Interactive and Immersive Dynamic Perspectives: A Case Study of Piazza Castello in Turin

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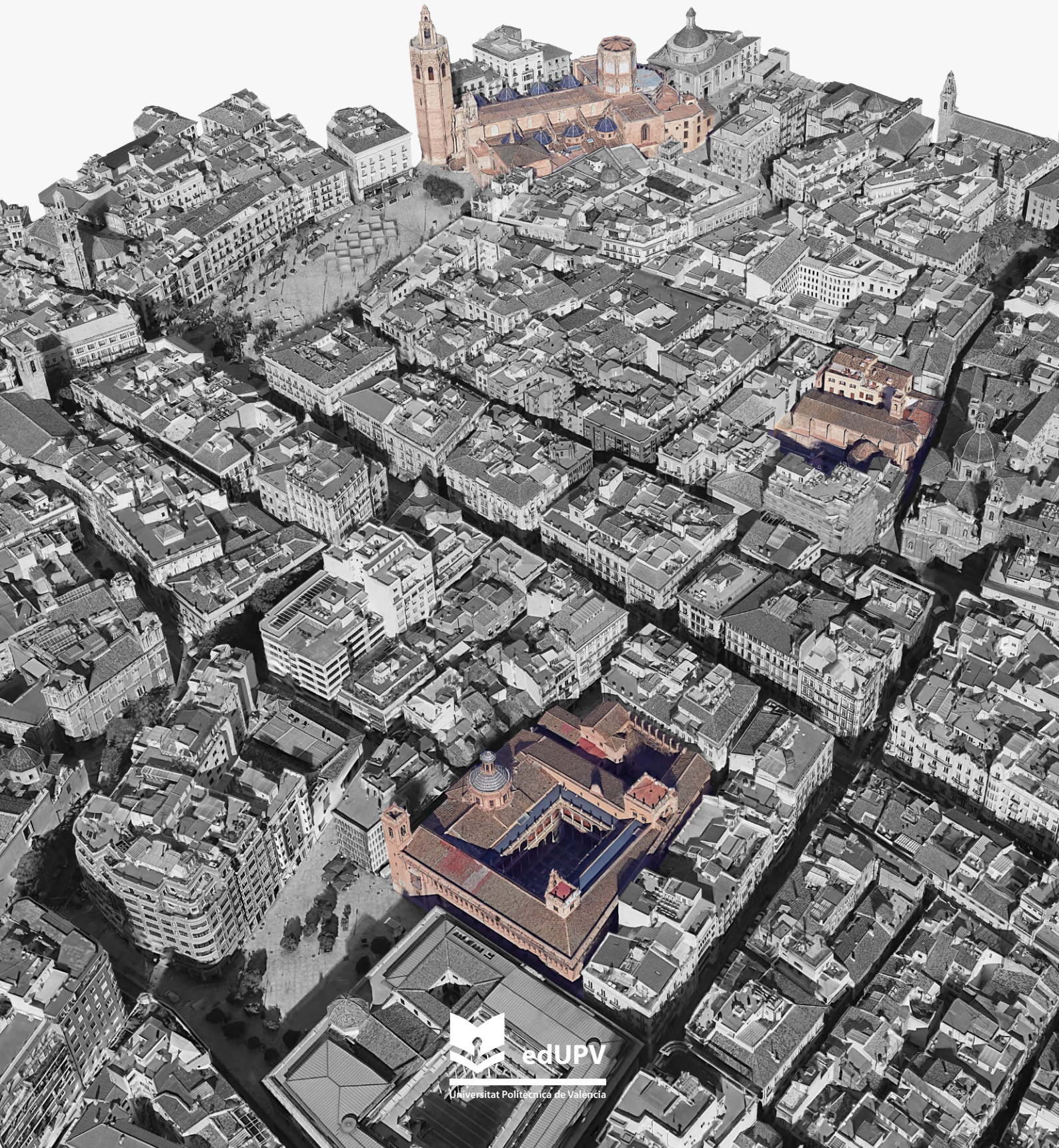

