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**Figure 1**: The four rooms of the exhibition.

# Blended Museum: The Interactive Exhibition "Rebuild Palmyra?"

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## Abstract
"Rebuild Palmyra?" is a multimedia exhibition about the ancient city of Palmyra, its destruction by Daesh, and the question of whether it should be rebuilt. As such, it tackles today's pressing question of how humanity should deal with the destruction of cultural heritage. In the design of the exhibition, we pursued the Blended Museum approach, in which we strive to seamlessly integrate interactive media into exhibition design to increase the overall visitor experience. In this work, we present the exhibition, which consists of four rooms. We focus on three interactive installations in which the topic of reconstructing Palmyra is mediated using new technologies such as 3D Printing, Augmented Reality, and Virtual Reality. The installations helped visitors in developing their own point of view on the question of rebuilding Palmyra. Lastly, we provide insights into the technical implementation of the installations and discuss the results of quantitative and qualitative evaluations.



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## CCS Concepts
• Applied computing~Media arts

## Author Keywords
Blended Museum; Exhibition; Cultural Heritage; Virtual Reality; Augmented Reality; 3D Printing; Tabletop; Scenography

## Introduction – About the exhibition
The exhibition „Rebuild Palmyra?" was designed by an interdisciplinary team of Architecture, Communication Design, Computer Science, and History students of the University of Konstanz and HTWG Konstanz. The goal of the exhibition is to enable visitors to understand the historical significance of Palmyra and the current discussions about the protection of World Cultural Heritage. Therefore, they are confronted with the impact of its destruction and different points of view on rebuilding it. At the end of the exhibition, the visitors

## The exhibition rooms

**Room 1 (Palmyra in the Media)**: Numerous national and international newspapers are showing visitors the importance of the exhibition.

**Room 2 (The history of Palmyra):** Palmyra's historical significance is highlighted on various interactive installations.

**Room 3 (The destruction of Palmyra):** Through the use of AR and VR installations, visitors experience how the city was destroyed by Daesh.

**Room 4 (Rebuild Palmyra?):** Visitors are confronted with different perspectives about the destruction and various possibilities of rebuilding Palmyra in different states. At the end, they have to decide themselves whether they would rebuild the city or not.

have to decide whether and for what reasons the city, which has become a symbol of the thread to World Cultural Heritage, should be rebuilt. Thus, a key artistic question in the design of the exhibition was:

*How can we support the visitors' decision-making process through the use of interactive media?*

The exhibition[1], which was displayed from 30.06.17 to 17.09.17 in the BildungsTURM Konstanz and from 20.12.17 to 29.04.18 in the Braunschweigisches Landesmuseum, is divided into four consecutive rooms, each with a different topic. In the first room of the exhibition (see Figure 1.1), numerous national and international newspaper articles from recent years are hanging from the ceiling, emphasizing the topicality of the exhibition. Palmyra's ancient history is the topic of the second room. Here, a wall-spanning timeline and several interactive exhibits such as a tabletop or a map showing ancient trade routes highlight important historical events and developments in the city (see Figure 1.2). In the third room, the focus is shifted to the current destruction of this World Cultural Heritage Site (see Figure 1.3). A satellite image of today's Palmyra stretches over the entire floor of the room. 3D prints of the destroyed buildings are placed at their corresponding geographical positions. The visitors can use Augmented Reality (AR) Tablets to augment various historical states of the buildings on top of the 3D prints to see how they have changed over time. Additionally, Virtual Reality (VR) Headsets enable a virtual tour through the ruins of Palmyra before their destruction by Daesh. In the fourth room, visitors are guided along a *Decision-Path* printed on the floor (see Figure 1.4), where they are repeatedly confronted with statements that argue in favor of or speak out against reconstruction and which ask them to answer the question "Rebuild Palmyra?" for themselves.

[1] http://rebuild-palmyra.de

## The Blended Museum approach

Mark Weiser's famous vision of ubiquitous computing describes technology that seamlessly blends into everyday life [9]. Today, this vision has partly become reality in many different contexts, including contemporary exhibitions. Here, artifacts are no longer solely presented in a clean exhibition room but are embedded in a comprehensive design with the goal of creating a thematically coherent spatial narrative for the visitors [5]. This approach, called scenography, includes the targeted staging of the exhibition space using curatorial, architectural and design methods among others. Moreover, interactive media is used as a way to expand traditional knowledge transfer methods and to make exhibitions more interesting to new generations of visitors. Thus, in the context of the research project *Blended Museum* of the HCI Group of the University of Konstanz, we focus on the development of new knowledge transfer methods using interactive media for exhibitions with the main goal of increasing the visitor experience [4]. Thereby, we distinguish between two general use cases for interactive media:

- Interactive media as an exhibit on its own
- Interactive media to enrich the information about another exhibit

We use the term *Blended Museum* to emphasize that interactive media in exhibitions should be used as an extension of current methods of knowledge transfer in exhibitions. We will now describe the two use cases based on examples from the exhibition.


