Interactive Projection Mapping in Heritage

The Anglo Case

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Abstract. This work is the outcome of a multidisciplinary collaboration in the context of the VidiaLab (Laboratorio de Visualización Digital Avanzada). It proposes an application of interactive video mapping techniques as a form of experiencing the Fray Bentos industrial landscape, declared as a World Heritage Site by UNESCO in 2015. An immersive environment was created by enriching a physical scale model of the site with projected digital images and information, providing new and attractive ways of interaction with the cultural heritage. Proposals for future work and educational applications of the developed tools are also discussed.

Keywords: Video Mapping, New Media Art, Heritage, Museum, Human-Computer Interaction

1 Introduction

This papers presents work as part of the research project "The smart city; A Digital Palimpsest" which is currently being developed by VidiaLab, which is part of the Design Applied Information Technologies Department of the Universidad de la República. This project has as its central theme the recent designation of the "Paisaje Industrial Fray Bentos" as a World Heritage Site by UNESCO in 2015. (Delgrosso, 2015).

The Fray Bentos Industrial Landscape is located in the Department of Río Negro (Uruguay) and covers 275 hectares, including the Liebig's-Anglo slaughterhouse, its industrial facilities, the docks on the Uruguay River, areas dedicated to grazing, the residences of chiefs and workers and their places of leisure. Its value lies in that the place allows "(...) to apprehend the whole process of meat production that had world importance" (Damino, 2006) in the XX century.

The three-dimensional digital model referred to in this work was obtained through a mixed technique of scanning and reconstruction using photographs (terrestrial and using drones) with digital modeling from plans and historical documents. This model

was materialized in a scale model 1/400 by processes of digital manufacture and 3D printing in white PVC and paperboard respectively, by the VidiaLab.

This paper presents the work processes adopted to integrate this model into an open *in situ* exhibition environment in an innovative way by incorporating interaction with *video mapping* techniques. By means of an installation placed at the exhibition, the visitors are provided with an attractive access point to explore the landscape and information on the historical heritage of Anglo by using interactive digital multimedia.

Video mapping is considered, in the context of this project, as a form of augmented reality -according to the conceptualization of Azuma (1997) which makes it possible to integrate a digital dimension to the tangible one. Which, as stated by Prendes (2016) allows for a more experimental learning process and facilitates knowledge acquisition. Video mapping as a projected augmented reality can, therefore, have a promising future in education given its potential for the presentation of information in ways that increase the possibilities for conceptual assimilation by facilitating inference processes and contributing to the transformation of the object (scale model) into knowledge in the sense that authors such as Prendes (2016) highlight.

1.1 Video Mapping and Model as a Metaphor for a Digital Palimpsest

The research project "The smart city; a digital palimpsest" proposes the incorporation of digital contents for architectural-urban space in heritage contexts. Within these contents are applications that seek the interaction user-reality by physical-digital information. These devices should provide an intuitive interface while minimizing the complexity of the interaction with the applied technologies.

In the work referenced in this paper the physical reality is the scale model (intervened with video mapping), which becomes the support on top of where different layers of information overlap, giving form to the “digital palimpsest”: a mix of strata containing fragments of texts, images, sounds and other discursive forms from different times, disciplines and perspectives that provides a departure platform for intellectual exploration without having to leave the model / palimpsest / territory. (Corboz, 2004).

1.2 Interaction with Heritage in the Digital Age

Information technologies, as Castells (1996) highlights, constitute not only a new form of production and economy but also intervene in the relationship with the environment through the production of meaning. The mediation that these technologies generate both interrupts and enrich the experimentation of reality.

By their ubiquitous nature, digital communications provide new access paths to the material heritage of a society, fostering its knowledge and appropriation.

Cultural industries, traditionally responsible for safeguarding and disseminating heritage, have opened up new spaces by means of the incorporation of new technologies, generating exchanges with new creative industries and actors in diverse

academic fields. The case analyzed in this work is an example of such productive interaction.

Nowadays, institutions and heritage dissemination strategies demand for novel ways to attract users for who rely on digital technologies in most aspects of their lives; in particular as means to select and access information. This requirement calls for the collaborative contribution of actors with different backgrounds and expertise, as is the case in the present study, where design and digital architecture has a determining role.

Fig. 1. Projection on the model

2 Methodological Procedures

Through the observation and analysis of ethnographic qualitative data, the description and identification of the main methodologies, strategies and relevant elements that are carried out in the planning and implementation of this project are intended. The chosen methodology was considered appropriate for a first exploration.

