

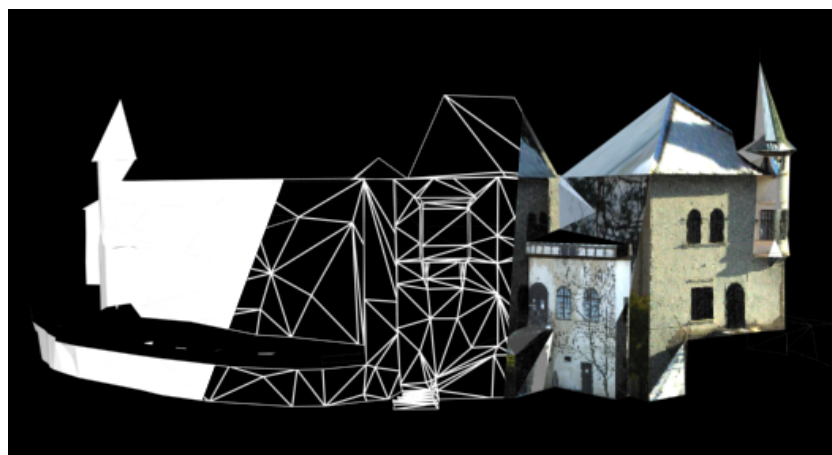
# Virtual Museum Technologies

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## Abstract

*We review the technology of virtual museum creation (authoring). Our intention is to teach virtual museum authoring in a summer school at Comenius University. We focus on free software tools and web services. Methodologically, there is a need to solve multiple partial problems and inverse problems to obtain models and data for online and projected presentations. The underlying metaphor is 3D xerox. The goal of this paper is to report on the state-of-the-art in technology for authoring. The paper is illustrated with a particular research project for a world-wide-unique museum of tinkering craft and art.*



**Figure 1:** The 3D model reconstruction from 2D terrestrial photos – surfaces, triangle mesh, textures. The Budatin castle model and main phases of photogrammetric processing illustrated by K. Tátraiová.

## 1. Introduction

Virtual university site may consist of multiple forms of communication the digital content. These include – among others - e-learning units, additional multimedia materials, virtual galleries, and virtual museum. While museum is a modernist concept, related to gallery and encyclopedia, **virtual museum** is defined as “a multimedia collection of digital data accessible telematically (...) cognitive space with an endless capacity of expansion, combination, composition, recomposition” [For00, p. 251]. The **ontology** of such a space is defined with 84 entities and 141 properties, which specify the museum data model to support semantic interoperability [Cro05]. The museum content should be **interesting**, but this attribute is not defined, we witness practical adopting of two levels of observed interestingness – local and global. The global one is officially evaluated e.g. by UNESCO World Cultural Heritage initiative [UNE06]. The local level can be

characterized as **genius loci**, a category from phenomenology [Nor80]. In both cases, the interesting collection or location has a unique story or multiple stories. The taxonomy of all inhabited virtual environments with respect to **interactive digital storytelling** is given in [Qvo02]. The methods for managing narrative multimedia production grow from software design (oriented to **functionality**) and traditional media (oriented to storytelling approach and focused to **content**). The quality of them includes the business and narrative quality. The latest story of given place is the story of creating its virtual museum, including the technologic project decisions. World leading conference on virtual heritage is VAST [VAS07].

The rest of the paper is organized as follows. The following section introduces the general workflow in seven steps. In section 3, we describe the technologies in more detail. Section 4 introduces briefly the tinkering craft and art. Section 5 shows some of our recent results and Section 6 draws the conclusions.



**Figure 2:** The initial screenshot of the virtual museum with project and partner logos. The upper left logo opens the virtual museum main menu. Design by Stanislav Stanek.

## 2. Virtual Museum Workflow

Previous work in virtual museum field is well known and we can mention just two broad categories, as discussed by Delia Tzortzaki in [Qvor02, p. 259n]. The “Space of Illusion” using virtual reality extends the very physical space of museums. The museum can be simulated by analogy (modern approach) and hyper reality (postmodern approach). The example of hyper reality is illustrated with the Digital Miletus CAVE project. There not only physical space of museum is reconstructed, but even the illusion of being immersed into the illusive world of ancient creatures living in the past myths near historic Miletus.

