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From archival research to the digitization of existing architectural heritage: methods and processes compared

The study presented aims to experiment with the various possible applications of 3D modeling, both parametric and non-parametric, using historical and project archives as the primary source for acquiring documentation. The initial questions posed were: What are the peculiarities of the different types of approach? What are the outcomes in terms of content and reliability? Indeed, the different types of modeling lead to different considerations and conclusions, along with methodological approaches that require unequal specific attention.
The main objective is to explore the possibility of digitizing built heritage using 3D modeling, both parametric (according to the BIM process) and non-parametric, starting from the information, as mentioned, contained in the documents from historical archives, project documents, and all relevant archives. The research undertaken introduces some initial limitations, focusing particularly on the digitization of protected heritage and properties owned by public administrations.
The case studies addressed for the development of the theme are identified in two buildings by Ignazio Gardella and the historic Palazzo del Governatore in Parma. The selected outcomes were subjected, respectively, to non-parametric 3D modeling and parametric BIM modeling, highlighting the differences in modeling management processes, which are highly correlated with archival research. The aim is to understand how to effectively use both techniques, both to digitize architectural heritage and to optimize the conservation and management of its information.

Keywords:
Archival drawings; BIM; Modeling; Heritage

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BACKGROUND: A STEP BACK, BUT TOWARD THE FUTURE

The birth of BIM (Building Information Modeling) and the concept of the virtual model according to Charles M. Eastman [1] represents a fundamental change in the construction sector. The term BIM, originally used as an acronym for various expressions such as "Model," "Modeling," and "Management," has evolved over time. Today, "Modeling" is the most commonly used term, as it describes the entire integrated building process, which is based on interconnected and interoperable digital models.
The virtual model, as described by Eastman in 1974, is the starting point of BIM. In his publication "An Outline of the Building Description System," he presented a system to store and manipulate project information through an interactive graphical language.
This system allowed the representation of a building as a spatial composition of parts, with detailed information on materials, geometry, and more, introducing the possibility to analyze, design, and construct more efficiently. The evolution of the software through which this process is achieved has made it possible to adopt more sophisticated virtual models, making BIM a concrete reality for the construction industry in terms of innovation and production.

