Conception and creation of a 3D model of the Bavariathek

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Abstract

The present work demonstrates the process of modelling the Bavariathek. The Bavariathek will provide a public contribution to the media education of student groups and other interested parties. The construction of the building is currently underway and it is scheduled to open at the end of July 2019. In this paper general aspects and methods of modelling will be discussed and evaluated as well as hurdles to be overcome when collaborating with the modelling software Blender. Finally, possible future work will be identified and analyzed on the basis of the model created. This paper shows that a 3D model offers a variety of possibilities to consolidate and enhance the digital services of an institution, in the case of this work the services of the Bavariathek.

1 Introduction

The coherent and effective planning of exhibitions in museums and galleries is a decisive factor for the success of an exhibition (Bitgood and Loomis, 1993). Many different tools and concepts can be used to support the planning phase. One of these tools is ExViz, which was developed with and for the *Kunstmuseum Bonn* (Museum of Arts, Bonn). ExViz supports the curator by presenting a computer generated three-dimensional (3D) model of the exhibition area in which artwork can be placed. The primary goal is to give the curator the opportunity to get an detailed impression of the overall concept without actually having to build it up in the real world (Eckel and Beckhaus, 2001). A similar approach has been followed during the design, development and evaluation of the Bavariathek within in this work.The Bavariathek is part of the*Haus der bayerischen Geschichte* (House of Bavarian History), which will be a museum complex focused on the recent Bavarian History. The Bavariathek is intended to serve as a media-educational hub and will include several project rooms with the latest technical equipment. In these project rooms interested groups, such as school classes, can inform themselves about the latest Bavarian history and experience it up close (Bayern, 2019). The technical equipment will enable users of the project rooms to create videos, apps and virtual exhibitions on topics related to Bavaria in the past and present. Some of the created media will be offered on the website of the Bavariathek to enthuse and inspire other people. A feature of these project rooms will be the possibility to create and present virtual exhibitions in the Bavariathek. In order to be able to offer this digital service, a 3D model of the Bavariathek is needed.

In a meeting with a representative of the Bavariathek, the following goals were determined for this work:

- Creation of a true-to-scale model of the Bavariathek.
- Integration of basic architectural features, like door frames, stairs and windows.
- Creation of a highly detailed model of the project room. This contains the creation of sample assets.
- Creation and integration of basic material assets for architectural elements in the model, like walls, windows, doors, glass elements and the roof.

By translating the above points into a 3D model, the Bavariathek has a solid foundation to build more digital services. The remaining paper is structured as follows: Section 2 presents works related to virtual reality used in museums for planning and designing exhibitions. In Section

3, this paper explains the methods used to create the model of the Bavariathek. Section 4 of this paper discusses the process used to implement the methods mentioned in Section 3 to create the model.Subsequently, in chapter 6, this paper explains any limitations that have arisen during implementation. Chapter 7 summarizes and presents the outcome of this work. Last but not least, this paper shows in its last chapter how the model could be used in future projects.

2 Related Work

There are already many different tools for planning and designing exhibitions. Often these tools are tailored to a specific environment or museum. Despite these local limitations, the general methods of these tools and the results in the corresponding work can also be applied to the developed Bavariathek model. The authors Eckel and Beckhaus were able to show how a virtual prototype of the ExViz tool could significantly accelerate the process of creating an exhibition (2001). The designed tool is able to create a virtual exhibition in real size. This exhibition may then be explored and viewed by curators using a stereoscopic display in order to obtain an authentic spatial impression of the exhibition. In their work, the authors have scanned and digitized various exhibits in order to integrate them into the virtual exhibition. The curators, who used the software, were able to place these exhibits as they pleased in order to observe and experience the interplay between the different pieces. Through their work Eckel and Beckhaus defined a general method on how to create a virtual model of a museum. The authors also briefly demonstrated how user should be interacting with the model.