The project was divided into two layers in order to facilitate observation and description. The first layer refers to the production / management and editing of digital contents to be projected on the physical model. The second layer describes software and hardware used for implementation of the interaction component of the project.

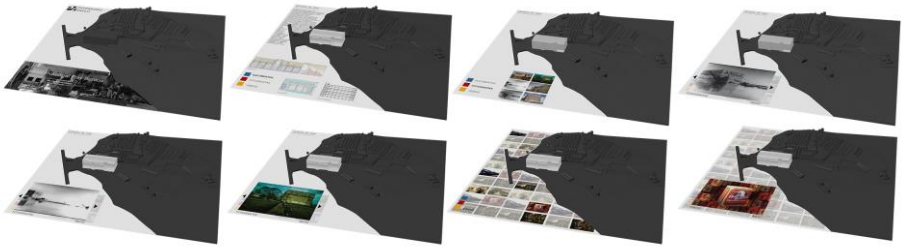

Fig. 2. Information displayed on the model

2.1 Delimiting This Project. Layer 1: Managing Digital Content

For the analysis and development stage of the digital content management component of the project we followed the guidelines of second level interactive digital objects[1] as educational objects[2], and in particular, in relation to their use in the context of managing and accessing architectural heritage information.

A contribution of this project is the exploration of new methods and practices to manage digital educational objects taking into account aspects such as the modularity, interactivity, usability and reusability required for their integration into the proposed interactive components of the project, including the video mappings.

Limitations of this association were also identified. For instance, not all the guidelines had application in this case[3] given that it was not sought to strictly develop an EDO (Educational Digital Object)[4], but to use the criteria of these to improve the proposal.

The adopted strategy for the management of digital content to be used in the projection is based on three elements observed during the process:

- The scale of the model was rather small and made difficult the performance of a strictly visual animation, as well as the display of information directly on its elements. For this reason the informational contents were given more prominence.
- The understanding that a digital content management that integrates an educational perspective will allow the production of structured and organized

[1] According to the norm UNE-EN 71361.

[2] According to the LOM standard of the IEEE *Learning Technology Standards Committee* (2002) in which any entity, digital or not, is used for learning activities.

[3] For example, it does not apply the rule of integrating some form of evaluation or self-evaluation to verify that a specific educational objective was fulfilled in the context of this model, because of its performance character, However, it can be assessed in a high school or school context within the teachers or professors interests.

[4] It is understood that it is not a proper EDO, as it is not momentarily disposed as a hypertext document in html accessible by web. Nevertheless, we are facing an object of learning as it is proposed to teach some themes studied in secondary / primary school on the Anglo heritage.

layers of information that includes the historical and social complexity of object of this installation.

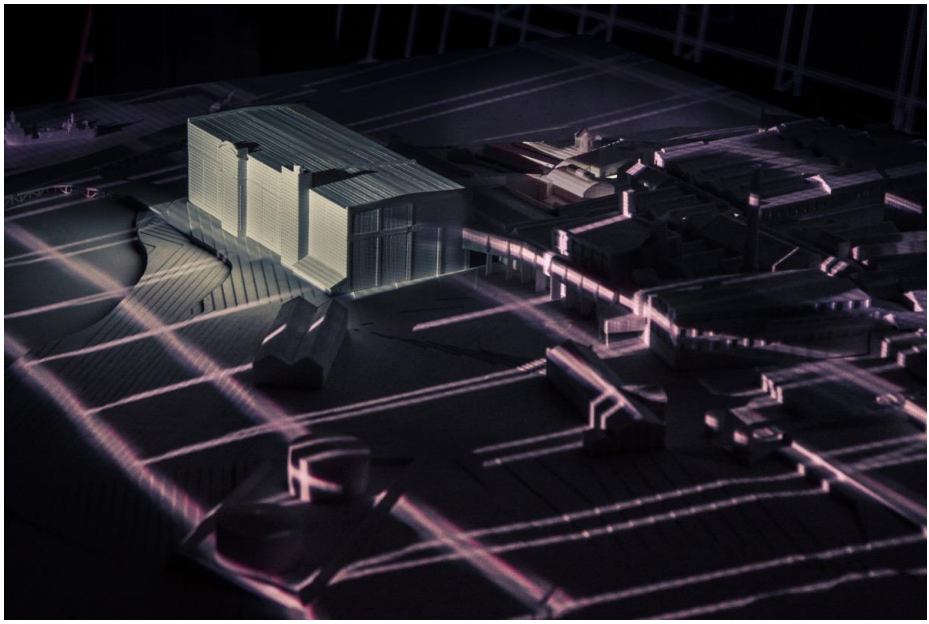

Fig. 3. Projection on the model

Based on these factors, it was proposed to prioritize the digital content on performance, referring the following elements:

- The integration of some of the contents used in the primary and secondary program units that deals with Anglo's complex and its historical context.
- The theme of the complex was approached in relation to the first and second world war, so that interactive menus containing textual information of them, photographic material and audiovisual under public domain license, as well as audiovisual animations and remixes containing images captured by drones, connected with photographic and audio-visual records of both wars.
- Digital objects are grouped together according to a modular structure, allowing their relocation in other modules or content proposals.
- Associativity is present from the use of buildings and structures represented in the scale model as an element of access to themes that are associated with these historical facts.
- Reuse of digital objects handled in the scale model through a digital repository.

Regarding the steps followed in this layer, the upcoming instances can be distinguished:

Documentary research and selection of digitized documents of historical value. Relationship with associated institutions of the context where the installation would be located was fundamental because it contained the memory and associated documentation. Specifically the Museum of Revolution and its archive, as well as those works of compilation and investigation carried out by referents of the theme Anglo complex.

Structuring and production of digital content. At this stage the presentation of information, the main projection script and the digital design are discussed. Strategies (activities in context, presentation of the project in community, etc.) and methodologies (interviews, conversations) were developed to integrate the perspective of the Industrial Revolution Museum, a fundamental actor, as well as other actors of the environment such as teachers and Design professionals linked to Anglo. Scholars were also consulted on the contents and the program that is handled to address the Anglo theme in the classroom.

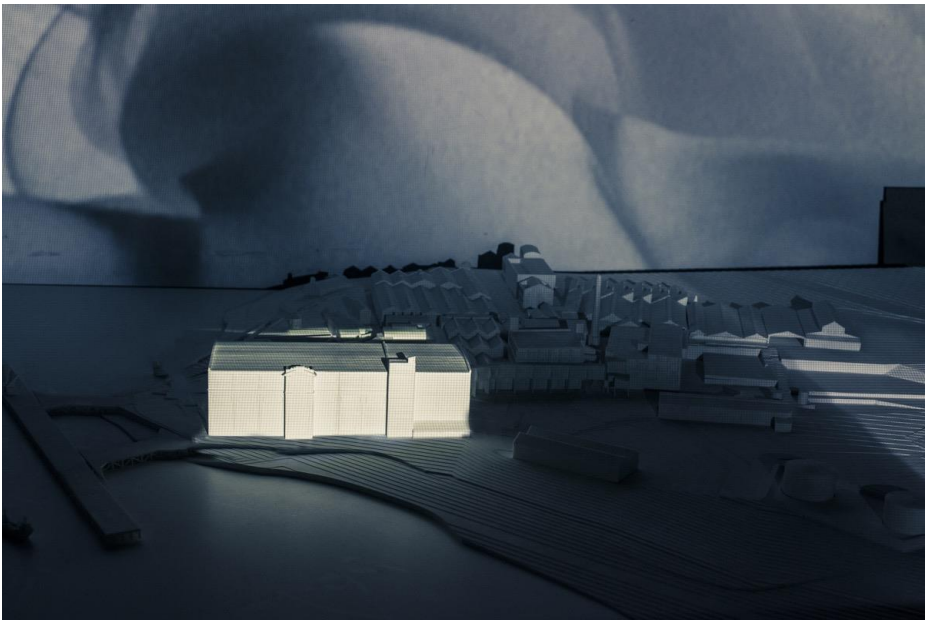

Fig. 4. Projection on the model

As Zapata (2012) highlights, "the production of digital content demands complex production steps, since convergence includes multiple supports and requires an information organization thought about the interaction and usability towards the user."

There are three levels of contents: the first –and most important one- is the one that references and designates the main features of each physical area represented in the model, for which was consulted the School of Architecture's History Institute pre-Inventory, as part of a university extension work.

This level provides information about the characteristics, functions and historical evolution of each area represented in the scale model from which are grouped photographs, videos and related animations. In summary, the digital model was intervened generating layers with information associated with each part of the model. For the development of a second level of structured content, the contribution of the museum's guides as well as teachers of secondary education was fundamental. This level was developed as a pilot on a thematic axis in which to deepen, on one hand the touristic route (that covers almost all the production process that was developed in the Anglo complex) and on the other hand the topic of the first and second war to contextualize the heritage involved.