**Figure 2**: The interactive media in room 2 is used as an exhibit on its own.

## Interactive media as an exhibit on its own

The interactive installations in room 2 are a good example of interactive media used as an exhibit on its own (see Figure 2). The interactive tabletop, for example, is used to inform the visitors about the city's development in the times of the antique (see Figure 2c). By moving a slider, visitors can see how the city, which is displayed as outlined, changed over time. On the other side of the tabletop, visitors can switch between the most important buildings of Palmyra, which are then highlighted on the tabletop. A short introductory text explains their significance to the city. As the tabletop can be used by multiple visitors, it also fosters communication among each other, which is an important aspect to enhance the visitor experience [2]. Moreover, all interactive devices – the tabletop, the interactive projection of trade routes (see Figure 2b), as well as the tablets integrated into the timeline (see Figure 2d) – follow the overall aesthetic and are indistinguishable from the more traditional elements of the room. Therefore, the interactive devices *blend* with the overall design and architecture of the room.

## Interactive media to enrich other exhibits

Interactive media can also be used to enrich the information about other exhibits, thus *blending* analog and digital information. Because of this, we can classify knowledge transfer methods based on their blending of analog and digital information. In room 3 for example, we exhibited the 3D prints as miniature substitutes of the original ruins and used AR and VR to enrich the information about these exhibits (see Figure 4). This is emphasized again in Figure 3, where the installations are classified on a continuum ranging from analog to digital. In the following, we describe the installations and knowledge transfer methods in detail.


**Figure 3**: The exhibits differ in their blending of analog and digital information.

*3D Printing*

By 3D printing digital 3D models, destroyed artifacts or artifacts not accessible to the public can be exhibited in the classical sense. Numerous museums – including the British Museum and museums of the Smithsonian Institution – already make selected exhibits available on their own or on public portals such as Sketchfab[2] or Thingiverse[3]. Additionally, there are approaches to create 3D models of cultural heritage by crowdsourcing and thus to let society actively participate in the archiving of cultural heritage [3]: In the project #NEWPALMYRA contributors can send photographs of the ruins prior to their destruction by Daesh that serve as basis for the digital modeling of Palmyra or help directly with the digital reconstruction of the destroyed sites[4]. The current intermediate results of the models are available online and can be edited freely. The aim of the project is the digital reconstruction of Palmyra by crowdsourcing. In the exhibition, we use self-created models, as well as one model that is provided by the Smithsonian Institution. This bust, shown in Figure 3 on the left, is printed and exhibited piecewise during the course of the exhibition in order to set the focus on the

[2] https://sketchfab.com
[3] https://www.thingiverse.com
[4] https://www.newpalmyra.org


**Figure 4**: The interactive media in room 3 is used to enhance the information about the 3D prints.

reconstruction of cultural heritage and not on the bust itself. The displayed 3D prints (see Figure 4a) of the ruins in the exhibition are reconstructions made by architecture students (see section Technical Implementation).

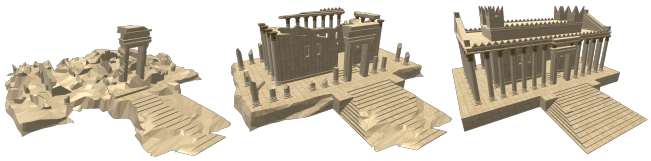

**Figure 5**: Three reconstructions of the Temple of Bel. From left to right: After Destruction; Before Destruction; Antique.

*Augmented Reality Tablets*

These 3D prints are placed at their respective geographical position on the floor map in room 2. Visitors can use AR Tablets, that are freely available in the room, to augment the 3D printed ruins with their states at different points in time. The tablets function as "digital glasses" and merely show their own camera image. If the visitors hold their tablet over a ruin, its virtual equivalent is placed over the 3D print visible in the camera image (see Figure 4b). This is achieved by using markers on which the 3D prints are glued on to. By tapping on arrows on the screen, the buildings can be viewed at the times of antiquity, before the destruction by the Daesh, and in their current state (see Figure 5). A zoom button enlarges the buildings and allows for a closer investigation. We divide the available information on the application into two layers: The most important information is displayed on the main layer as described above. The second layer for more in-depth information is available in the zoom mode. Here, visitors can view additional details on the history and architecture of the buildings (see Figure 4c) by selecting orange *highlight points* displayed on top of the virtual models. Since only the markers are needed to display the virtual buildings in the camera image, we also published the App both for iOS and Android devices[5]. The required markers are available online[5] and also printed as a booklet that is available in the exhibition, which allows for a usage of the app at home.