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María José Viñals

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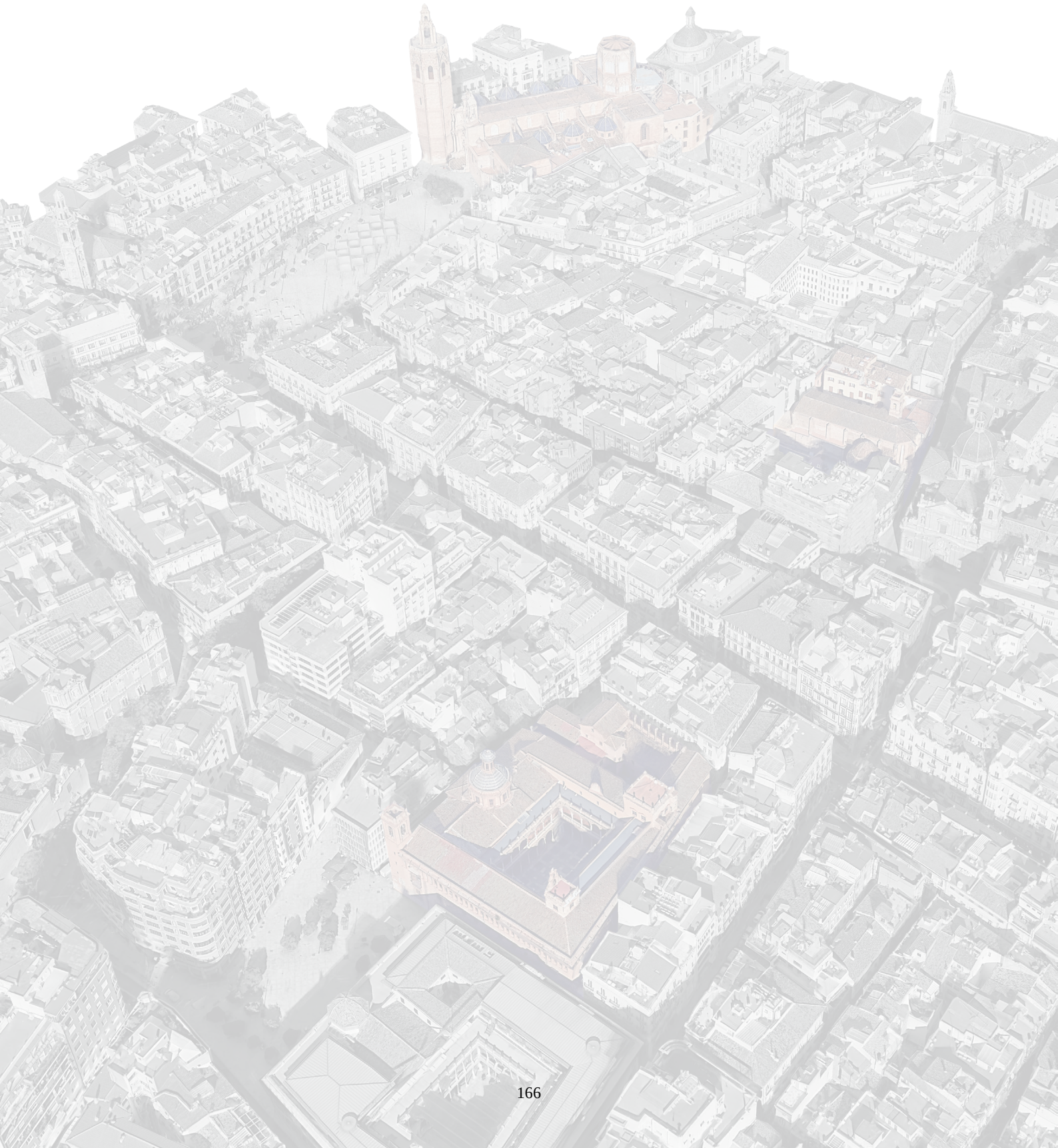

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Interactive and Immersive Dynamic Perspectives: A Case Study of Piazza Castello in Turin