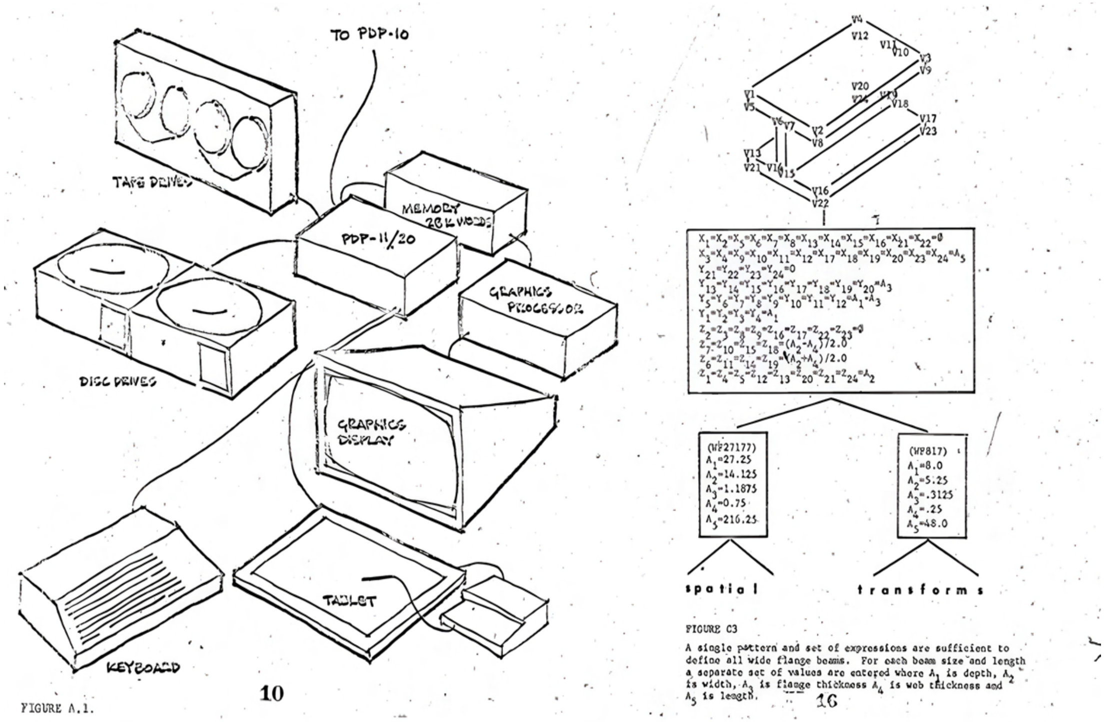

Fig.1 Extract from "An Outline of the Building Description System"

METHODOLOGY: THE CONDUCTED EXPERIENCE

1. The use of digital modeling (Non-Parametric) as a tool to analyze and understand the design.

The research begins within the archives of the Centro Studi e Archivio della Comunicazione at the University of Parma (CSAC). The archive, structured into five sections—art, photography, media, design, and performance—holds around 12 million items in total and offers the opportunity for in-depth scientific consultations. The study focuses on the rich production of Ignazio Gardella, particularly two works created by him: the Alfa Romeo executive office in Arese and the Olivetti canteen in Ivrea. Achieving a deep understanding of these projects solely through archival drawings allows for acquiring awareness and a detailed analysis that fosters interesting reflections. Understanding how Gardella's working method—operationally—evolved over time is a significant theme.
This interest stems from two main factors: the different temporal placement of the projects (with nearly a ten-year gap between them) and the different clients involved. In one case, the client is the visionary Adriano Olivetti, who sought an innovative approach for his company, with particular attention to its employees; in the other, the late 1960s client requires a well-structured executive center, with appropriate functions and spaces capable of representing the productive identity of Alfa Romeo.
This becomes evident in the representational outcomes of the analyzed drawings and the information they contain: the altimetric and linear dimensions, together with other graphic indications such as the representation scales, are detailed and precise for the Alfa Romeo executive offices, while they are less defined in the Olivetti canteen.

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The significant differences arise from the lack of dimensional information needed for a correct understanding of the project, creating difficulties in the digital
modeling phase, which is simpler and more immediate for the Alfa offices (drawings rich in details) and more complex and thoughtful for the Olivetti canteen (drawings with few dimensional data).
To achieve a satisfactory result from the digital restitution process of a project using archival material [3], three fundamental factors must be managed: quantity, quality of available material, and the researcher's awareness. It is necessary to have a clear understanding of the architect's identity, along with a historical contextualization. The abundance of graphic and descriptive material provides the opportunity to compare it and collect information often scattered and fragmented across various documents.
Written documents are also essential, such as Gardella's notes and the correspondence between him and the client, which represent valuable sources of data. After examining all the available material, a selection process of the documents was started to identify the most relevant evolutionary phases in Gardella's design process, which eventually led to the final results of the works and their realization.
Specifically, six phases were identified for the Olivetti canteen and two for the Alfa Romeo executive offices [4].
The six phases of the canteen show a significant evolution of the project, developed gradually. Gardella appears to work with great attention to the forms, exploring various variants and refining them, seeking a clear relationship with the surrounding landscape. In the case of Arese, where the phases are only two, they correspond to an initial design presented for the competition for the assignment of the works and a second that represents the final version built.
The change is marked by some simple but effective modifications that lead to two distinctly different outcomes.

Fig. 2 Olivetti Canteen, Ivrea, 1953-59, General distribution scheme, first version (OL/M2). Gardella Archive, CSAC.