Another major factor influencing this work has been the paper "Digitisation *[sic]* to Presentation-Building Virtual Museum Exhibitions." by Patel et al. (2003).In their work, the authors demonstrate the entire process which is necessary to digitize a museum. This process includes the digitization of exhibits, the creation of suitable 3D models and the subsequent combination of exhibits and model. Patel et al. concentrate their work in particular on the digitization of exhibits. It is shown how the whole process can be considerably simplified with the help of the system designed by the authors and also made accessible to non-technical users, such as museum members. A significant advantage of this work is that the researchers do not necessarily focus on a particular museum, but attempt to establish a universal concept. In summary, the paper is crucial to this thesis for two different reasons. Firstly, the general approach designed by the authors is also applicable in the framework of the modelling of the Bavariathek. Secondly, the writers point out how the created models ought to be presented to users who have no particular affinity for technology in order to achieve the best results. This fits perfectly to the target group's digital service of the Bavariathek, which is meant to be used as a hub for medial education.

The authors Lepouras and Vassilakis go one step further than the previously presented work in fully integrating a museum into virtual reality (Lepouras and Vassilakis, 2004). The authors show that museums already understand the potential of new technologies such as virtual reality. However, the expected acquisition costs and the necessary know-how are often a daunting prospect. Furthermore, the work shows how the aforementioned resources could be conserved through the use of state-of-the-art game engines. A game engine is software that is usually used to create games. Nevertheless, they also offer the possibility to develop applications that are not classically considered games, such as a tool for exhibiting a museum in virtual reality. Finally, the authors show on the basis of an informative study that the use of game engines in a museum context is quite suitable. The work of Lepouras and Vassilakis is not only of importance for this paper but also for future concepts and approaches based on this work. In addition to establishing the foundations of efficient and structured modelling of the exhibition space, they show how the models created can be integrated into a virtual reality environment using a game engine. The integration of the Bavariathek into a virtual reality environment is quite possible and should be considered in the future.

3 Methods

For the actual modelling of the Bavariathek the free and open-source software Blender was used (Blender, 2019). The Bavariathek consists of 210 different rooms distributed over four floors. In the course of this work, all 210 rooms were modelled and selectively equipped with basic features such as doors, door frames and windows. As already

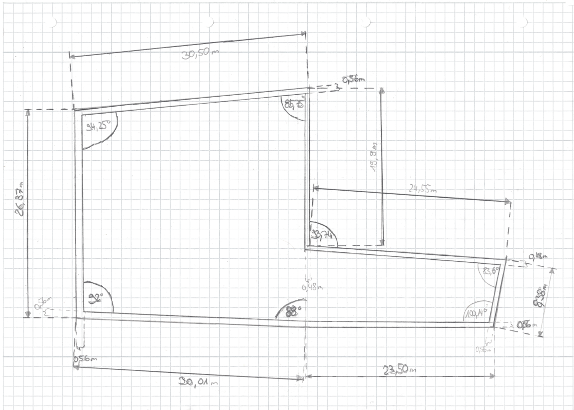

Figure 1: Sketch of the ground level, based on technical map material.

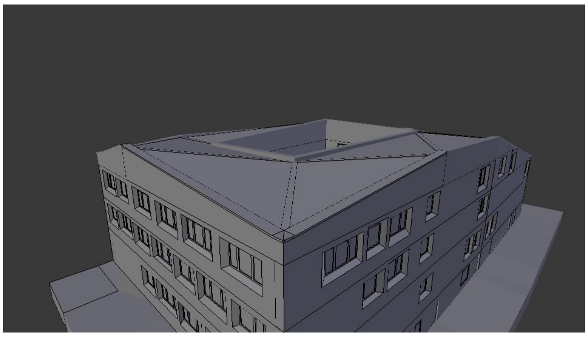

Figure 2: Solid exterior view of the Bavariathek.

mentioned, special attention was paid to the modelling of a highly accurate representation of the Bavariathek. In order to achieve the particularly high degree of accuracy of the model, technical map material from the architect's office involved was used as the basis for the modelling. First of all, we used these rather technical maps to create our own map material, which was used as a template for further modelling. **Figure 1** shows an excerpt of the drawn sketches. In the next phase, the actual modelling began with the transfer of the floor plan and the exterior walls of the Bavariathek to Blender. In order to correctly represent the external dimensions of the museum, an exemplary outdoor area was created. Although the museum has no cellar per se, parts of the building are below street level.