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Abstract

This contribution describes an interesting experience of reconstructive digital modeling related to a project of significant documentary relevance attributed to a young Alessandro Antonelli (1798-1888). During his training period in Rome, the architect proposed an intervention project for Piazza Castello in Turin. The proposal's outcome is contained within six crafted panels accompanied by extensive archival, graphical, and textual material, currently shown at the exhibition "Neoclassicisms in Turin. From the 18th century to the young Antonelli" at the Accademia delle Belle Arti in Turin. The static nature of the original representations can be overcome by defining new digital environments that track Antonelli's proposal and the current configuration of the urban space. The proposed solution enables a virtual tour inside a navigable and immersive space equipped with the architect's original drawings. In the second part of the experience, participants find themselves immersed in the unusual space of Piazza Castello, with the possibility to move within the urban scene, capturing unconventional viewpoints that technical representations in mongian projections cannot convey. The experience also serves as an opportunity to critically reflect on the definitions of interactive and immersive dynamic perspectives, analysing their various components, from presence to immersion to embodiment, about modes of spatial exploration and the combined use of movement and orientation. These elements complement the visual perception of three-dimensional digital environments. These strategic activities shape the definition of the image in virtual reality environments based on three-dimensional models. The objective is twofold: firstly, to enhance the visitor experience at the Accademia by integrating original drawings with new multimedia content to supplement the physical experience; secondly, perhaps even more relevant from a disciplinary point of view, to identify a balance between user action and the adopted narrative model.

Keywords: *reconstructive modeling, VR, navigable environments, Antonelli, digital storytelling.*

1. Introduction

The exhibition "*Neoclassicisms in Turin: From the Eighteenth Century to the Young Antonelli*", held in the rooms of the Pinacoteca Albertina, allowed exploration of some treasures usually kept in the depots of the Accademia Albertina di Belle Arti. Specifically, the focus is on the boards depicting the decoration project of Piazza Castello in Turin, produced by Alessandro Antonelli, at the time an architecture student of the Savoy capital of the early 19th century, after his "*pensionato*" at the Accademia di San Luca in Rome (Accademia Albertina di Belle Arti di Torino, 2022).

After winning the scholarship competition in 1826, the architect, originally from Ghemme, immersed himself in the historical and architectural richness preserved by the Eternal City, finally having the opportunity to observe classical models that were previously studied directly. He consolidated his approach to neoclassical architecture in Rome, fully manifesting it in the architectural proposal he sent to the sovereign in September 1831. The influence derived from the two cities where Antonelli developed his education is indeed of fundamental importance: the studies conducted in Turin and Rome offered the architect a multitude of suggestions, foremost among them are the Pantheon and the Chiesa della Gran Madre di Dio by Ferdinando Bonsignore, his master (Ciattaglia, 2022; Rosso, 1989).

The Piedmontese architect's drawings, preserved in Accademia di Belle Arti depots in Turin, describe the grandeur of the idea he developed. He proposed a revolutionary version of the Turin command centre, justifying the demolition of the medieval castle of Palazzo Madama and the Beaumont gallery; he suggested constructing a new cathedral of monumental dimensions placed in the centre of the square. The latter aims to represent a worthy substitute for the Renaissance-era cathedral, now unsuitable for the role of capital bestowed upon Turin. The ambition was to transform the appearance and presence of the city's heart, reorganising it according to a strict symmetry that can confer the ideal mould sought by the architect. For this reason, the small square in front of the royal palace was duplicated on the opposite side, towards the East, thus replacing the secretariat's wing, which was also demolished with the castle and the gallery. The long portico connected the design system and the uniformity of the facades, punctuated by the spans of the above-ground first-floor arches and by the giant Ionic pilasters that envelop the context of the church, including the sovereign's residence. Indeed, a new facade was applied to the royal palace, hiding the original front behind an imposing colonnade and displacing the royal palace from the role of the main subject of the square. The communicated ambition hidden in the drawings shows how the symbol of power, King Carlo Alberto, steps back to renounce the search for dynastic glory: the heart of the capital becomes the stage of the sacred space at the service of the people.

Six drawing boards recount the magnificent project that describes the cathedral and the context of the square. A three-dimensional model faithful to the drawing project was developed, using these elements and rich in precious details. New technologies related to digital modeling and the creation of immersive virtual environments can be considered exciting resources for enhancing this academic exercise, which, as such, has never been realised. The only drawing board testimony remains difficult to understand when addressed to a broad audience. The urban scene modelled in three dimensions becomes the protagonist in the development of the immersive experience, which allows the end user to perceive the conceived spaces through a new, more personal, and immediate key, exploiting the tools of virtual reality vision.