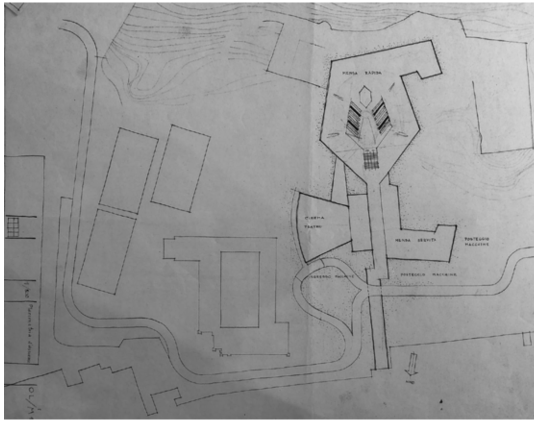

Fig. 3 Olivetti Canteen, Ivrea, 1953-59, Overall floor plan, fifth version (OL/M10). Gardella Archive, CSAC.

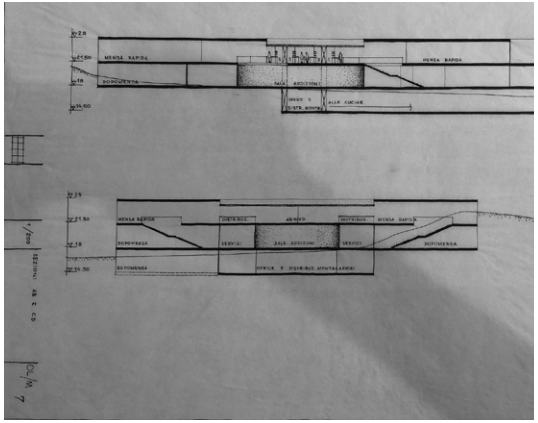

Fig. 4 Olivetti Canteen, Ivrea, 1953-59, Sections (OL/M7). Gardella Archive, CSAC.

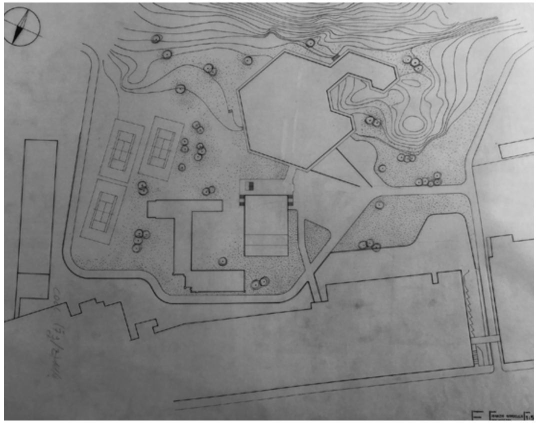

Fig. 5 Olivetti Canteen, Ivrea 1953-59, Floor plan of the external layout (OL/M183), July 1959. Gardella Archive, CSAC.

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Fig. 6 Olivetti Canteen, Ivrea, 1953-59, Photograph, ASG, CSAC.

