# A 3D VIRTUAL MUSEUM

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*Spaţiile virtuale 3D devin din ce în ce mai mult utilizate, de la jocuri până la aplicaţii industriale, medicale, militare sau ştiinţifice. Unele dintre cele mai importante aplicaţii ale acestora sunt în e-learning şi edutainment.*

*Lucrarea de faţă prezintă elementele constitutive şi aspecte ale creării unui"muzeu virtual 3D", pornind de la experienţa autorilor în dezvoltarea aplicaţiei software „Muzeul Tehnic Virtual din Viena". Aplicaţia, care a fost concepută de către autori împreună cu specialiştii Muzeului Tehnic din Viena, implementează şi permite navigarea în spaţiul virtual al muzeului. Ea este în prezent integrată în sistemul informatic al muzeului, extinzându-l cu noi functionalităţi oferite vizitatorilor. Figurile incluse în lucrare sunt capturi ecran din rularea aplicaţiei.*

*The 3D virtual spaces are more and more used, from games to industry, medicine, military and science. Some of the most important applications are in e-learning and edutainment.*

*This paper presents the constituent elements and creation aspects of a "3D virtual museum", based on the authors experience with the development of "The Virtual Technical Museum of Vienna" software application. The application, which has been conceived by the authors together with specialists from the Technical Museum of Vienna, implements and enables the navigation into the virtual space of the museum. Now it is integrated in the museum's informatic system, extending it with new functionalities offered to visitors. The figures included in the paper are screen shots from the application's running.*

**Keywords:** 3D **v**irtual spaces, edutainment, e-learning, virtual museum

## 1. Introduction

A 3D virtual space is a 3D computer representation of a real or imaginary space for the field of a certain application. Anything that is visible in a real space can, theoretically, be represented in a virtual 3D space, for example buildings,

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persons, water, vegetation, etc. Sound and various physical dynamics and interactions can be simulated also.

With the increase of computing power and particularly of computer graphics, such virtual spaces are becoming more and more used, in applications ranging from various types of computer games to life-critical systems in industry, medicine, military or science [13], [14], [15].

A very promising field is the use of 3D virtual spaces in e-learning and edutainment (education + entertainment). This is due to the fact that the realistic and immersive representations that can be achieved capture the attention of the users of such systems and, at the same time, are able to deliver a lot of heterogeneous information, unlike any other methods used before [6]. Also, 3D virtual spaces can be a very modern mean of collaborative interaction between their users, fact that can also be very useful in the above mentioned fields [10], [11], and [12].

Authors have experimented with one particular type of 3D virtual space which is a 3D virtual museum. In this case, the virtual museum is a replica of a real museum – The Technical Museum of Vienna [9]. The system was developed in close collaboration with the specialists of the museum and is already in use inside the museum, as a mean to provide information and guide the visitors.

This paper starts by explaining what a 3D virtual museum is and what kind of elements it usually contains, then it describes the means of creating a virtual museum, based on the particular experience with the "Virtual Technical Museum of Vienna". It explores also into the means of providing information to the user with such technology.

Based on the experience with this particular virtual museum, we are currently elaborating a more complex concept and software architecture – a virtual mega-museum.

## 2. Typical elements of a 3D virtual museum

A 3D virtual museum is a computerized 3D virtual space [1] populated with objects of museographic interest (buildings, paintings, sculptures, other works or art, historical or technical artifacts or other object that can be found in a real museum).

Also, the visitors can be represented in these virtual museums by means of animated 3D characters (avatars) [3], [7], [8].

In this chapter we shortly describe the main types of elements that can be found in a 3D virtual museum.

**Building or site architecture**

The site architecture consists of 3D volumetry describing the building area that hosts the real museum. Basically, it includes the floor, the ceiling, the walls, columns, arcades, niches, various decorations, pieces of furniture without role of exhibit (Fig. 1).

