Virtual and Augmented Reality for Edutainment

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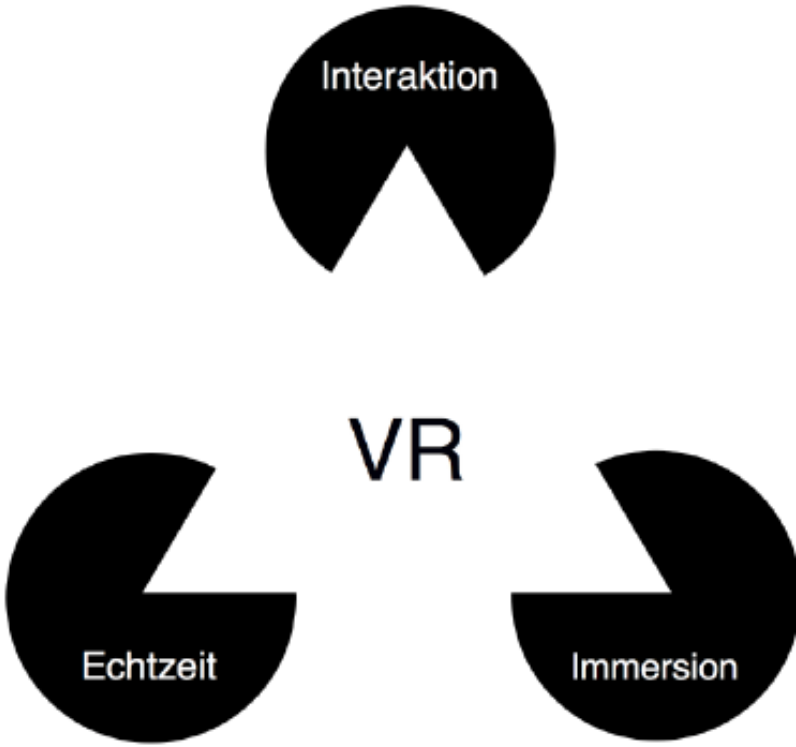
Definition of Virtual and Augmented Reality

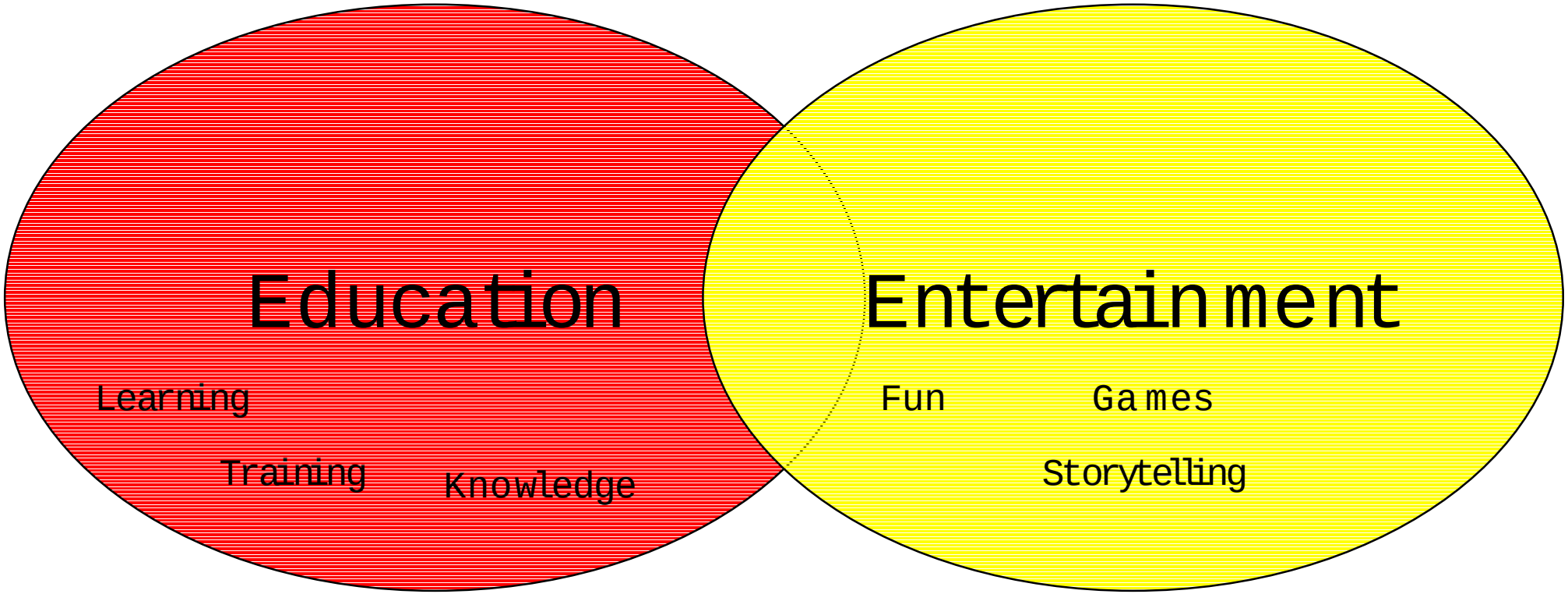
Definition of Virtual Reality

- Realtime rendering
- Interaction
- Immersion

- Mixing real and virtual images



What is Edutainment



Movies & Games

Movies:

- No interaction
- Less immersive

Games:

- Less immersive
- Mostly standard input devices

Zur Anzeige wird der QuickTime Dekompressor „IFF (Unkomprimiert)“ benötigt.

Why should we use VR/AR for Edutainment?

New forms of teaching:

- Learning by experience
- Learning by doing
- …

Zur Anzeige wird der QuickTime Dekompressor TIFF (Unkomprimiert) benötigt.

Problem

- The learning matter hast to be experiencable

Why should we use VR/AR for Edutainment?

Virtual and Augmented Reality offer:

- Flexibility
- Direct experience
- Interactivity
- Interesting technology

Trends in learning and public education

Education as a recreational activity

- At Museums and science centers
- On vacations and study trips

  ↳ Learning becomes more informal

Popular science programs top television ratings of pure entertainment formats in German TV

Understanding of science as an entertaining experience

Attractiveness of VR and AR

A lot of variations of the technology :

- Degree of immersion in the virtual world
- Interactivity
- Mobility
- Dynamic of the virtual world

A lot of different needs:

- Preservation and digital documentation of cultural sites
- Presentation world wide
- Presentation on-site of disappeared constructions
- Exploiting the didactical potential of 3D graphics

Attractiveness of VR and AR

People are very interested in the technology

cybernarium days:

- Waiting time up to 4 hours
- All ages

	%
Up to 15	5,6
16 - 25	41,2
26 - 35	22,0
36 - 45	7,9
46 - 55	9,0
Over 55	14,1

Types of virtual learning environments

Training environments

- flight simulators
- driving simulators

Explorative worlds

- Virtual Cathedral of Siena

Experimental worlds

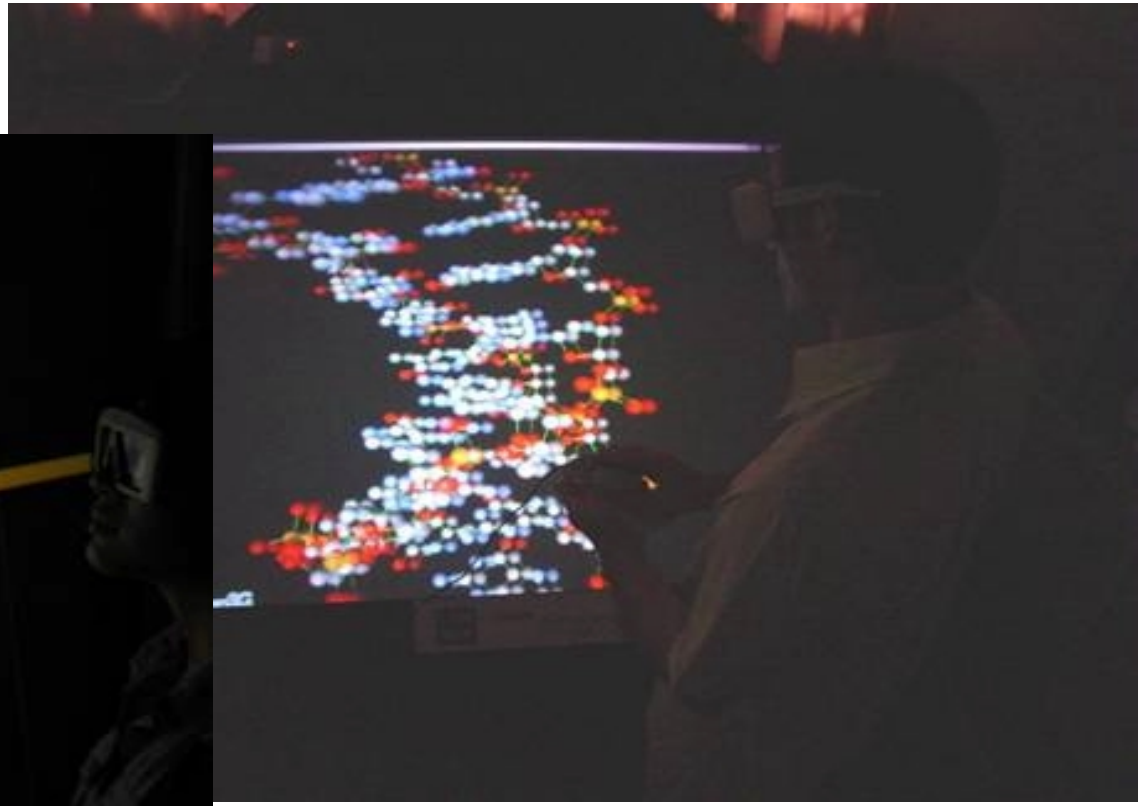
- Virtual Universe

Constructive worlds

- Virtual Gorilla Exhibit project
- ALICE

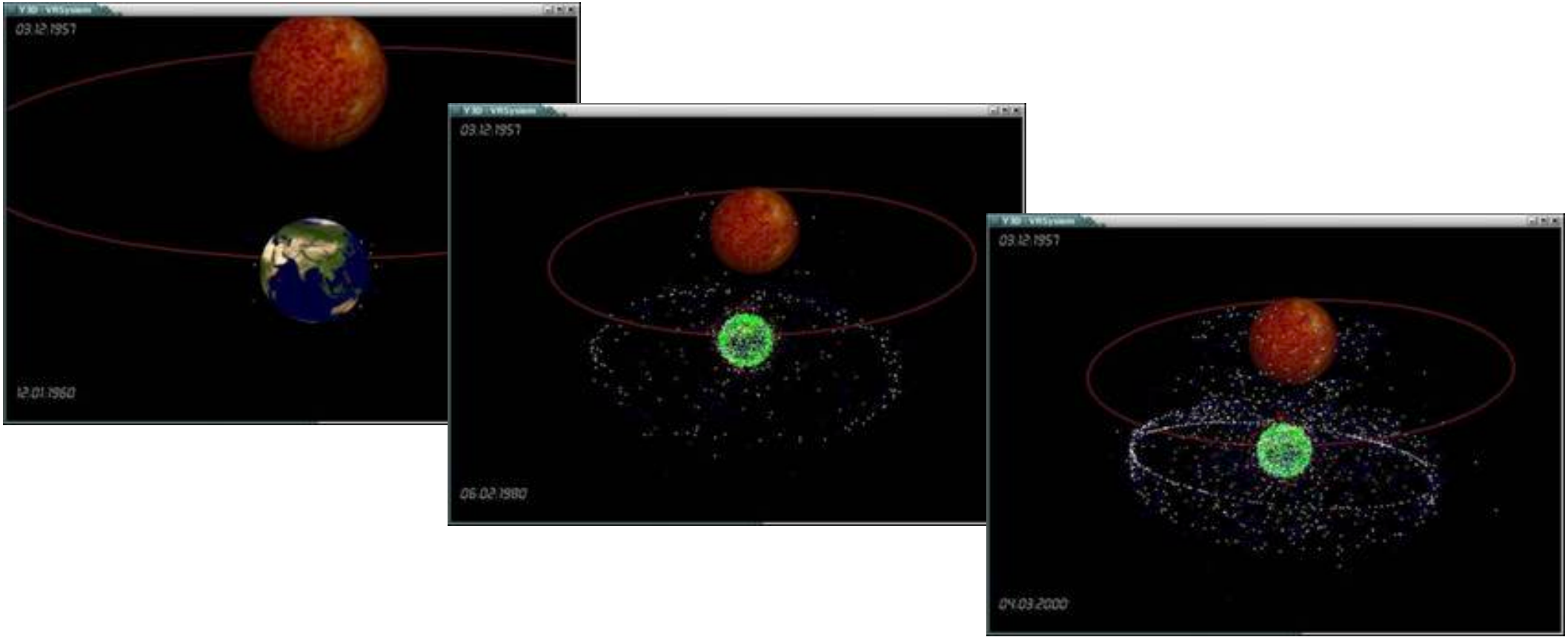
Learning Environments!