The exhibition project is an opportunity to investigate the relationship between the museum environment and the new tools for developing communication and user engagement through spatial digital media. The contribution reflects on the use of digital innovations, specifically those related to Virtual Reality (VR), capable of favouring the recontextualisation of the object of knowledge and consequently multiplying the potential of its narrative. According to this thought, E. Bonacini's words in describing museums as "an architecture in continuous evolution, giving rise to a rethinking of collecting and exhibiting significant objects" (Bonacini, 2020) remain current.

To address this reflection, other traditional boundaries of the Drawing discipline must be overcome by incorporating codes previously integrated by other disciplines such as photography, cinema, or video games. This broadening of perspective allows, on the one hand, the identification of a taxonomy referring to this specific

research area; on the other hand, this approach lets the identification of the codes that characterise it: orientation, stereoscopy, interactivity, and sensory involvement (Rossi, 2020).

2. Aims and objective

The contribution critically reflects on the possibilities of using digital technologies to represent, understand, and communicate characteristics and information belonging to a work that is part of the cultural heritage. The identified work is a project that remains unrealised, characterised by rich documentation consisting of wonderful technical representations in orthogonal projections and a fascinating perspective at a human scale that enhances the power of Antonelli's revolutionary proposal. It also includes a technical report that motivates the proposed choices and integrates the graphic elaborations preserved in the archival collection of the Accademia Albertina. The immersive experience aims to relate to the museum environment in the Accademia called "Pinacoteca", reflecting on the significant role these digital tools have assumed within museum spaces, particularly during the pandemic and post-pandemic period. This revolutionises the relationship between the collections on display and the visitor, with evident repercussions on the proposed communication methods and the definition of exhibition paths that involve hybrid forms of interaction between physical objects and multimedia content.

The medium identified within this digital revolution consists of systems capable of positioning and interacting between real and virtual environments. The first theorisation of the hybridisation through these two different worlds and the identification of a specific lexicon capable of representing the variables identified within these two extremes is the Reality-Virtuality Continuum by P. Milgram and F. Kishino (Milgram & Kishino, 1994). As often happens in the academic field, researchers rework and adapt some technologies used in sectors other than those they investigate or specific disciplinary scientific sectors to particular contexts, sometimes very distant from their original purposes. For instance, a couple of years after the taxonomy proposed by Milgram and Kishino, id Software developed and published Wolfenstein 3D, a first-person shooter video game in which the player fights against the Nazi army. Later, it was made available for many other platforms after its initial release for MS-DOS by Apogee Software. This video game constitutes the first example of a navigable three-dimensional scenario where the user/player can move within a three-dimensional model and interact with it, albeit using very different functionalities from those proposed in a museum context. The video game draws inspiration from the older Castle Wolfenstein (1981), which adopted a more traditional top-down view. Another exciting element was the presence of brief sequences of digitised voices, which is rare for a home computer video game of that time. Over the years, first-person video games have experienced exponential development in graphic quality and computing power.

It is precisely from the video game industry sector that some immersive experiences designed for educational purposes draw inspiration: the proposed experience uses the same applications used for the entertainment world, imagining fruition that can employ augmented reality visors to represent with greater effectiveness the evocative power of this unfinished work, offering the public the opportunity to explore and understand it in a new and engaging way while also receiving some notions about the training and professional life of the architect Antonelli through interaction with certain parts of the digital model. Video games, but more broadly the concept of "gamification," allow for an experience defined as "story doing," in which the user takes on the role of an active protagonist in the proposed story, making continuous decisions that can influence the outcomes (Izzo, 2017).

3. Methods and procedure

3.1. Analysing, reading, and digitising sources

Before starting the reconstructive digital modeling activity, it is essential to analyse the drawings meticulously. The architect's legacy comprises six boards dated September 15, 1831, drawn with ink and watercolours by Antonelli himself (excluding the perspective panel engraved by Alessandro Angeli). Since the project included three different versions of the cathedral, two in a Constantinian style and only one referencing " the most famous

cathedrals in Europe," it is necessary to identify which versions have the richest representations to provide helpful information for developing the immersive environment The proposal of the new cathedral, crowned by the central hemispherical dome, which excludes the preservation of the Beaumont gallery and has a more international vision, contains the most details among the received illustrations; therefore, we have identified it as the object of study. Scans are made from the original panels preserved in the Academy di Belle Arti, generating high-resolution image files that, adequately scaled and positioned in the workspace, form the basis for developing the three-dimensional model.