Technically, virtual museum successfully combines the previously unrelated fields of e.g. history, geometric modeling, museology, photogrammetry, computer graphics, scientific visualization, multimedia, human-computer interaction, and (collaborative) (distributed) virtual reality. Therefore, they have to be created by a renaissance interdisciplinary team. Virtual museums provide new tools for local *policy of memory* [Huy05]. Local people decide what to forget and what to memorize in memorials, local names... and in virtual museums. Practically, digitalization and online broadcasting of interesting local datasets (e-content) can be seen as a process of building *Semantic Web* [Ber01] or a global *digital library* [EDL07].

Obviously, Virtual Museum Algorithm has to integrate both hardware and software solutions (HW&SW). We will not discuss here the hardware requirements in general, as they should be adapted to local conditions to save money. E.g. if a museum has large screens or virtual reality hardware already, they are used for virtual presentation, as well. The cheapest option is to accept the level of standard PCs and internet. However, the optimal presentation of virtual museum requires at least the projected virtual reality set-up. Our hardware solution has the form of a kiosk of a special shape. The triple metaphor for the kiosk design is discussed below. These first 8 kiosks will be installed at public places in Zilina and Bratislava, Slovakia. The virtual museum will be online at [www.pmza.sk](http://www.pmza.sk). This will happen until the end of the year 2007. To our best knowledge,

virtual museums up to now just accepted the hardware given.

The virtual museum workflow can be briefly summarized as follows. The only input information is the need for given virtual museum. The output data are the versions of virtual museum. Note, that there are two multimedia datasets – acquired and interpreted. Primary, or acquired dataset include books, documents, maps, images, sound records... Secondary, or interpreted data we obtain by processing, e.g. as a layer of names in aerial image of landscape. We assume, that only interpreted data are suitable for presentation. The seven steps of the algorithm are the following ones.

1. Identify the world unique dataset given the need for a new virtual museum
2. Acquire primary dataset
3. Processing primary datasets offers secondary datasets suitable for presentation
4. Design and implement HW&SW for interactive projected virtual reality and for Internet
5. Organize digital content for presentation
6. Integrate and verify the prototype
7. Produce, publish & medialize the solution

## 3. Workflow Details and Technology

We will report on each step and comment selected issues or procedures. Some procedures, data formats, and technologies are well discussed in literature. We try to select relatively innovative ideas.

### 3.1 The need for a new virtual museum

The importance of virtual museum depends on local policy of memory. We will briefly resume the metaphors of memory. Historically, metaphors of memory include wax table, theatre, photograph, movie, computer, and neural network [Dra03]. Another metaphor is added in [Huy05]. It is an urban text understood as a *palimpsest*. This metaphor interprets the urban area as a form of memory with multiple historic and interpretation layers. The city leaders and the local people opt for priorities – what to forget and what to memorize. In other words, both real and virtual musealization process interprets space to create *place*. [Huy05] even reports on musealization of living city centers (London, Paris). Recent examples include Virtual Sarajevo [Avg07], Virtual Berlin, and Virtual Old Rome. In the year 2008 about 500 cities will be virtualized within the Microsoft’s project Virtual Earth [Leb07]. The need for virtual museum is a Boolean variable. If it is not needed, nothing happens. Otherwise, many competent people must agree to invest money and data. In our project, the original data available were limited, but later the scientific committee of museum agreed to document all data available. This represents several thousands of documents, images, stories, songs, and 3D entities. Methodologically, we have to solve multiple partial problems and inverse problems. Roughly speaking, our metaphor is 3D xerox and the underlying theory is computational geometry, geometric modeling, graphics, and vision. Graphics and Vision are (to certain extent) mutually inverse ways of information

processing [Len98]. While one starts with a model to create a picture, the other processes images to understand the model. Virtual museum requires combining both approaches, which can be named **visual computing** [Leb07]. Last, but not least, the decision to make the virtual museum provides legally all primary datasets, even not measured ones, for this “3D xerox” processing. The output from this first step has typically the form of a contract.