- Explore and interact with complex data and processes



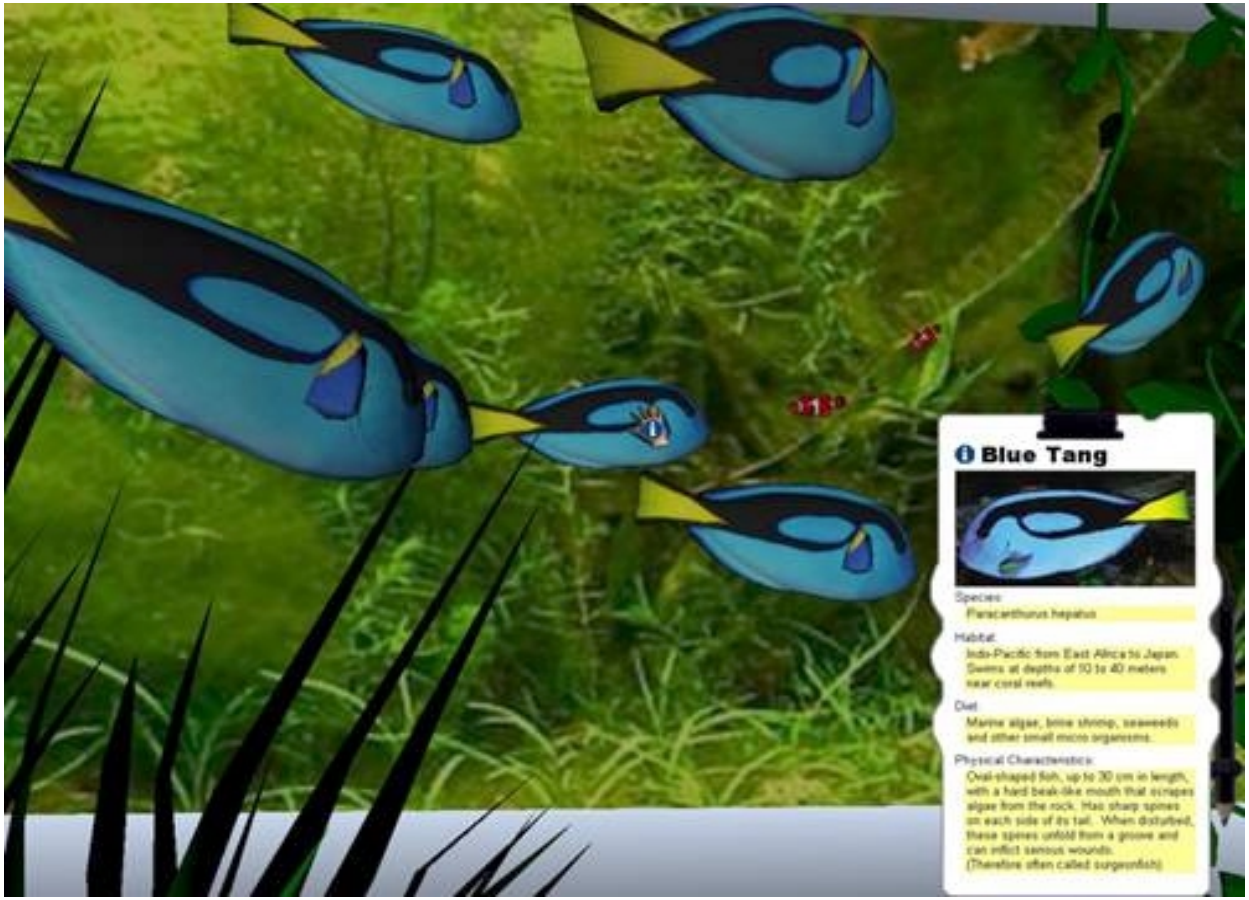
Learning Environments !

- Be a hitchhiker to the virtual galaxy
- Get a better understanding of debris in space



Learning Environments !

- Be a virtual diver in a fascinating underwater world



Where to present it?

- Schools
- Universities
- Training centers
- Exhibitions
- Museums

How to do it

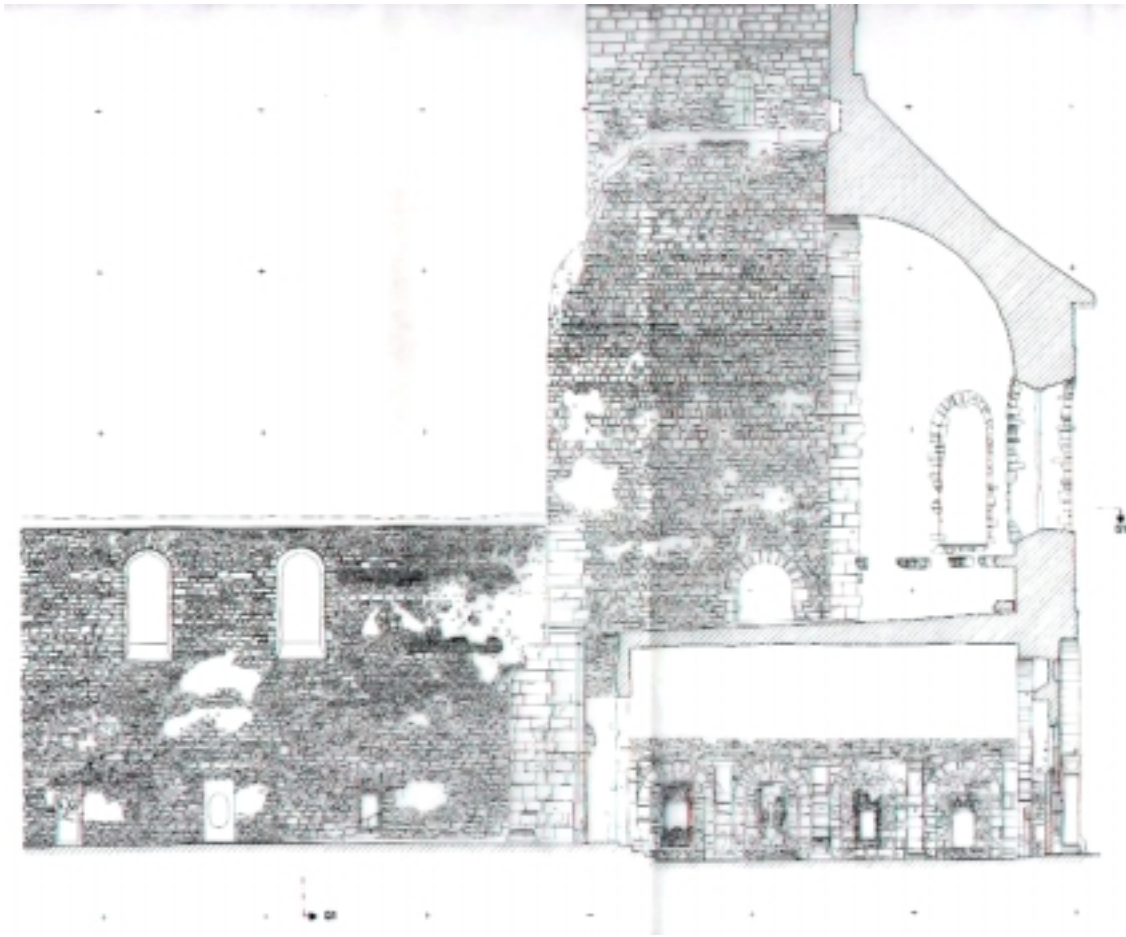
Creation of the presentation

- Preparation phase
- Models, textures, lighting, etc.
- Authoring
- Interaction
- Presentation

How to do it: Preparation phase

Data acquisition

- Background information
- Storyboard
- Plans, pictures, etc. of objects needed



Preparation

- Definition of Soft- and Hardware
- Definition of workflow

How to do it: Modelling

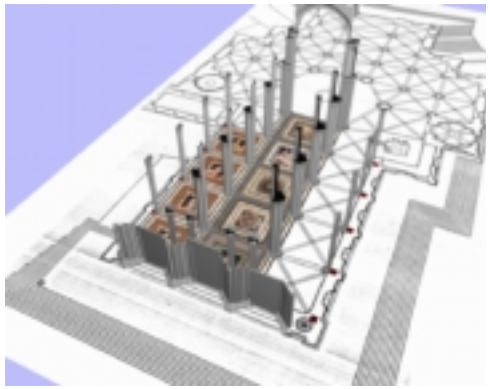
Hardware

- Scanner

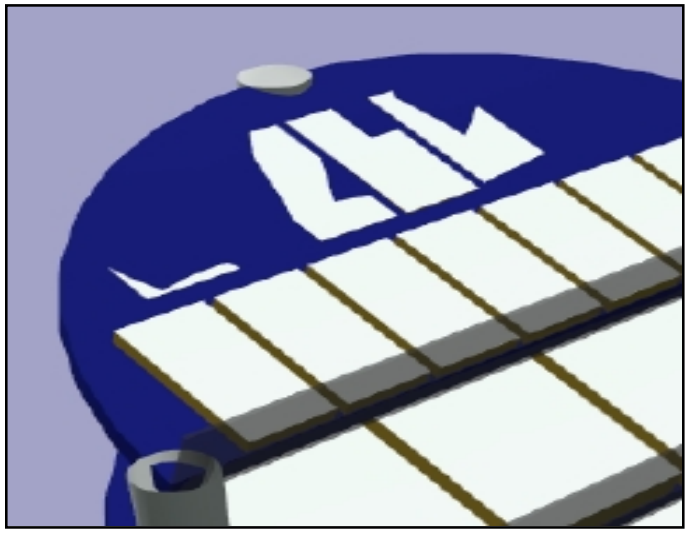
Software:

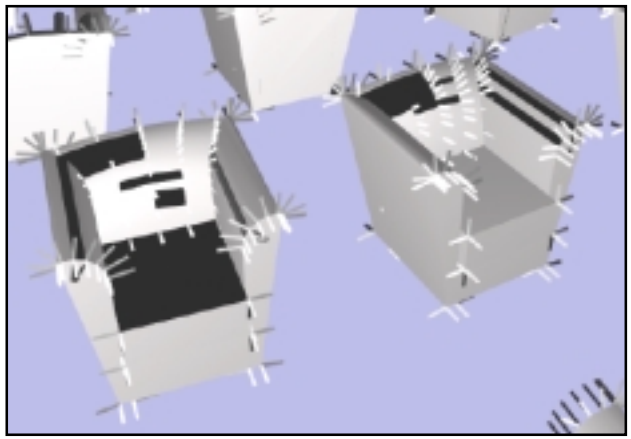
- CAD Software
- Modelling tools
- Animation software
- Photogrammetry
- Converter
- …

Zur Anzeige wird der QuickTime Dekompressor „IFF (Unkomprimiert)“ benötigt.



How to do it: Modelling





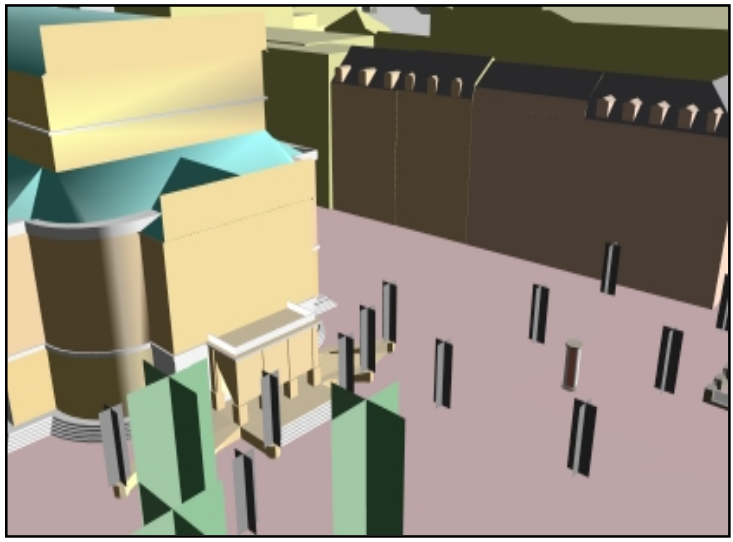
Problems:

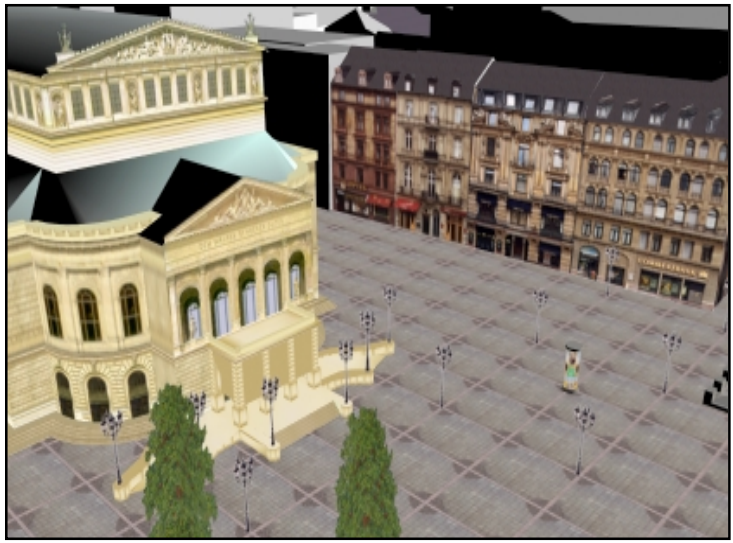
- Polygonal models
  - Polygon count
- Special effects
  - Reflections
  - shadows
- Data structures
  - Converters
  - simulations

How to do it: Textures

Textures:

- Add realism
- Presentation of surfaces
- Reduce polygon count
- Animation





How to do it: Textures

Bitmap textures:

- Image sources:
  - Photographs
  - Scans of surfaces
  - Computer generated images

How to do it: Textures

Image processing steps:

- Perspective correction
- Cropping
- Colour correction
- Removal of disturbing objects

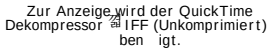
Hardware bottlenecks:

- Texture size should be a power of two (e.g. 1024x 512, 128x512 pixels)
- Maximal texturesize (1024x1024 or 2048x2048)
- Limited texture memory

How to do it: Textures

Shaders:

- Algorithmic images
- Supported by the GPU
- Unlimited resolution
- Special effects