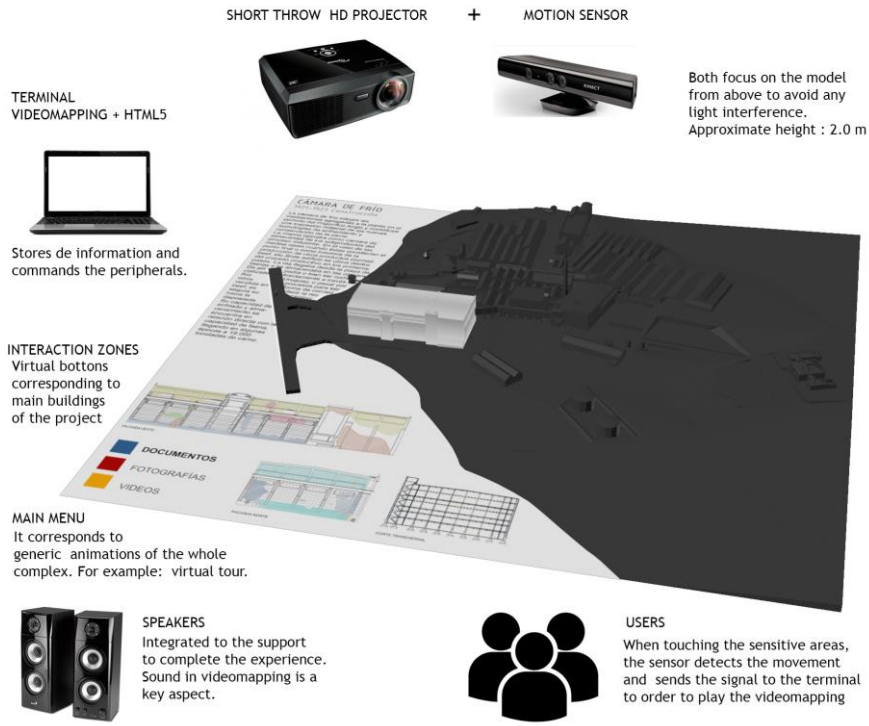

Fig. 5. Work scheme. Devices

In the third level of content the interaction is left aside and the contents are structured in order to create an automatic video mapping (in loop). From a script that emulates the typical site tour, it was gathered documentary and current photographs, historical audiovisuals and current aerial views in video editing software combined with the video mapping software. This part allows the installation to be configured as a passive show, but preserving a visual and sound impact force as a real time video mapping.

Table 1. Scheme of processes and workflows

PROCESSES	SOFTWARE	HARDWARE	DESCRIPTION	RESULTS
Obtaining the digital model of the site.	Autodesk 360 3ds max	Gopro 4 camera Drone Dji Phantom 4 Reflex Photo Camera	It was obtained through aerial photography with drones and ground level photography. These photographs were loaded on Autodesk 360 platform to get the first approximation of the digital model. Then we loaded it on 3ds max to make it accurate.	Digital model of the site with digital fabrication technologies and 3D printing.
Production and edition of contents. Model manipulation	3Ds MAX Adobe Premiere Pro Adobe After Effects Adobe Photoshop			Video clips and sound. Digital remix. Visual representation based on informational layers. Projection mapping setting up.
Projection mapping installation. Image display and sound testing.	Resolume Arena	Projectors of 3000 lum Multi-screen graphics card - Matrox	Model projection testing. Adjustments and calibration of projectors.	Projection mapping installation.
Interaction testing	Ubi software	Kinect - sensor Projector	Combination of a motion sensor (Kinect camera) and software that makes any surface interactive by creating nodes of recognition. We load the information previously produced on the software.	Interactive projection mapping setting up.

Reuse and dissemination of digital contents used in the projection on the model. For this purpose, the implementation and development of a digital repository using the Omeka digital object management software were done simultaneously. Omeka uses the OAI-PMH protocol (protocol for content transmission open access), which allows metadata to be harvested by other services generating greater international visibility, allowing interoperability, information exchange and integration to the networks of national cultural information and international sources. Through a wide variety of plugins available for this software it is possible to provide access to the

contents used and produced for the model for later reuse by any interested party. It also provides concrete tools to generate digital exhibits with the curated content facilitating its integration in the development of learning objects in educational settings.

Fig. 4. Model interaction through hands

2.2 Delimiting This Project. Layer 2: Hardware and Software Required

In this layer there are two fairly defined methodological divisions. On one hand, the design and implementation of video mapping in the model, and on the other one, the possibilities of interaction by users with it.

