Manufacturing worlds. Towards a Metaverse of Uruguayan Heritage.

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Abstract. This project seeks to digitally recover, restore and preserve the architectural heritage of Uruguay through 3D scanning, with the aim of creating an interactive Metaverse that represents this heritage. To do this, virtual reality, augmented reality and mixed reality (VR/AR/MR) technologies will be used as key tools. The spectrum of relevant buildings is wide, considering works of architecture with structural, formal and testimonial value. The digitization of these works presents diverse challenges, from urban to rural settings. It seeks to establish a consistent methodology using data capture and processing tools, as well as open standards for the exchange of information. In addition, the importance of involving the community in the study and use of the selected architectural heritage is emphasized.

Keywords: Digital heritage, Metaverse, 3D Scanning, Virtual Reality, Interaction.

1 Introduction

This article presents the advancements of an ongoing project, scheduled to last three years. The proposed project aims at the recovery, restoration, and digital conservation of Uruguayan architectural heritage using 3D scanning technologies. The goal is to construct an interactive heritage Metaverse allowing the study of ten heritage sites of high interest, in accordance with the criteria established by the National Heritage Law.

The ten analyzed works represent different historical periods, from the 18th century and colonial architecture, through the 19th century with eclectic styles, to the 20th century with examples of modern architecture. These locations are distributed in six departments of the country and cover a wide range of architectural programs, from industrial buildings to religious spaces, some designed by recognized architects and others of unknown authorship. Some of these buildings have been restored and reused, while others are in ruins or have been subject to incomplete interventions. In this progress report, results

from two of the ten case studies will be presented: the Calera de las Huérfanas, and the Susana Soca Chapel.

In the 21st century, the valuation and enhancement of built heritage have been driven by the theories of scientific restoration. Precise and detailed documentation of heritage goods is fundamental for developing new intervention methods that consider the building as a palimpsest. Throughout the 20th century, significant intellectual contributions have been made in the field of heritage documentation, evolving from 17th-century theories to contributions from architects like William Morris, John Ruskin, or Eugène Viollet-le-Duc.

Currently, in the context of the fourth industrial revolution, there is a need to use advanced digital documentation and virtual reality, augmented reality, and mixed reality (VR/AR/MR) technologies as tools for understanding and building a national heritage Metaverse. These technologies will allow an interactive and experimental experience of architectural heritage, providing new forms of registration and intervention possibilities. Precise and detailed documentation, along with emerging technologies, will enable the development of new forms of understanding and preservation of heritage in the digital age.

2 Methodology

This study was structured in six phases, from preliminary planning to final implementation and dissemination. Each phase consisted of a series of detailed and strategic steps, designed to ensure an efficient and effective workflow..

2.1 Phase 1: preliminaries

As a first step, a general action plan was defined, which included the order of data capture, coordination with the authorities and owners of the selected locations to be digitized, and the request for flight permits from DINACIA. Specific work strategies were designed for each building. During this phase, work also began on this paper, so as to present the work at a relevant conference.

2.2 Phase 2: Data capture

Data capture follows the plan outlined in Phase 1. For each location, digitization is proposed using a Trimble X7 3D laser scanner to capture point clouds of the interior and exterior of the buildings. This digitization is complemented with aerial photogrammetry using Mavic 2 Pro and Mavic 3

drones for exterior captures. LiDAR cameras were also used to make photographic adjustments.

2.3 Phase 3: Data processing

After data capture, the processing begins, which takes place in the laboratory. This process involves optimizing images and the point cloud using specialized software. In this case, Metashape Pro. The raw model is refined, and the final global model is generated. Exporting the complete model to various formats is suitable for use for different purposes, from integration into the Metaverse to web browsing.

2.4 Metaverse settings

The obtained models will be prepared for integration into the Metaverse using development tools such as UNITY or UNREAL. The scope of interactivity, access to information, and avatar integration will be defined.

2.5 Metaverse and virtual reality

In this phase, Head-mounted Display type visualization devices will be optimized.

2.6 Phase 6: Project Launch and Dissemination

Finally, an open-source web platform containing all the information produced in the project will be launched, from the navigable Metaverse to the models for download. Dissemination will be broad within the national university scope, and the final result will also be delivered to the Ceibal Plan and other educational platforms. The project results were presented at relevant conferences, and the generated material will be handed over to the Documentation Center of the Institute of History of the School of Architecture, Design and Urbanism FADU/UDELAR. Additionally, a compilation volume of the process will be edited and published in digital format, which will be timely submitted to the CSIC Support for Publications call to obtain a physical format.

3 Partial and expected results

This project seeks to provide a response, through the creation of a digital backup, to the potential destruction, modification, or loss of national architectural heritage at a physical level. The current state of progress refers, as stated in the previous section, to the study of two of the ten planned interventions: the Calera de las Huérfanas, and the Susana Soca Chapel.

3.1 Case Study 1: La Calera de las Huérfanas

It involves a basilica without a roof and an altarpiece as a vestige of the complex that was once the Estancia del Río de las Vacas, an agricultural establishment of the Jesuits. These missionaries, before their expulsion by the Spanish crown, had a presence further north of the territory and aimed for productive self-sufficiency, from the land, livestock, and subsoil, involving tens of thousands of indigenous people in their work.

Figure 1. Calera de las Huérfanas. Aerial drone shot.