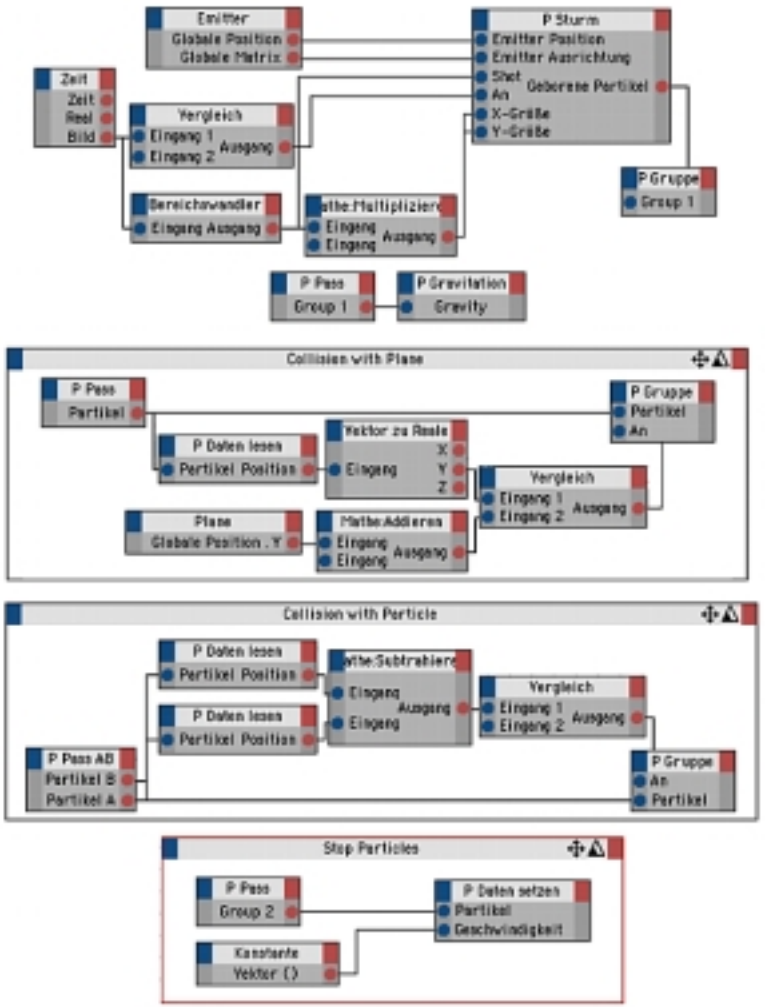
How to do it: Authoring

Scene composition / configuration

- Composition of complex scenes
- I/O devices
- Level-of-Detail
- Camera

Setup of dynamic components

- Interaction between objects
- scripts



How to do it: Authoring

flow control system:

- Controls the reactions of the system
  - Navigation
  - User interaction
  - Changes of system state
- Controls the learning process

Depends on:

- VR/AR system used
- Type of learning environment
- Learning matter
- etc.

How to do it: Authoring

Flow control system

- Navigation control
- Finite state machine
- ...
- Complex simulation system
- Learning management systems

Interaction

Interaction devices

- Intuitive use
- Robust
- Usability

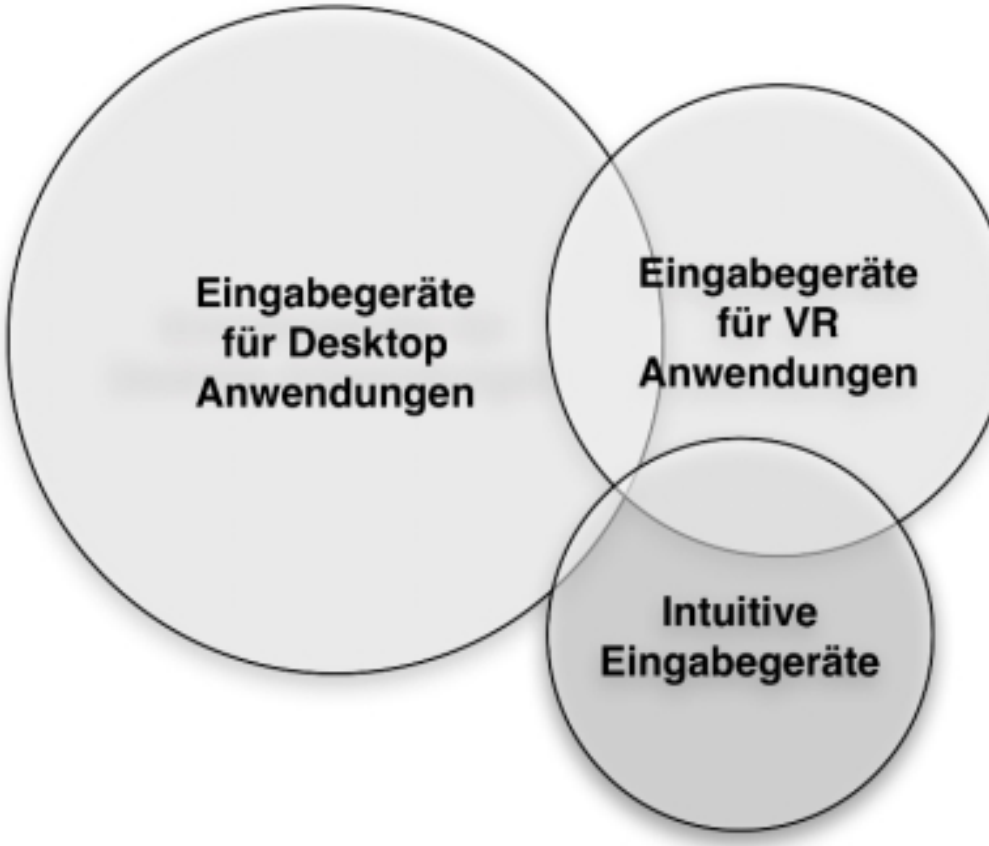
Interaction

- Navigation with 6 degrees of freedom
- Interaction with the world
- Shouldn’t distract from the learning matter

Input devices

Classification of input devices

- Desktop device
- VR input devices
- Special devices



Input devices

Classification of input devices

- **Desktop device**
- VR input devices
- Special devices

Zur Anzeige wird der QuickTime Dekompressor ‘TIFF (Unkomprimiert) benötigt.

Input devices

Classification of input devices

- Desktop device
- **VR input devices**
- Special devices

Advantages:

- Specialised for VR

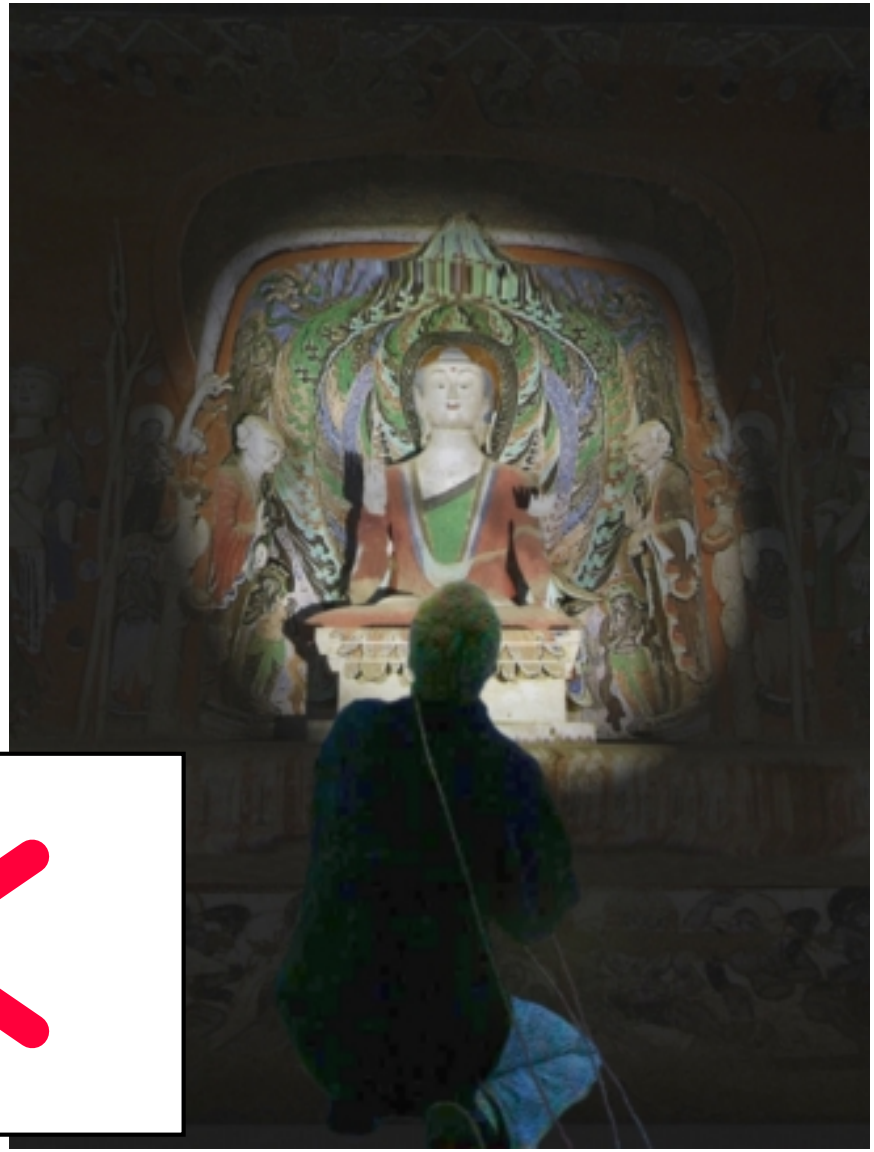
Disadvantages:

- Expensive
- Problems with sizes (children)

Input devices

Classification of input devices

- Desktop device
- VR input devices
- **Special devices**



Advantages:

- Intuitive to use

Disadvantages:

- No standard
- Made for one purpose

Input devices

Desktop devices

(e.g. mouse, keyboard, joystick)

Advantages:

- Cheap
- Well-known

Disadvantages:

- No standard
- Not intuitive to use

Zur Anzeige wird der QuickTime Dekompressor TIFF (Unkomprimiert) benötigt.

Input devices

VR input devices

(e.g. spacemouse, data-glove, wand)

Advantages:

- Optimized for the use in VR
- 6D input

Disadvantages:

- Expensive
- Difficult to use
- Not for children

Input devices

Special devices (e.g. steering wheel, flashlight)

Zur Anzeige wird der QuickTime Dekompressor „IFF (Unkomprimiert)" benötigt.

Advantages:

- Optimized for the application
- Intuitive to use

Disadvantages:

- Sometimes expensive
- Only usable for special applications
- Only usable for a special task

Presentation

Virtual Reality:

- Projection based
  - Computer-Monitor
  - Largescreen Display
  - CAVE
  - HEyeWall
- Head-mounted Systems
  - HMD
  - BOOM

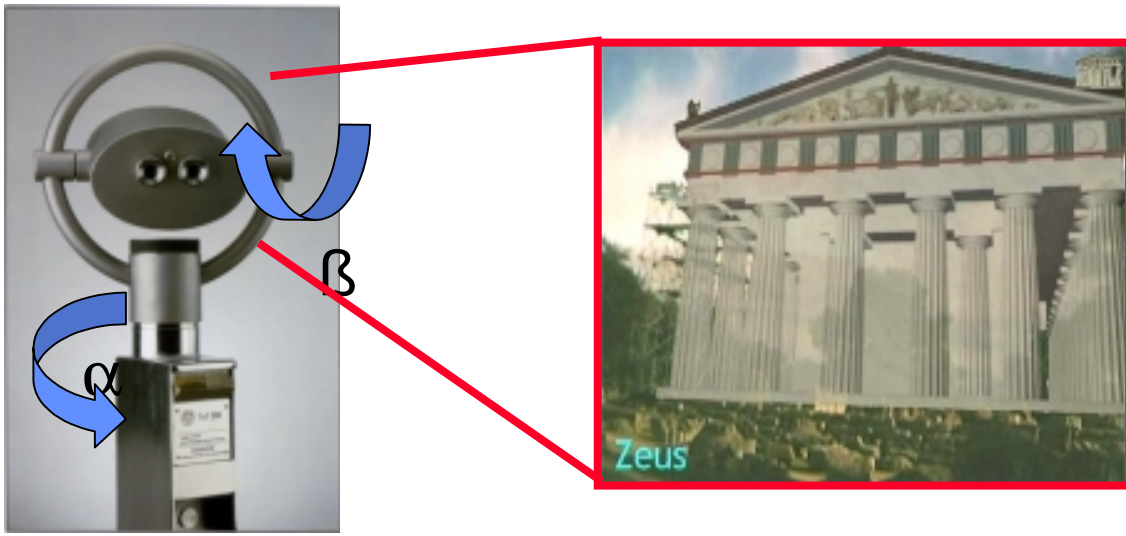
Zur Anzeige wird der QuickTime Dekompressor „IFF (Unkomprimiert)“ benötigt.