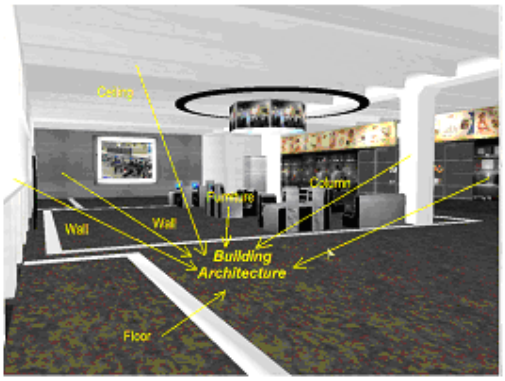


Fig. 1. Example of building architecture inside a virtual museum

Architectural objects are usually 3D meshes of high complexity.

The architecture can be obtained by various means:

- modeling starting from existing plans
- modeling based on measurements
- photogrametry
  - manual
  - semi-automatic
- laser scanning

Usually, the development team of a virtual museum includes an architect or a 3D modeler.

**Textures**

Textures are images mapped to the 3D surfaces, using different mapping methods.

Realistic representations require high resolution textures, which are usually extracted from optimized on-site photos.

Other techniques like dynamic loading of textures, level of detail, etc. are useful to solve the issue of speed and memory versus texture quality.

**Video textures**

It is also possible to map video content to 3D surfaces, usually rectangular planar surfaces, but not necessarily.

Such videos can have:

- small dimensions, providing various animation to the virtual space
- big dimensions – providing cinema-like presentations right inside the virtual space

Fig. 2. Screens with video textures

**Exhibit objects**

These are the 3D or 2D objects corresponding to the exhibits in the real museum.

3D exhibit objects are basically 3D meshes and mapped textures. Some of them, like sculptures of various technical objects, might have high complexity.

Similar to the architecture, they can be built by a modeler or with photogrammetry / laser scanning. They add realism to the virtual museum.

Another advantage of using 3D exhibit objects is that the user may rotate them as he likes, to see them from various angles/sides.

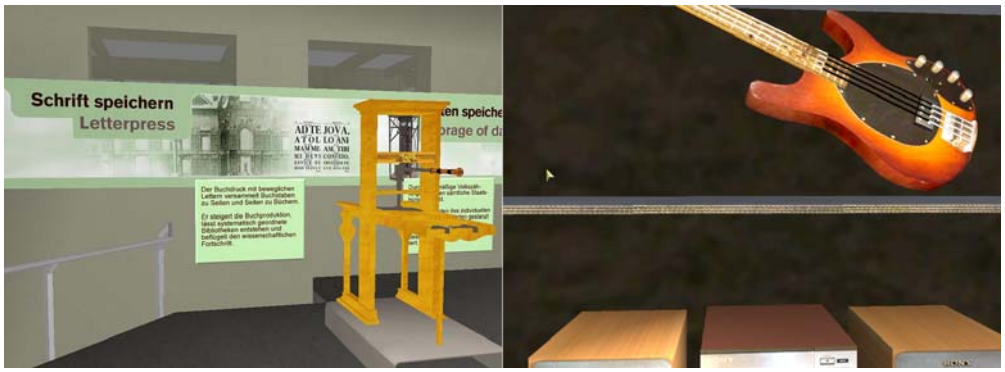


Fig. 3. 3D exhibit objects

Sometimes, to reduce modeling or computational costs, some exhibit objects are represented as 2D objects – basically rectangles with a mapped picture or video. For example, this is a natural representation for paintings.

**Lighting**

Lights and shadows add realism to a 3D scene.

- Static lighting: pre-defined with the 3D editor that is used to assemble the 3D space, these lights have fixed position, color and intensity; as their contribution to the scene is precalculated and mixed into the texturing, they won't require any CPU or GPU time at runtime.
- Dynamic lighting: these lights have dynamic position, color and intensity (Fig. 4), and their contribution to the scene is calculated in real time.

It is a common practice to use some variable (dynamic) light sources in the 3D scene to simulate some natural light variations, like sunlight or weather conditions, in order to make the scene more realistic.

