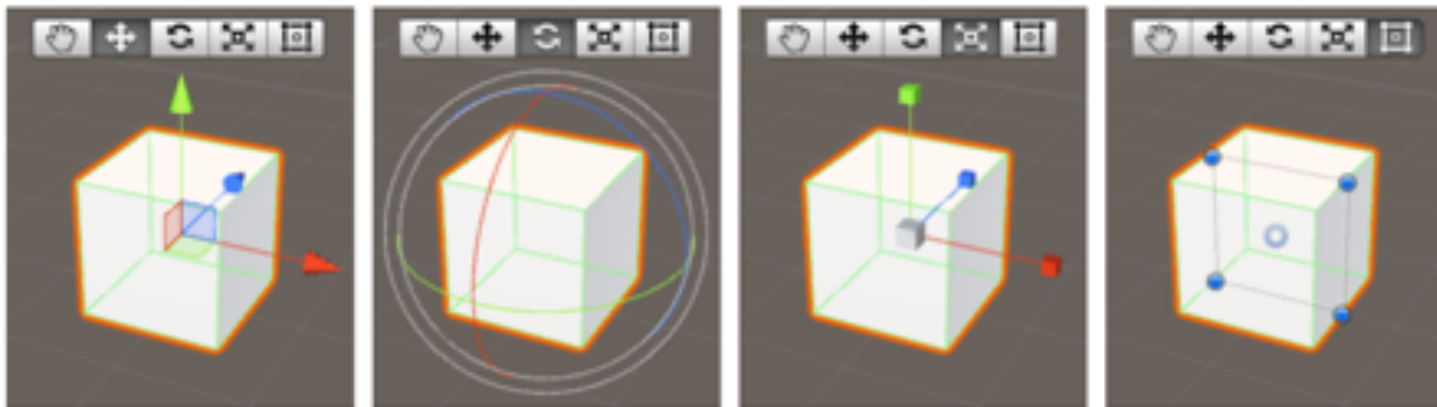Selection techniques not always suitable for manipulation

eg: virtual ray for rotations

Combining several interaction tools

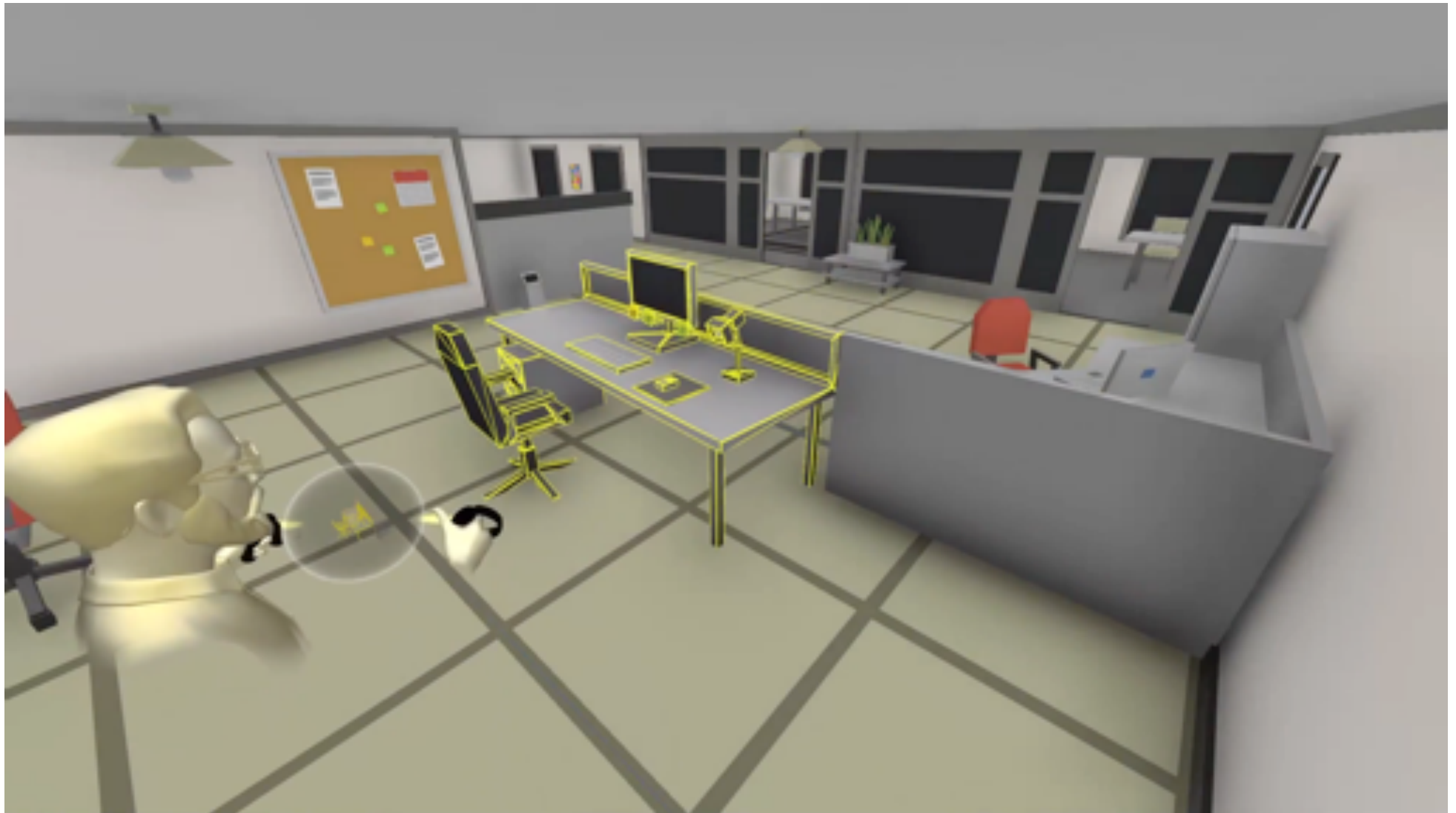extend hand reach HOMER [Bowman & Hodges, 1997]

move the manipulated object close to the user

attached the interaction tools to the objects

Multi-object manipulation

Containers & controls in Spacetime [Xia et al., 2018]

Application Control

Control

    Application (exit, pause,…)

    Rendering parameters

    Tools/actions selection

[CDS – Bowman et al., 1991]

[Coquillart et al., 1999]

[CHIMP – Mine et al., 1997]

Techniques used

    2D menus

    3D menus

    Control on a tablet/smartphone

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Collaborative Virtual Environments

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Collaboration in Mixed Reality

Several users work/play together in a VE

Co-expertise of 3D data

Complex manipulation (real or virtual)
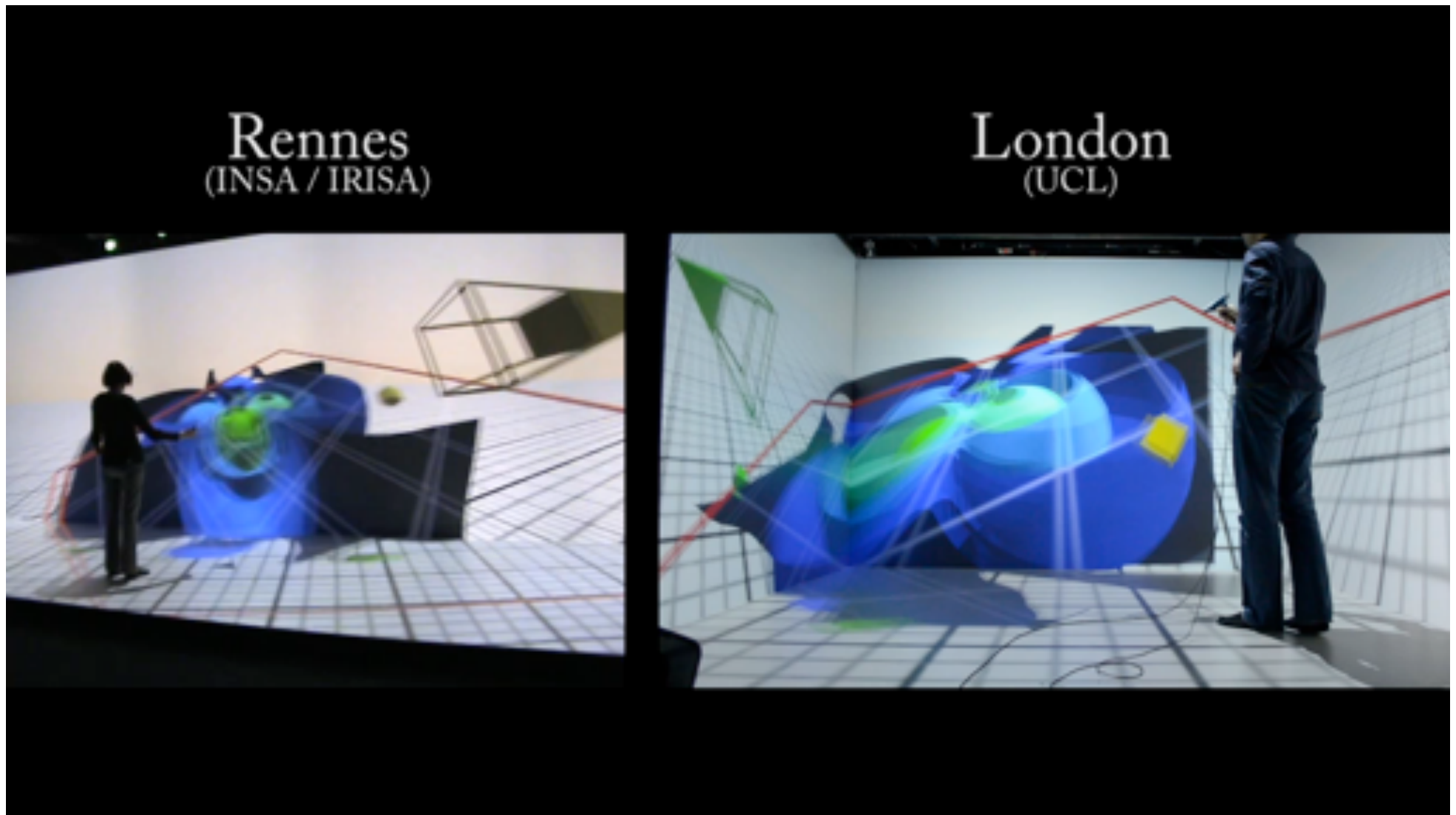
Training

