A METHODOLOGICAL APPROACH FOR AN AUGMENTED HBIM EXPERIENCE THE ARCHITECTURAL THRESHOLDS OF THE MOSTRA D'OLTREMARE

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ABSTRACT:

Digital survey and parametric-semantic modeling of historical or conventional building artifacts are becoming progressively more oriented toward HBIM (Heritage Building Information Modelling) to XR (Extended Reality) digital fruition projects. This encompasses a wide range of applications, from technical management to historical-scientific popularization of the architectural heritage. In this sense, the research explores the potential of BIM-to-XR virtualization systems concerning the systematization of historiographic documentation and interaction between different types of datasets for managing and disseminating the heritage. In particular, the research presents a prototypal experience conducted on Mostra d'Oltremare in Naples, Italy, a mid-20th-century exhibition center. In particular, the northwest access area had a rationalist layout, while the current configuration strongly differs from the monumental, exedra-shaped one built on a project by Arch. Stefania Filo Speziale, which was largely destroyed by World War II bombing. Thus, to document and facilitate the analysis of the original configurations, the original archival sources have been digitized and cataloged; moreover, reality-based integrated digital survey campaigns have been performed for the acquisition of metric-morphological data of the complex and the segmentation of the characteristic chromatic features of the residual decorative apparatuses. This has enabled the development of a BIM-oriented multi-scale information repository to enrich the real environment with digital content, thus creating an augmented reality experience. The latter has been introduced to create a virtual tool for querying and manipulating BIM databases, using the potential of visual programming languages and traditional scripts to create a two-way flow of data between BIM and AR.

1. INTRODUCTION

The work presented here illustrates the results of the *Heritage Building Information Modelling (*HBIM) to XR *(Extended Reality*) digitization and fruition project (Plecher et al., 2019; Rauschnabel et al., 2022), conducted through reality-based acquisition processes and integration of historiographical information on the northwest access area to the rationalist construction of Mostra d'Oltremare in Naples, Italy, today characterized by a very different configuration from the monumental exedra executed in 1940 on a design by arch. Filo Speziale (Aveta et al., 2021, 166) (Fig. 1). Largely destroyed by the World War II bombing, the area stands as an example of a currently naked architectural palimpsest whose construction solutions raise great interest.
The project is keen on the geometric-figurative construction of the exhibition and public area, established along the main directions of the 'green park,' which marked some of the main access points to the site on the fence (Siola, 1990). Though only some external areas are visitable, the site - which initially housed the pavilions of the 'production sector and various exhibitions' - appears profoundly changed from the original project, marked by a sense of majesticness, with a prominent function in welcoming the visitor to the exhibition route.
Unfortunately, it was damaged by the bombing, which deconstructed the integrated system of art and architecture. Therefore, after the indispensable historical, archival, documentary, and iconographic investigations, our work has focused on surveying and interpreting the current configurations to bring the episodic residual architectural elements back to their original dimension: a work with a fundamental scenic and symbolic role.
A queriable and implementable model was developed through procedures of semantic discretization and parametric characterization of residual architectural elements to produce an adequate technical representation of undocumented areas. It relies on geometric and informational components to convey the characteristics and transformations of a place in various forms, attracting virtual tourism and standing as an engine of conscious actions for the management of the architectural heritage.

1.1 Augmented HBIM experience to Cultural Heritage

The themes of survey and parametric modeling for the management and dissemination of the existing historical architectural heritage have been of interest to the scientific community for years and are still very relevant (Balletti et al., 2019; Parisi et al., 2019; Ferretti et al. 2022), pushing toward the segmentation and semantic classification of the typifying forms and elements of the built heritage, sometimes characterized by more complex and non-standardized geometric transposition. Moreover, the digitization of historic buildings, based on range- or image-based data, is increasingly oriented toward the HBIM-to-XR digital fruition project for a wide range of applications, from technical management to historical and scientific dissemination of the architectural heritage (Bekele et al. 2018; Argiolas et al., 2022).
The reason for the integration between systems is rooted in the need to combine a deep knowledge of the building object with its wider dissemination, accessing heterogeneous descriptive data conveyed to different users and integrated in an interactive experience across the real and the virtual. In this context, great significance is held by issues related to data accessibility and transmissibility and by the extent to which the data are explanatory for the model, including the artifact's evolutionary sequences. In other words, information power varies with the context and its semantic discretization; moreover, the accessibility of the database from which the model is produced depends on the organization of the data.