In this case, the complete digitization of the building was carried out, combining point clouds and aerial photogrammetry. The technology used consisted of a Trimble X7 Scanner, terrestrial photographs with a LiDAR camera, and aerial photographs with a Hasselblad camera from a Mavic 2 Pro. The result, processed with Metashape, erects the first digital model of this building, which was then processed within the Unity environment, to create an internal tour of the model through a first-person avatar, with an HMD device, of the Meta Quest 2 type. The result is satisfactory, awaiting to be tested by users who will validate the experience.

Figure 2. Point cloud of the Calera de las Huérfanas.

Figure 3. Point cloud of the Calera de las Huérfanas.

Year declared as a NHM	**Res Nr. 989/976**
Author	José Schmidt (Presumably)
Location	Buenahora, Departamento de Colonia
Dates:	1745 – 1750

Source: García Amen, F., 2023

3.2 Case Study 2. Susana Soca Chapel

This involves a notable case of modern architecture in Uruguay, executed by a renowned Catalan architect, Antoni Bonet. According to Méndez: 'The small chapel, located 60 km northeast of Montevideo, is the only religious building that the Catalan architect constructed... Economic reasons and others never known determined the halting of the work in 1966; it was not finished and, therefore, was never consecrated.' Although it is a property in a state of partial abandonment, its material situation is apparently recoverable, valuing its structure of triangular patterns in reinforced concrete, as well as the systems of colored glasses that operate as enclosure within said structure.

Figure 4. Soca Chapel. Aerial view.

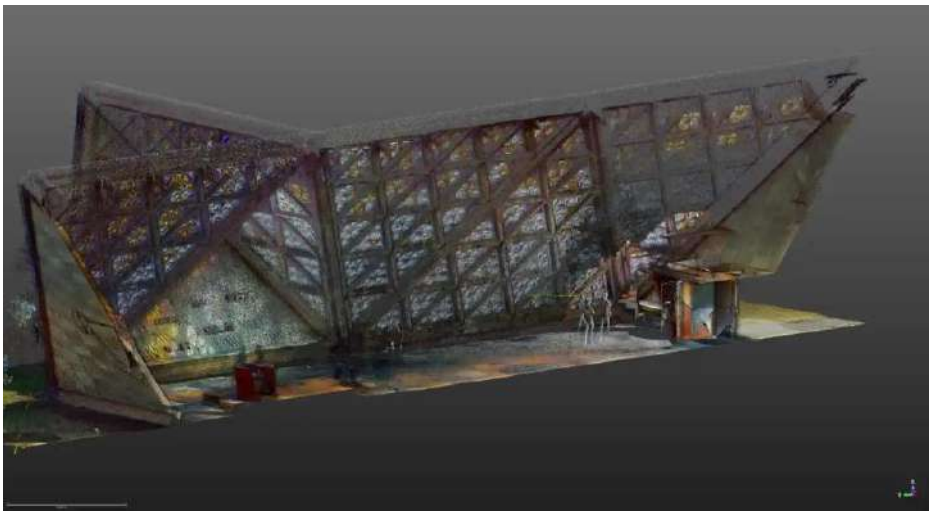

Figure 5. Soca Chapel. Cloud point. Section.

Figure 6. Soca Chapel. Cloud point.

The process carried out at the Susana Soca Chapel was very similar to the one described for the previous case, also encountering the difficulty of morphological complexity. To overcome it, it was necessary to appeal to the complementarity of registration between point cloud scanning and LiDAR cameras from the inside and outside, thus being able to obtain a dataset from which to extract graphic records previously non-existent. The result allows us

to know with high precision the dimensional values of inaccessible sectors, and to work on current and potential pathologies, as a way of risk management and prevention of possible future damages.

Year declared as a NHM	**Res Nr. 725/014**
Author	Antoni Bonet Castellana
Location	Soca, Departamento de Canelones
Dates:	1952-1962 (Project) 1962-1966 (Construction)

Source: García Amen, F., 2023

4 General results

For both cases referred to, criteria had to be established for determining the potentialities of architectures with heritage value before being digitized. Based on this, a particular work plan had to be developed for the global survey of each project.

The systematization of the processing of the information obtained and the construction of these digital models served the team as exploration and experimentation of procedures, where some weak points were detected, which needed to be addressed. Based on this experience, the following cases will be resolved.

The surveyed heritage architectures are integrated with each other through Unity. The web implementation will be available shortly. The overall result is an organized, open, and online database, containing the graphic and technical records of each digitized architecture (3D model, textures, geometries), which can be consulted at any time by the Academy, national and departmental authorities, and society in general.

5 Discussion

The collapse of the dome of Notre Dame in Paris is the inspirational starting point for this project. Following that sad event, it was realized that there were

no precautions, inputs, or digital resources that could be used for its reconstruction, total or partial restoration, or simply formal geometric documentation.

Therefore, the project proposed here seeks to respond to this lack by generating a digital backup to cover the eventual destruction, modification, or loss of national architectural heritage at the physical level. Likewise, it seeks to propose, design, and generate a Metaverse of architectural heritage, to integrate the architectures studied into a current platform, with inter-platform exchange formats, and thus enable their intervention in various fields.

The project gathers several horizons in terms of contribution to the academic environment, and to the environment in general. Firstly, it seeks to contribute to the concrete and accurate material knowledge of a series of heritage pieces. Secondly, it is expected to start building a trade -technologically very specialized- to continue a line of work on heritage surveys through digital scans that in the near future can link the School of Architecture, Design and Urbanism (FADU/UDELAR) with other public or private institutions. Thirdly, it aims to contribute to the dissemination of heritage through new virtual platforms, precisely through the construction of metaverses. Likewise, it aspires to reflection and contribution of new documentary bases for potential future interventions in the selected properties

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