Figure 2 depicts the solid exterior view of the Bavariathek. In Blender lingo, the expression "solid" refers to an image that has not been rendered and is only displayed with Blender's standard material. **Figure 3** clearly illustrates the above mentioned displacement of the building below the street level.

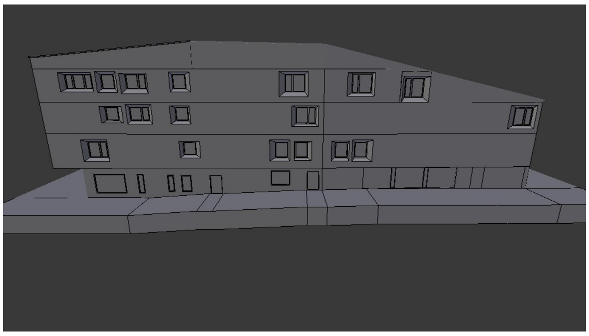

Figure 3: Solid exterior view of the Bavariathek, showing the displacement on the west side.

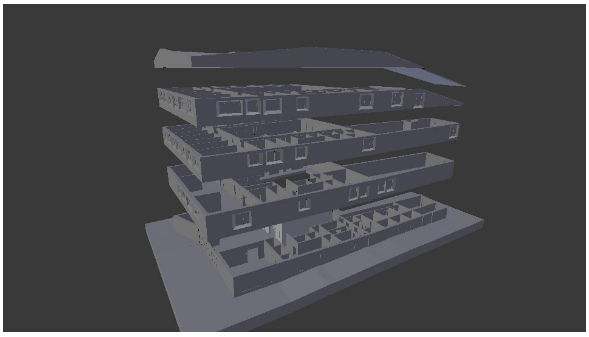

Figure 4: Solid exterior view the of the individual floors and the roof. The depicted elements were individually modeled and later combined in a central file.

After creating the outer shell of the model was created, it was split into six different files. Five of these files each represent one floor and the roof of the Bavariathek and one file represents the central project room . This division was necessary in order to work collaboratively on the model (this topic will be addressed again in the further course of this work). The individual files were then joined together again in one main file after completion of each individual floor and the project room. **Figure 4** depicts the partitioning of the model during the entire project phase. After splitting the model into the various files, the work on the details of the individual floors and on the details of the central project room began. During the detailed work on the floors, all corresponding rooms were inserted in order to be able to reproduce the greatest possible degree of detail in the internal modelling. Subsequently, the rooms were then expanded to include basic functions such as door frames and windows. When modelling the project room, attention was paid not only to the general requirement of high degree of dimensional accuracy but also to an exemplary interior. **Appendix A.1** shows a rendered version of the project room including equip-

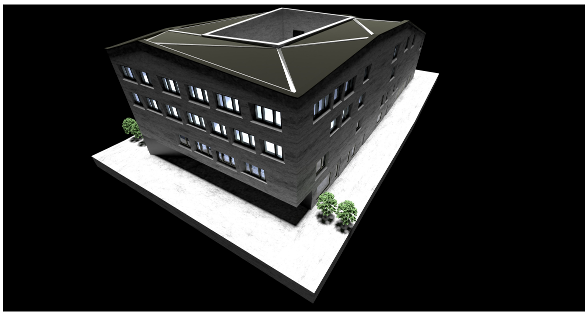

Figure 5: High definition render of the Bavariathek, showing the unique positioning and placement of the roof tiles.

Figure 6: High definition render of the Bavariathek, showing the final model in bright daylight.

ment such as tables, chairs and technical gear. Following the detailed work on the floors and project space, the external characteristic features of the Bavariathek were modelled. In the course of this step, the inner courtyard, the outer facade and the roof were constructed. **Appendix A.2** shows a high definition render image of the modeled inner courtyard. A particular difficulty was the modelling of the roof, as it does not consist of the same elements in terms of angle and size, but consists of many different individual panels. **Figure 5** and shows an rendered view of the roof showing the unique positioning of the panels. This picture can also be found in a higher resolution in **Appendix A.3**.