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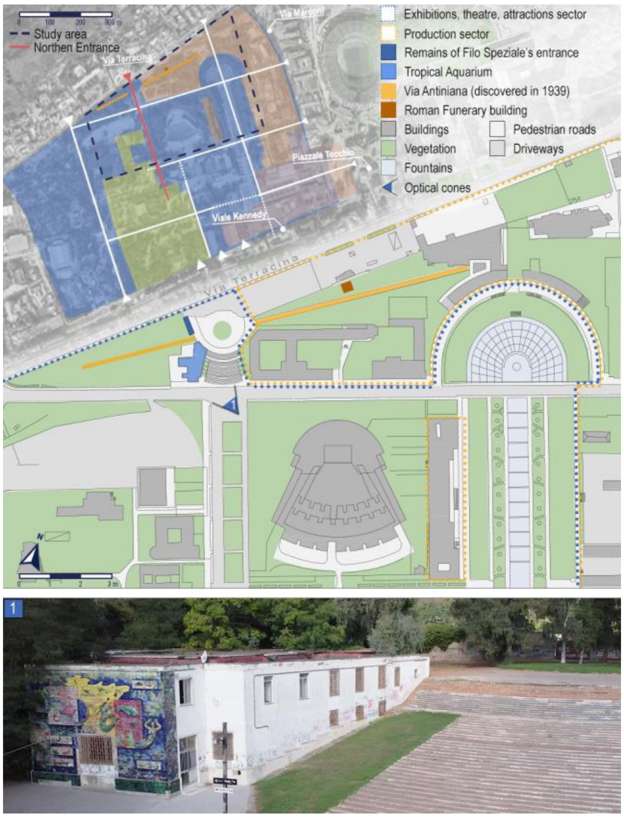

Figure 1. Above, thematic map of the study area, focusing on the Northen Entrance and its remaining elements. Bottom, aerial photo of the sites in their current state.

In this sense, the development of BIM systems is pursuing the implementation of functions linking the ontological apparatus and semantic coding tools. The desired workflow involves operating in a navigable and parametric three-dimensional space, where queries are performed in a reference database, and the entire construction process of both the model and its database is made explicit. This aspect is significant, as the process leads from the detailed survey of the object to its 3D model in the HBIM environment (Rocha et al., 2020; Allegra et al., 2020; Aricò, Lo Brutto, 2022). Moreover, in recent decades, the methodology has been supported by advanced survey techniques and the development of new modeling tools from point clouds (Costantino et al., 2021; Martinelli et al., 2022). Although many strides have been made, some open challenges remain when considering historical artifacts' specific material and technological characteristics (Santoni et al., 2021), highlighting an unresolved discrepancy between the rigidity of object-oriented modeling information structures and the high variability that is typical of built heritage elements. Alongside the need to create new libraries of reusable parametric objects based on surveys and historical documentation (Intignano et al., 2021), it is also crucial to find ways to represent thematic information about materials, decay, diagnostics, and information about the building's development or restoration interventions (Delpozzo et al., 2022). Based on these prerequisites, several solutions have been developed to outline the forms of decay and instability, differing by the desired level of detail, the specific characteristics of the object, and the semantic structures available (Santagati et al. 2021). They include material decay information (Matrone et al., 2020), using - for example - adaptive components (Malinverni et al., 2019) to develop a semantically conscious 3D model. Strategies based on segmenting and classifying data annotated in BIM models and used in Extended Reality applications (Alizadehsalehi et al., 2020) are being implemented to support the database implementation. A growing number of research groups are adopting these technologies, highlighting the lack of adequate knowledge and full and open interoperability between HBIM and XR (Sidani et al., 2021). The methodologies and practices for creating such systems are still heterogeneous (Teruggi and Fassi, 2022). There is no specific set of standard procedures and practices for creating BIM-XR flows. Thus, this paper seeks to outline an optimal flow for developing a BIM-oriented multi-scale information repository of augmented fruition enrichment with virtual tools for real-time querying data associated with parametric models in real-virtual coordinate overlapping.