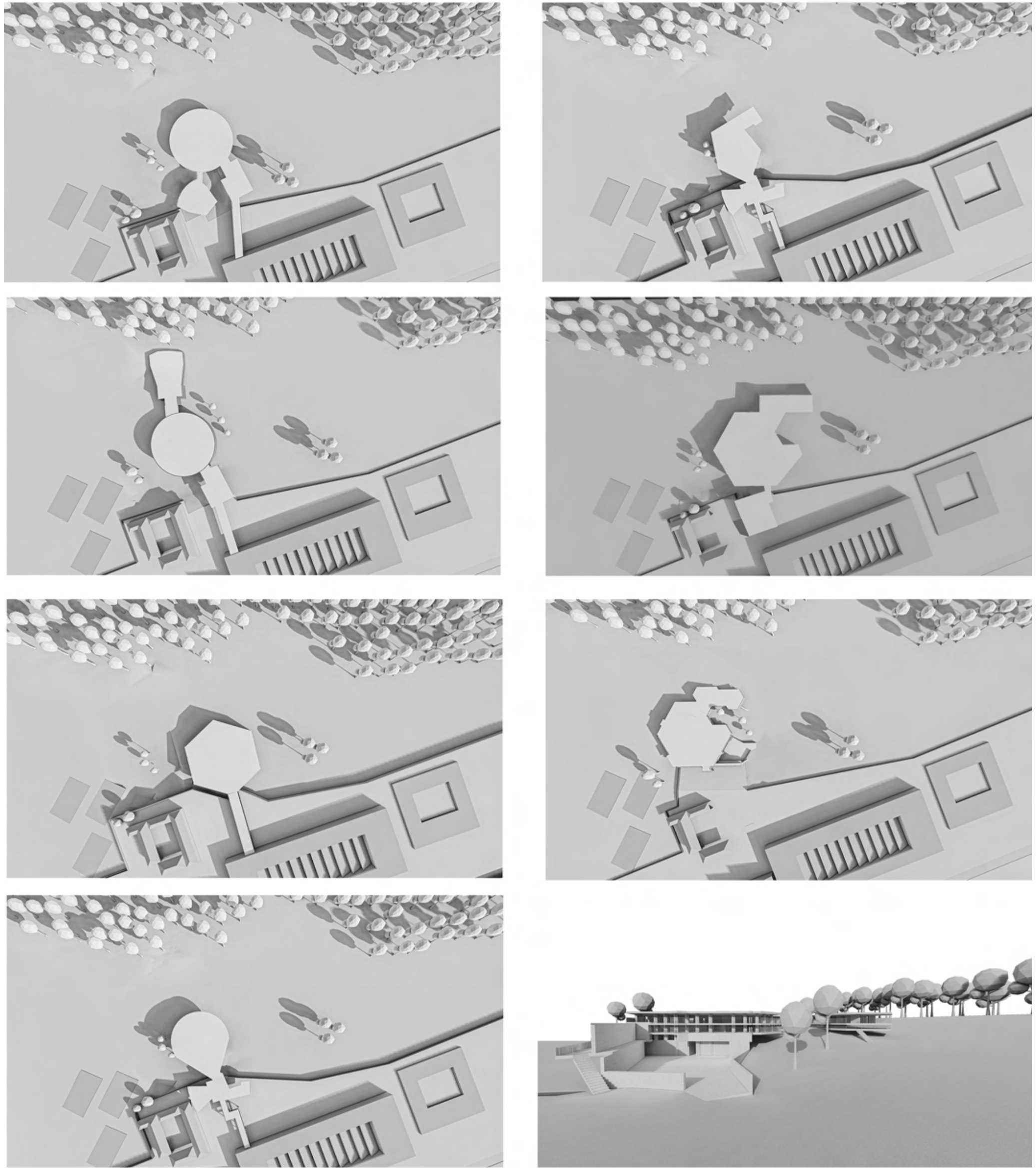

Fig. 7 Rendered floor plan of the Olivetti Canteen in Ivrea (from top left): First phase: Circle (Nov-Dec 1953), second phase: Circle Second Variant (Nov-Dec 1953), third phase: Hexagon (Nov-Dec 1953), fourth phase: Polygon (Nov-Dec 1953), fifth phase: Polygon Second Variant (Nov-Dec 1953), sixth phase: Hexagon + Addition (Nov-Dec 1953), final drawing (1954-1959), perspective of final drawing (1954-1959). Realization by Virginia Droghetti.