The last step of the modelling included the allocation of the created model with suitable textures and materials. The main purpose was to give the stakeholders of the Bavariathek the opportunity to immediately recognize distinctive landmarks of the Bavariathek, such as the entrance area, which consists mainly of glass. A high definition rendered image of the inner gallery is attached to **Appendix A.4**. A high degree of modularity was taken into account when assigning the materials. If necessary, the materials can be easily exchanged by the museum staff themselves. **Figure 6** shows a high-resolution render image of the exterior view of the final model of the Bavariathek. **Figure 6** can be found in **Appendix A.5** as well. The next chapter of this work briefly describes the experience gained during the above implementation and discusses said experiences.

4 Discussion

A project management style based on the SCRUM method was chosen for the temporal and personnel structuring of the project (Schwaber and Beedle, 2002). The project was divided into so-called SCRUM sprints. In the methodology used, a sprint lasted one week and aimed at achieving certain milestones. At the end of each sprint, the results were discussed in a sprint review and the next sprint was planned. During the first sprint reviews it became clear that the time required was underestimated.The modelling and especially the high-precision modelling turned out to be extremely time-consuming. In order to solve this problem, the content of a milestone was reduced for future sprints. In addition, the duration of the sprints was shortened in order to be able to react early and flexibly to possible difficulties. The clear structuring and agile adaptation of the project management used made it possible to create the model of the Bavariathek successfully and on schedule. Finally, the knowledge gained can be summarized as not to underestimated the time required for modelling. Another important finding is that Blender is not inherently suitable for collaborative work based on version control systems. The version control software GitHub was used to implement the project (GitHub, 2019). GitHub recognizes changes to a file and updates this file in an online repository. The problem arises from the fact that Blender stores the entire model of an object in a single file. So the slightest change to a model also leads to a change to the model file. However, GitHub can only detect that a Blender file has been changed, but not exactly which modelling-object has been changed. As a result, two versions of a file can no longer be merged. However, this merging of files is the great advantage when using version control software such as GitHub. In order to be able to use the other features of GitHub, such as the project board and the issue-tracker, only one person was allowed to work on a Blender file at a time, which led to the already mentioned distribution of the model. At the moment there is no proper way to collaborate with Blender and Github. Thus, neither Blender offers a tool for Git integration, nor GitHub offers a possibility for Blender integration. Another important experience was gained by working with the map material provided. Since the material was provided by the commissioned architectural firm, the maps were very technical. To achieve the desired high degree of scale accuracy, it was essential to interpret the map material correctly in order to implement the information and dimensions obtained properly. During the preparation for the actual modelling phase it became clear that working with the maps as a template for the Blender model was extremely impracticable and complicated. For a simpler implementation, own map material was produced, which in turn served as a template for the overall model. The level of detail was maintained during the production of the own maps. The new maps accurately reproduce the dimensions of the Bavariathek, but do so without excessive additional technical information.

5 Limitations

As is customary with comprehensive projects, we encountered a number of limitations in the course of the project implementation. These limitations were of a technical personnel nature. The following sections describe these limitations and their impact on the project outcome and progress. The biggest limitation we had to face due to a lack of personnel is the level of detail in the modeling itself. Although the resulting model is a very accurate representation of the Bavariathek, the model lacks some details. The reduction of the level of detail was defined so that the project could be implemented in a realistic time frame. For example, apart from the project room, none of the rooms have an interior design. For the chosen Blender materials, such as walls, wood, glass and metal elements, only simple materials were used, which primarily aim to improve the overall impression of the model.In addition, the fact that the Bavariathek will only officially open in July 2019 has reduced the possible level of detail, as it will not be possible to inspect the premises until then. A further limitation was the lack of the possibility for proper collaborative work. As already explained in chapter 4, it is impossible to utilize Blender in combination with GitHub. Due to the missing version control it was not possible to work on the same Blender file at the same time. Although the problem could be avoided in the broadest sense by partitioning the model as described above, it was still a tremendous limitation. With the method used, all changes had to be manually loaded into the central file, and only then was it possible to get a complete overview of the changes made by each contributor. In summary, it can be said that although the experienced limitations have in some cases considerably hindered the course of the project, but could ultimately be circumvented or eliminated. Furthermore, the limited level of detail creates space for future work, which will be discussed in a later chapter. The results of this paper will be briefly discussed in the next chapter.