1.2 HBIM to XR to explore the architectural thresholds of the Mostra d'Oltremare: methodological notes

Based on the assumptions above, the research aims to experiment with HBIM-to-XR virtual fruition systems that enable an immersive experience perceptually adherent to reality and innovative ways of direct, real-time querying of HBIM informational metadata for various types of users and different design purposes. In this regard, the research explores the potential of interactive sensory virtualization systems in terms of the interaction aspects of different types of datasets useful for managing and disseminating existing heritage.

In particular, this prototypical application conducted on a part of Mostra d'Oltremare in Naples, Italy - inaugurated in 1940 as a "Universal Thematic Exhibition" - aims to restore dignity - in the digital domain - to the original project, born in the dialogue and collaboration between the arts (AA.VV. 1940, 9; Biancale, 1941). The study area - the northwest accesses, whose monumental character was lost due to World War II bombing, originally housed the pavilions of the 'production sector and various exhibitions,' organized adjacent to the monumental exedra entrance designed by Arch. Stefania Filo Speziale, now replaced by a bare, seemingly anonymous and degraded space (Fig. 1). Only a few elements and artifacts show an organized design on the theme of greenery, water, and respect for the archaeological features of the site discovered during the construction (Aveta et al., 2021, 166). The project reveals an unprecedented monumentality in the corner plot at the northwestern end between the Tropical Aquarium and the area of the Capitalist Colonization and Colonizing Entities of the Agricultural Industrial sub-sector (Aveta et al., 2021, 326). Some of its architectural and decorative elements contributed to the scale and expressiveness of the regime's works from the fundamental scenic and symbolic role. Thus, to document and support the comprehension of the current, lost, or overwritten configurations, the preliminary stage of the study included investigations concerning the digitization and cataloging of original archival sources, according to a methodological approach from survey to AR-BIM environment, through data segmentation. (Fig. 2).

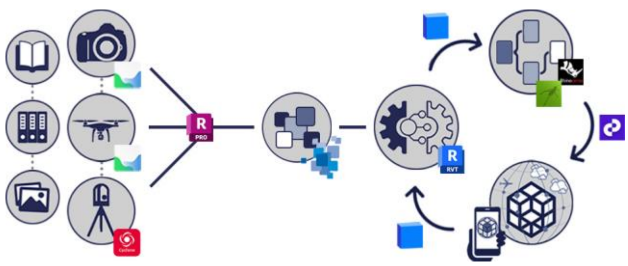

Figure 2. Workflow: from survey to AR-BIM environment, through data segmentation, for the visualization of historical elements and maintenance of existing parts.

Indeed, reality-based integrated digital survey campaigns were performed to acquire metric-morphological data on the architectural complex and its environmental system. The survey also proposes structuring a specific digital filing aimed at the census and recording morphological and taxonomic characteristics of the most relevant architectural units. To this end, the study devotes much attention to researching a semantic classification mode according to a multi-resolution (MRS) approach for region growing to identify and quantify the contours of architectural regions with qualifying chromatic features of decorative apparatuses and decay areas from digital survey data. In particular, a BIM-oriented multi-scale implementation information repository was developed to enrich augmented fruition with virtual tools for real-time information querying on the parametric models. In fact, for the latter, the research wants to test innovative methodological protocols based on viewing and localization (with marker tracking) of digital content in AR (Gupta et al., 2019; Fiorillo and Bolognesi, 2023). In this specific case, it was decided to design a non-standalone application for any technical or non-specialist user based on a tracking system through QR codes for displaying various content. The Grasshopper (GH) plug-in, Fologram, was adopted to create and manage the AR application (Jahn et al., 2020; Kyaw et al., 2023) from the project directly from the Rhinoceros platform. Real-virtual coordinate overlapping is performed through a QR system. This app allows users to manipulate the data and interrogate the digital model in an interactive augmented reality experience. This virtual model is directly connected to the BIM database, thus allowing the visualization of BIM parameters in augmented reality. Moreover, user inputs in AR can change or implement parameter values. Through several mixed visual scripting and traditional scripting algorithms, these values are sent back to the BIM model, updating only the value that has been changed.

