

# Documentation of the Baroque Theatre at the Cesky Krumlov Castle

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## Abstract

The baroque theatre of the Cesky Krumlov castle represents a baroque stage in its mature form. The original theatre fund is preserved in both existing buildings such as auditorium, machinery, decorations, lighting technology, other technical facilities and information on the theatre life from 17th to 19th centuries. Only one royal theatre in the world is comparable to the Krumlov baroque theatre, that is Swedish Drottningholm near Stockholm built in 1766. The ancient town Cesky Krumlov is located in the south part of Bohemia and it is one of UNESCO's World Monuments.

Laboratory of photogrammetry as a part of the dept. of mapping and cartography in co-operation with the Foundation of the Baroque Theatre and the administration of the Cesky Krumlov Castle have already taken interest in the documentation of this unique building. The main purpose of the documentation activities is to create 3D model of the theatre, which will give an opportunity to scientists, architects, conservationists as well as potential visitors for looking at and studying this building and its details in virtual form.

The documentation of the baroque theatre of the Cesky Krumlov castle is a project in which various methods of data acquisition (analogical/digital photogrammetry, surveying) were used and various methods of a presentation of 3D data were tested. The baroque theatre is a very complicated space and the combination of different methods seems to be the best way. Each part of the theatre needs its own level of data generalisation (stage, auditorium, machinery) and has specific demands. The comparison of various methods, their applicability and precision leads to creating technology and it is another aim of this project.

3D photo-realistic model of the theatre exists now. This project will continue and the next step is presentation of this set of the spatial data on the Internet and finding of the ways leading to creation of the Cultural Heritage Information System.

## 1. Purpose of the project

The focus of this project is to verify the applicability of new technologies in the acquisition, processing and visualization of three-dimensional data. The main purpose is to search and check the appropriate technologies and workflows of processing and visualization of the data. Retrieving optimal usability of digital non-metric cameras would be the next aim of this project since this is modern facility in the whole scale of methods for an effective acquisition of the planar and three-dimensional data.

## 2. Introduction

Laboratory of photogrammetry as a part of the dept. of mapping and cartography in co-operation with the Foundation of the Baroque Theatre and the administration of the Cesky Krumlov Castle have already taken interest in the documentation of this unique building. The baroque theatre of the Cesky Krumlov castle represents a baroque stage in its mature form. Only one royal theatre in the world is comparable to the Krumlov baroque theatre. That is Swedish Drottningholm near Stockholm, which was built in 1766. The interior of the theatre is very complicated (e.g. wooden machinery etc.), it has big influence on an appropriate selection of method of data collection, software for processing of data and on the end on operators.

There have been several stages of documentation of this building done primarily by students of Geodesy and Cartography specialisation working on their diploma projects. The differing technologies used in the acquisition of spatial data were dependent upon the part of the theatre being documented. Classical methods of analogue photogrammetry were chosen in some cases (mainly during the first few years of project) - analogue form of results has been converted into digital form. The different methods of digital photogrammetry were used - stereophotogrammetry for the documentation of the auditorium of the theatre, resection photogrammetry for the documentation of the lower part of the machinery (under the stage) in combination with surveying method. These later data are fully in digital form, due to probable student inexperience, have only a few usable data sets.

In the beginning of the last year there were only few usable sets of data - lower machinery and two scenes. The form of these data sets is very close to expected form which are photo-realistic models consisting of wire models (vector) with surfaces. The surfaces of these models are filled with colours and in some cases with textures and photographic images in raster form. Simple methods of visualization - rendering, animation (e.g. flights) could be accomplished with this form of the data.

## 3. Solution

New data sets were obtained during the past year by surveying other parts of the theatre. The data covers these areas - auditorium, stage, upper machinery (above stage). Due to nature of these areas methods of documentation were chosen - photogrammetric method (the first part), surveying method (the rest). All of this data was originally received in fully digital form. Processing of the three-dimensional data was done by MicroStation software package, which was the only software package available in that time. The primary purpose of these data sets was the creation of photo-realistic models of all of the related areas and testing the possibilities of visualisation and animation. The requirements of good data relationship and data homogeneity were very closely monitored because

these data sets will be required during the next phase of the project which will be creation of complete three-dimensional model of the entire theatre.