Social presence (telepresence)

Remote Collaboration in AR

Remote Collaboration in VR

[Fleury et al., VRST 2012]

Co-located Collaboration in AR

Co-located Collaboration in VR

Integrate several users in a VE with the same devices

[Kulik et al., 2011]

Multi-stereoscopic display

C1x6: A Stereoscopic Six-User Display
for Co-located Collaboration
in Shared Virtual Environments

Alexander Kulik, André Kunert, Stephan Beck, Roman Reichel,

Roland Blach, Armin Zink, Bernd Froehlich

[Kulik et al., 2011]

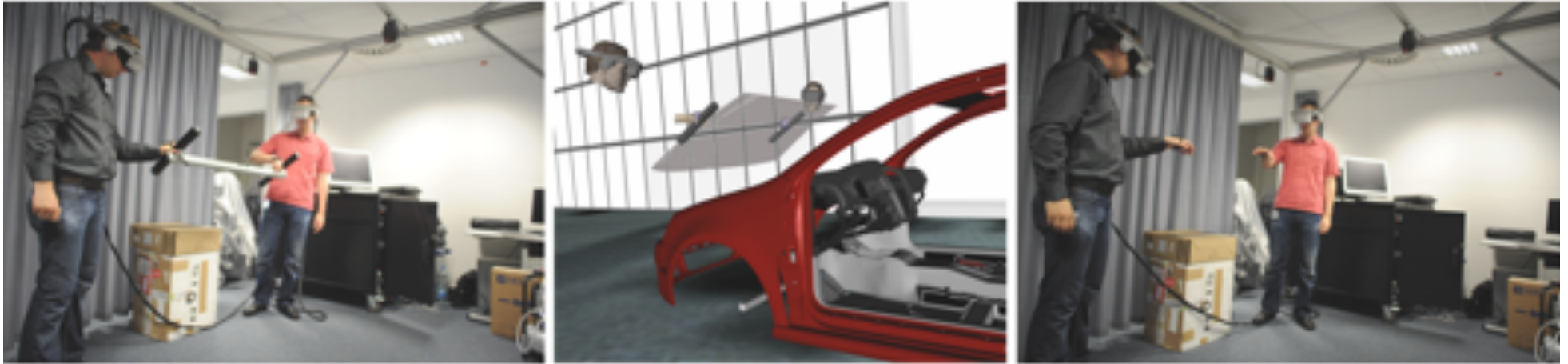# Co-located Collaboration in VR

Users cannot see the other in the real world

Users can hear the other

Users can feel the haptic force of the other

Co-located vs. Remote

Limits between co-located and remote collaboration are not clearly defined

2 users with AR headsets in the same room?

2 users in a CAVE?

2 users with HMDs in the same room?
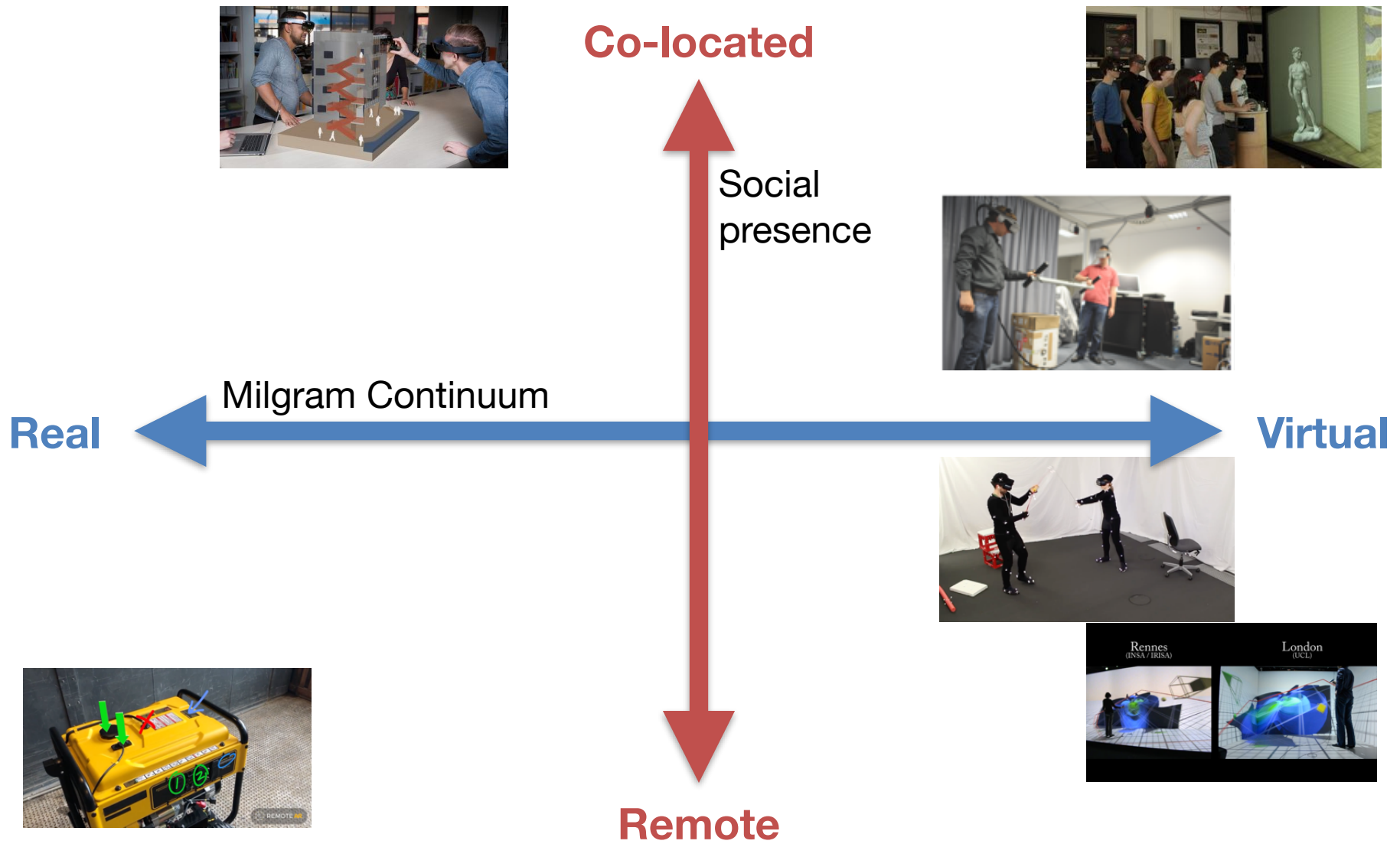
2 users with HMDs in a different room?

2 users with HMDs & headphones in the same room?

Unknown (Unwanted?) collaboration

[Cheng et al., UIST 2017]