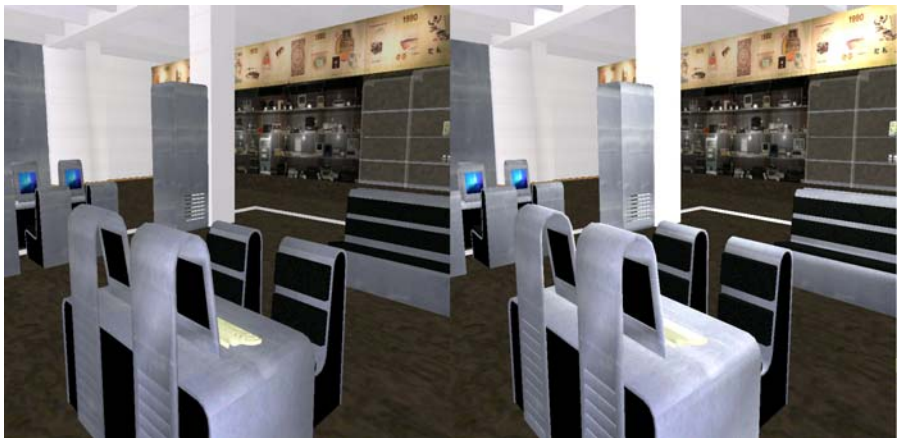

Fig. 4. Variable intensity lighting

**Sound**

Sound enhances the immersion in the 3D virtual space. It can be:

- background music and sounds
- voice records
- audio for the video textures
- various other sounds (example, step sound for animated characters)

3D spatial sound is to be used.

**Mini-Map**

The mini-map included in our virtual museum is a 2D schematic view of the 3D museum (or just of the current floor), as seen from above, usually with an orthographic projection (Fig. 5).

This map is overlayed over the 3D representation of the virtual museum, usually in a corner of the display. It can be shown / hidden by the user as he wishes.

The mini-map facilitates both the user's orientation and its fast movement in the virtual space:

- The current position of the user is indicated on the map by a specific symbol
- The map is divided in disjunctive sensitive areas, provided with tool tips
- The map contains teleportation points – with a click on such a point, the user is teleported in the corresponding position.

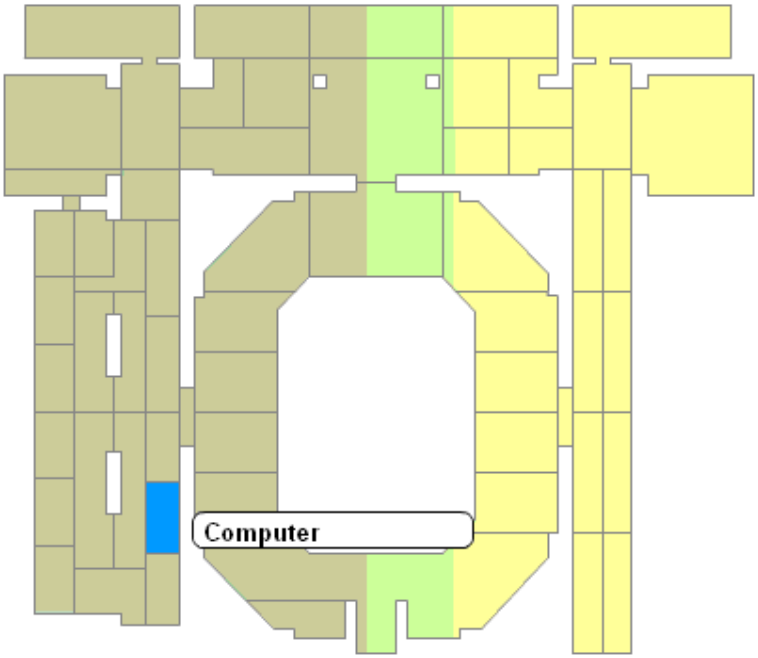


Fig. 5. The mini-map of the Technical Museum of Vienna

**Multimedia Information**

Each exhibit object can have a lot of associated multimedia information of various kinds: text, pictures, audio, video.