3.2. Reconstructive digital modeling

Digital scans of Antonelli's drawings are imported into the model space of Rhinoceros software and then correctly scaled by converting length measurements from piedmontese trabucchi to meters (1 trabucco = 3.082596 meters[1]). The panels are aligned in three-dimensional space, and the modeling phase can start through a "trace" of the drawings, serving as graphical references for generating surfaces and solid geometries from those drawn on paper (Figure 1). Almost the entire square was recreated following the traces of the illustrations produced by the young Antonelli. However, some small areas of the project inevitably result in less metric reliability, such as the rear part of the cathedral. This part is not visible from the perspective panel, which is the most detailed.

Figure 1. The proposed workflow, from left to right: 3.1: Digitizing sources; 3.2: 3D Modeling; 3.3: Geometry retopology; 3.4: Interoperability between Rhinoceros and Unreal Engine. Source: Vanni, E.

In the experience, the user can compare the two versions of the square: the one imagined by the author and the current one. For the 3D modeling of Palazzo Madama (Viano, 2002) and the remaining architectural structures that characterise Piazza Castello, a similar process was followed. Through the drawings from surveys conducted for the restoration of Palazzo Madama, the model of the medieval castle and the juvarriana staircase were defined. Finally, the square is completed by defining the facades of the entire perimeter. To maximise the potential of the technologies allowing the use of the model in virtual reality, a narrative path is conceived to accompany the visitor throughout the experience. It is articulated in a series of rooms representing a hypothetical depiction of the architect's studio in 1831. Various objects are arranged within this space, referring to topic moments and concepts directly related to the project for the decoration of Piazza Castello. The entire apparatus is realised through digital modeling.

[1] According to the official conversion factor adopted for the Piedmontese trabucco in the province of Mondovì before 1818 (as indicated in the Tables of Equivalence of weights and measures already in use in the various 'province' of the Kingdom with the decimal metric system. Approved by decree on May 20, 1877), (Novello & Piumatti, 2012).

3.3. Geometry retopology

Next, the step involves transforming the modelled geometries, known as “polysurfaces”, into meshes, allowing the multitude of elements to be exported in a .fbx file format for use in subsequent stages of work to complete the development of the immersive application. Another necessary process involves optimising the meshes, which, through transformation, acquire an excessively dense and disorderly polygonal structure, making the digital model excessively heavy and, therefore, difficult to manage. In this case, the “QuadRemesh” command, specific to the Rhinoceros software, was used to reconfigure the geometry structure and simultaneously lighten the mesh by organising its shape using quadrangular faces. This allows the desired level of detail to be maintained while drastically reducing the number of polygons present in the model.

3.4. Importing the model into the graphics engine used to define the immersive environment

In the following stages of developing the immersive experience, the focus shifts to the Unreal Engine graphics engine, where a working project is created from the Games's virtual Reality template.

Then, import the geometries produced in Rhinoceros into the Editor. At this stage, it is essential to highlight the choice to utilise the recent Nanite technology. This algorithm allows the import and display of large 3D models while maintaining high-performance thanks to automatic and real-time management of the Level Of Detail (LOD).

The different modelled parts are imported into the virtual space and arranged neatly. Various materials are assigned to the surfaces of these elements, along with a thoughtful arrangement of light sources, to enhance the realism of the experience and increase visitor engagement.

Once we complete this phase, the environment will be structurally and aesthetically ready, but we will need further modifications to support the user's presence. To facilitate movement within the modelled spaces, we define collision attributes in the imported meshes, rendering the geometries solid and enabling them to behave like physical objects: impassable, providing a surface for visitors to walk on, etc. Specifically, we consider geometries related to floors, walls, handrails, etc., and we exclude meshes that users are unlikely to interact with from this process for optimisation and file lightweight purposes.

Another crucial aspect is the movement system for the user participating in the experience. The Meta Quest 3 headset is the selected hardware for the application and is compatible with the teleportation locomotion system, already present by default in the Games Virtual Reality template. With the joystick on the suitable controller, users can point and choose their movement position, while using the joystick on the left controller allows them to rotate their view by pointing it left or right.