Collaboration in MR

Co-located

Social
presence

Milgram Continuum

Real ← → **Virtual**

Remote

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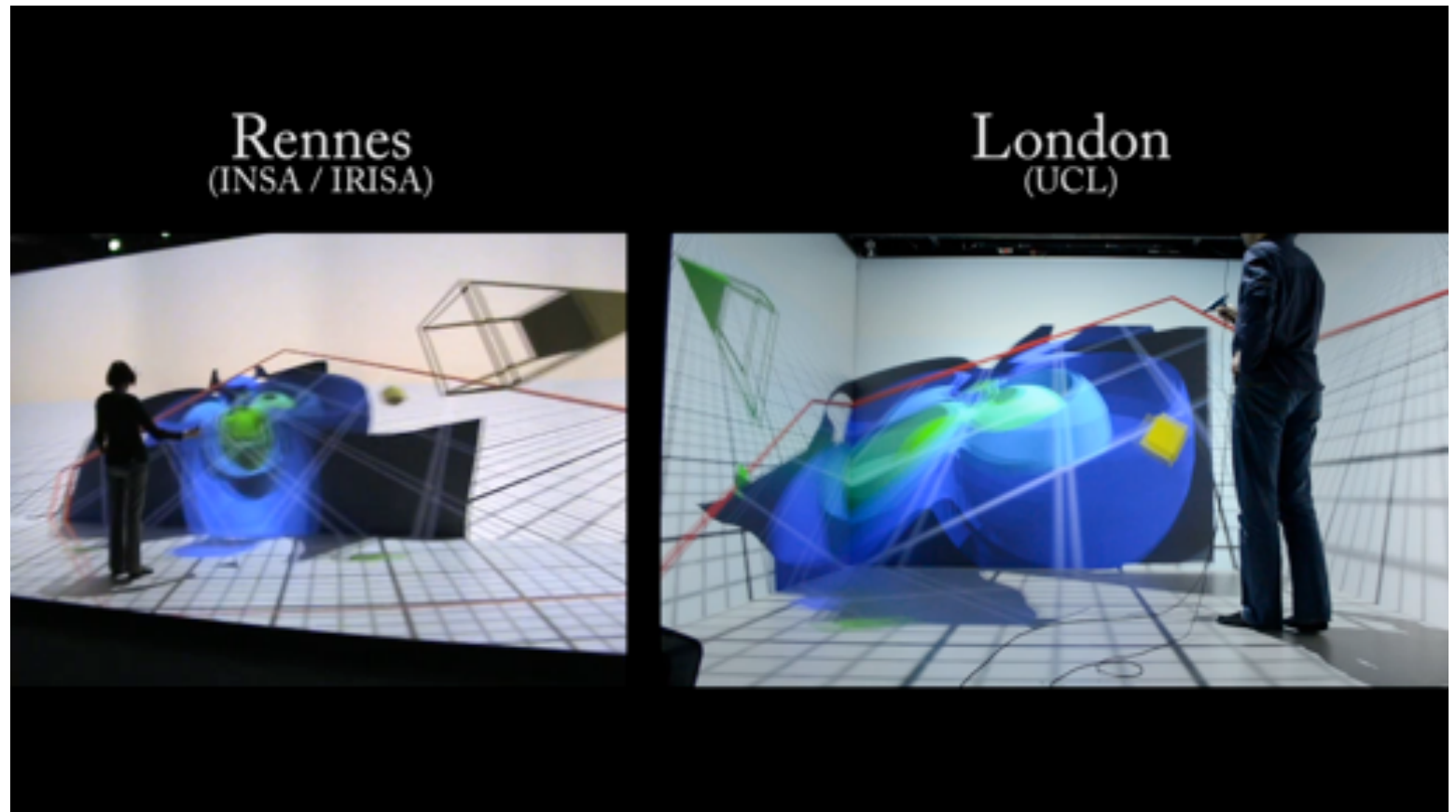 Co-located Collaboration

Awareness and Communication

Collaborative Interaction
  Navigation
  Co-manipulation

Collaborative Virtual Environments

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Social Presence

[Fleury et al., VRST 2012]

Simplified Avatars

Collaborative interaction

Social Presence

[Facebook Social VR Demo - Oculus Connect 2016]

Animated avatars

Collaborative interaction

Video facilites

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Social Presence

Real 3D video integration

Collaborative interaction

Specific tools for collaboration

[Beck et al., IEEE VR 2013]

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Awareness

Perception of the other users

Where are they?

What are they doing?

What are they looking at?

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?

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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
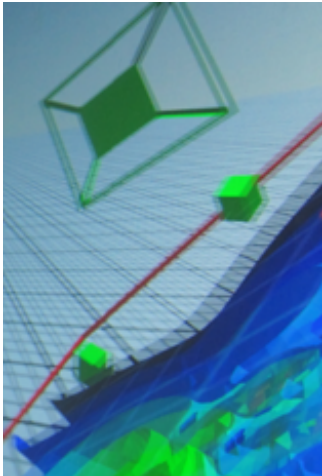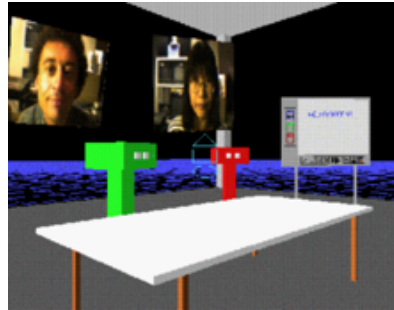
    Visual awareness

    Audio awareness

    Haptic awareness

Visual Awareness

Avatar: representation of users in the VE

Simplified   Realistic

[Fleury et al., 2012]

[DIVE, 1991]

CALVIN, 1996

Second Life, 2005

[Beeler et al., 2010]

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Visual Awareness

Animation of the avatars
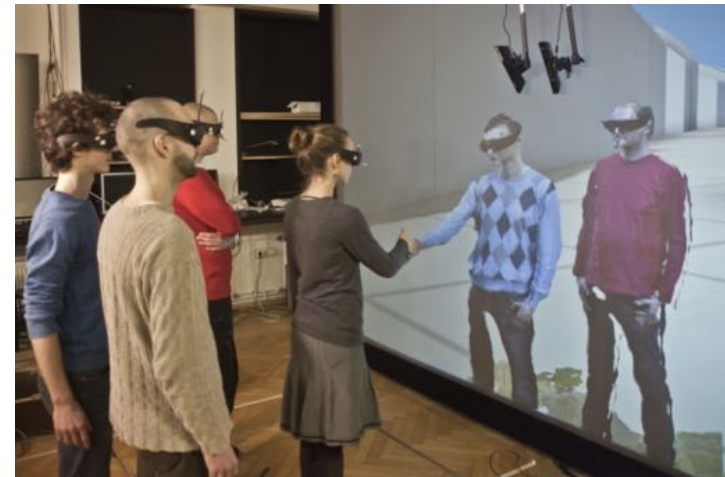

Kinect Avatar

Body tracking

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Kinect Avatar

Telepresence in virtual reality

Animated virtual characters

Real 3D video integration

Video facilities

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

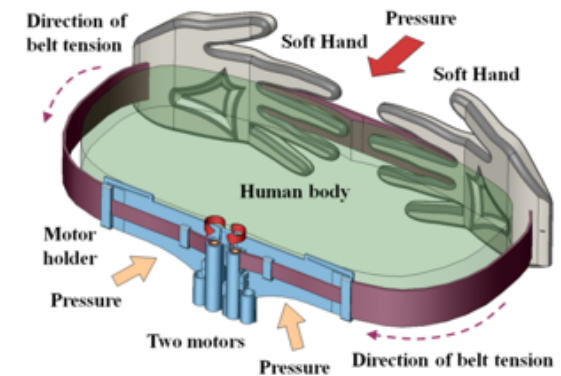Virtual handshake

Affective haptic

Can be asymmetrical

Indirect

Manipulate an object together

Feel the force applied by the other on the object

Awareness Model

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

Compute which users can interact with which others
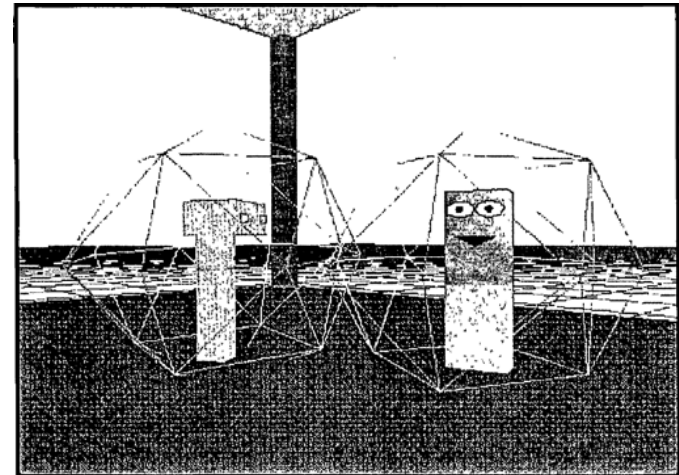
Measure of awareness between two users

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

Focus and **Nimbus**
Sub-space bounding the presence
in a particular **Medium**

[Benford et al., 1994]

Awareness Model

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

Focus
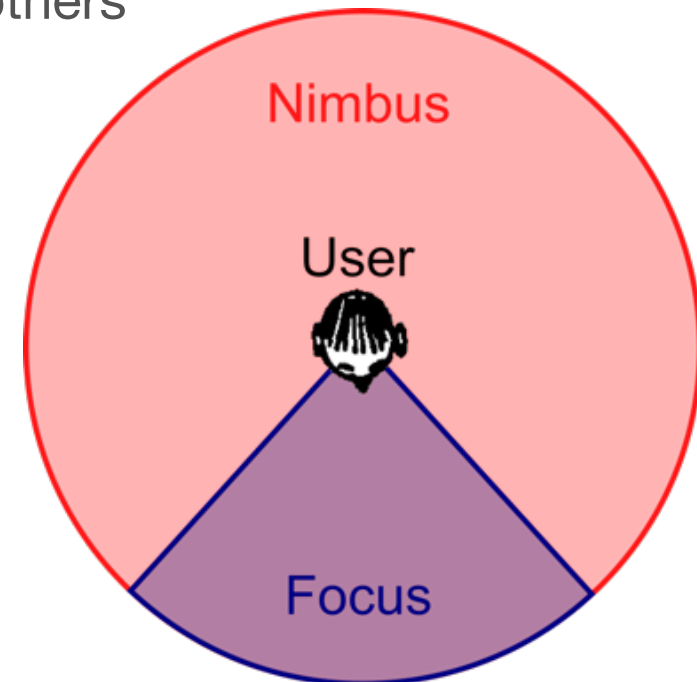
Area where a user perceives the others

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?