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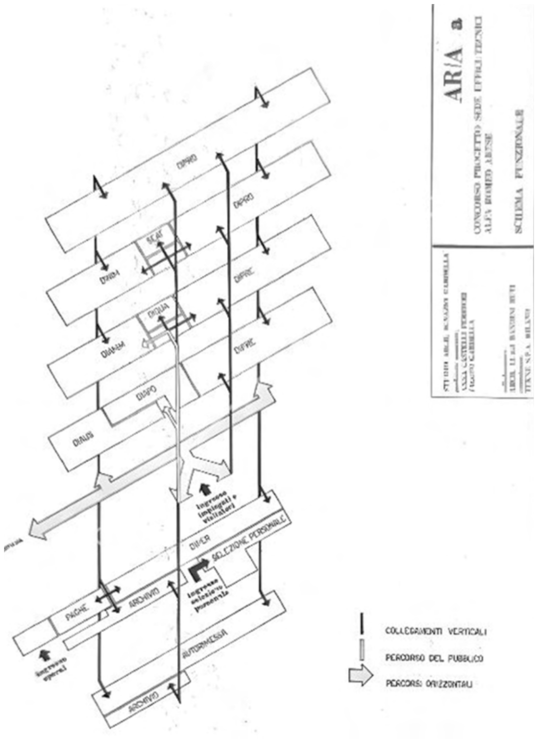

Fig. 8 Alfa Romeo Office Building, Arese, 1968-74. Competition plans, functional scheme, 1967. Gardella Archive, CSAC.

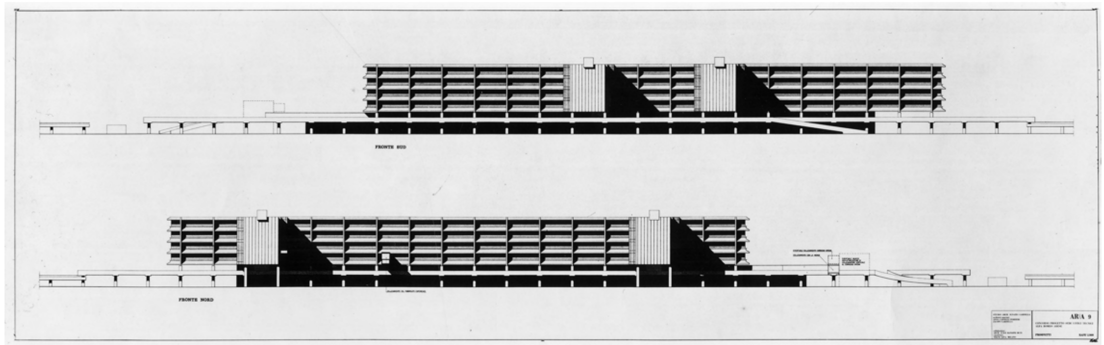

Fig. 9 Alfa Romeo Office Building, Arese, 1968-74. Competition plans, elevations, 1967. Gardella Historical Archive, CSAC.