The decision to maintain this movement system is due to its ease of use and minimal risk of inducing motion sickness, even for users who are inexperienced or unaccustomed to virtual reality.
To complete the work, interaction types between the user and the environment in different areas of the experience are defined and implemented through the Blueprint visual programming language native to the Unreal Engine:

- Box collisions trigger animations once a particular area is crossed (for example, when pressing buttons, automatic door opening, or text and pop-ups appear);
- The ability to grab, carry, and release various objects in the environments (to observe details up close and to define small puzzles distributed along the narrative path).

The application is then completed and ready to be exported and used.

4. Results

The immersive experience involved various figures from different scientific-disciplinary sectors: the group coordinated by Prof. Lo Turco (Drawing) together with Dr. Enrico Zanellati (Curator of the Accademia Albertina) and Prof. Elena Gianasso (History of Architecture). This collaboration allowed for the definition of a multidisciplinary and engaging experience capable of addressing highly heterogeneous themes. The initial concept phase was the first step in undertaking an operation of this magnitude, which involved the design of a storyboard for visual aspects and the storytelling to delve into narrative aspects. Both were useful in clearly defining the setting of the proposed virtual experience. We identified two main scenarios, each with different morphology, configuration, and proposed levels of interaction.

4.1. The "studiolo"

The first virtual environment, Antonelli's "studio," serves as a filtering area, a primary mediation zone guiding the visitor through the transition between the real and virtual worlds without straying too far from the former. The proposed digital environment attempts to evoke the physical-real space through simple and familiar forms, hypothetically placing the experience fruition within the rooms of the Museo della Pinacoteca dell'Accademia Albertina. We configure the new virtual space as an additional room to add to the current visitation path established within the museum spaces for the exhibition "*Neoclassicisms in Turin: From the Eighteenth Century to the Young Antonelli*".
The space thus configured is an indoor environment characterized by:

a. A designated area for introducing and demonstrating the fundamental commands required to navigate the immersive environment;
b. An exploratory space resembling the architect's "*studiolo*", where visitors can delve into the cultural interests of the author (Figure 2).

This intimate space contains objects to evoke some of the architect's fundamental life stages, with specific interactions highlighting their importance. These elements facilitate understanding and closeness between contemporary visitors and the past author, achieving an immersive experience capable of transcending spatial and temporal boundaries and focusing the viewer's attention on the multifaceted and complex figure of architect Antonelli. The spatial boundaries are overcome by connecting and overlaying two distant cities, Rome and Turin, which are the main scenarios for the author's education and biography. The temporal boundaries are overcome by placing elements from crucial moments in the architect's life within a single space. This allows for a cohesive narrative that reveals the significant stages to visitors, enabling them to understand Antonelli's personal and professional growth. The central identified life moments include:

- The "*pensionato romano"* corresponds to the subsequent five-year training completed in Rome after obtaining the title of architect and engineer, mainly focusing on the grand civic (Pantheon) and religious (Basilica San Pietro) architectures of the past;
- The apprenticeship was when the young architect acquired his language and characteristics, developing his strong personality;
- The earlier projects for the city of Turin influenced the young Antonelli's proposal for a new Cathedral in Piazza Castello, referencing illustrious figures such as Juvarra, Alfieri, and Canina.

Figure 2. The interior environment is reminiscent of Antonelli's "studiolo" (foreground) and the introductory space to the experience (background). Source: Vanni, E.

The interactive aspect plays a crucial role, engaging two critical figures in the museum ecosystem: the visitor, who explores and acquires new knowledge, and the content, which carries a diversity of hidden meanings waiting to be revealed. This interactive process plays a significant role in the real/physical museum environment, where certain elements may act as barriers or filters to ensure the proper protection and conservation of content. This relationship also gains relevance in the virtual environment, where digital tools allow overcoming physical interferences inherent in the real world, enabling a sophisticated and increasingly intimate connection.

Interaction is realised through touch controllers, allowing interaction with crucial elements and activating puzzles/micro-games. Completing these challenges enables the acquisition of multimedia content to enrich and consolidate the experience and a portion of a plastic model. Assembling this model allows for the visualisation of the entire Cathedral project for Piazza Castello, unlocking and providing access to the subsequent immersive scenario (Figure 3).