Interactive data and multimedia content overlap with reality to get a picture of the whole architecture functionally and attractively (Teruggi et al., 2021). The methodological approach aims to fit into the wide and open debate of interoperability between HBIM and XR systems for the digital management and dissemination of cultural heritage.

2. THE CASE STUDY. FROM THE SURVEY TO THE HBIM-AR FRUITION MODEL

2.1 The northwest access area between past and present

The area along the northern perimeter overlooking Via Terracina was organized to incorporate Roman structures unearthed during excavations for the Triennial Exhibition of Italian Overseas Lands, including a section of the ancient Via Antiniana (Aveta et al., 2021, 335) with a burial mausoleum adjacent to a bath complex. A reorganization project was created for it, with the primary function of welcoming visitors to the exhibition route.

The area has undergone significant remodeling over time, particularly regarding the entrance pavilions making up the entrance at the far northwestern end, designed by Stefania Filo Speziale. This space lacks its original architectural features, with a residual staircase in a splayed circular sector. Adjacent to it are the remodeled pavilion of the Cocchia Tropical Aquarium (Aveta et al., 2021, 166) to the west and the remains of the pavilions of the Agricultural Industrial sub-sector of the 'production sector and various exhibitions' to the east. The latter was repurposed in the second half of the 20th century to house the Boccioni-Palizzi Art Institute (Fig. 1).

The analytical study of sources (iconographic and bibliographic collections, historical cartographies, archival documents) facilitated the process of 'retro-design' (Verdiani, 2017) aimed at increasing cognitive data on existing structures.

Figure 3. Cocchia’s Tropical Acquarium and northen Entrance, designed by Arch. Filo Speziale, F. Patellani Archive, June 1st 1940.

The most significant evidence consists of the photographs taken at its inauguration (AA.VV., 1941), the historical views conveyed through the rich publicity promoted by the regime between 1938 and 1941 (Fig. 3), and numerous aerial shots Istituto Luce took. All these valuable sources (Capano, 2016) reveal to us, with unusual glimpses, the unprecedented monumentality of the original exedra entrance solution: a semicircular-plan "door" in front of the entrance plaza, at the apex of the broad staircase, which marked the planimetric arrangement of the adjacent hinged pavilions to manage both the irregularity of the trapezoidal site area and the altimetric configuration of the site. This was a successful solution both because it absorbed the lack of orthogonality of Via Terracina with the north-south Cardinal Massaia axis and because the concavity outward allowed the formation of a forecourt on the street, which was necessary to accommodate visitors, who could observe the Roman archaeological layout through the filter of the porch. Unfortunately, almost nothing of the original structure is left. It was characterized by two overlapping orders, the first of which is made of white *pilotis* with a high trellis supporting the thin inverted jack arch vaults, which composed a modern everted *velarium*. The project connected with the unique volumetric articulation of the pavilion of the Tropical Aquarium, which went along with the semicircular profile of the exedra. The aquarium is the only element that mostly corresponds to the original design in its external envelope. It shows the original design choices aimed at researching and highlighting pure, almost sculptural volumes declaredly juxtaposed and contaminated with each other in a marriage of architecture and art visible in the ceramic cladding of its main elevation, still present though heavily degraded. In contrast, only a few traces of the West pavilions destined for the Agricultural Industrial sub-sector have been preserved. These consist of some walls enclosing the outer steps and other small artifacts largely absorbed by later area transformations.

To reconstruct such a complex architectural scenario, the documentation activity can only be flanked by a digital survey activity, which is indispensable to acquire the degree of knowledge needed to guide the reconstruction project of the original *facies*, including data collection and organization and selection of documents related to the buildings in the area under consideration. This is compounded by activities aimed at metric-functional knowledge, interpretation, and evaluation of the artifacts' size and state of preservation.