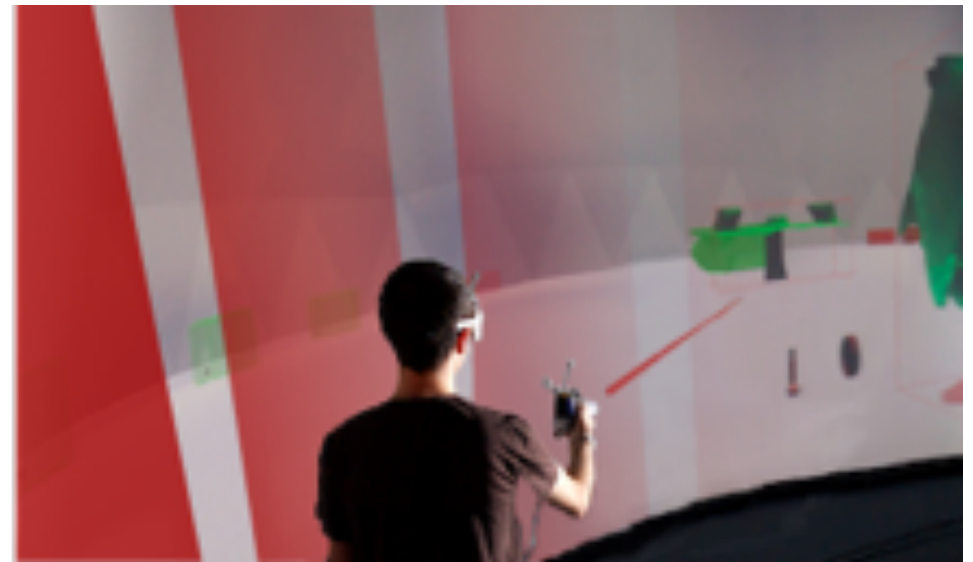⇒ How can they understand what the others can do?

(how much info do they need)

Show the *interaction workspace*
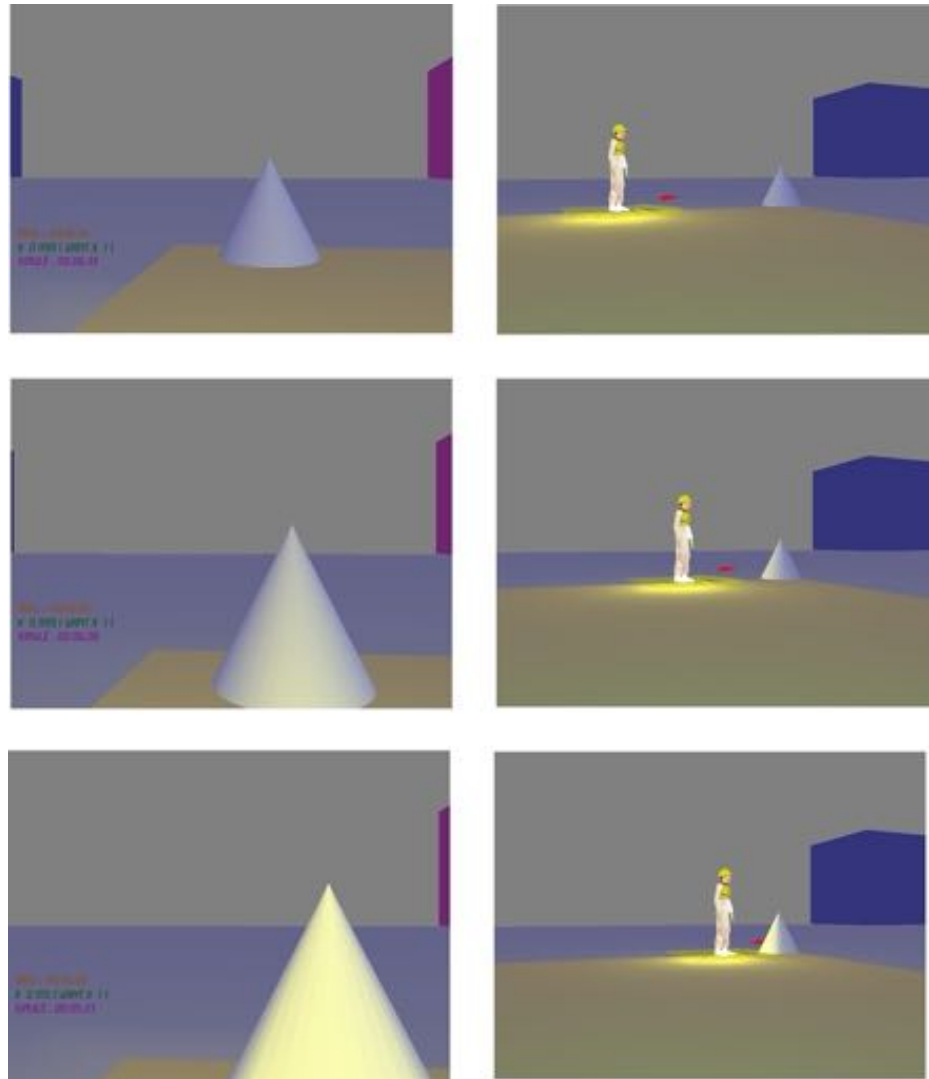
Capabilities Perception

Example for the user themselves:

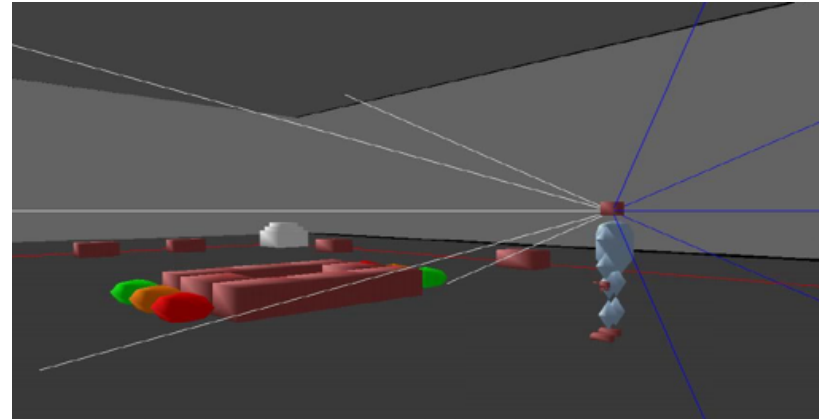   User's displacement workspace

Capabilities Perception

Example for another user:

Interaction workspace

Activities Perception

What is the user seeing?

What is the user doing?
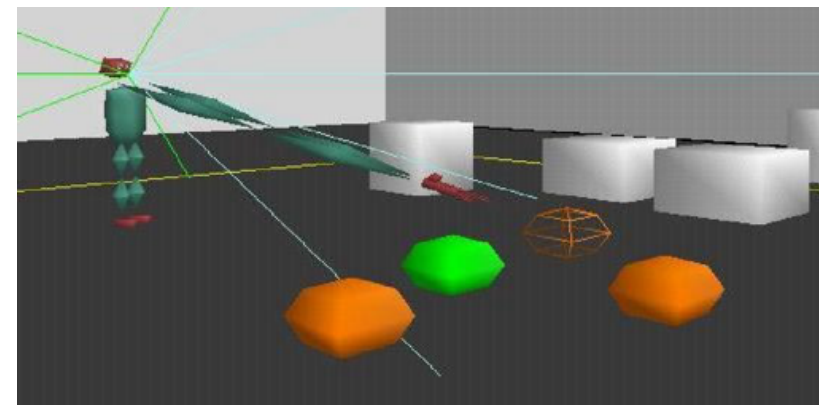
[Fraser et al., 1999]

(how much info do they need)

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Voice communication

Essential for collaborative application

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

Share different point of view

However:
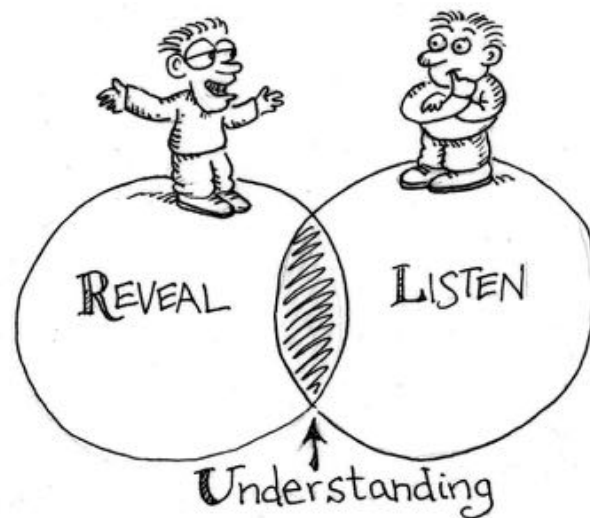
Voice communication induces also discontinuity in interaction

[Bowers et al., 1996]