Figure 3. The space dedicated to the collection and completion of the model depicting Antonellini's Cathedral project (light) and its location within the city of Turin (dark). Source: Vanni, E.

4.2. The cathedral

The second virtual environment represents Antonelli's project for Piazza Castello, the Cathedral, in its urban dimension and is visitable at a human scale. In contrast to the previous environment, this one visualises an imaginary open space, traces only found in the tables preserved at the Pinacoteca. Repairing the architect's never-realized project on a 1:1 scale allows for discussions and evaluations that are not possible priori through only iconographic sources. Compared to the static nature of the boards, using an environment that enables immersion in a dynamic space allows visitors to capture new perspectives of Antonelli's work and the surrounding urban configuration (Figure 4). The realisation and crystallisation of this project from a specific historical period, translated into a digital environment, also allows for temporal parallels between the imagined configuration by the young architect and the current situation. These historical overlays are visualised through interactions, which occur through specific points within the urban environment. These elements are placed mainly along the city's most critical historical axes or at specific optical cones capable of capturing the essence of the Cathedral project and its relationship with the context. To be explored and experienced fluidly, an environment of this size requires specific navigation aids, such as the teleporter using touch controllers.

Figure 4. The external environment recalls the imaginative design of the Cathedral, which Antonelli designed for the city of Turin. Source: Vanni, E.

Teleporting is one of the possible variations of spatial cognition investigated in gaming concerning the relationship between embodiment and environment (motion perception). Our body needs to be involved through its three physical sensors (visual, vestibular, and proprioceptive systems) to respond naturally to the movement instilled by the digital medium. Teleportation lets visitors move quickly between specific points within a vast virtual space (Figure 5). These points, called Points of Interest (P.O.I.), must be identified in advance, and their representation must follow specific graphical rules, such as shape, colour or size. A specific purpose guides these choices: they must be easily recognisable yet discreet to attract and maintain the visitor's focused attention. This way, the participant in the experience receives guidance and direction to follow a specific visual narrative, as seen in the case of the magnificent, never-realized work of young Antonelli, even though it may seem unconscious. However, there is no pre-established path to complete the itinerary, which remains at the user. The individual might be driven by the Fear Of Missing Out (F.O.M.O.), prompting them to repeat the experience multiple times to ensure they see all its parts. (Rossi, 2020).