Presentation

Augmented Reality:

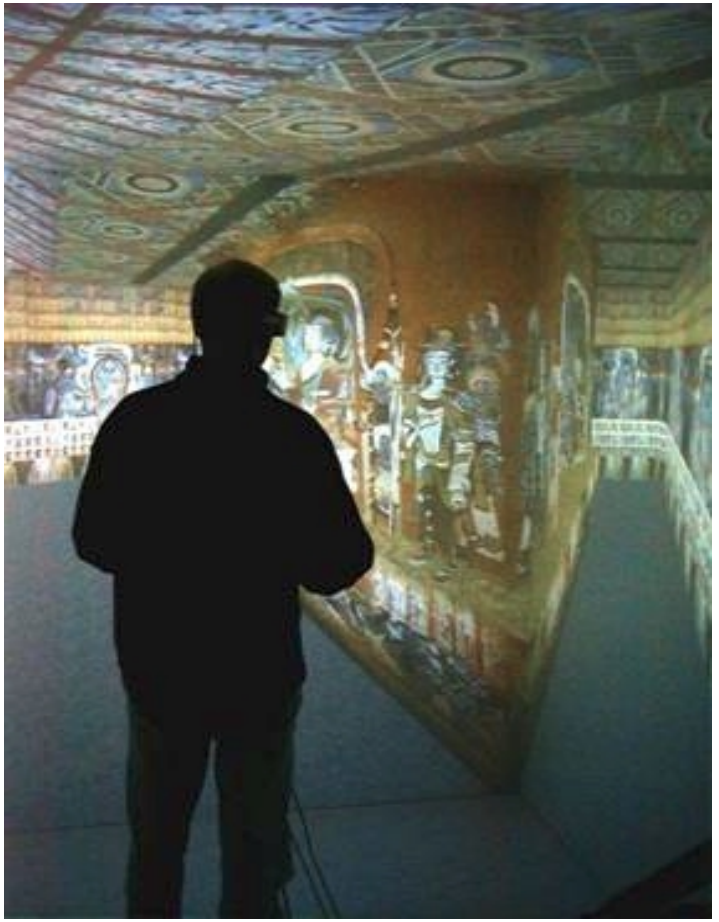
- See-through devices
  - ↳ See-through glasses
- Video-see-through
  - ↳ Video glasses
  - ↳ AR-Telescope

Zur Anzeige wird der QuickTime Dekompressor 'IFF (Unkomprimiert) benötigt.



Dunhuang Art Caves

- Virtual representation of the Mogao CAVES
  - 500 caves in the north of China
  - Only 30 are still open to the public
- **Digital documentation** of the site
- **Preservation** of vulnerable cultural assets
- **Presentation** to a large public
  - The virtual visit becomes a real experience
  - Appeal to the visitor emotions



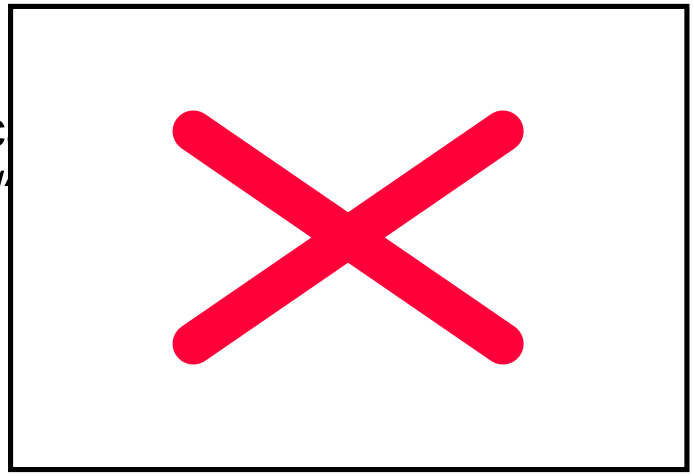
Dunhuang Art Caves : Immersion

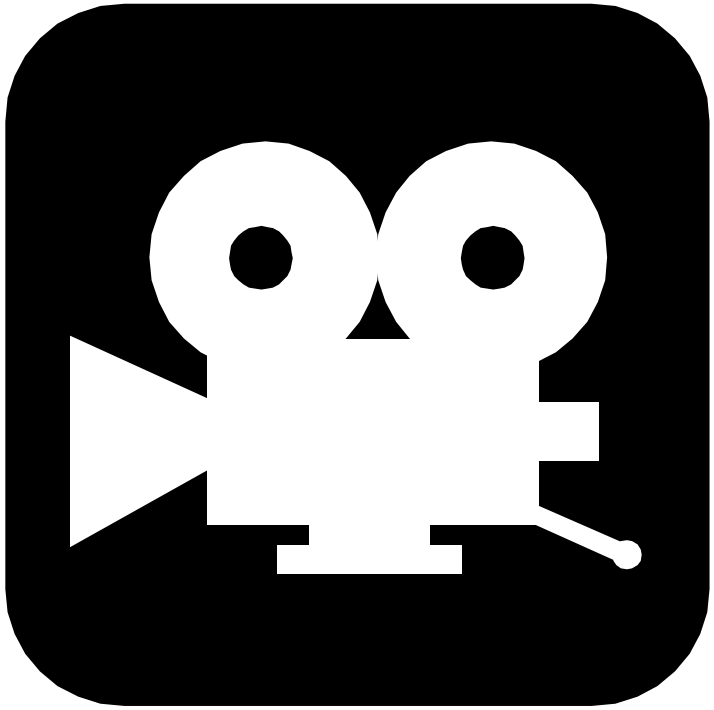
Not only watch but *experience* history

Dunhuang Art Caves

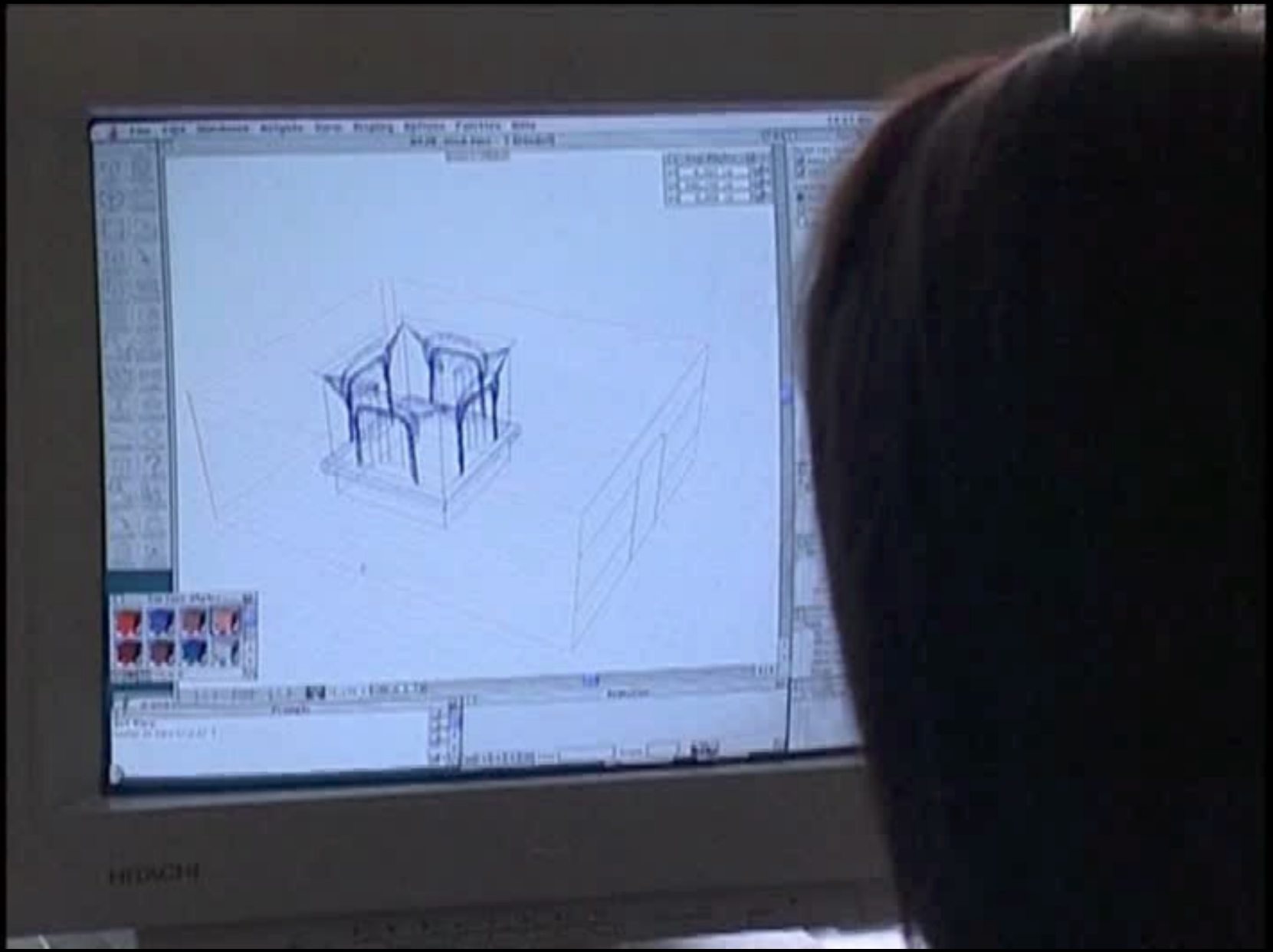
Involve the visitor by

- Finding the right interface
  - Flash light as input interaction device
  - Correct lighting and shadows
- 3D Sounds
  - Audio text information
  - Music
- „Exploring the c
  „Being in China“





Video: Dunhuang Art Cave



Cathedral of Siena

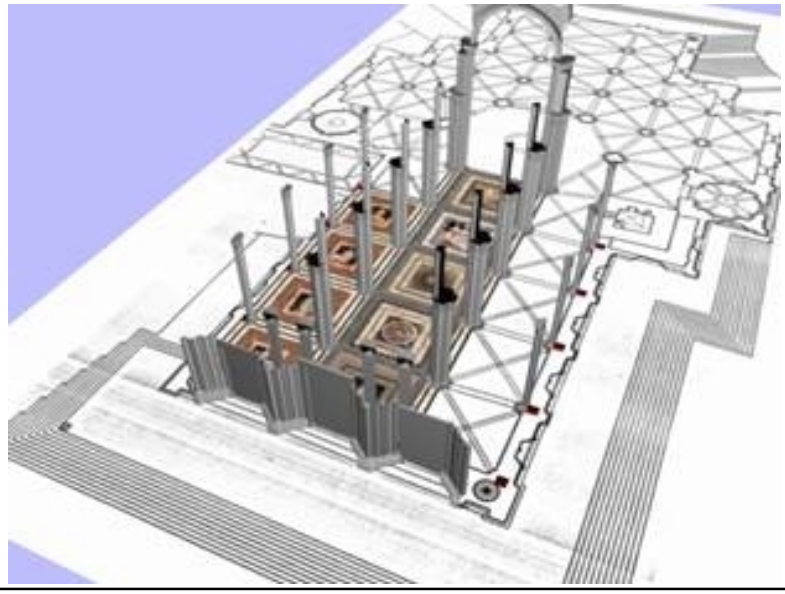
- Challenge of content creation and complexity of the content creation
- Huge construction with a lot details
- High realism is necessary to ensure the acceptance of the digital model
- Fidelity to the real building and real context must be respected

Cathedral of Siena

The „Making of“

- 5 000 images
- 4 hours video-tape
- plans – books

- Modeling tools
- Constant update among the designers



Cathedral of Siena

Applying high resolution textures (300 MB)

Cathedral of Siena

High realism through physically correct light simulation

- 150 000 polygons
- 800 light sources
- day light simulation

- hierarchical light simulation
  to handle the model complexity

Cathedral of Siena: light simulation

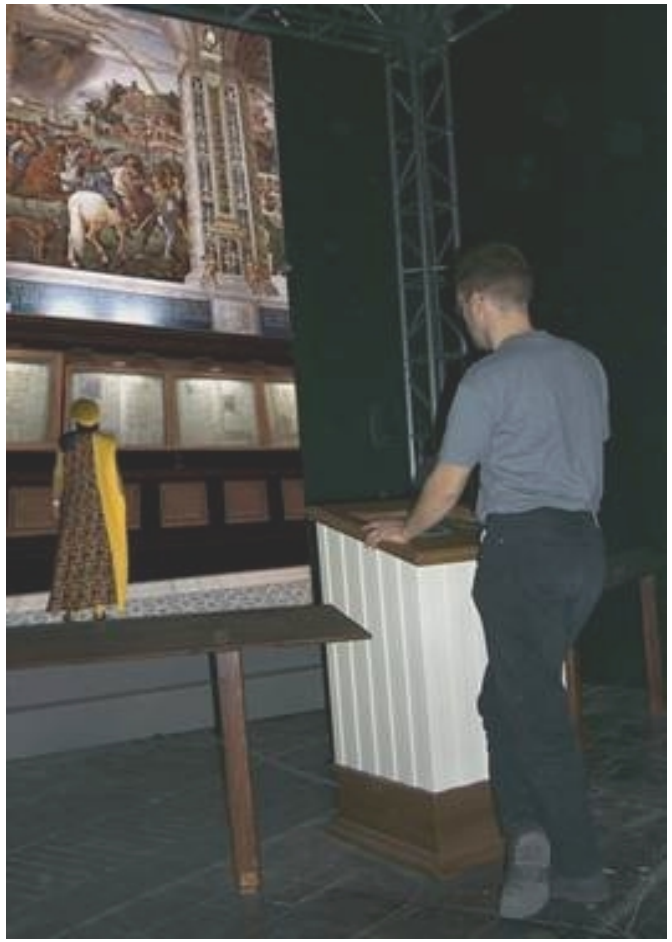
Without light simulation

With light simulation

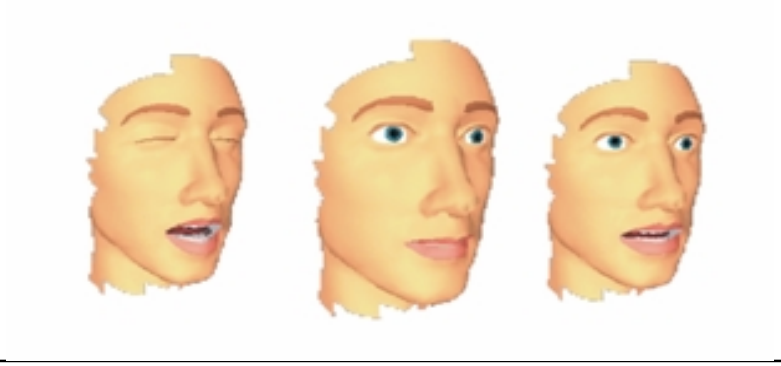
Cathedral of Siena: the user interface

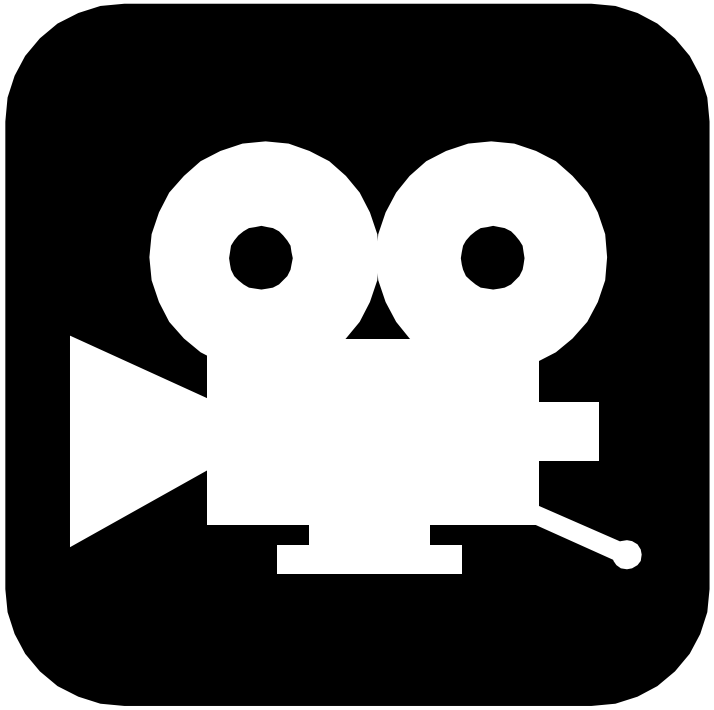
Interface for large publics and groups presentation