⇒ Users need specific tools for communication

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Tools for communication

Virtual Ray

Laser pointer metaphor

Easy and intuitive manipulation
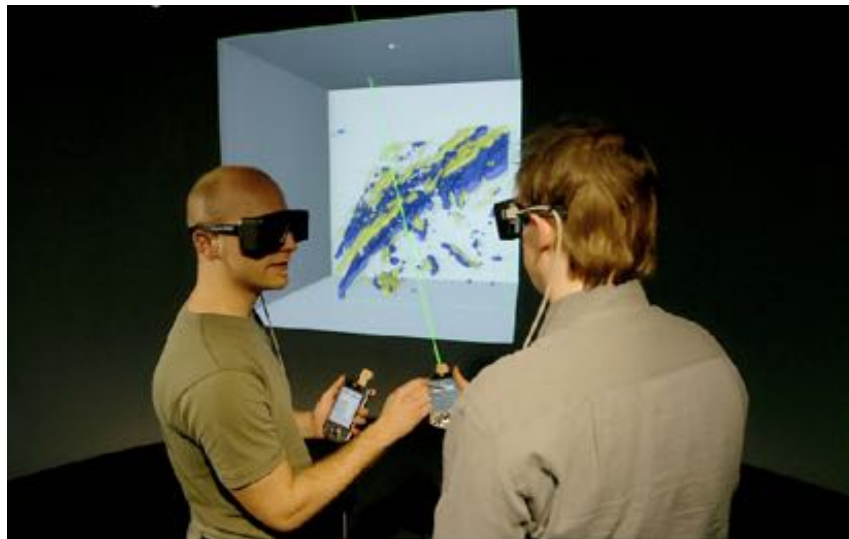
[Simon, 2005]
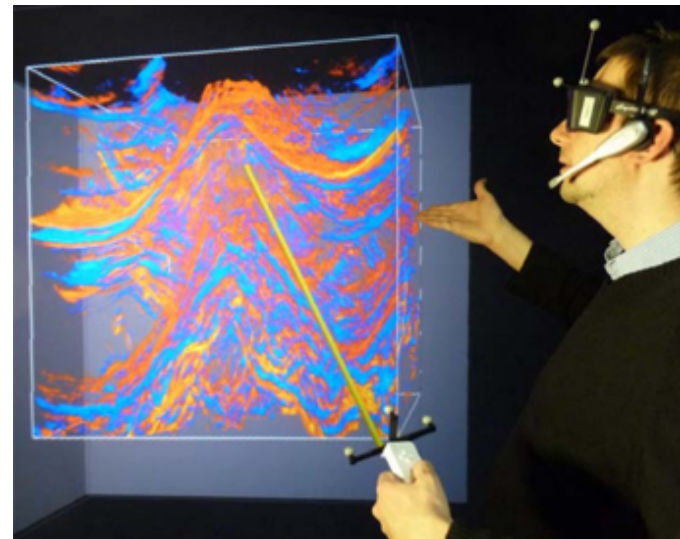
[Schild et al., 2009]

Tools for communication

Annotations

    Sketching, text, audio, videos

    Especially relevant for scientific data analysis

    Synchronous and asynchronous collaboration
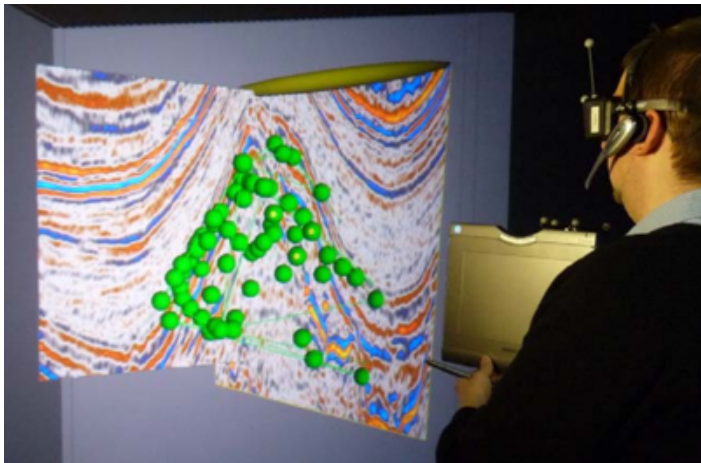
[Schild et al., 2009]

Tools for communication
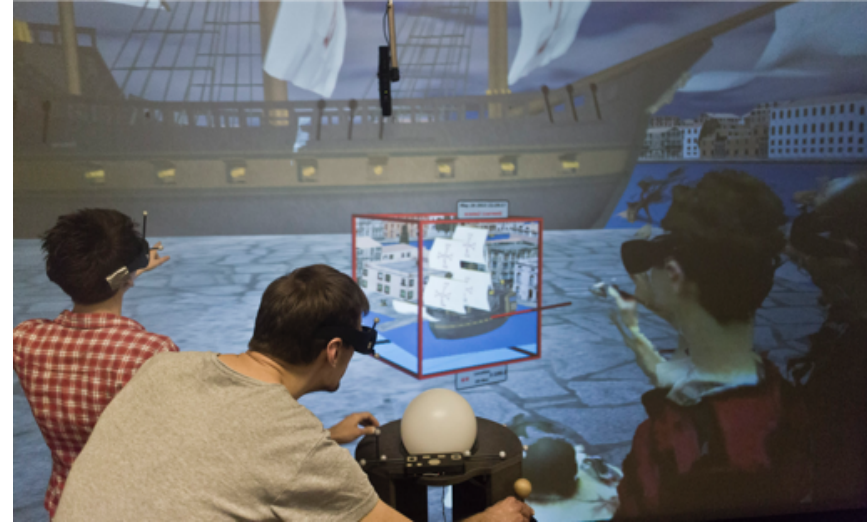
Photoportals

    Shared 2D or 3D views

    Annotations

    Interaction with the shared views

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Photoportals
[Kunert et al., CSCW 2014]

Photoportals:
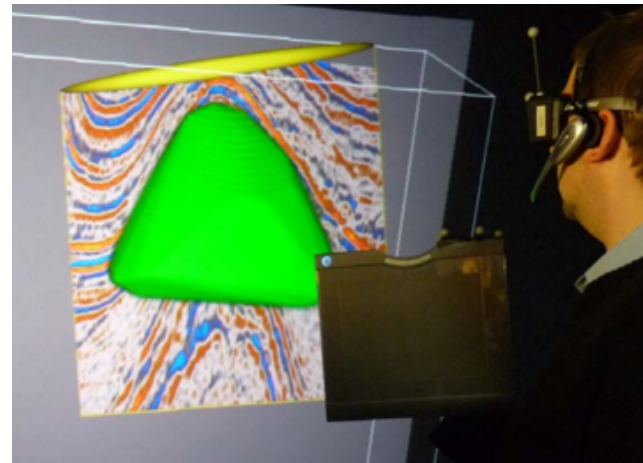## Shared References in Space and Time

André Kunert, Alexander Kulik, Stephan Beck, Bernd Fröhlich

Starring: Jan Beckmann, Anniek Vetter, André Kunert, Felix Trojan and Eik List
Voice: Ben Sassen
Production: Marcel Karnapke

3D model of Castle Vianden (Luxembourg)
Courtesy of ArcTron 3D GmbH (www.arctron.com)

Additional 3D Models from Blendswap Members:
Sizzler, Hjford, Michal David, Nicolas Damore, Ian57, Komtraya

CSCW 2014

Bauhaus-Universität Weimar
VR-Systems Group

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Collaborative Virtual Environments

Collaborative Navigation

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

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Collaborative Navigation

3 main modes of collaborative navigation

Share the same point of view

One user drives, the other follows

One moves and the other follows with an offset
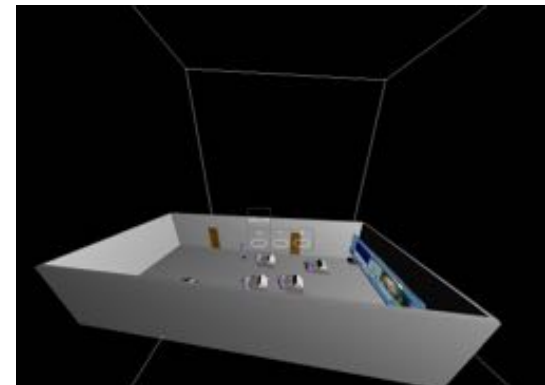
One user drives, the other can modify his offset

World in Miniature

Guide the others through the WIM

Move the others through the WIM

[CALVIN, 1996]

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Viewpoints sharing

[Duval et al., 2008]
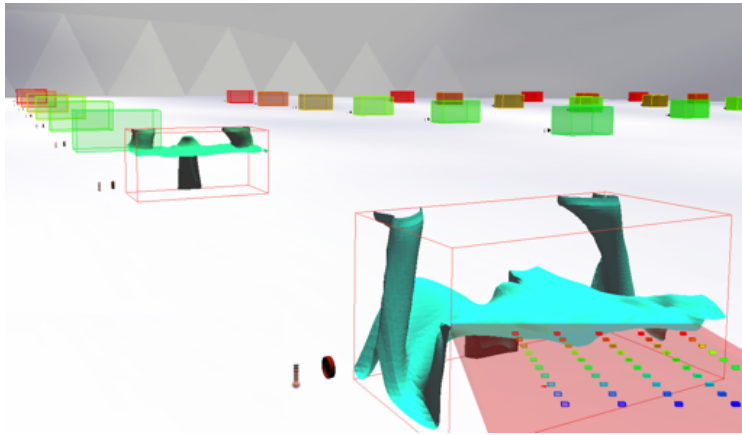
Context: scientific data analysis