Each of these will be available to the user in an easy, predefined way (Fig. 6).

## 3. Creating a virtual museum

Like the creation of any 3D virtual environment, the creation of a 3D virtual museum is usually a complex plan, involving different types of specialists and technologies.

**Modelers**

An architect or modeler will create the 3D meshes and textures for the museum architecture and exhibited objects. These can be created with manual measurements and modeling or using helper technologies, like laser scanning or photogrammetry.

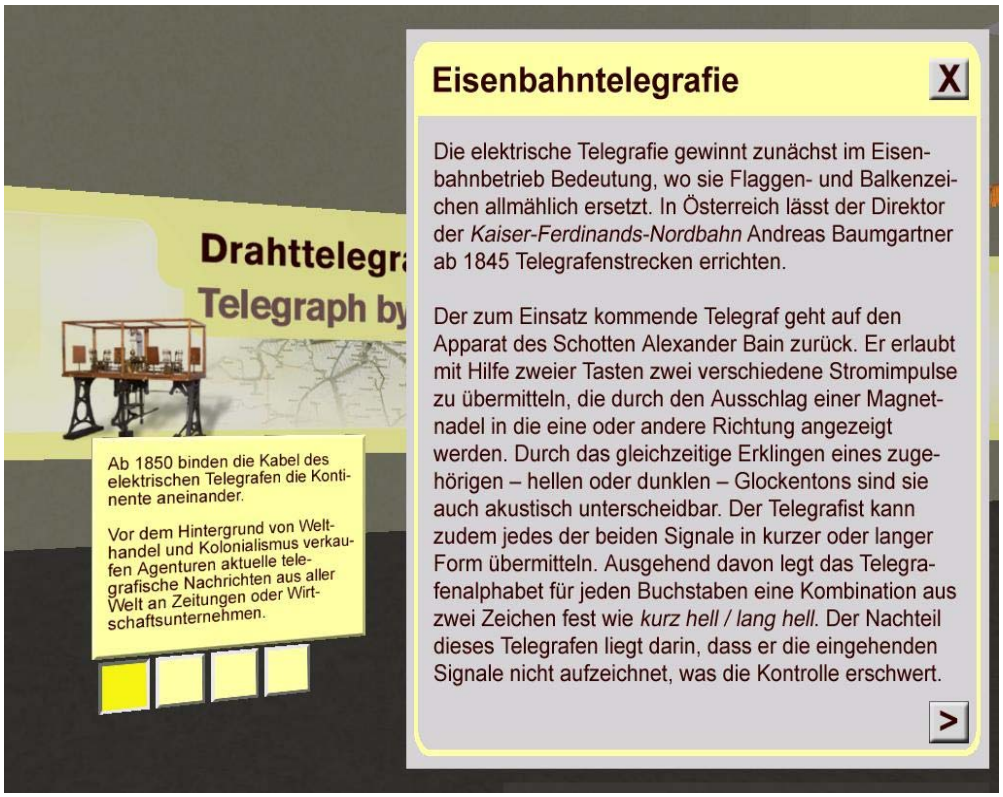

Fig. 6. Displaying some textual information for an exhibit object

**Software developers**

A 3D and multimedia programming team will develop the software that will:

- allow the integration of the artifacts produced by the modelers into one unique 3D environment
- display the 3D environment
- display and animate the user(s) avatars
- read user input and control avatar movement and behavior
- communicate with other on-site systems for real-word integration of the virtual museum
- allow the definition of data associated with different elements of the museum
- allow the definition of predefined tours/guides

### Museum stuff

The museum stuff itself is also involved within the creation and updating of the data associated with the exhibit objects or the definition of the predefined virtual tours/guides etc.