The precision of the data sets obtained during this phase was one of the primary parameters observed. Various control measurements were put in place. The level of data precision is connected to the method of data collection and also to the level of experience of the operator. In addition, it is very dependent on the degree of a generalisation necessary in so complicated area and problems with an identification of documented entities and individual points as well. The degree of generalisation is related to the requirements of the end customers, strictly speaking a solution could be obtained during discussions with them - the typical question is what is technically possible. The timbers and wooden components of the theatre, which make up the technical equipment, are good examples of it.



*Fig. 1:* Visualization of the upper part of machinery

The digital non-metric camera was mainly used for a simple photo-documentation of the areas and for acquisition of textures of materials. In some cases the images for the single image photogrammetric restitution were taken too. These images were processed with specialised software (TopoL - Czech product) - the rectification of images and vectorization were done with the data. The results of these steps were planar and they were moved into the space via identical points. Testing evaluation was performed in one of stereo-pairs (digital workstation - VSD).

#### **4. Results**

The purpose of the project is searching and checking of an appropriate technologies and workflows in the acquisition, processing and visualization of three-dimensional data.



*Fig. 2:* Visualization of the stage

In the Baroque theatre in Cesky Krumlov castle various methods of data acquisition were applied up to now. The kinds of the methods differed according a character of a documented part of the theatre. Photogrammetrical and surveying methods were used.

The digital non-metric camera was used in various ways - simple photo-documentation, taking images for visualization, data for photogrammetrical processing. The photogrammetric evaluation of the data was done by way of two digital methods - rectification, stereorestitution. The first type of the result was planar. Applied technology, a vectorization above a raster data with consecutive placement into the space via identical points, was convenient for this application. This technology is the ideal tool of documentation mainly for planar parts (e.g. wall painting, drawings etc.). The testing of the digital stereorestitution on one of the stereo-pairs was not so successful. The main problem we found was that the digital non-metric camera has a known problem with precise calibration (interior orientation). This necessarily requires a lot of control points and values, which have to be determined within the area of documentation. The time required is much longer which negates one of the main advantages of photogrammetry. The application of digital non-metric cameras is convenient for documentation where a high degree of precision is not required. The precision attained in this particular case was not acceptable.

The data acquired by surveying methods had to be complemented by additional data (measurement of dimension etc.) because of creation of the complete model.

The processing of the data sets into photo-realistic models was done by MicroStation software. The wire models of the documented parts of the theatre were acquired firstly. The processing has been done by editing of input data - editing of space position of some points (a threshold was assigned by expected precision), elimination of some data etc. The design as one of the methods of a creation of the model was used mainly in the case of processing of the data acquired by the surveying methods. During the creation of the models, great emphasis was placed on the logical classification of entities into particular levels. This request was very important to avoid any big changes of each simple model in the consecutive creation of complete three-dimensional model of the entire theatre. During the next phase, the surfaces were defined and filled with colours or textures. The textures of materials were acquired by digital camera and the images were subsequently adjusted in a graphical editor. The diversity of textures had a big influence on the credibility of visualization. MicroStation system has a number of tools for visualization. The results of this visualization are very dependent on the choices and use of light sources. This means that illumination is of primary importance in the general impression of visualization. The next phase of the documentation will be focused on this topic - localisation and determination of kinds of light sources also. The best results of visualization were obtained by Phong method of rendering. Some simple animations of the models - flights through the area - were created as the last step of workflow. The number of available techniques of animations was a little bit narrow, but the results of animations are in a good quality and usability for presentation purposes is very good.