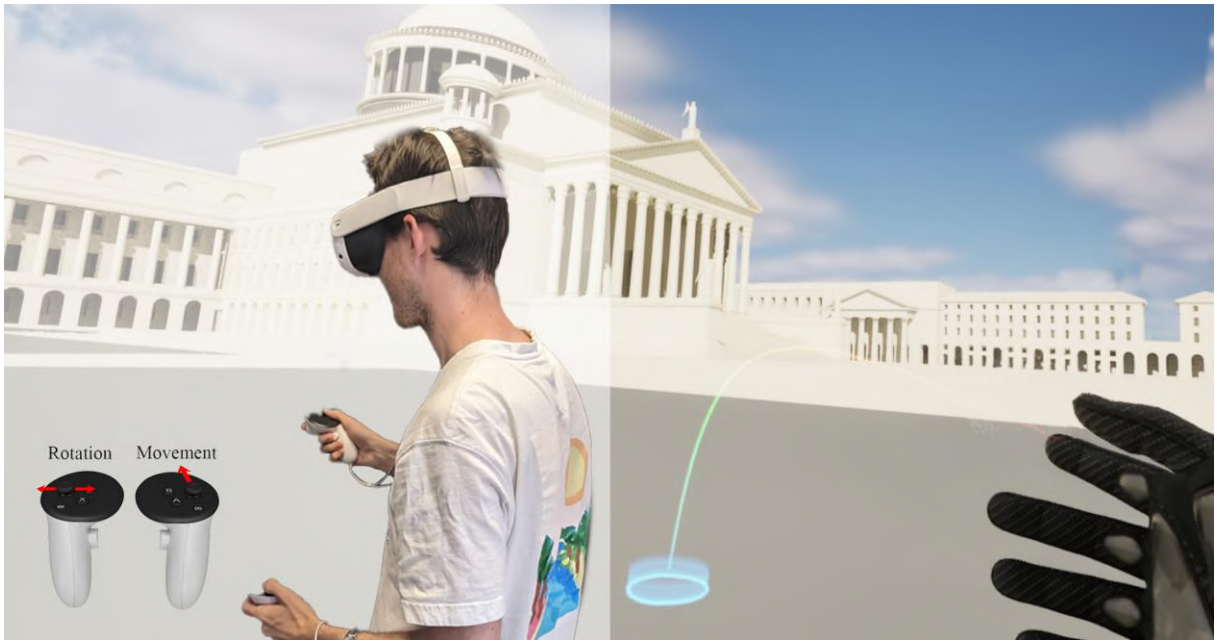

Figure 5. Navigation of the virtual environment using the teleporter with the joystick. Source: Vanni, E.

5. Conclusions

In the 1930s, the Science Museum of London unveiled the "Children's Gallery," an innovative area designed to spark curiosity among youngsters about science: a pioneering example of blending education and entertainment. Sir Henry Lions, the museum's director, prioritised engaging primarily with ordinary visitors rather than exclusively targeting specialists. Fast forward to today, one cannot overlook the experience of the Archaeological Museum of Naples with the video game Father and Son, designed by Fabio Viola (Viola & Cassone, 2017), which has garnered over 4 million downloads worldwide.

The illusory image of a dimension other than the real one has always accompanied creative processes, including those closest to us, such as those used to envision architectures, cities, and worlds projected into an apparent or unattainable ideal future. Contemporary visual culture, fueled by the film and gaming industries, has benefited from new technological opportunities capable of enhancing the perceptual experience of the observer. Since the pandemic, these processes have further strengthened, prompting us to reflect on the use and importance of such devices for scientific, educational, and leisure purposes. Thus, the words of William Gibson (Gibson, 2014) become relevant again when the protagonist of the science fiction book Case navigates data cities and infiltrates archives as if they were fortresses to conquer. In this case, the proposed technology can be applied in speculative or design contexts and extended to educational purposes aimed at less qualified users, supporting practical efforts to valorise existing knowledge through interactive observation, primarily stimulating visual learning (Basso, 2020).

New technologies related to digital modeling and the creation of immersive virtual environments can be valuable resources for enhancing the cultural heritage of architectural projects never realised, of which only paper documentation remains, consisting of a report and some highly detailed technical drawings, many of which are difficult to understand for a broad audience. Essentially, what changes concerns how we perceive things: from a static view, heavily influenced by the canons of perspective representations, we have transitioned to a continuous and changing view, altering cognitive conditions and expanding investigation spaces from a dynamic interactive perspective. Riccardo Migliari, who first coined the term (Migliari, 2008), acknowledged the debt that representation culture owes to the gaming sector, attributing to it the crucial role of remediating the perspective device. The three-dimensional modelled urban scene becomes the protagonist in the development of the immersive

experience, allowing the end-user to perceive the spaces conceived through a new, more personal, and immediate key, leveraging virtual reality viewing tools.

The developed application offers an alternative to traditional modes of experiencing museum exhibits: participants in the immersive experience can visit a series of unexplored and fully explorable locations. Active participation is required inside these locations to interact with the elements present and solve puzzles related to the project's theme and author. This way, curiosity about exploration and discovery drives visitor engagement, allowing them to experience a digital yet immersive journey firsthand. When the dimensions of the virtual environment necessitate bodily movement, the perceptual modes of sight integrate with those inherent to the human body and its neuro-cerebral apparatus. One thing is sure: the plastic intelligence of a three-dimensional space cannot be exhausted in a two-dimensional representation, or the construction of scale models alone (Antinucci, 2004), but digital models can enhance it. Suitably arranged models allow firsthand experience through virtual navigation tools that integrate visual perception stimuli with those induced by our body's movements relative to the environment (Rossi, 2020).

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Although the contribution was conceived jointly, M. Lo Turco is the author of paragraphs “5. Conclusions”; J. Bono of paragraphs “2. Aims and objective” and “4. Results,” and E. Vanni of paragraphs “1. Introduction” and “3. Method and/or procedure.”

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