2.2 Digital Survey and Semantic Data Segmentation

The goal was to describe the current conservation state of the site, compensating for the lack of accurate and up-to-date surveys

supporting new considerations related to spatial stratification in different ages. For this purpose, several reality-based integrated survey campaigns were carried out to obtain the dimensional data needed for the subsequent analytical determination of the conditions of the current state of the sites and the definition of the laws that characterized the design process of the complex (Fig. 4). In particular, to obtain a high level of metric-colorimetric accuracy for each architectural element (Bevilacqua et al., 2018), a TLS (Terrestrial Laser Scanning) acquisition methodology was integrated with image-based acquisitions (terrestrial and aerial photogrammetry from SAPR) (Hassan et al., 2020). This allowed obtaining metric, morphological, geometric, and colorimetric data, developing timely solutions to address the critical issues related to the inaccessibility of some places and the significant decay conditions of some areas. Moreover, the activity plan was completed with an attentive methodological approach, considering the artifacts' intrinsic qualities, history, materials, intended uses, and environmental contexts. Considering the size of the study area, the target-based TLS survey - employing a Leica BLK360 - produced a close loop of 80 scans covering the individual residual pavilions and green areas of the section of the Roman Antiniana road, along with the driveways and pedestrian paths adjacent to the plaza with the wide steps. This led to a three-dimensional model with a 5-mm resolution at 10 meters, which provided the metric reference to associate the accuracy of the photogrammetric survey. Terrestrial images were captured with a Nikon D7000 Reflex camera (with a 16-85mm f/3.5-5 lens) and processed in Metashape; aerial shots were produced with a DJI Spark drone (equipped with 35mm f/2.6 lens camera) and processed in Zephyr Aerial. After processing the discrete models of the individual surveyed portions, the data were scaled and georeferenced from Ground-Control-Points (GCPs) already surveyed by TLS. In the following phase of digital data analysis, the data content was translated into graphic transposition into plans and sections, starting with the orthophotos of the exterior walls. This stood as an essential basis for the artifacts' thematic mapping concerning their material characterization and surface decay.
In line with recent advances in image classification, this study tested a multi-resolution (MRS) approach to identify and quantify contours of regions with homogeneous material composition or recurrent degradation types. For example, for one of the most evocative and decorated surfaces (Aveta et al., 2021, 372) on the primary prospect of the Tropical Aquarium pavilion, the process was tested in the eCognition application by exploiting the region growing algorithm to divide the image domain into similar segments by consecutively grouping pixels (Baatz and Schäpe, 2000) according to the color, scale parameter, and shape of the segments (Im et al., 2008) (Fig. 4). By varying the values of VAR_Shape, VAR_Compactness and VAR_Scale, and using the RGB and HSV channels, the joints of the majolica tile regions were identified. The limited variability of the shapes of ceramic tile joints facilitated their recognition. The process was aided by the definition of a length-to-width shape ratio of the maiolica tiles, which also succeeded in identifying those regions later classified as lacunae. In addition, the analysis was also able to highlight the composition of the fenestration of the window void and the greater fragmentation of the embossed decorations. In addition, regions associated with densely vegetated areas, or those characterised by erosion or dripping phenomena, have been described with respect to the colour channel and through the relationship of shape and scale, resulting in a classification that tends to minimise the heterogeneity of each polygon/seed generated. Their classification was accompanied by the visual recognition of some segmented tiles undergoing removal and replacement, or subject to colour alteration.