6 Outcome

Despite the fact, that some hurdles occurred while developing and creating the Bavariatheks model,the project was completed within an acceptable timeframe. The finished project was presented to the stakeholder in a personal meeting. In the course of the work we were able to fulfil all demanded requirements to the satisfaction of all participants. A high-precision replica of the Bavariathek was created in Blender. This replica is equipped with basic building features such as rooms, door frames, windows and stairs. Furthermore, some sample materials were created, which were applied to important landmarks of the building to improve the overall impression. Finally, we successfully demonstrated how the interior design of the project room could be laid out. We demonstrated this by implementing detailed models of objects like chairs, tables or technical equipment, into the project room which can be observed in **Appendix A.1**. The next chapter briefly discusses some possibilities for future work based on the developed model.

7 Future Work

The presented model offers various opportunities for future work. One possibility is the already mentioned increase of the level of detail. The goal of this work was not to create a very detailed, but a very accurate replica of the Bavariathek. In the course of future work it would be desirable to further increase the level of detail further. For instance, it would be advisable to use more appropriate materials for the texturing of the individual objects. For the texturing of the individual objects such as door frames, glass elements or the roof, only simple materials were used. In order to avoid repetitions in the texture, the materials were extended by procedural methods. Basically, this means that the materials randomly change their appearance to give a overall natural look. This approach should be continued in upcoming projects and extended by high-resolution materials. Another way to increase the level of detail is to create an interior for all rooms. This work focused on the presented project space, for which an interior design was created and textured. All other rooms, with the exception of textured walls, door frames and windows, received no further interior decoration or details. As a first step, important interior design features such as doors, elevators, interior design and various wall materials could be integrated into future works. Another interesting aspect would be the integration of emergency exits and corresponding signage. After increasing the level of detail, the model could be used to simulate various emergency scenarios.The use of the model for emergency simulation shows only one possibility how the created model could be used semi-interactively or interactively. The different application possibilities for the model are extremely diverse and multi-layered. The model can be used to create a three-dimensional map for visitors of the Bavariathek. In this way, visitors could access the map at certain points via counters and actively interact with the material. The user could be shown his current position, the route to a desired destination as well as other various useful information. Furthermore, such an application can also be integrated directly on the visitor's smartphone to present more than just location-based information. The smartphone could provide visitors with continuous orientation. Additionally the smartphone could also supply users with detailed information about their location. For example, the smart phone could display information about exhibits located around the user, combined with a three-dimensional model that guides the visitor directly to selected exhibits. In addition, the created model can also be used to create and plan exhibitions in virtual reality or the real world. This could be done either in the modelling software Blender or in a specially designed application. The model can also be used with other modelling suites such as Autodesk Maya (Autodesk, 2019) or Cinema4D(Maxon, 2019). Blender offers an export as FBX file. This file can then be imported into the various frameworks. To create an interactive application, the model could be imported into the Unity3D (Unity, 2019) game engine (either directly as a Blender model or as a FBX file). With the current state of the model, an application could already be developed in Unity that allows the user to view and walk through the architecture of the Bavariathek from inside and outside.

As shown, the possibilities offered by this model are versatile. We hope that the model will be further used in many different projects to support the enhancement of the digital presence of the Bavariathek.