**Tab.1:** Stages of the project

year	part	Method	model	v	a	notice
1996	Scene - Baroque hall	Analogue phot.	w			
1997	Part of auditorium	Analogue phot.	w			unused
1997	Scene - Forest	Analogue phot.	w			
1998	Lower part of machinery I	Resection phot.	p-r	x		
1998	Lower part of machinery II	Surveying	p-r	x		
1999	Auditorium - left part	Digital photogrammetry	w			unused
1999	Auditorium - right part	Digital photogrammetry	w			unused
2000	Auditorium	Semi-analytical phot.	p-r	x		
2000	Stage	Surveying	p-r	x	x	
2001	Upper part of machinery I	Surveying	p-r	x	x	
2001	Upper part of machinery II	Surveying	p-r	x	x	

v - visualization, a - animation;

Models: w - wire, p-r - photo-realistic

<b>Methods</b>	Analogue photogrammetry	- analogue stereoplotter <b>Technocart</b> with registration
	Semi-analytical photogrammetry	- stereoplotter <b>Topocart</b> with <b>AutoCAD</b> system
	Resection photogrammetry	- <b>RolleiMetric CDW</b> software
	Digital photogrammetry	- stereorestitution - <b>DWS - VSD</b> software
		- single image - <b>TopoL</b> software
	Surveying	- total station ( <b>Topcon, Leica</b> )

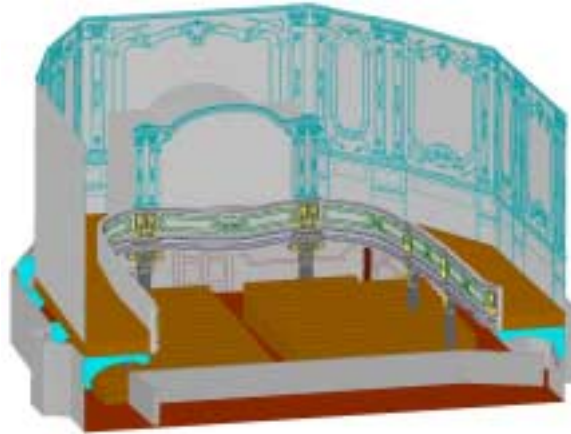
## 5. Conclusion

The various modern methods of collecting three-dimensional data were used in this particular building. These data were acquired in fully digital form. Photo-realistic models were then created using different tools for editation. Presentation of these data sets was done using various techniques of visualization and animation. The main purpose of this part of the project - verification of applicability of the new technologies in acquisition, processing and visualization of the three-dimensional data was achieved.

The variability of data collecting methods was high in this case. This would be problematic for small companies working in this area and interesting in this kind of work. It would almost be necessary to combine surveying methods on one side and photogrammet-

ric methods on other side. This brings requirements of appropriate equipment, software and experienced operators. The co-operation of companies looks as a good way to accomplish this task.

During the process of joining all of these models together, some problems with the data relationships and data homogeneity appeared. This required checking the data directly with the physical building of the theatre. The amount of these problems was not so large (some details) because of monitoring of this during processing.



*Fig. 3: Visualization of the auditorium*

## **6. Perspective**

There will be three-dimensional photo-realistic model of the entire theatre. What would be the next step? The trend leading to creation of Spatial Information Systems is obvious. In this particular case it will be something like Cultural Heritage Information System. The second way, which has a very close relationship to the first, is the presentation of three-dimensional data via Internet - virtual tours, virtual tourism. That is why it is necessary to continue with new technologies leading the way to utilising three-dimensional data and their actualisation.

## **7. Internet sources:**

[http://www.ckrumlov.cz/cz1250/i\\_index.htm](http://www.ckrumlov.cz/cz1250/i_index.htm)  
*Official Information System of the Cesky Krumlov Region*

[http://gama.fsv.cvut.cz/~hodac/vyuka/laborator\\_ftgm/](http://gama.fsv.cvut.cz/~hodac/vyuka/laborator_ftgm/)  
*Official pages The Laboratory of Photogrammetry*