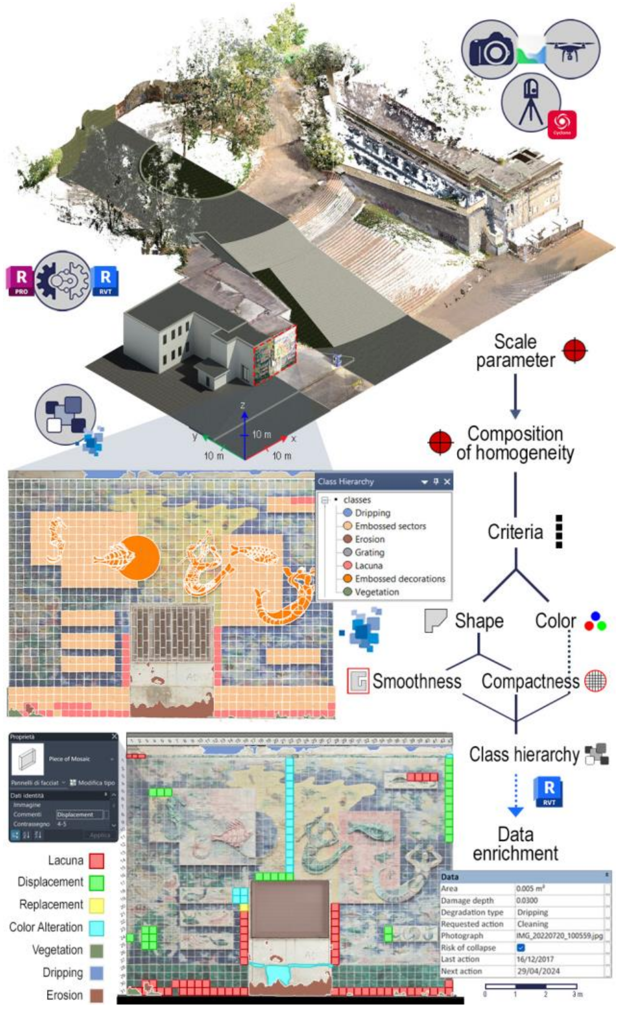

Figure 4. Above: Information Model based on the digital survey.Below, workflow for the eCognition segmentation of the main façade of the Aquarium, with data enrichment in Revit.

Finally, the classification divided those classes of embossed elements, i.e. a first level described by quadrangular sectors and a second level described by the shapes of marine decorations. The encouraging results of the semi-automated approach facilitated data enrichment of each element of the HBIM model (Pocobelli et al., 2018) with ex-ante and ex-post technical and technological information (Fig. 5), potentially helpful in building a multilayer system of multidisciplinary data storage and management (Dell'Amico, 2020), helpful in understanding the relationships between different building elements (Bianchini, 2014) and the maintenance phases of the surveyed areas.

2.3 Data enrichment and 4D-HBIM modeling

The narrative of such a complex architectural scenario, conceived with a monumental spirit at the time, can only be conducted through a three-dimensional approach whose parametric-informational component amplifies the spatial understanding and helps to skim the historicized superfetations. From the integrated digital survey data and the results of the documentary and thematic restitution, the current state was modeled through a Cloud to BIM process to integrate the geometric data with the corresponding virtual elementary architectural units in their virtualizations (Noronha Pinto de Oliveira and Sousa and Correa, 2023) (Fig. 5).

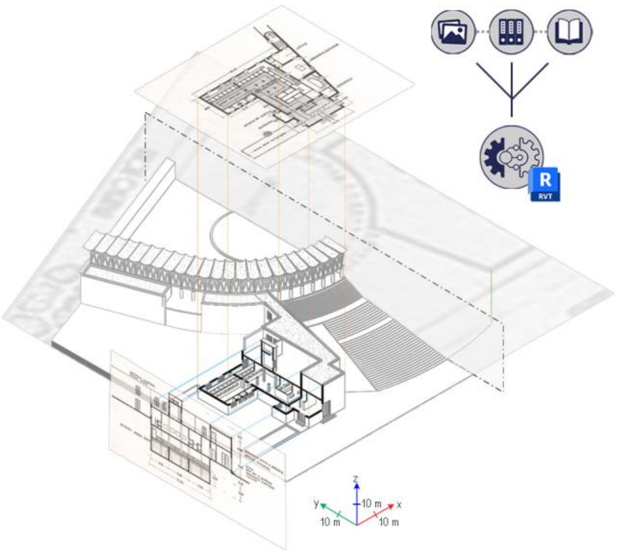

Figure 5. Ex ante model of the northen Entrance and the Tropical Aquarium based on historical plan and section (AA.VV., 1940).