### 3.2 Acquire primary dataset

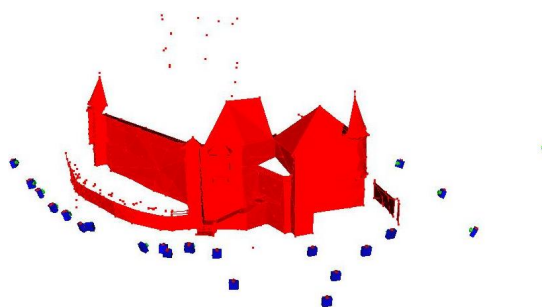
We perceive reality and process information given by both media and our sensory system. Human visual system is not completely understood. The same applies for light distribution in the scene. Both vision and graphics research communities manage the problem solutions by employing approximations. However, any approximate solution involves an error. The intermediate goal of visual information processing is to keep the errors bounded. This applies when simulating the museum by analogy. We have acquired and processed aerial images, terrestrial photos, floor plans, interior photos, scanned documents, taped videos with living artists, documented several exhibitions, etc. When simulating by hyperreality, the precision issue is replaced by the goal of appropriate visualization of the illusive part of presentation. In our project, this part is represented by the exhibitions, stories, or movies, which are not more available. In terms of coordinate systems, we have to complete multidimensional shape modeling in multimedia applications [Adz98]. Besides spatial coordinates, additional coordinate systems are needed for creation and afterwards navigation in virtual space.



**Figure 3:** Aerial image of Budatin Castle locality. Red line surrounds the part of park and buildings for which the photogrammetric preprocessing, especially for rooflines, was needed. Courtesy EUROSENSE Slovakia, [www.eurosense.sk](http://www.eurosense.sk).

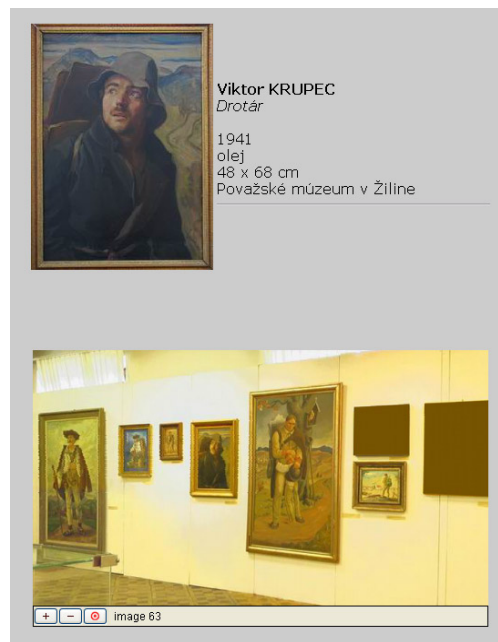


**Figure 4:** Museum front facade. Photo by K. Darilkova.



**Figure 5:** Budatin Castle photos using a calibrated Canon D30 (borrowed from International Laser Center) for Photomodeler processing. Photos by K. Darilkova-Tatraiova.

The exhibition *Tinkers in Painting* we simulated in both manners. We reconstructed the interactive copy of the exhibition, but we used the PowerPoint presentation of selected painting sequences, commented by annotations, using the book written by the author of the exhibition. In this hyperreality case the geometric, temporal, or radiometric error of the event cannot be measured, in general. The MySQL database communicates using Apache web server, PHP programming language [PHP07], and a Java applet PTVIEWER (<http://www.fsoft.it/panorama/ptviewer.htm>) for Hugin panoramas [Hal03].



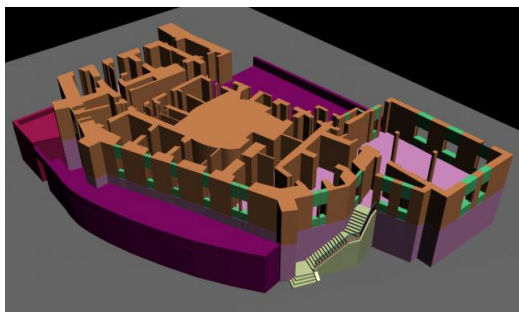
**Figure 6:** Interactive panorama using hotspots and metadata on exhibition held and documents in 2005. Photos and solution by Elena Sikudova. Viktor KRUPEC: Drotár. A painting at the exhibition held in summer 2005. Photo courtesy Považske muzeum.