**Figure 6**: A visitor moves from one scene to the next by selecting a virtual signpost (orange arrow in the left image).

*Virtual Reality Binoculars*

A more realistic look at the buildings of Palmyra before their destruction by Daesh is made possible by the use of VR Headsets, that are suspended from the ceiling (see Figure 4d). For this purpose, we use 360° photographs of Palmyra before its destruction, which are linked together in a fixed geographical sequence. The visitors can explore these photographs by rotating the headsets freely in space. To allow the visitors to move from one photograph to the next, we place virtual signposts in each scene (see Figure 6). These signposts can be selected by pressing a button on top of the binoculars. With this, it is possible to create the impression for the visitors that they are moving through the ruins of Palmyra. As with the AR Tablets, visitors can select highlight points to gather additional information about buildings in the scene (see orange points in Figure 6).

[5] http://www.rebuild-palmyra.de/#app

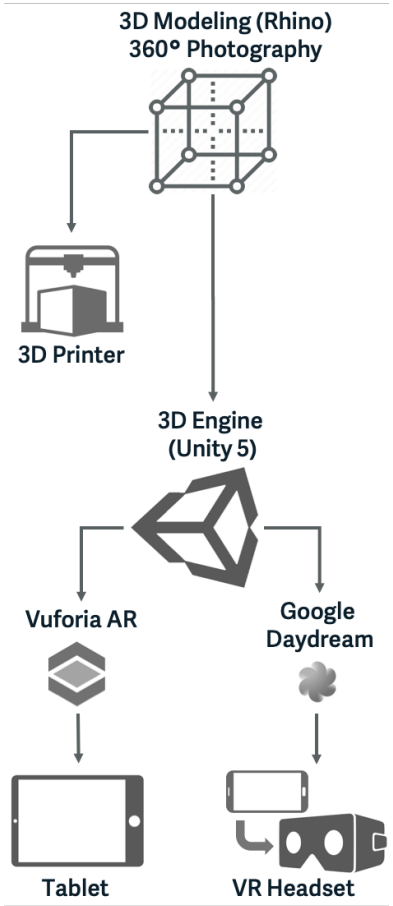


**Figure 7**: Schematic representation of the production process of the exhibits.

## Technical Implementation

As described in the previous section, we used various technologies and devices to reconstruct cultural heritage (see Figure 7). Firstly, we used 3D Modeling and Printing to exhibit reconstructions of artifacts and buildings from Palmyra. The 3D models needed for the print can be produced either by reconstructing or by digitizing the original object. To digitize an object, various techniques can be used, such as Photogrammetry [7]. The 3D printed ruins of the buildings of Palmyra and their virtual counterparts in the AR app were reconstructed during a student course in which architecture students learned how to use 3D modeling software for their work. The students analyzed photos and floor plans of the sites and buildings and cooperated closely with two archaeologists to reconstruct them as precisely as possible given the limited sources and timeframe. For the implementation of the AR and VR applications, we used Unity, which is also increasingly being used in the area of cultural heritage [1,8]. A major advantage of Unity is its platform independence. Content produced for a specific device can often be made available on other devices. The source code for the AR app, for example, had to be changed only slightly in order to publish the app for both iOS and Android devices. Furthermore, the development of the 3D environment and the code are separate from each other, allowing a division of work between designers and programmers. At the same time, this facilitates cooperation between the various disciplines in the design process. For example, curators can check initial drafts by designers early on and correct any errors in the content. We used the AR platform Vuforia to convert parts of the texture of the floor-spanning map into virtual markers that served as recognition points for the AR app. Since any texture with sufficiently recognizable features can be used, this is a very promising technique to be used in further exhibitions. For the VR binoculars, we used Google's Daydream VR headset and controller. Since the controller and headset are normally separated and to let the headsets more closely resemble binoculars, we designed and 3D printed our own case, in which we placed the controller on top of the headset.