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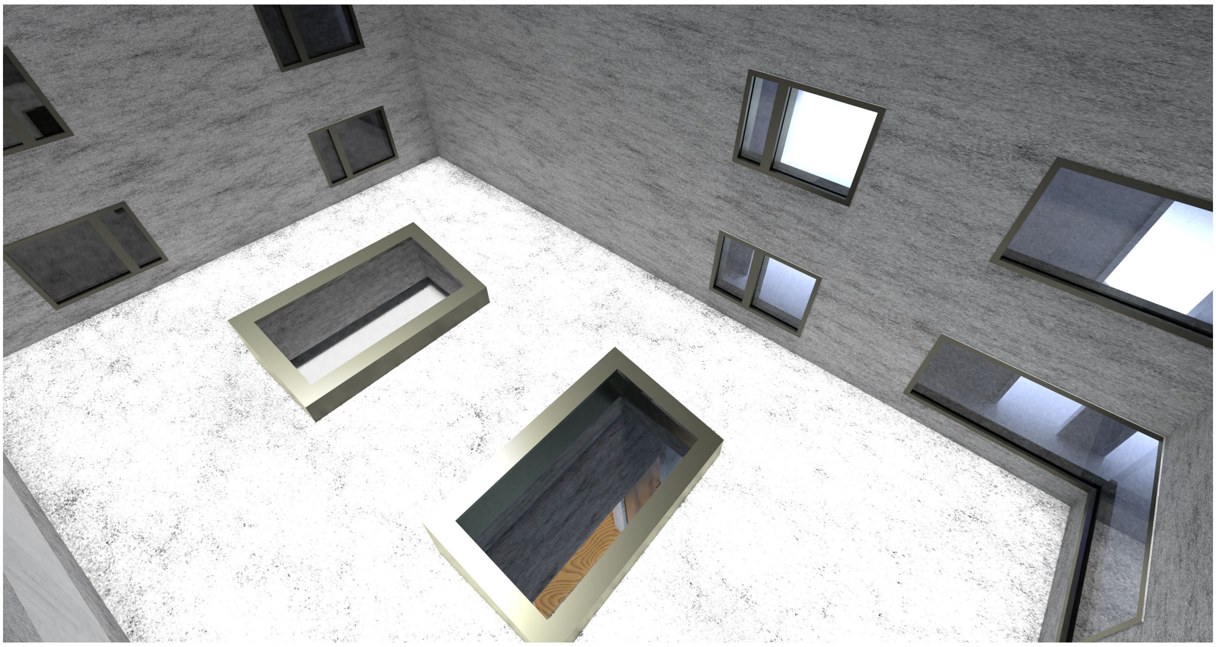
A Appendices

A.1 Render project room

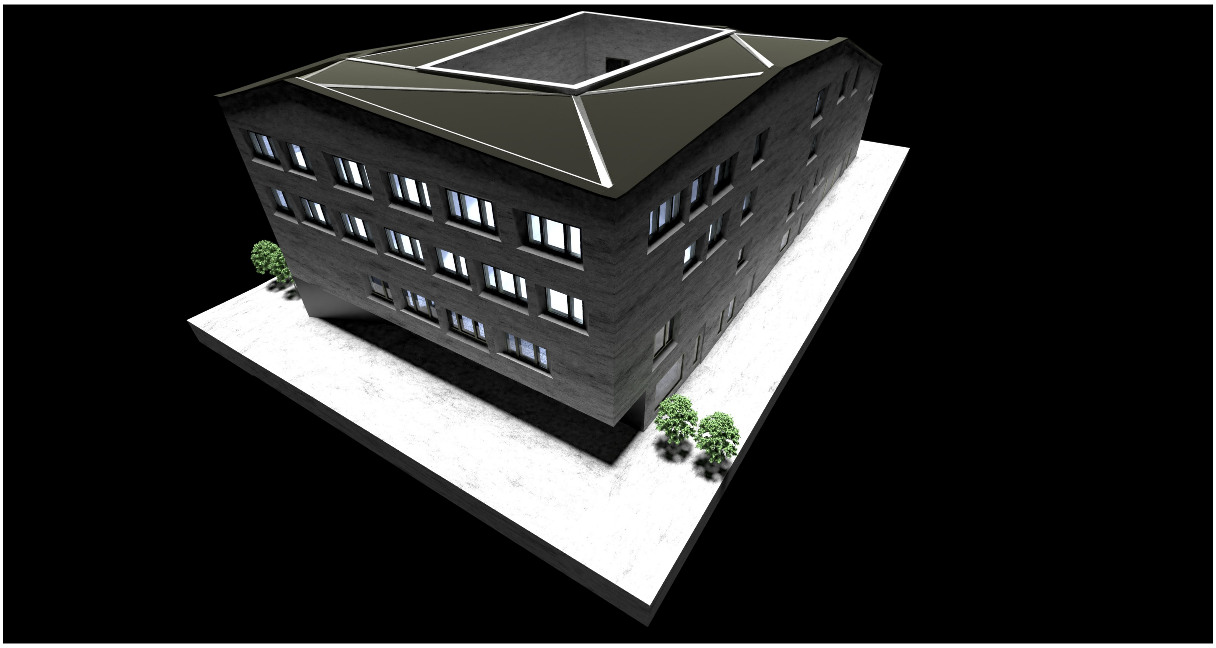
High definition render of the designed project room.