- Touchscreen
- Metaphor of a historical book
- Intuitive navigation
- Realization over a web-based client/server architecture



Cathedral of Siena: virtual guide





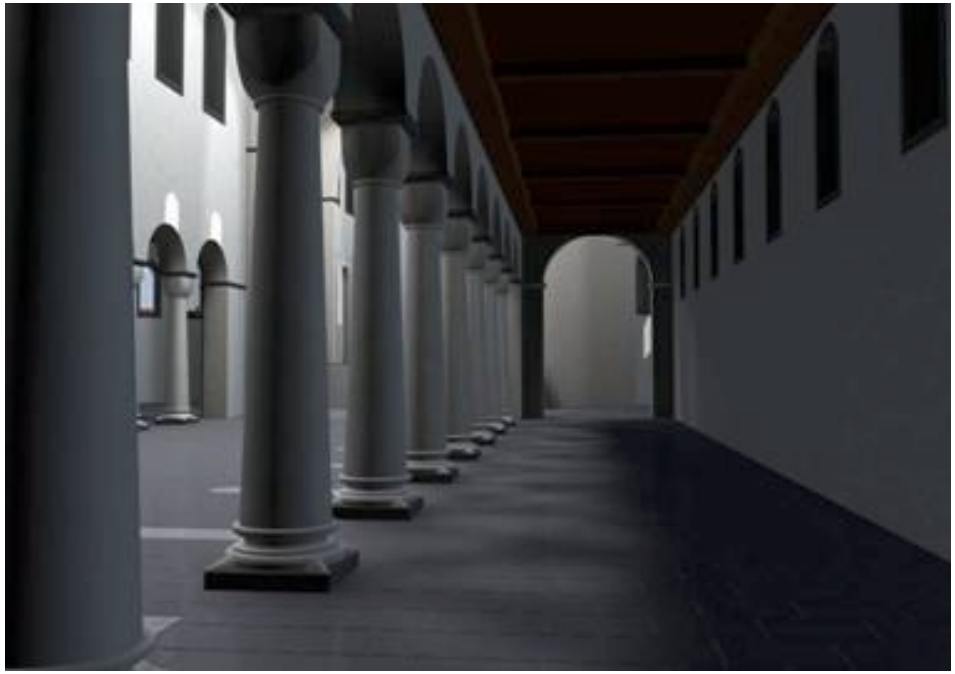
Video: Cathedral of Siena

Reliving destroyed sites (Bad Hersfeld)

- Virtual reconstruction of the church
- Presentation the evolution and history over time
- Museum presentation as well as creation of a video for visitors

Church Bad Hersfeld

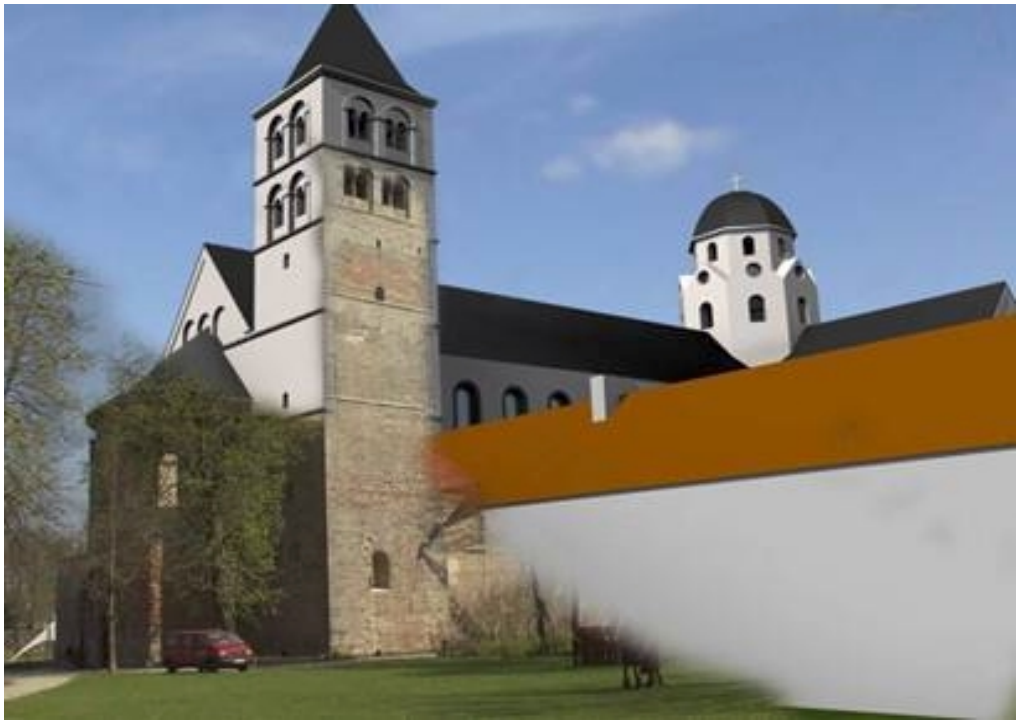
Interior of the Church



Church „Bad Hersfeld“

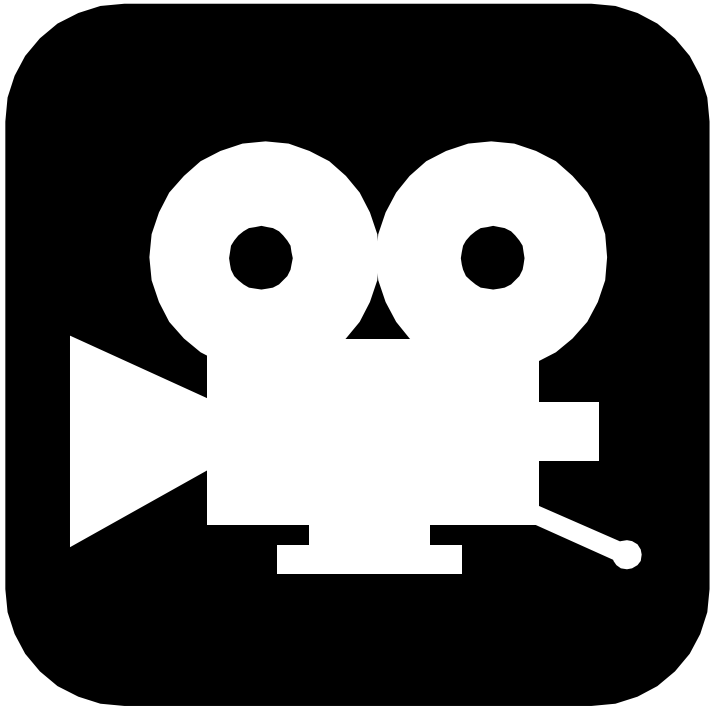
Travel in time and space

- From the present, back to past
- From real to virtual



Church Bad Hersfeld

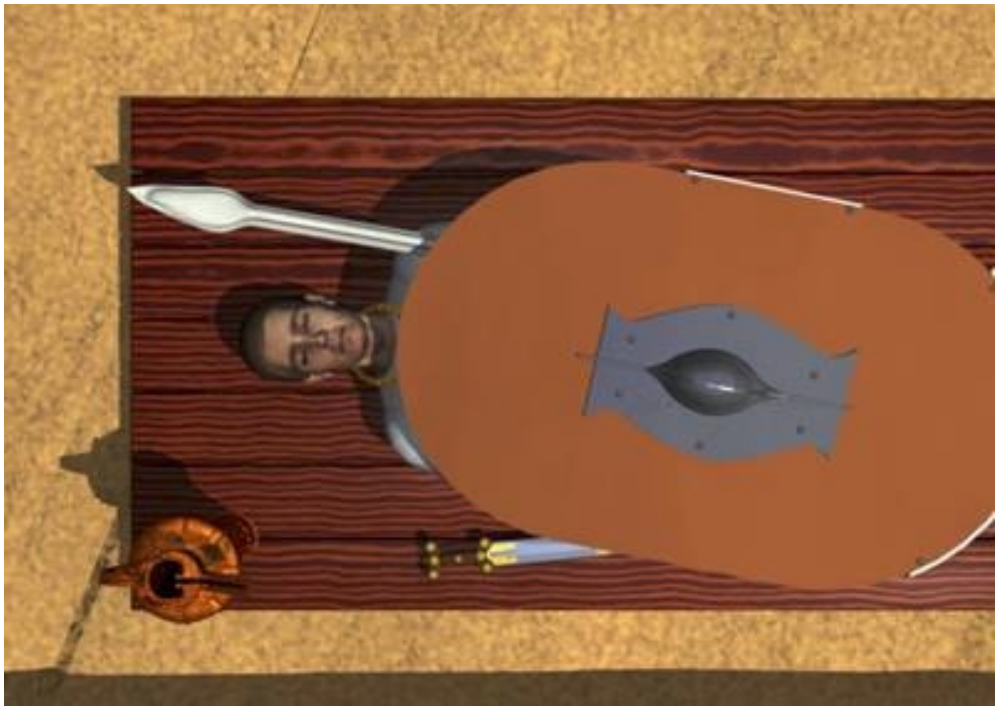
Switching between real and virtual for a better understanding of the historical evolution



Video: Church Bad Hersfeld

Presentation of historical ceremonies

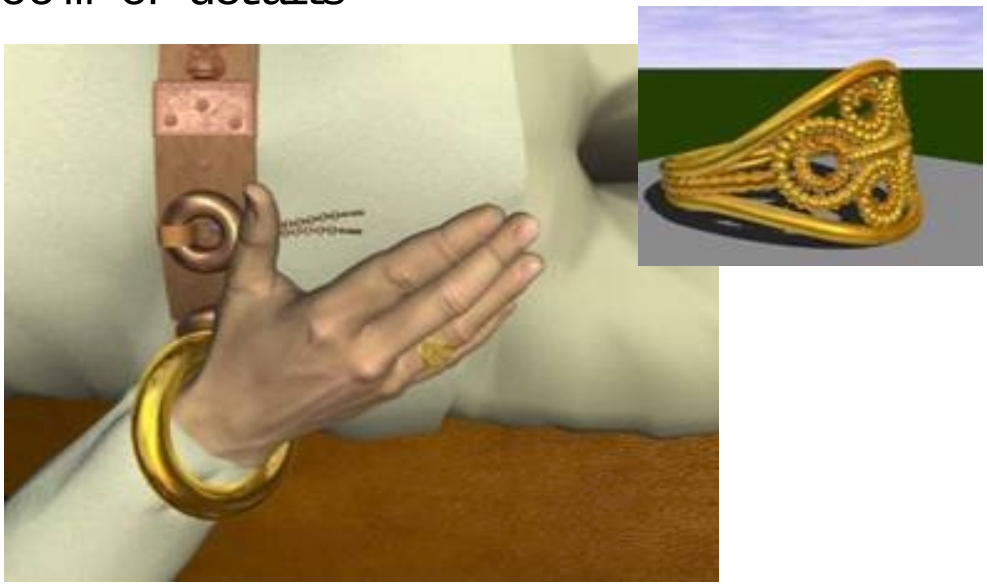
- An animation presents the funeral ceremony
- Valorization of the site through supplementary information
- Implementation: projection on the floor
- Feeling to look into the grave



Presentation of historical ceremonies

Representation of the grave objects

- At the right place
- In 3D
- With zoom of details



Igartubeiti Farmhouse

- Virtual reconstruction of 16th and 17th century wooden architecture
- Scalable presentation from web to high immersive projection screen

Igartubeiti Farmhouse

- Bringing the building to life with virtual humans
- Telling the history using digital storytelling techniques