## Evaluation

The exhibition was very well received by visitors and critics. It won the Adobe Government Creativity Award[6] in the category Interactive Design and a Silver Nail by the Art Directors Club Germany[7]. The monthly number of visitors was doubled in comparison to the average of other exhibitions at the BildungsTURM Konstanz. In the physical guest book of the exhibition, the elaborate design of the exhibition, as well as the interactive installations, were particularly emphasized by the visitors. Since AR and VR are both relatively new technologies in the context of exhibitions, we evaluated the AR and VR installations using the UEQ Questionnaire [6]. The results are scores for the categories Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty ranging from -3 (lowest) to 3 (highest). Both installations received positive results in all categories (see Figure 8). While the result of dependability is still positive, it is rather low compared to the other categories. This seems to be reflected in our observations of the visitors' interaction as well. Visitors often only used the first information layer of the installations and did not or only partially access the second information layer.

[6] https://adobecreativityawards.com/
[7] http://gewinner.adc.de/

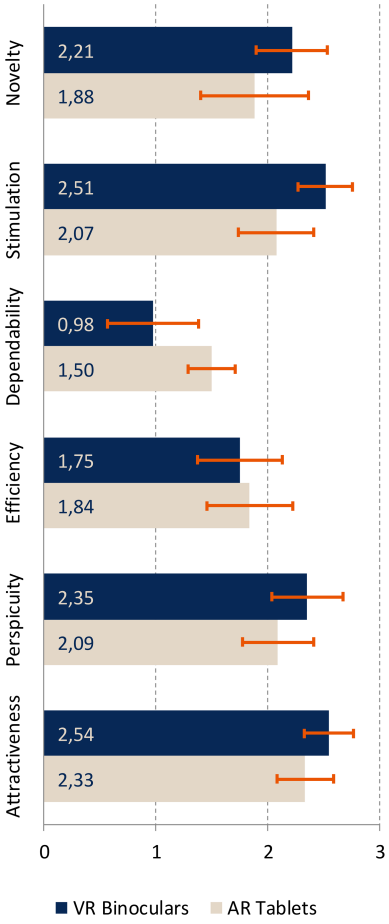


**Figure 8**: Results of the UEQ.
AR Tablets: n = 17;
VR Binoculars: n = 20.
Semantic Differential: [-3,3]

## Discussion

In the previous sections, we described several use cases for interactive media in exhibitions and how we classify these usages in our *Blended Museum* approach. The feedback from visitors confirmed our approach of embedding interactive media more strongly in the scenography of the exhibition (e.g. the installations in room 2). However, for mobile applications, such as the VR and AR applications shown in room 3, this is more difficult, since the devices cannot or only partially be hidden in the architecture. Nevertheless, we consider these applications to be a promising addition to existing methods of knowledge transfer for various reasons. They can be made available to visitors outside the exhibition thus allowing visitors to access parts of the exhibition from their home. In the context of the reconstruction of cultural heritage, VR and AR are especially useful, since they enable visitors to virtually explore destroyed or otherwise inaccessible locations and artifacts in an immersive way. Moreover, the use of these technologies makes it possible to provide different information levels for a typically heterogeneous group of visitors. However, our evaluation showed that these information levels were used to different extents. It is both possible, that the users overlooked the function to reveal more in-depth information, or that the information presented on the first level (e.g. the comparison of the buildings' states) was sufficient for the majority of the visitors. In order to obtain a more holistic view on the use of the applications by the visitors and the interaction patterns of the visitors, the mobile devices' various sensors could be used. Because of this, we will focus more strongly on the logging and analysis of the available data in future exhibitions.

## Conclusion

As museums are closely linked to society and its development, it is essential to create new, contemporary methods of knowledge transfer to open museums to new generations of visitors. We believe that this can only be achieved by following a holistic approach in which interactive media is closely embedded in the scenography of an exhibition. To achieve this, exhibitions must be designed by interdisciplinary teams, including architects, communication designers, curators, and interaction designers among others. The exhibition "Rebuild Palmyra?" is a good example of how this interdisciplinary work can create new ways of knowledge transfer using interactive media. We especially highlighted the technologies 3D Printing, AR and VR as suitable technologies for knowledge transfer in the context of the reconstruction of cultural heritage. For this reason, we described three exhibits in which these technologies were used, focusing on their content, their design, and their implementation. We have also shown how interdisciplinary teams could work together through the use of these tools. The evaluation of the AR and VR installations showed that these technologies can expand the current methods of knowledge transfer in museums and can thus contribute to increasing the visitor experience for a heterogeneous group of visitors.

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