To this end; the Revit platform has served as an environment for collecting and coordinating information through parametric element modeling, framed in a set of categorized semantic entities (Di Luggo and Scandurra, 2016) characterized by rules and parameters that are highly related to the specificities of the heritage (Campi and Cera, 2019). The available historiographic data facilitated the construction of the ex-ante digital twin, maximizing data enrichment (Antuono et al., 2021) to provide an informational database linked to the multi-scale 4D-HBIM model (Fig. 6). The diachronic definition of the volumes and elements as of 1940 led to a dynamic temporal simulation of the original design with the exedra door designed by Filo Speziale on Via Terracina at the apex of the wide staircase between the Capitalist Colonization and Colonizing Entities pavilions and the Tropical Aquarium. Concerning the latter, the modeling process and its level of detail adopt the lower-scale geometric approximations of the interior organization project by Giuseppe Muller (Aveta et al., 2021, 166). This includes a sequence of tubs-windows recessed along the side walls, classrooms for an experimental laboratory, a library, and a mechanical workshop. These functions were needed for the scientific autonomy of this small yet efficient structure, distributed on two levels. For this section, object coding has been carried out independently concerning the level of geometric detail and the level of information documentation (Abualdenien and Borrmann, 2022), in line with the concept of LOIN (Level of Information Need - UNI EN ISO 19650), aimed at modeling alternative scenarios, including material and decay aspects. Mapping has been performed on the model as true-to-reality as possible by the UNI 11182 standard, based on the segmented orthophoto, implemented with data that could not be automatically found (Fig. 4). Specifically, the mosaic face was modeled as a curtain wall, customizing its grids to place panels, parametrically enriched with the information needed to simulate individual tiles. Changing the instance parameters of an element allows assigning a specific form of degradation by associating a text in the Comments section and specifying the column and row number with a Marker to identify the element's location univocally.

For the remaining decayed parts, two different modeling solutions were used depending on the affected element: the Local Model for generic surfaces and the Adaptive Generic Metric Model specifically for flat surfaces (D'Agostino et al., 2023). This procedure allowed geometric and extra-geometric data to be associated with each parametric element. These data include the type of degradation, the intervention required and its cost, detailed images of the degradation, etc., to expand the database that can be used for maintenance and restoration.

Moreover, data enrichment also involved data extracted from archival sources and organized according to a cloud-based system with multi-user logic, thus creating a multidisciplinary database useful for artifact description. This supports both synchronous - more specifically designed for technical knowledge - and asynchronous knowledge - that is, with purely aesthetic information. This aspect deals with associating manifold alphanumeric parameters with each element, communicating different data needed to understand the work in its various parts and plan interventions (dos Santos et al., 2023). The result is a multi-series infographic reference system for different types of operators, including multiple types of information needed to easily trace elements and visualize the evolution of the building or its state of preservation in the subsequent augmented fruition experience as well (Fig. 7).

2.4 The augmented fruition model for heritage dissemination and maintenance

As said, part of the methodology involved implementing an interactive AR-BIM workflow within the Grasshopper (Rhinoceros) visual scripting environment. The goal was to create a non-standalone application that is independent of the model status, *i.e.*, regardless of whether the model is finished or in progress, to enrich the BIM database with user inputs in the AR experience (Fig. 7). This workflow relied on two external plugins: Fologram, which creates a live link between Rhino and your device (Mobil device or Microsoft Hololens), allowing visualization and real-time edits to the Rhino model, and Speckle, a 3D platform for real-time data extraction and exchange between the most popular AEC applications through tailored connectors.

The former is used in this methodology for synchronizing digital components with reality, such as geometry, text, or parameters. In other words, this first plugin is used to set up the AR experience. The settings include the possibility to create a QR code within Rhinoceros, ensuring that the real and digital coordinate systems overlap correctly.

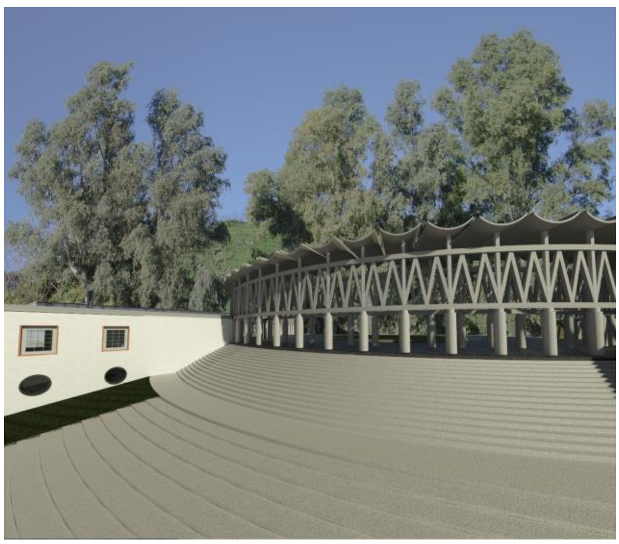

Figure 6. View of the parametric-information model at 1940. Note the exedra structure designed by Arch.F. Speziale at the top of the stairs adjacent to the Aquarium.