The first step in integrating the digital content referred to in the previous section into the scaled model was the digital three-dimensional model. Starting from here, video clips are generated when editing it in 3D design software such as 3ds max. In this software the development of complexity animations of the digital three-dimensional model takes place, which are subsequently rendered from a point of view coincident with the location of the projector in relation to the actual physical model. In this way the visual deformations are absorbed so that the projection can perfectly match the volumetry of the scale model. In the case studied, having two projectors, two video renderings must be made, each corresponding to each projector. At the time of testing the same model, perfect fusion or blending of both animations must be achieved with a multi-output graphics card (Matrox) and the projection software that

results in definitive calibration. With the calibration the connection line is adjusted as well as the colorimetry or color temperature of the projectors so that they coincide.

In parallel, images and videos that compile the contents selected from the previous stage are generated and edited. In this instance, raster editing software such as Photoshop is used as well as video editing software such as Adobe Premiere Pro and After Effects to treat audio-visuals also produced in the content production and editing stage. In the case of these animations, projection software to deal with visual deformations becomes more prominent.

In the actual installation two projectors of 3000 lumens each are used, being realized in the interior of a building, and allowing a control of light and darkness without demanding too much luminosity of the projector.

Both projects are connected through the Matrox device, and related hardware and software. A graphics card for multiple screens or graphic expansion modules allows managing and connecting more than one projector to the same projection control terminal to cover the surface with sufficient light intensity. The projectors are placed at a distance of 3 meters horizontally and at a height of 2 meters, arranged so as to generate a projection on the model and another on the back wall. It should be noted that in order to position the different pieces, it was necessary to design the corresponding supports to cover the surface / volume of the model. Along with these devices, the sound is integrated through the use of speakers to cover the entire area of the room where the installation will be arranged.

In terms of interaction, a systems engineer was incorporated to the team because of the inherent complexity of the project. This work consisted in the combination of several factors: on the one hand a motion sensor (Kinect camera) with a projector, and on the other one the projection software with the interaction software that determined the degree of interactivity with the users. This interaction was organized in a series of layers of visual, sound and textual content that are arranged according to the movements of the people detected by the sensor.

3 Results

It can be observed directly and indirectly throughout the project that this exploration (video mapping or projection mapping), if realized with some concepts in mind, allows to generate learning objects effectively adapted both for educational and dissemination purposes. While this implies some complexity in its realization, the results obtained so far validate this possibility.

Regarding the layer of hardware and software involved in the project, we highlight the importance of the integration and conjugation of design and editing software, which constituted the greatest degree of difficulty when implementing the project. In this sense, the observations made by some authors such as Manovich (2001) on this quality of hybridization that characterizes these new practices come to light.

On the other hand, a lesson learned is that the scale of the model was determinant in the execution of the project and has to be taken into account in the planning stage, as it poses limitations to the development of richer and more detailed animations as

well as to information conveyed by the models itself, such as textures at a level of detail that can be appreciated directly by the museum's visitors.

The project is currently in its final phase. It was already deployed *in situ* and open to visitors. However, not many definitive conclusions can be assumed yet. Visitors are responding in a positive way, taking advantage of interaction capabilities and getting involved with all contents provided regarding Heritage. Also, several surveys are being made among them with the purpose of evaluate the project. After this survey process ends, relevant data will be collected and some important conclusions could be taken regarding the level of integration, utility and general acceptation for the whole object. This final phase will determinate the future of this installation, in reference to adaptation, focus and upcoming growing.

4 Discussion

The opportunities offered by digitalization technologies, advanced visualization and new associated trends in digital and material world interaction can be striking, attractive and motivating; but it is also important that they generate significance and significant processes. This means: processes of learning and development of knowledge. In the case study, it is hoped that the citizens acquire a leading role through knowledge about the Anglo heritage complex and its historical relevance in the national and international context. Also, it represents a relevant opportunity for our Lab and our School of Architecture to get involved with Heritage and to include the society in our research, which is an essential part of the University purposes.

This case study is both an example and a catalyst for actions for the implementation of theoretical-practical conversational spaces that integrate digital design, architecture, education, engineering and other fields of study.

It is considered of great relevance to make the observations and lessons acquired by this type of projects available to different actors both in academia and in the society at large, in order to contribute to trigger a debate on the issues involved in the access to information on heritage goods. We aim at fostering, in this way the empowerment of citizens by having access to knowledge that conveys meaning and relevance to our heritage and its preservation as an essential component of culture.

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