### 3.3 Secondary datasets suitable for presentation

The encoding of natural and synthetic multimedia data is already available [Chi07a] and their indexed retrieval is in progress [Chi07b]. Secondary multimedia datasets are encoded in standard digital formats and a part of them can be directly presented to users. They use various multimedia coordinates [Adz98]. For instance, the VRML model of the castle, displaying the space with no access is in its own right interesting. The mysterious space under the tower is currently being investigated using sonar measurements by archaeologists from Slovak Academy of Sciences. Note that there is a legend about immured daughter of a cruel castle owner... The hundreds photos from shooting the movie *Ako dive husi* (Wild Geese Alike) by Matej Zeman was necessary to scan and apply image processing tools like GIMP.

Vision-based reconstruction of 3D models requires a lot of interaction (Photomodeler) and the precise models can be heavy for Internet transmission. We can avoid vision methods in image based modeling, rendering, and lighting. This is the case when we restrict the 3D model by panoramas etc. We produced several PPT presentations, short movies, animations, and videos in AVI format for direct presentation at the exhibition. However, they are not suitable for online version. Therefore we convert them into Macromedia Flash SWF for being integrated.



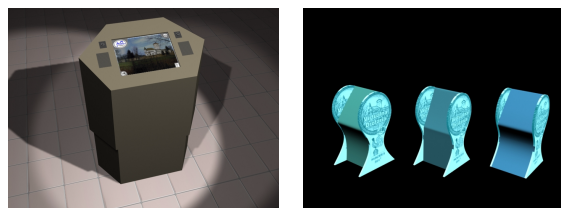
**Figure 7:** VRML model from floorplans authored Stanislav Stanek to produce the flyover video.



**Figure 8:** *The tinker in love with his Chinese woman.* Photo by Matej Zeman. The movie produced Peter Rufus, directed Martin Tapak, script by Andrej Ferko.

### 3.4 Design and implement HW&SW for interactive projected VR and for internet

Aesthetic aspects of virtual environments are discussed in [Qvo02, p. 213n]. However, nobody cares for aesthetics of computers. They are frequently used at exhibitions and in museums as constantly given. The aesthetics of market or consum thinking does not belong to high priorities there. Using the standard design of computers inside many installations can be viewed as a sort of noise. We propose to name this noise using grey, to be distinguished, e.g. from white or salt-and-pepper noise. Grey noise is a perceptual category, making people unconsciously tired from repeated shapes and colors of standard PCs. From this follows the first requirement – to hide the computer. As we have to hide it safely, the safe is needed. To hide the grey noisy safe, we have proposed two models, visible in Fig. 9. The first one has a honeycomb metaphor, it should have diffuse warm gold color, and its height can be adapted for children. The content taste should be the sweet taste of knowledge. The later one has triple metaphorisation - a drop of water falling up combined with the view through a locked door, using just the keyhole into the 13<sup>th</sup> chamber, where the source of knowledge is hidden. The third metaphor is inside the source of living water. The virtual water has sound rendering, as well, and after doubleclick it metamorphs into a book, symbolic source of knowledge. The drop falling up symbolizes the visit of a museum. Go back in the time and causality and refresh your memory. The UNESCO page mission is credited here **“Heritage is our legacy from the past, what we live with today, and what we pass on to future generations.”**



**Figure 9:** Two metaphorisations for a virtual museum.

We have extended the hardware functionality to support the final presentation in two modes. The first one offers the wide public availability at public places. The second one is in a form of interactive projected virtual reality with an external beamer, suitable for real museum. For public places we require power supply and data connection. The kiosk should be visible from some reception desk to avoid vandalism. It is impossible to use kiosk for pornography, as there is no text string input and all predefined links teleport the user to official institutions, strictly from heritage of education sector. The kiosk has two webcams and the software tool can recognize the presence of a user and switches automatically the kiosk on or off. We did not opt for the sound input. The computer and other standard components – loud speakers, cameras, computer, touch sensitive display and ventilator are then locked with a solid lock. The total weight of the kiosk is about 100 kilograms. The total costs are around 5000 euro in Slovakia.