Users can:

Save interesting viewpoints

Select on particular viewpoint

Travel cross of the saved viewpoints
of a particular user

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Group Navigation
[Dodds & Ruddle, 2008]

Each user can travel independently, … or

Users can become part of a predefined group, and they have functionalities that help them 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)

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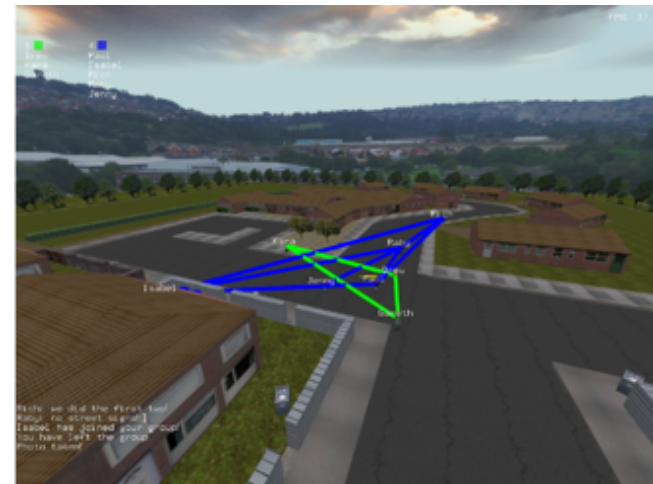
Collaborative teleportation

Spacetime [Xia et al., 2018]

Guidance techniques
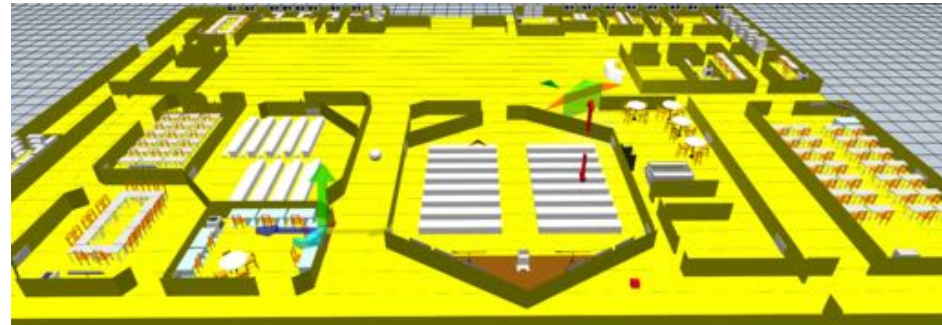
Context: collaborative navigation in a building

 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
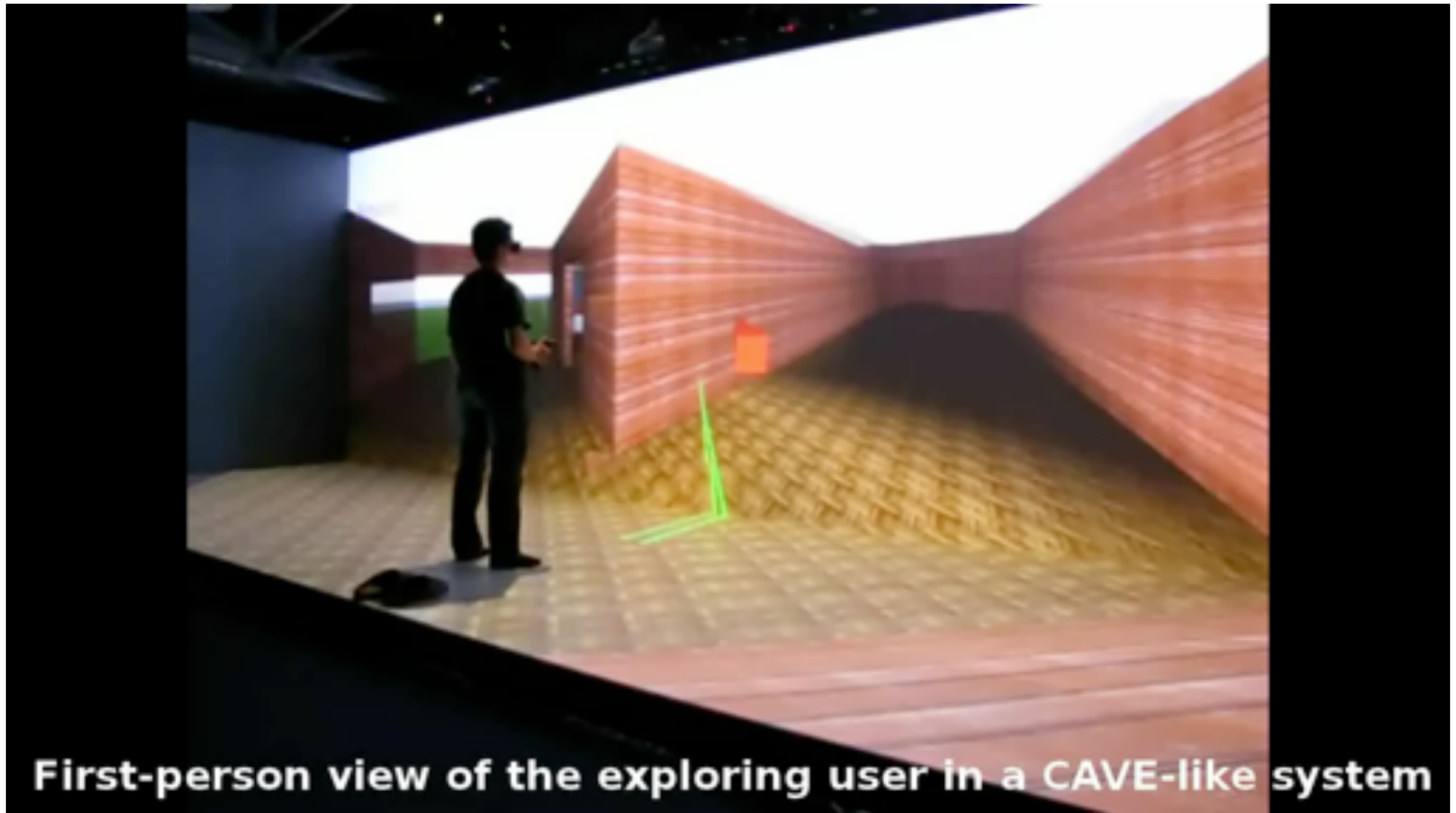
First-person view of the exploring user in a CAVE-like system

Co-located Navigation

[Kulik et al., 2011]

Co-habitation in a CAVE
[Chen et al., 2015]

Problems when several users are co-located in a CAVE

Collisions

Occlusion
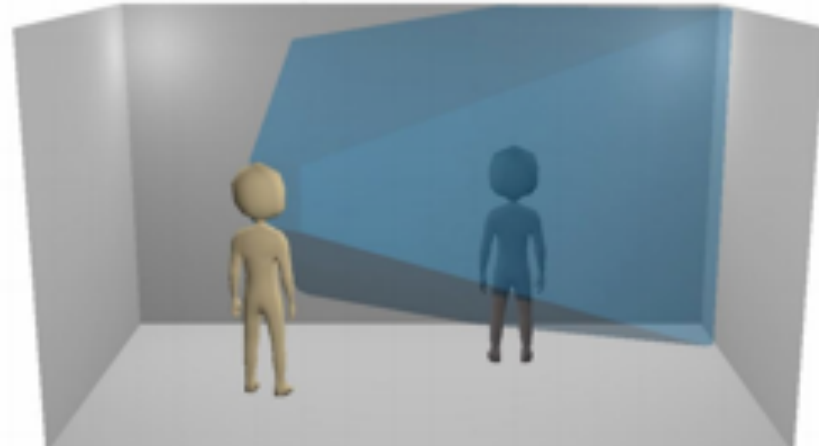
Co-habitation in a CAVE
[Chen et al., 2015]

Problems when several users are co-located in a CAVE

Consistent

vs.