## 4. Delivering information to the user of a virtual museum

A 3D virtual museum is most valuable as an education and entertainment tool. It offers a multitude of new ways to deliver information to the user and, not only that, but to be used as space for complex interaction and collaboration between its users.

### 3D immersion

The 3D environment itself has a huge informational value by itself:

- The user is able to see how the museum looks like
- The user gets a feeling of immersion in the museum surrounds
- There is the possibility to study in detail a 3D exhibit object (like a statue for example) by rotating it or even magnifying (zooming in).
- As a new type of application, it attracts users and serves as a support for the other integrated means of delivering information and collaboration.

### Associated data

Basically, any kind of information can be linked to the exhibit objects, thus being immediately accessible directly from inside the virtual museum.

### Predefined Virtual Tours

It is possible to define (by the authors) and run (by the users) some predefined tours inside the virtual museum, based on topics. For example, in an art museum, we can have tours named “Renascentist Painting” or “Early Greek Sculpture” or “Early Impressionism” etc.

A tour is basically a series of locations inside the museum together with a narrative. The user will just start the tour and the program will take him to all these locations and narrate the story. The user has also the possibility to pause, stop, move forward and backward.

Such tours are a very valuable mean of delivering structured, topic-based information to the user.

**Annotations**

As a learning tool, the system should provide the user with the means of easy-taking notes, like an electronic notebook. Copying text or multimedia information, saving links to museum exhibits or locations, etc. should be functions available at any point to the user.

**URLs**

Any exhibit inside the virtual museum, as well as other objects, should be uniquely identifiable and accessible by the means of an URL-like value.

For example: www.tmw.au/3DVM/telegraph

This very simple concept is very powerful, allowing the information contained in the virtual museum to be accessed in a way similar to the information on the www. Links to exhibits or other objects or even actions inside the virtual museum can be shared by users, embedded in web pages, etc.

Moreover, the concept can be extended by associating various simple data to each URL, like:

- using keywords
- using classifications (example: sculpture/miniature/Greek art, etc.)
- using brief descriptions and images – which can even be shown inside WebPages
- using a clone-like technology, which allows creating replica of an exhibit object

**Communication and interaction between users**

The system will include many specialized functions to support communication between its users:

- chat with various channels (public, private, friends, group)
- friends lists
- groups of interests
- message board
- voice chat

**Educational games**

The system should include a couple of pre-defined educational games that the educators can customize in order to use as home-works or exercises.

Examples could be: basic quiz games, topic based compositions, classification games, etc. [2], [4], [5].

**Personal exhibitions**

The users will be able to act as curators by creating their own virtual museums, exhibitions or tours:

- some easy to use tools or wizard will help the user configure the basic environment of it's virtual museum
- later, the user can populate this space with exhibit objects:
  - personal objects, through import mechanisms
  - cloned objects from the museum
- the user can also create virtual tours
- it can share the personal exhibition with friends and colleagues
- this facility can be used for home works or fun.

Many other ideas can further enhance the usefulness and attractivity of the virtual museums, the above ones being just a foundation to build upon.

## 5. Conclusions

The paper presents the concept of 3D virtual museum and it's applications in education and entertainment as a very promising type of 3D virtual environment. Many of the functionalities of such a virtual museum are already implemented in our software application, "The Virtual Technical Museum of Vienna", as the included screenshots demonstrate. Some future extensions of the actual application are: more information delivery means (defining guided tours, associating URL and other types of data with exhibit object), more means of communication and interaction between users with the goal of socialization.

The limits of the technology are far from being explored as they are permanently enlarged with the advances in virtual reality and human-computer interfaces.

We predict that, with the advance of technology, as virtual spaces will become common knowledge, a network of interconnected and inter-related virtual spaces will eventually replace the web pages and messenger programs as a mean of delivering information and interacting over the Internet.

Our present research include also the concept of « Virtual 3D Mega-Museum », as a software system interconnecting distinct virtual museums and

providing a cheap, convenient yet powerful platform for rapid development, integration and hosting of such virtual spaces.

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