Peranakan Culture

- Promotion of Singapore´s unique heritage

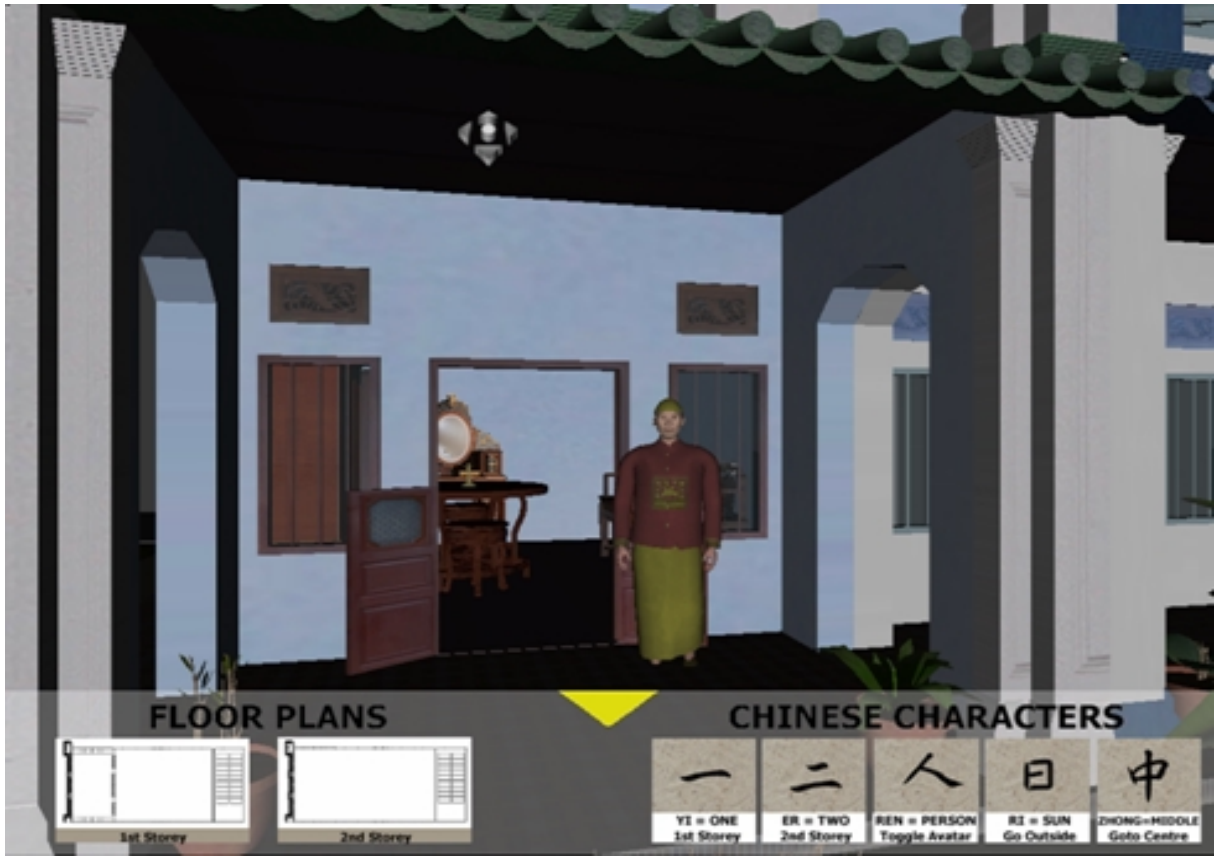
Peranakan Culture

- Virtual Tour Guide

		
Base	**Blink**	**Smile**
		
Walk	**Climb Up Stairs**	**Turn Right**

Peranakan Culture

- Interaction with context-sensitive cursors, on-screen menus, and the virtual tour guide



The Interactive Museum Exhibit

Idea

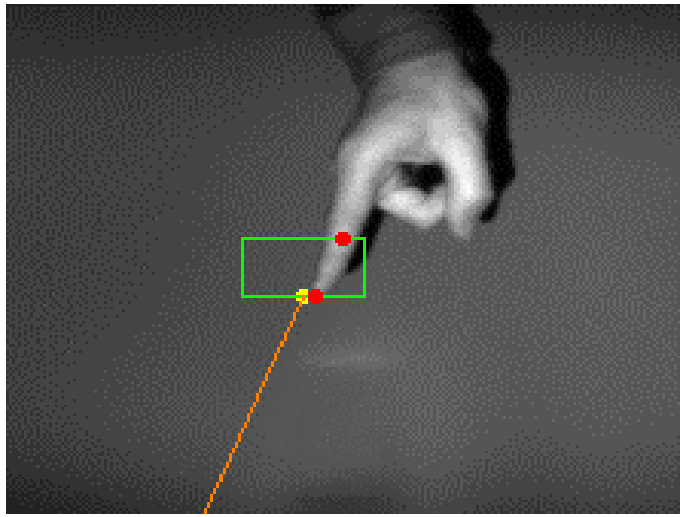
- to confront the museum visitor with interactive exhibits
- to provide informal learning through interactive exploration
- to overcome the „do-not-touch“ caution
- to offer an interactive environment to complementarily present art works „in stock

The Interactive Museum Exhibit

Requirements

- "… novel combination of intuitive interaction techniques and the presentation of multimedia content …"
- "… digitized paintings on projection screens …"
- "… novel experience during an exhibition visit …"
- "… invisible computer …"
- "… no special physical device like a mouse or pointer shall be needed to interact with a system …"

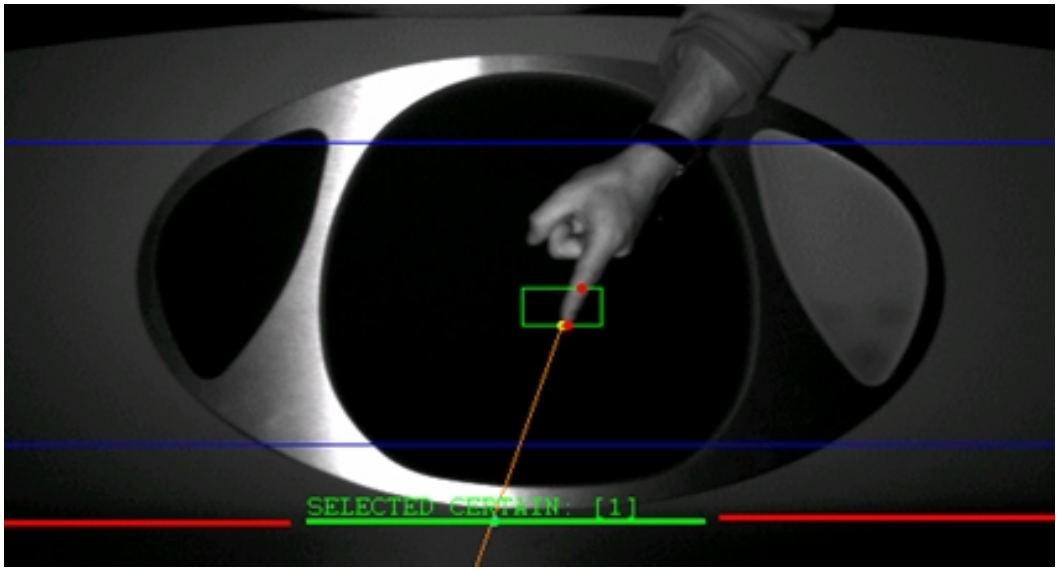
The Interactive Museum Exhibit



Scenario

- museum exhibit installation
- as intuitive as possible => usable without training
- pointing gesture based interaction

- large scale screen
- video-based interaction



- 2d digitized paintings
- 3d VRML sculptures

The Interactive Museum Exhibit

Pointing at predefined areas

Selection of

- images
- artists
- thematic areas
- help buttons
- interaction tools

The Interactive Museum Exhibit

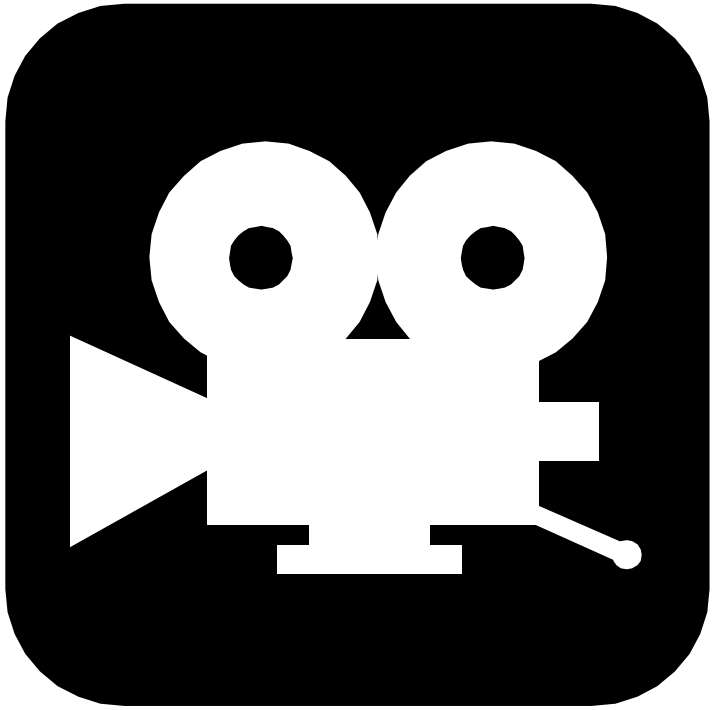
- laser pointer
- magnifying glass
- torch light

The Interactive Museum Exhibit

Magnifying Glass

The Interactive Museum Exhibit

Torch Light



Video: Interactive Museum Exhibit

Interactive Museum Exhibit
ZGDV

The Virtual Gallery Exhibit

Idea

- to offer museum visitors a personalized exhibition
- to combine a virtual exhibition in a real setting
- to offer an interactive environment to complementarily present art works „in stock“ first evaluation results

The Virtual Gallery Exhibit

Requirements

- "… novel combination of innovative visualisation techniques and the presentation of multimedia content …"
- "… digitized paintings in real picture frames…"
- "… novel experience during an exhibition visit …"
- "… intuitive interaction similar to a traditional visit of an exhibition …"

The Virtual Gallery Exhibit

Scenario

- virtual gallery exhibition
- personalised exhibition

- look and feel similar to real exhibition
- as intuitive as possible

- combining virtual world and real setting
- takes place in a real exhibition room

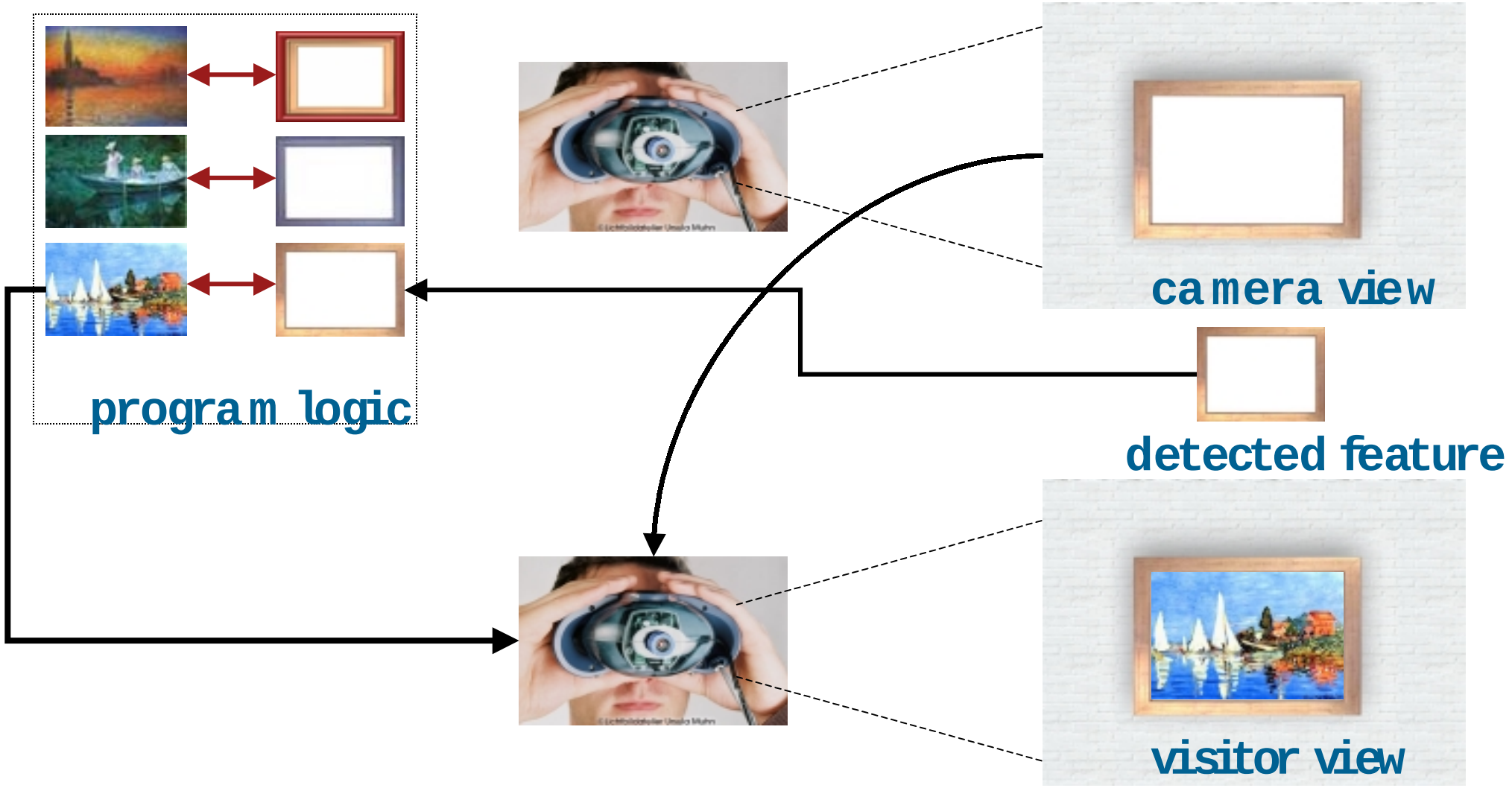
- provision of additional information

The Virtual Gallery Exhibit

Scenario

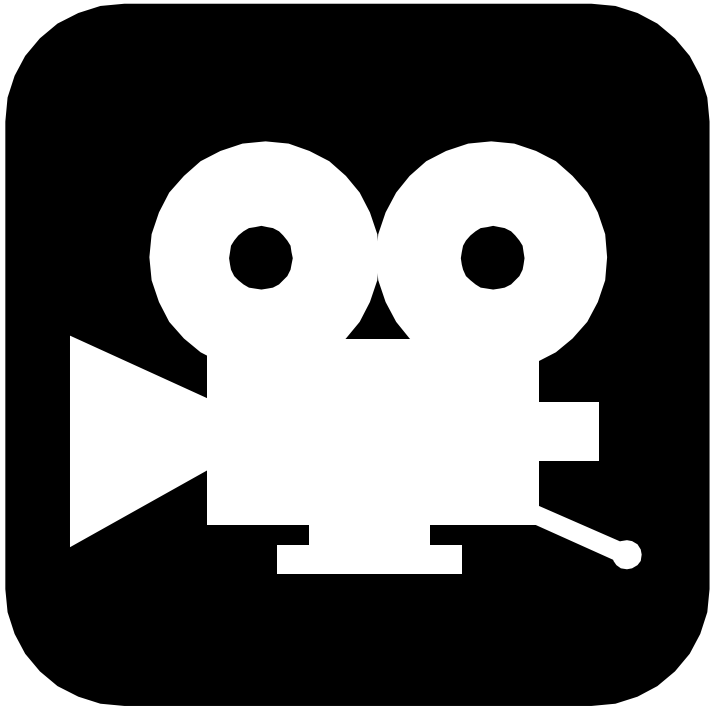
- visitor moves from one frame to the other
- detection of location is based on hidden features
- superimposition of images into the frames
- location aware audible explanations