Inconsistent
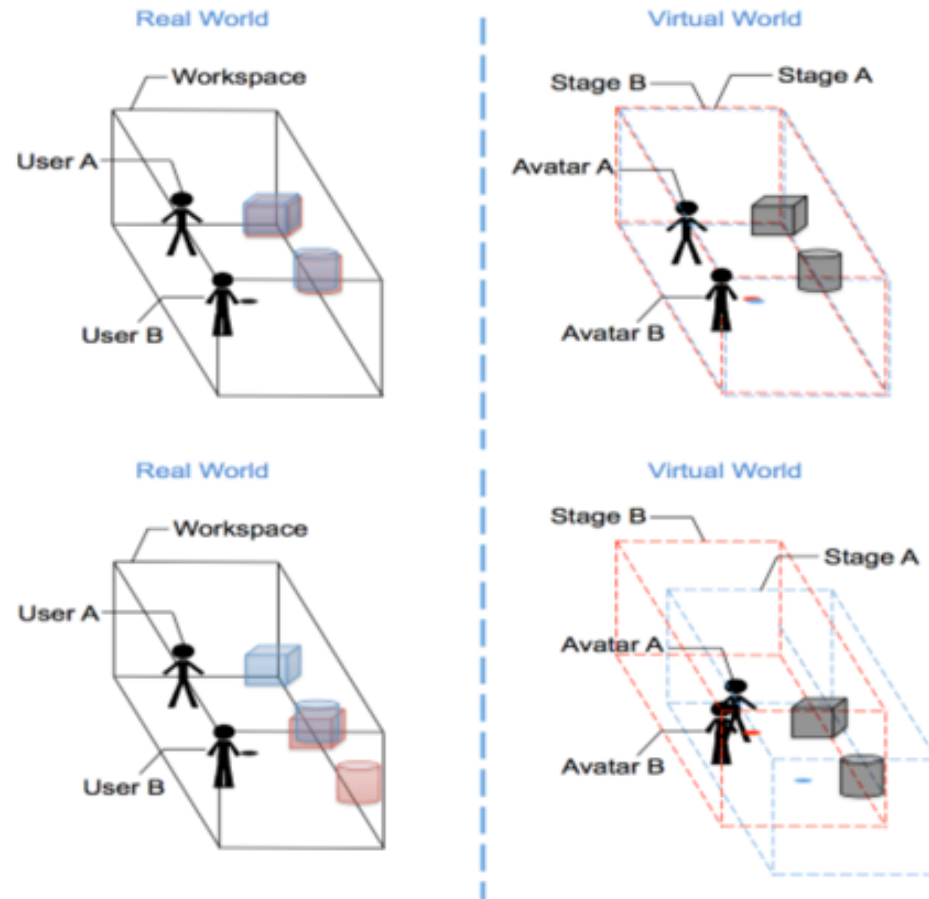
Co-habitation in a CAVE
[Chen et al., 2015]
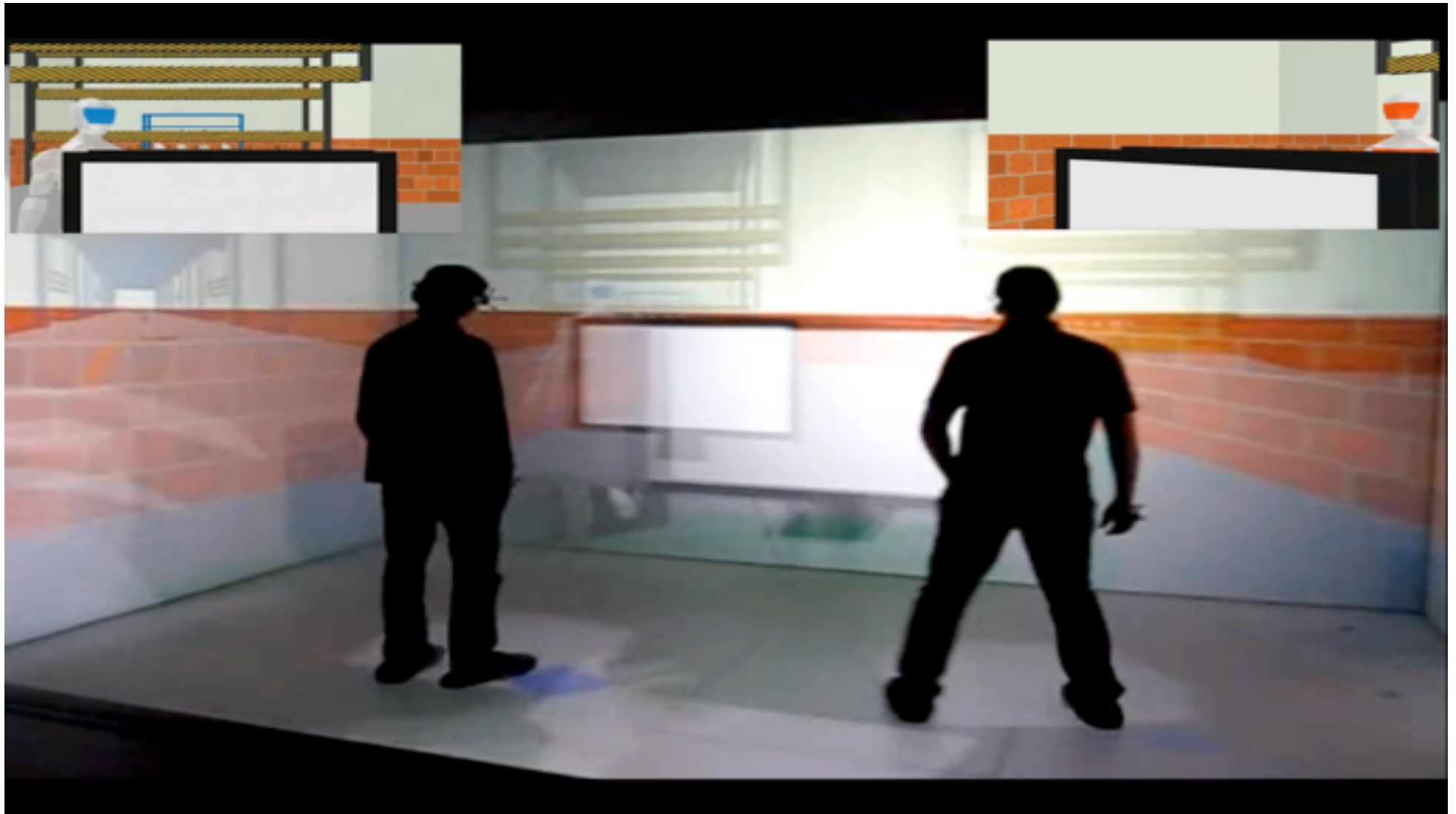
Co-manipulation

Several users manipulate a same virtual object

Edit a same virtual objet

Achieve a hard manipulation task in VE

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

Degree of Freedom (DoF)

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

Some other parameters (color, shape, etc.)

3 solutions: users manipulate

Copies of the object

Different DoF of an object

Same DoF of an object

Manipulate copies

Spacetime [Xia et al., 2018]

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
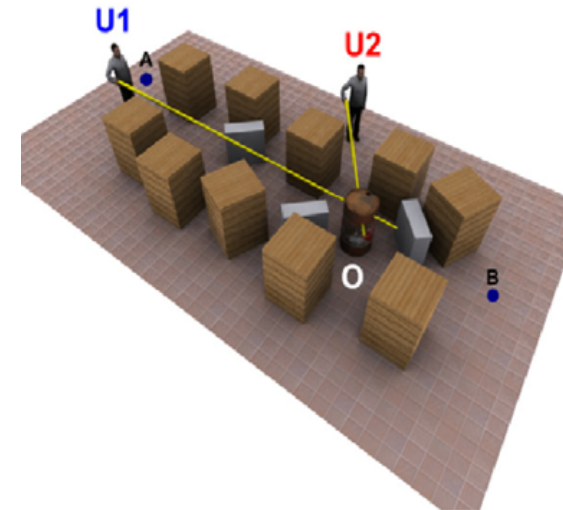
User U1's view

User U2's view

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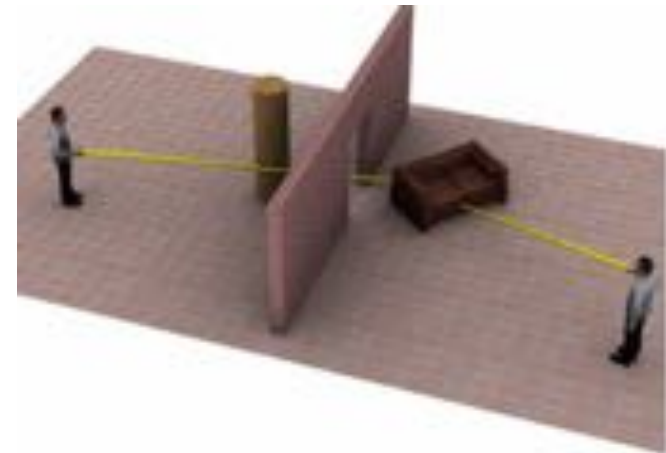
Manipulate different DoF

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
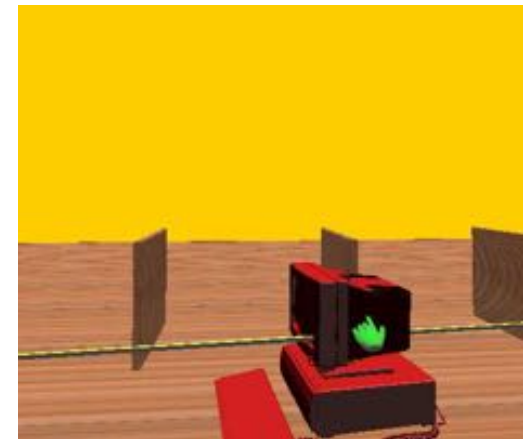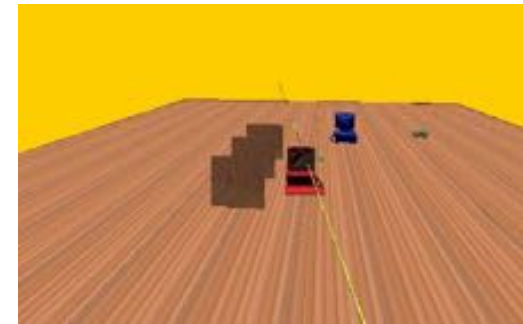
[Pinho et al., 2002]