A.2 Render inner courtyard (day, lateral view)



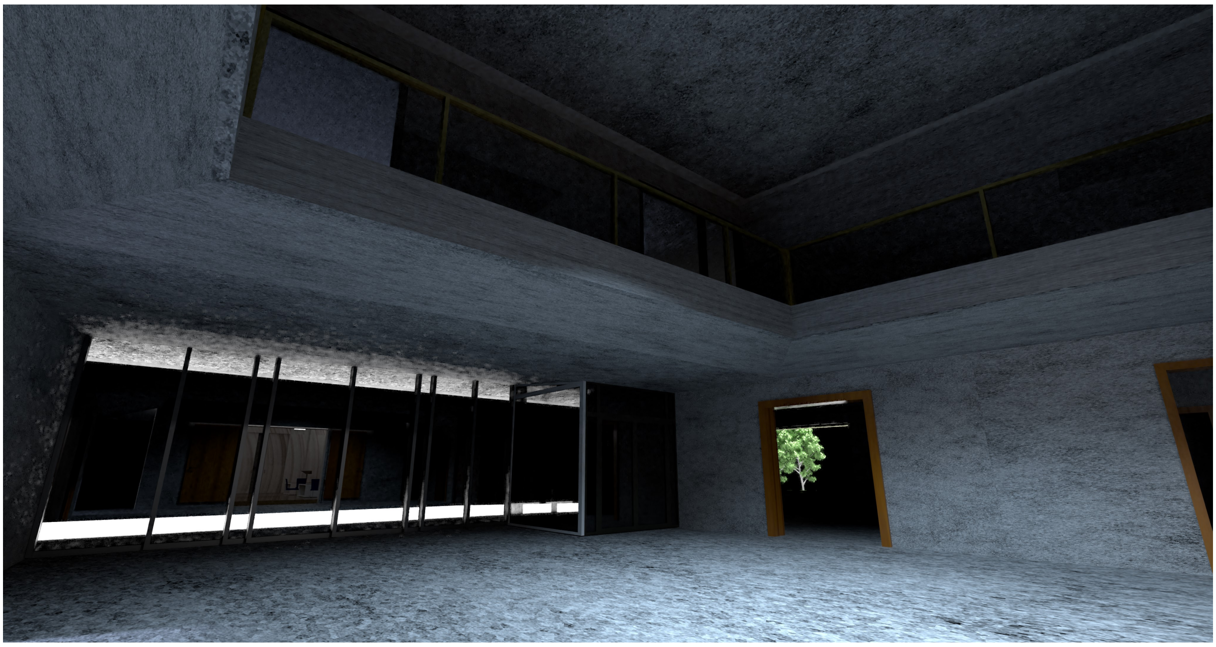
High definition render of the inner courtyard in bright daylight.

A.3 Render Bavariathek (night, lateral view)



High definition render of the Bavariathek, showing the unique positioning and placement of the roof tiles.

A.4 Render inner gallery (night)



High definition render of the inner gallery by night. The view is directed to the outside to illustrate the unique glass front of the Bavariathek.

A.5 Render Bavariathek (day, front view)

High definition render of the Bavariathek in bright daylight.