The Virtual Gallery Exhibit

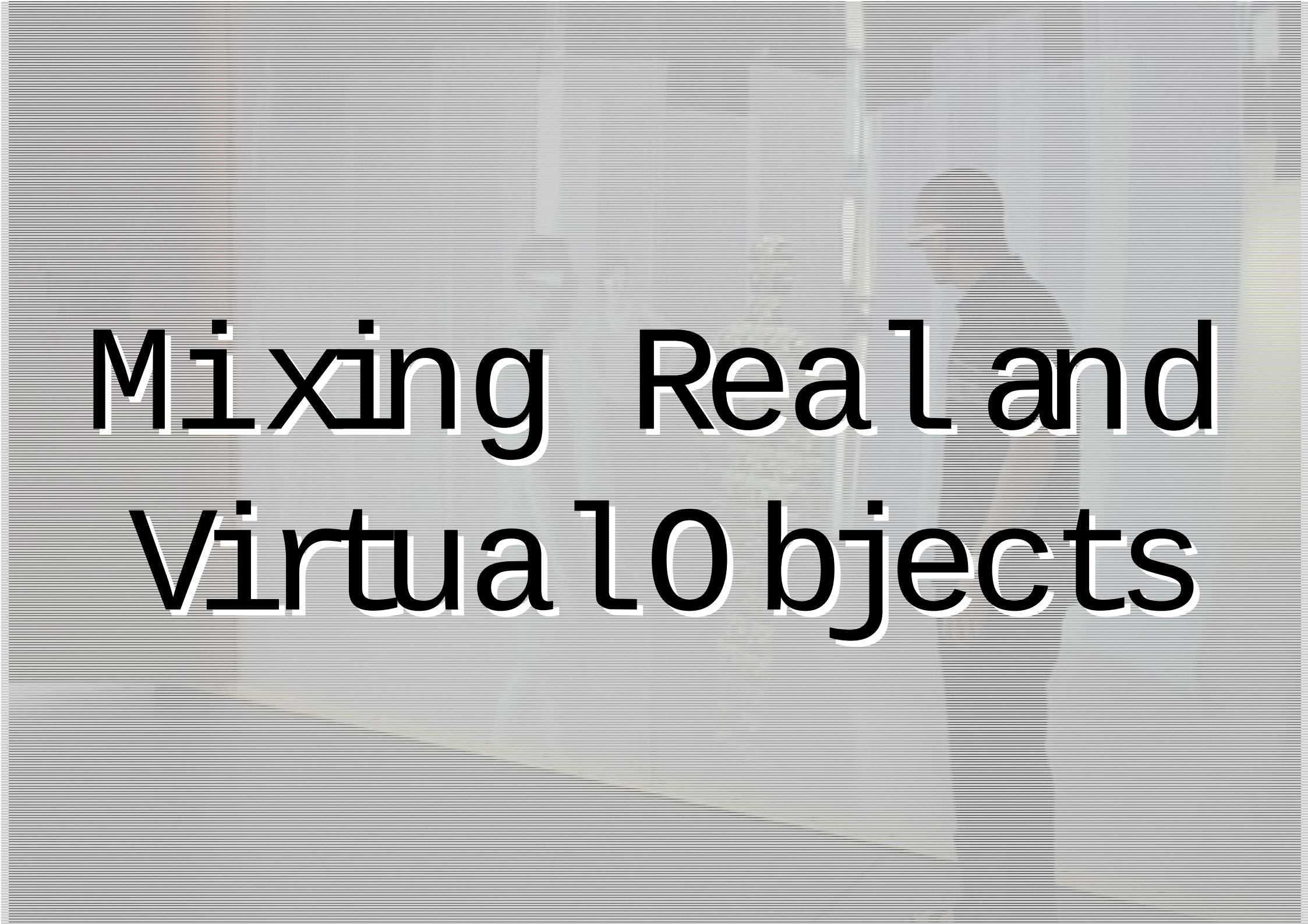


Virtual Graffiti

- Getting famous - legally



Video: Virtual Graffiti


Mixing Realand
VirtualObjects

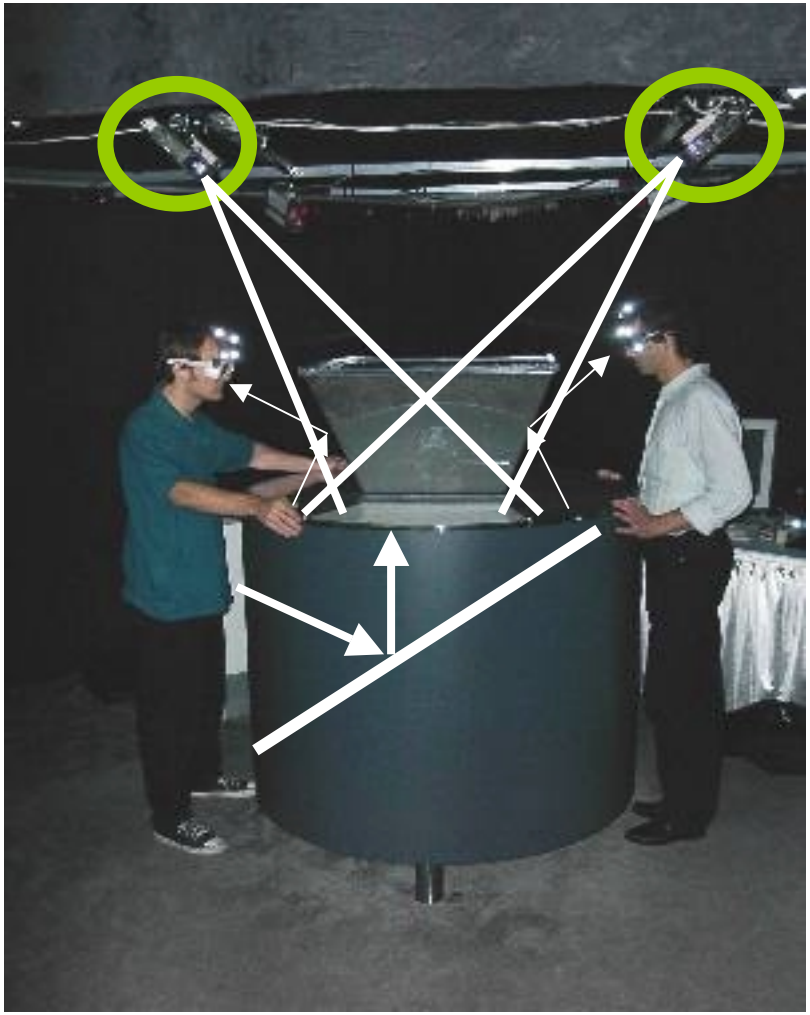
„Virtual Showcase“

Enrich real objects with virtual information with help of the „Virtual Showcase“

- small objects are magnified on monitors
- Missing parts are added virtually

Stereo „Virtual Show Case“

- Projection-Based Augmented Reality
- Allows interactive presentation of a mixed content
- Supports multiple users
- Stereoscopic (3D) viewing
- Realistic combination of virtual and real objects
  - high resolution graphics
  - matching illumination
  - correct occlusion
  - matching depth perception
  - animations

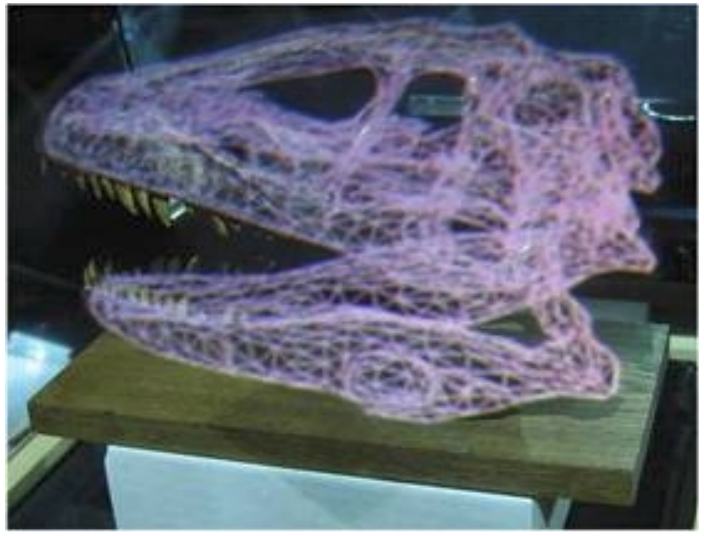


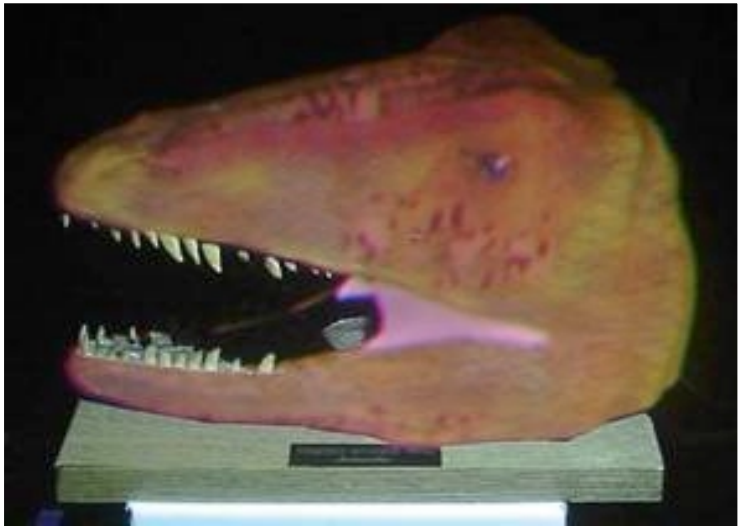
Packing and Presentation

muscle

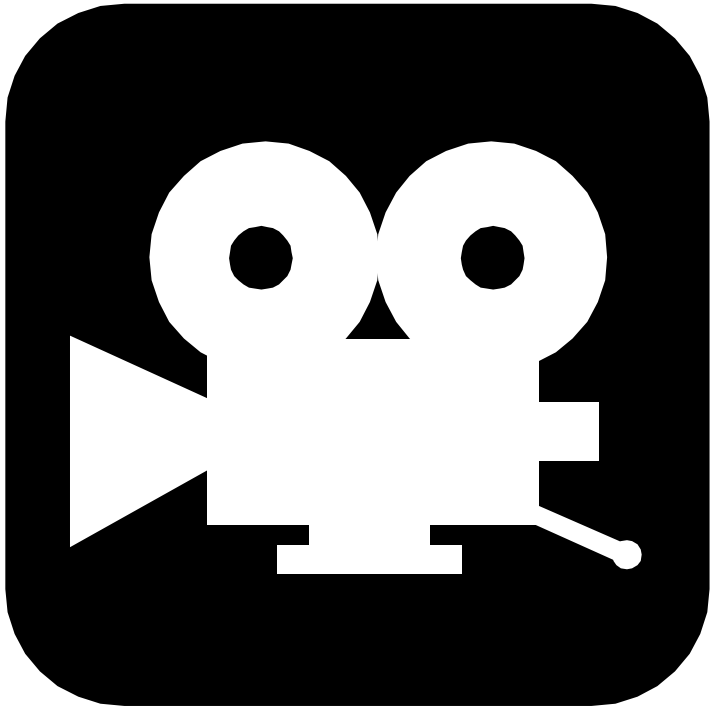
registration and calibration

muscles, sinus, bony ring





skin



Video: Raptor

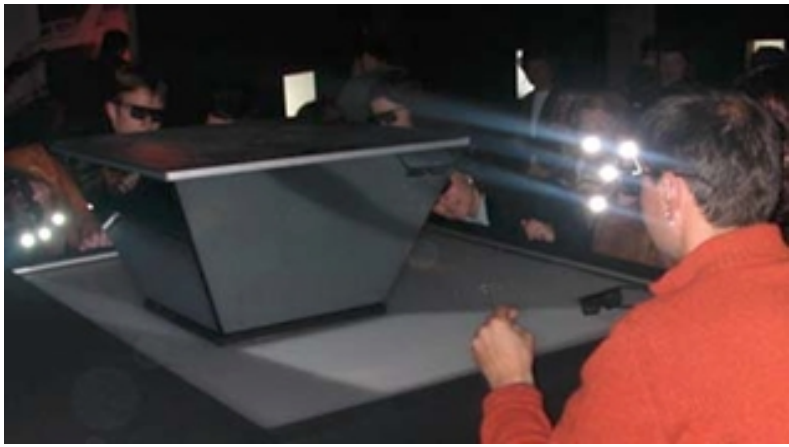
RAPTOR: Towards Augmented Paleontology

Oliver Bimber and Miguel Encarnação
Fraunhofer Center for Research in Computer Graphics, Providence (RI), USA, {obimber,me}@crcg.edu