Figure 7. AR Heritage Experience: A) Interactive model completeness with tap functionality, featuring top-right methodology display. B) Click on elements for an informative panel. C) Change comment triggers a panel with options to modify comment type. D) Confirm data button syncs new comments with the BIM-database.

In the following paragraphs, we refer to using Fologram components within GH when mentioning synchronization or AR content. The latter, Speckle, is used for the interaction between Revit and GH. Therefore, it was used for creating the data flow between the BIM model - with its metadata and data - and the AR experience in both directions, thus as a round trip. The Speckle platform implements a data flow system to create this data flow. First, data are selected in the first software and sent into a stream. Then, data are received in the second software using the same stream. Speckle packages the data, making them readable and exchangeable between software, thus avoiding compatibility issues. Data are packed according to a hierarchy system created by Speckle following an organizational system.

A stream with the project's name was first created on the Speckle platform to apply this methodology. This stream was used to configure the Speckle connector within the Revit software. The selected data were sent and received in GH. The stream was imported into GH with the Speckle connector, and the BIM data was received. Then, the data had to be broken down. In this case, to make them state-independent, they were broken down according to BIM data patterns, not according to the order in which they were imported into GH. This was done since the order of the data could change at different stages of the project.

A system of Python RegEx (Regular Expressions) functions for data filtering and sorting was used to break them down. This part is essential to pass on a specific parameter of a given object, as explained below. The following step was to develop AR interaction, starting from selecting the geometric elements to synchronize. BIM metadata and RegEx functions ensure that when a given geometry is selected (Fig. 7A) the ID of the BIM element obtained corresponds to the clicked one. Therefore, an algorithm was created to associate the user's input with the BIM element's ID, which is unique for each project element. This ID and its linked BIM data create an AR interface panel. The panel was used to display all the desired BIM parameters in the AR app, including the ID itself. Until this point, the project's data flow is BIM-to-AR.

The opposite direction of data flow - AR-to-BIM required creating another part of the user interface in the application, allowing users to interact with the selected elements (Fig. 7B). This required a logic gate or state, notifying the algorithm of users' information add. A Boolean value was used for this. This information had to be associated with the previously selected object. In this regard, the RegEx functions step was crucial to associate any information with any element, which may or may not have information. It should be clarified that the data to be processed are sensitive data from a database for historical heritage management.

For the Boolean state, a Change Comment or Add Comment button is created (Fig. 7B), which changes depending on whether the selected object in the BIM database already has a value for each field. After tapping this button, a new panel appears, allowing users to enter different forms of decay by tapping: Null, Detachment, Substitution, Chromatic Alteration, and Lack (Fig. 7C). Finally, a Confirm Data button was created (Fig. 7D), which allows the logic gate to send the new field value back to the BIM database using the same Speckle stream.

This last button was created to avoid updating the BIM database whenever a button of a degradation type is tapped.

3. CONCLUSIONS AND FUTURE DEVELOPMENTS

The integration and implementation of data between BIM and AR represents an opportunity to give meaning and enable the sharing of technical information of the surviving and lost architecture of the Overseas Exhibition.

In particular, the digital reconstruction has highlighted the potential of data schematisation through multi-resolution data segmentation and classification approaches, as well as the opportunity to transmit real-time information that can facilitate the transmission of features and communicate the transformations of a place for informed actions on the existing architectural heritage.

The results obtained appear encouraging. With reference to the automatic recognition of gaps or differences in information for a regular and periodic cladding, the result obtained is acceptable if compared with a visual inspection of the facing: in fact, both the missing tiles and the sources of degradation that we were able to trace are superimposable on the raster grid used without significant differences, which are irrelevant, however, when these geometries must then be rendered into solid forms for the relative simplified BIM modelling. It is also true, on the other hand, that when the geometries for automatic recognition deviate from a rigorous grid, the state of progress of the work does not allow this geometric variability to be discretized. These initial results, therefore, show a promising, scalable and developable start-up that, however, requires further investigation into the feasibility of the approaches investigated for generic cases or, in any case, their comparison with more evolved operational workflows that start directly from the structuring of the survey point clouds.

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