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

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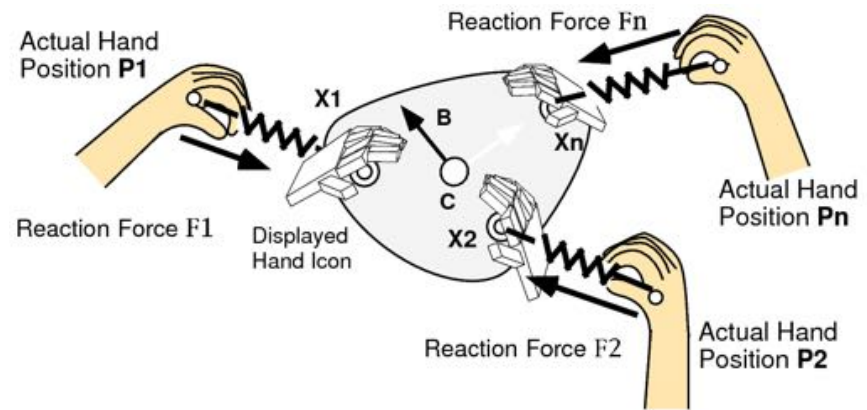
Manipulate the same DoF

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

Implemented with a prop
(Reconfigurable tangible device)
[Aguerreche et al., 2010]
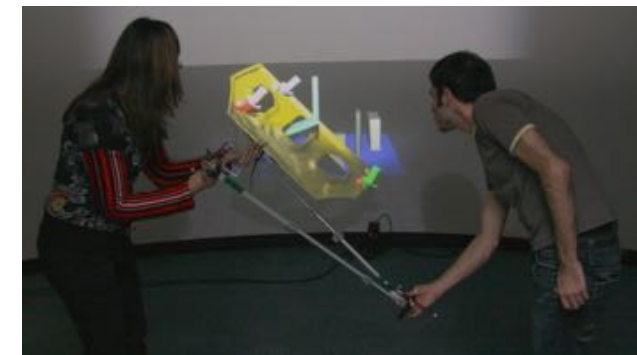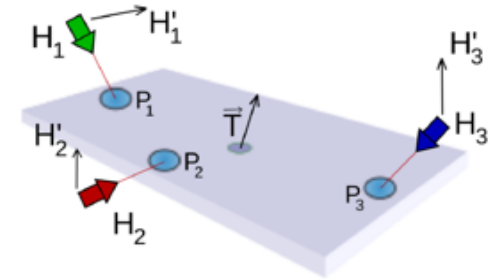
Co-located manipulation
[Aguerreche et al., 2010]
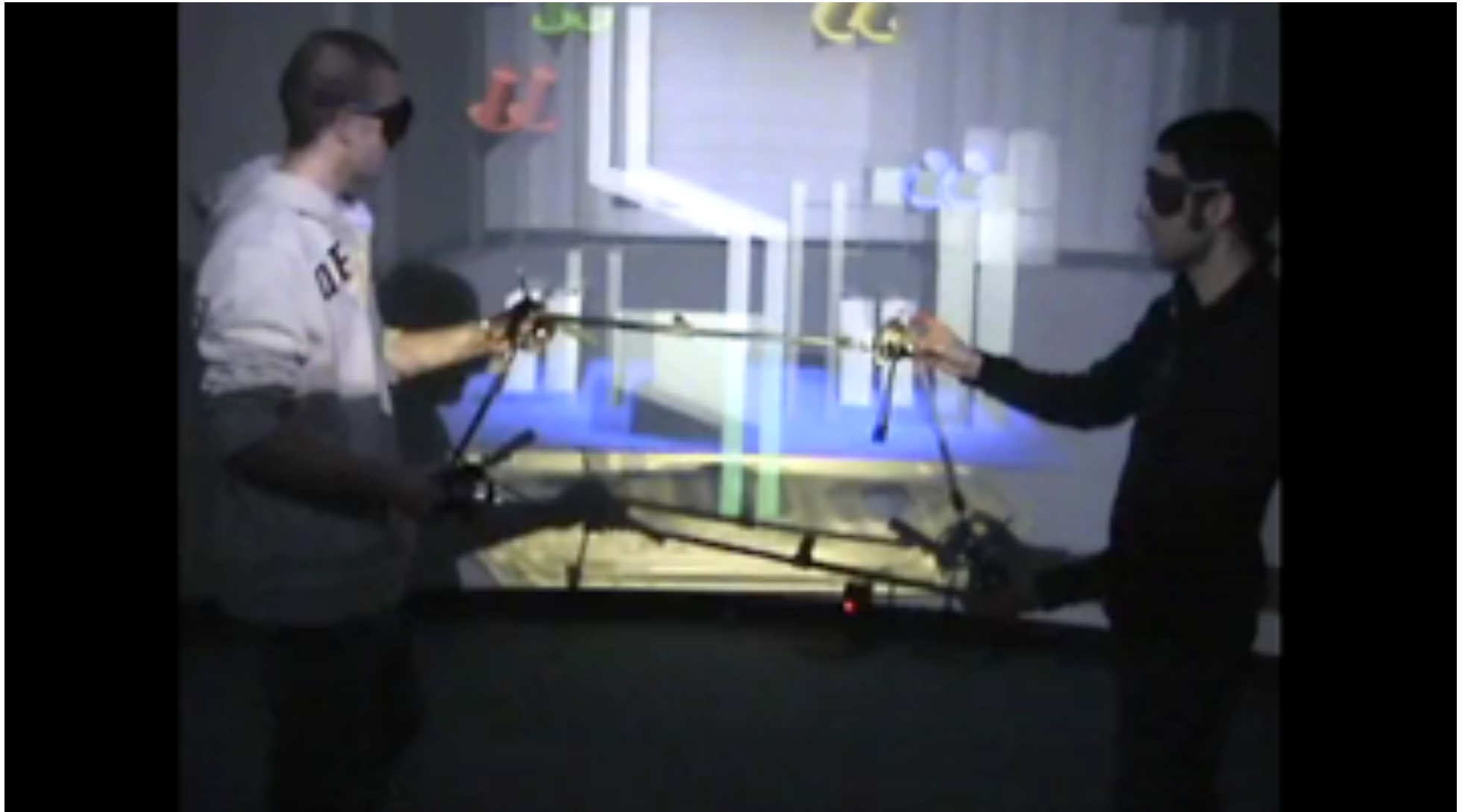
Co-located manipulation
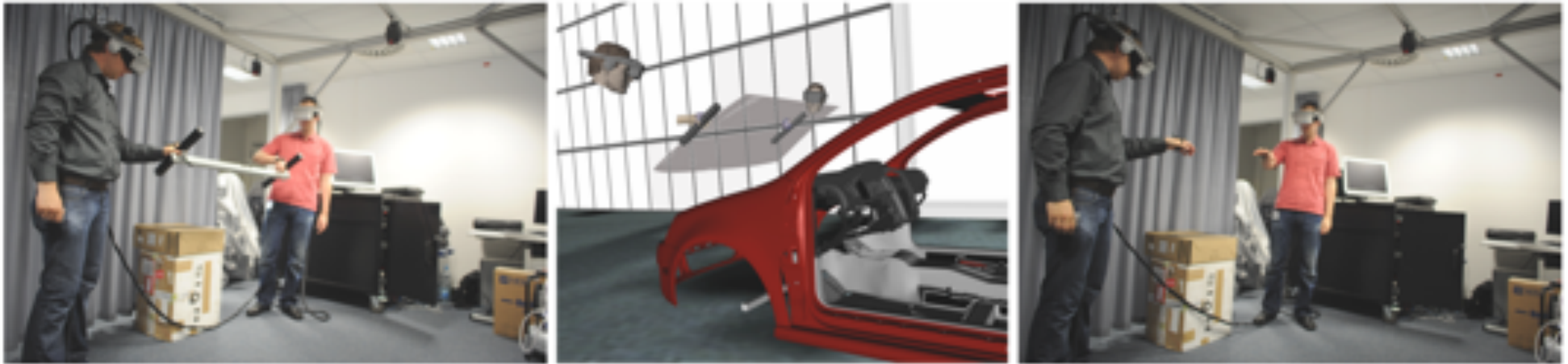
Even if users cannot see the others,

haptic feedback is still important

[Salzmann et al., 2009]

Take-aways

Take-aways

Co-located vs. Remote collaboration

Social presence is a continuum

Several solutions to represent users in a CVE

From realistic to simplified solutions

Activities/Capabilities perception

Usually voice communication

But still need visual tools to improve the communication

Wide range of collaborative interaction

Navigation together or help the other to navigate

Move virtual objects together

Take-aways

Feedback of the others are very important

Especially for co-manipulation

Applications of CVE

Co-expertise, collaborative review or design

Training

Learn a collaborative task

Learn with a remote teacher

Learn with additional virtual content

Entertainment (video games, artistic performance, etc.)

Social presence (telepresence)

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