### 3.5 Organize e-content for presentation

In this step the organization of the content is necessary according to presentation scenarios. Here the multimedia objects are composed into reasonable groupings and their access via interaction is designed and implemented. There are two screenshots from the standard menu-tree navigation in Fig. 2 and 10.



**Figure 10:** The book interface with clickable logos. The Demo button under the lower right corner starts the automatic demonstration.

The interior of the museum is modelled and displayed using VRML model and interactive panoramas. Panoramic interface was developed using Dersch tools [Der01].



**Figure 11:** We prepare the online avatar who will guide the virtual tourists. The guide is not very nice, using the 35-polygons minimal Perlin face and facial expressions, but she has nice transmission rates. Images by Stanislav Stanek.

### 3.6 Integrate and verify the prototype

The process of integration and verification is in progress. The general decision was to move everything into the Flash Macromedia SWF format with its known pros and cons. The verification of virtual museum is now re-ordering the priorities of processing the primary data sets. Some of the must wait for obtaining the courtesy of authors.

### 3.7 Produce, publish & medialize the solution

The main project output was at the Nostalgia 2006 exhibition with published press release. The response from media was encouraging. There were even TV interviews with the director of Povazske museum broadcasted. Post-Nostalgia media feedback was highly positive and another museums are willing to have the solution. (We plan publishing some pointers at [Wik07] and [GoE07], as well.)



**Figure 12:** Digital content interaction and display through touch screen is projected. The message *Touch, please* was added at the Nostalgia 2006 exhibition to encourage (older) people to interact. Space of illusion is immersed here into a standard small exhibition of tinker craft and art. The painting from a past exhibition is projected. Two ladies from Nostalgia organizers in historic costumes read the written messages. Photo by Elena Šikudová.



**Figure 13:** A combination of real and virtual exhibition at Nostalgia Expo 2006. Between both ones – real and virtual – there are employees of Povazske muzeum Elena Plzáková and Paulína Jankovská. Photo by Elena Šikudová.

The feedback was collected from visitors and written down by two employees of Povazske museum. First, we had to put there a prompt *Touch, please*, as this was the very first experience of many people with a touch screen. The installation was composed within a 3x3x3 meters small museum presentation. This was the first interactive virtual museum presentation in Slovak history. The feedback was highly positive in general. The critic voices asked for direct access to single movies, creation of a simpler introductory presentation for small children, and for CD availability.

### 4. Tinkering Craft and Art

The legend says, that the copper wire was discovered, when two poor men pulled each other a little copper coin... Today, we can see wire as an interactive metal model of a 3D curve with a material memory. “Wandering Slovak tinkers, compared to European nomads in the past, have influenced the history and culture of many countries and nations, not

only in Europe, but also in Asia and America. Ironically, although the origins of the tinkering craft are associated with material subsistence difficulties of the people from a little region on the north of Slovakia, gradually it became a specific ethnographic, sociologic and economic phenomenon and in the last decades even an art with specific means of expression" [Škv05]. Povazske museum is a world-wide-unique interesting collection documenting and interpreting the history of tinkering craft and art.



**Figure 14:** Leaving the home with the complete workshop backpacked. Photo by Vladimír Ferko.



**Figure 15:** A tinker with his little helper. Colored wire frame human-sized statues by Jozef Kerak. Photo courtesy Povazske muzeum.



**Figure 16:** The wooden house of king of tinkers, detail. Front façade decorated by 7 copies of golden awards like Gran Premio from Roma World Exhibition in 1911. Jozef Holanik-Bakel (1863-1942), nicknamed king of tinkers, won awards for marvelous silver masterpieces. Photo by Vladimír Ferko.



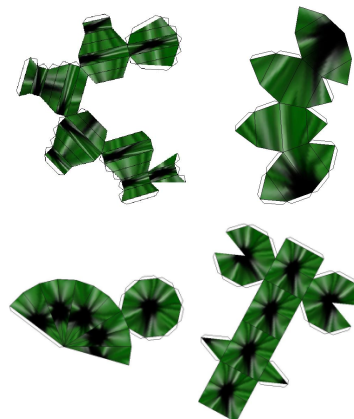
**Figure 17:** King of tinkers has a dilemma. Photo by Matej Zeman. The movie produced Peter Rufus, directed Martin Tapak, movie and museum scripts written by Andrej Ferko.