SIGGRAPH 2002

Ferrum Exhibition

- Virtual showcase in Ferrum Exhibition
- Virtual reconstruction of damaged or non-existent parts of artworks that cannot be shown otherwise

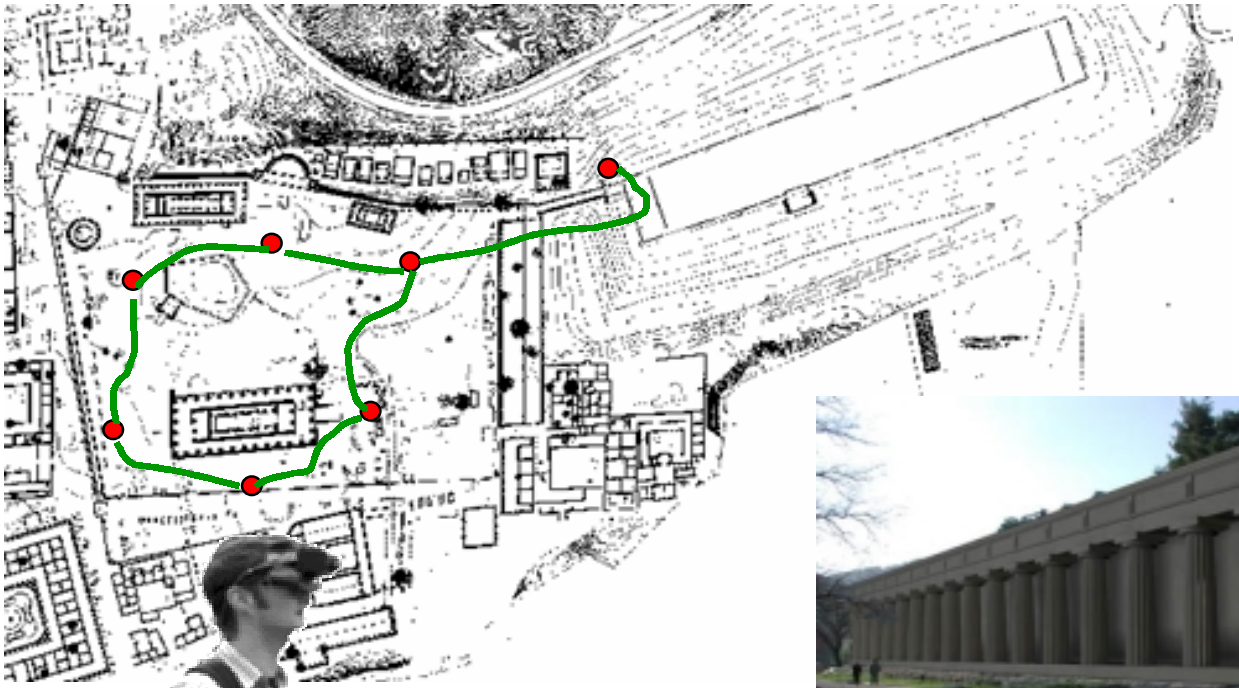



Mobile Traveling
in Time & Space

ArcheoGUIDE – Vision (Olympia)

Resurrect the past…

…with the help of modern AR technology



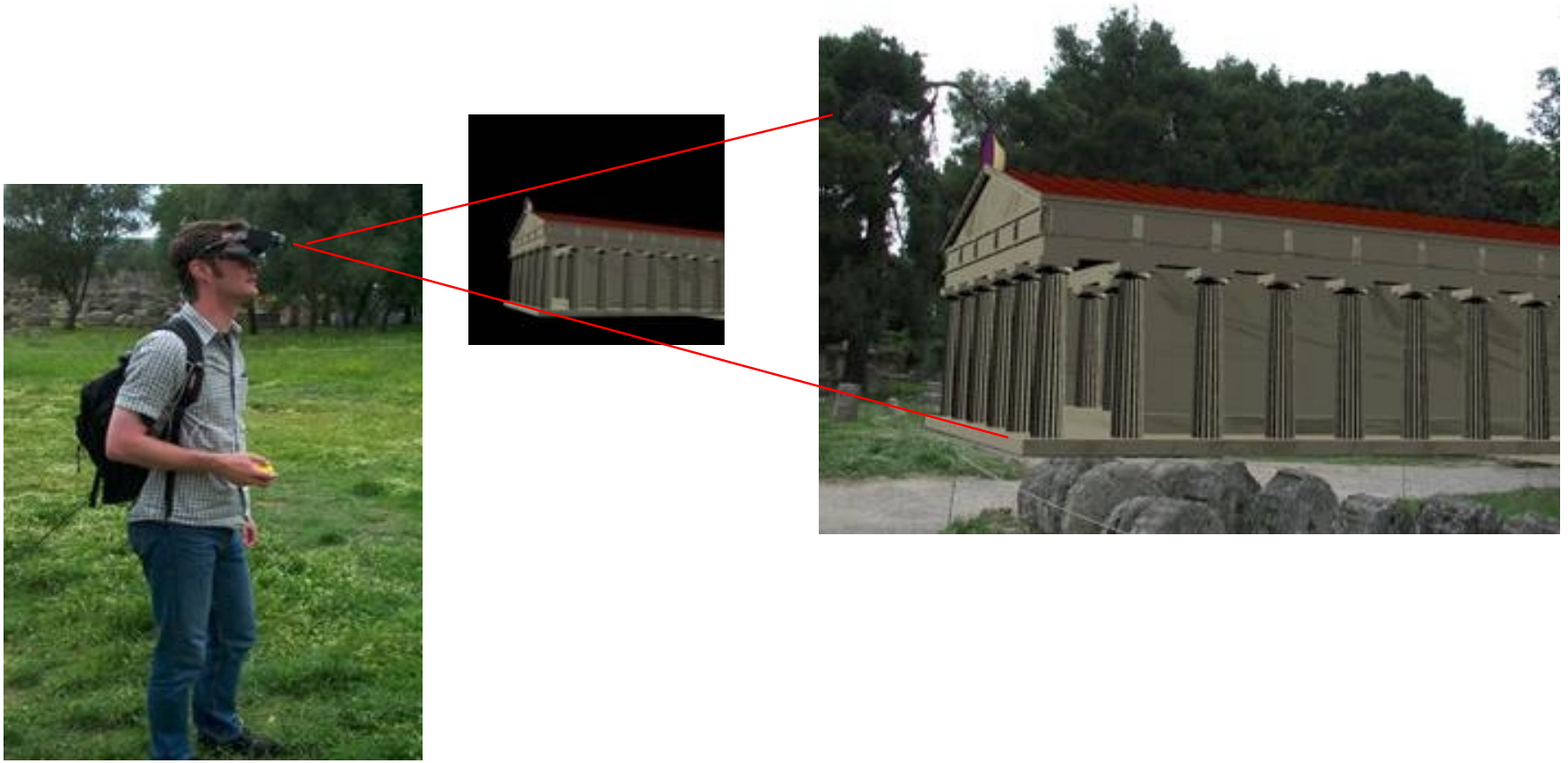
- **Text**
- **Sound**
- **Mixed-Reality Views**

PDA Approach

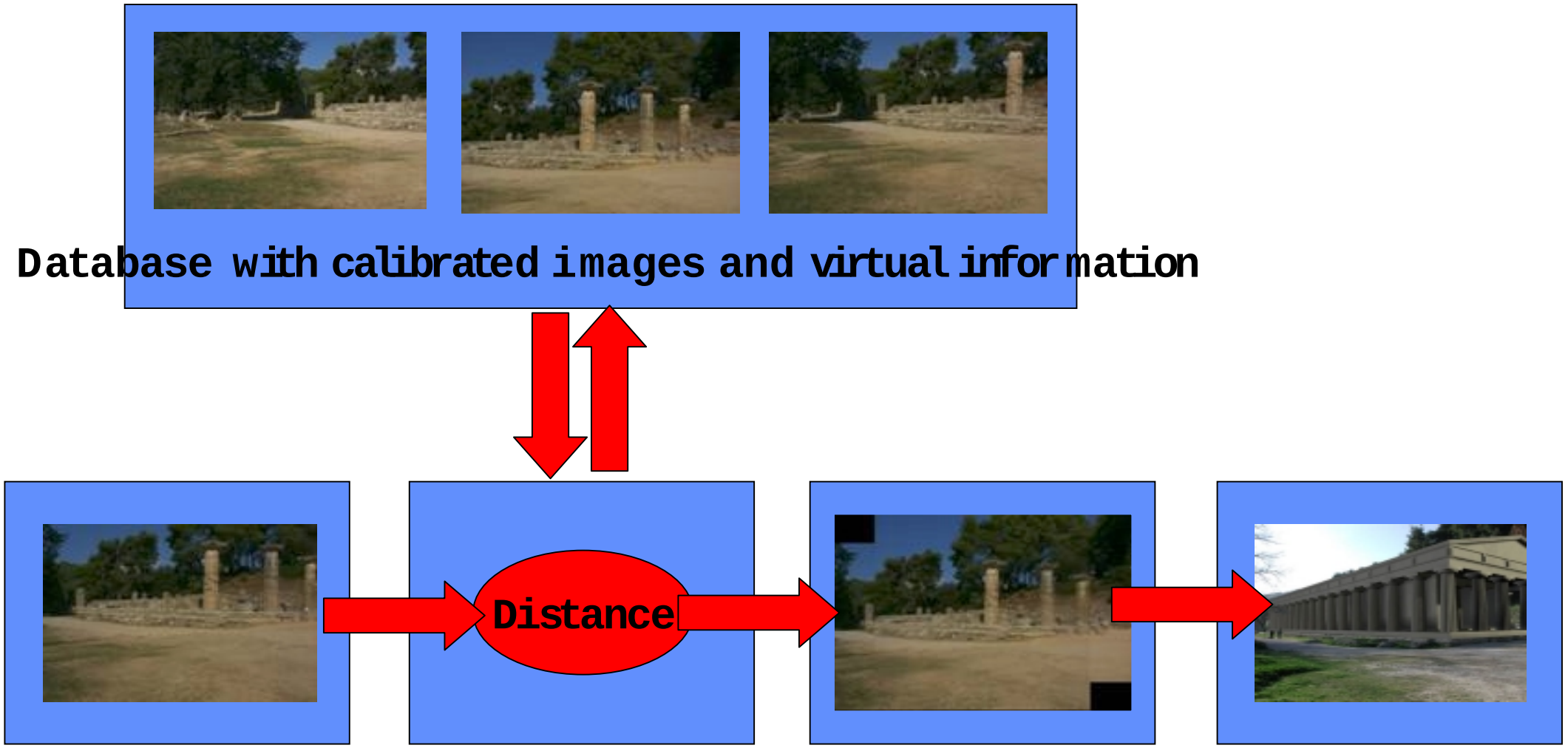
- The right information at the right time and at the right place through:
  - location-based information selection
  - Personalization of the presentation through profiling of the visitor (expert, interested, …)
- Use of augmented reality images to enrich view of the surrounding
  - Better understanding
  - Making the most of the visit

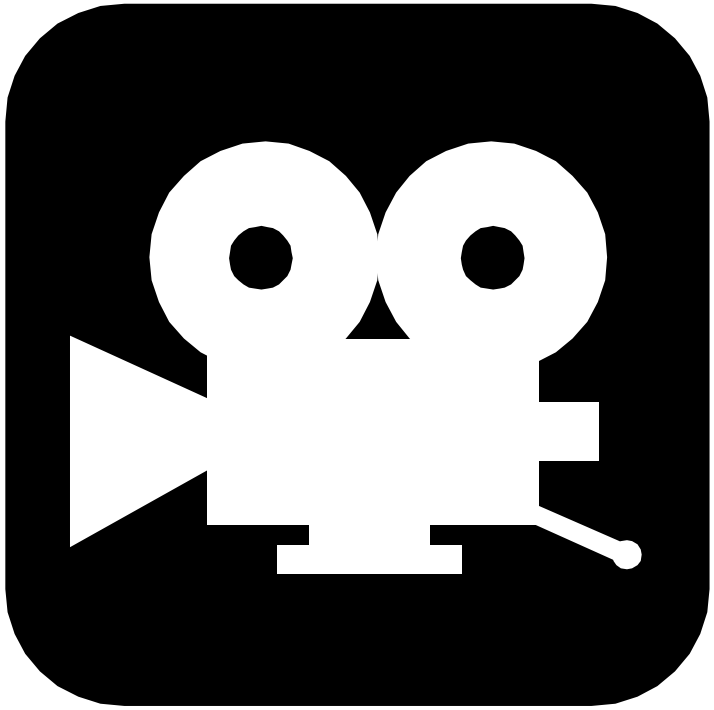
ArcheoGUIDE – Screenshots

Mobile augmented reality : high end solution



Markerless Tracking





Video: ArcheoGUIDE