### 5. Our Recent Results in Selected Areas

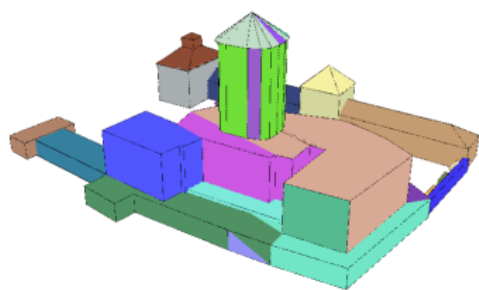
We experiment with many further ideas like modeling the park around the castle by Katka Smoleňová, employing more interaction with panoramas by Ján Laurenčík [Lau07], etc. Martin Samuelčík [Sam08] introduced a novel algorithm for computer-assisted papercraft [Pap07], which can be interpreted as a generalization of stripification.



**Figure 18:** A screenshot from a VRML textured 3D model of Budatin castle, created by Ján Lacko using Photomodeller and other tools. Photos by Kateřina Tátraiová.



**Figure 19:** Paper pieces created from basic geometrical objects by Martin Samuelčík.

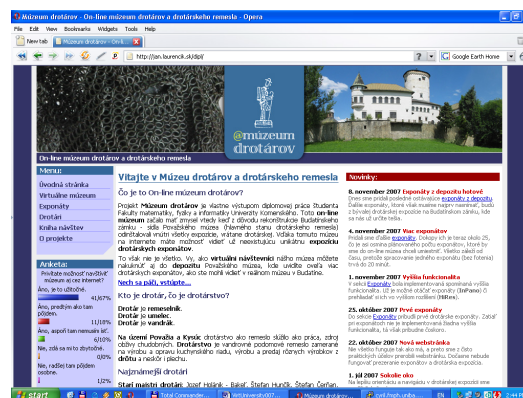


**Figure 20:** Model of Budatin castle with marked paper pieces. Visualization by Martin Samuelčík.

## 6. Conclusion, global contexts, and future work

We reviewed the technology of virtual museum creation (authoring) to report on the state-of-the-art in technology for authoring. The paper is illustrated with a particular research project for a world-wide-unique museum of tinkering craft and art. The workflow was used in Virtual 3D Bratislava projects and for Mestské muzeum Bratislava, as well. We may think about extending the technology, e.g. with expensive alternatives like [Ste07] within the priorities of Semantic Web [Ber01], Digital Libraries [EDL07], Epoch-3D [EPO07], etc. European Digital Library means the integration of the bibliographic catalogues and digital collections from 9 national libraries. EPOCH is a network of about a hundred European cultural institutions joining their efforts to improve the quality and effectiveness of the use of Information and Communication Technology for Cultural Heritage. In the first book on virtual heritage theory, Theorizing Digital Cultural Heritage [Ken07], “experts offer a critical and theoretical appraisal of the uses of digital media by cultural heritage institutions. Previous discussions of cultural heritage and digital technology have left the subject largely unmapped in terms of critical theory; the essays in this volume offer this long-missing perspective on the challenges of using digital media in the research, preservation, management, interpretation, and representation of cultural heritage. The contributors-scholars and practitioners from a range of relevant disciplines-ground theory in practise, considering how digital technology might be used to transform institutional cultures, methods, and relationships with audiences.”

Our future intention in abovementioned contexts is to enrich the museum functionality and to teach virtual museum authoring in a summer school at Comenius University, and online, e.g. like in [Štu00], [Ona07b]. We focus on free software tools and web services. Hopefully, some parts of the workflow can be better automated. We would like to offer the solution for other museums and to teach the technology our students. Eventually, we will prepare a summer course for people from museum community to enable them to create content from their unique data with relatively cheap free tools. We included in References most of our useful links, resources, standards, etc.



**Figure 21:** Another version of virtual museum by Ján Laurenčík. Especially the panoramic navigation and alternative visualization of wire products enrich the functionality.

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