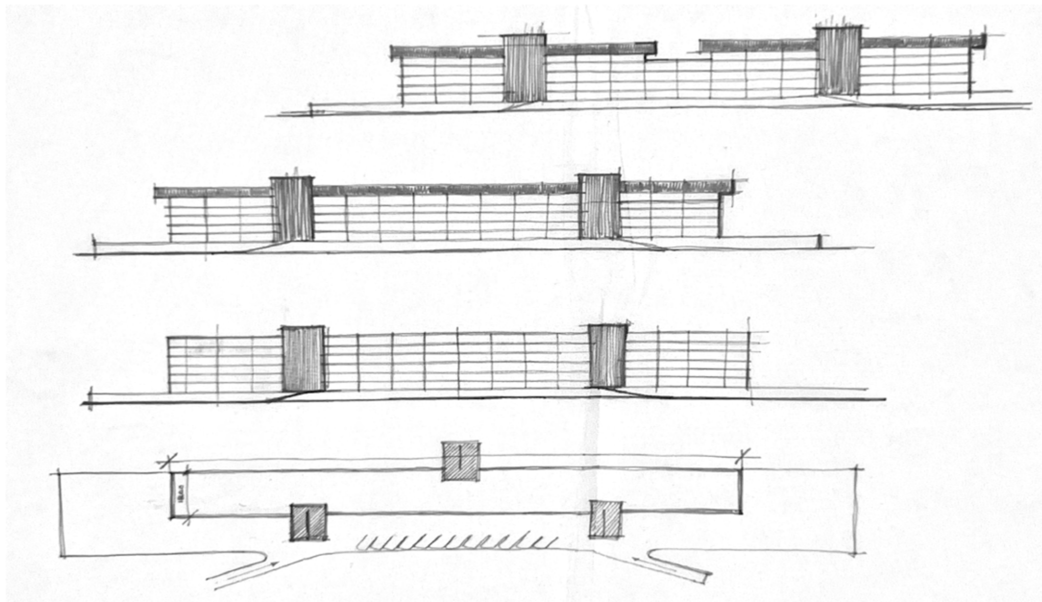

Fig. 10 Alfa Romeo Office Building, Arese, 1968-74. Competition plans, floor plan sketches, and facade study. Gardella Historical Archive, CSAC.

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Fig. 11 Alfa Romeo Office Building, Arese, 1968-74. Photograph. Gardella Historical Archive, CSAC.

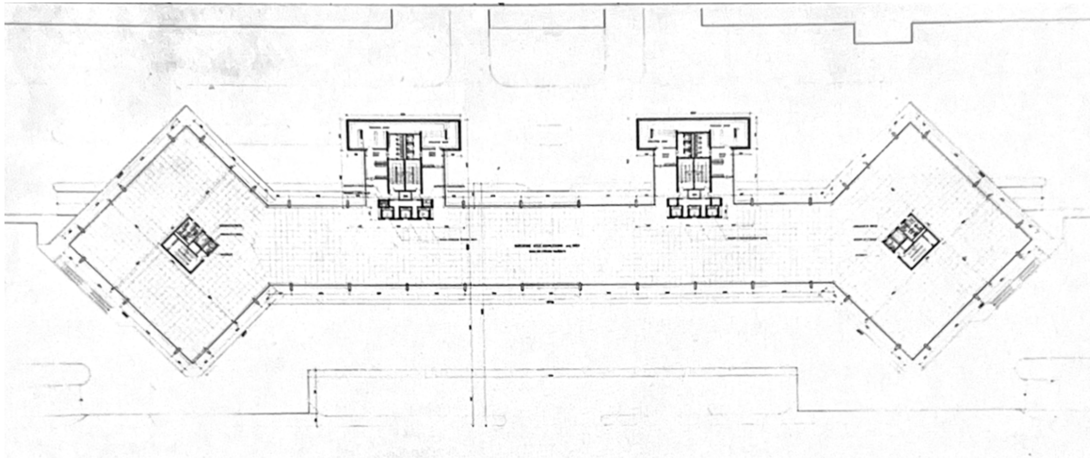

Fig. 13 Alfa Romeo Office Building, Arese, 1968-74. Final plans, typical floor plan. Gardella Historical Archive, CSAC.

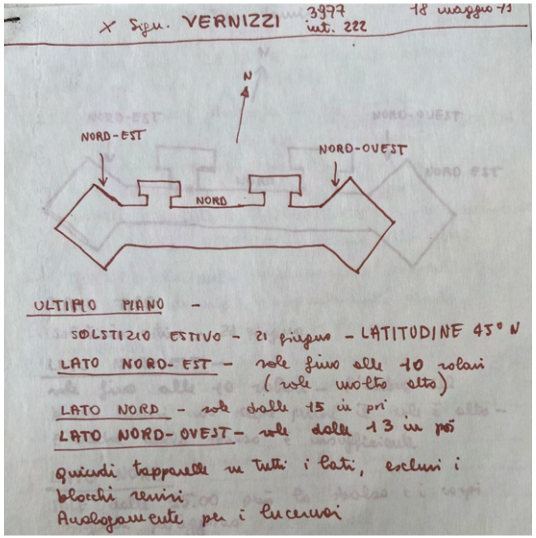

Fig. 12 Alfa Romeo Office Building, Arese, 1968-74. Project notes. Gardella Historical Archive, CSAC.

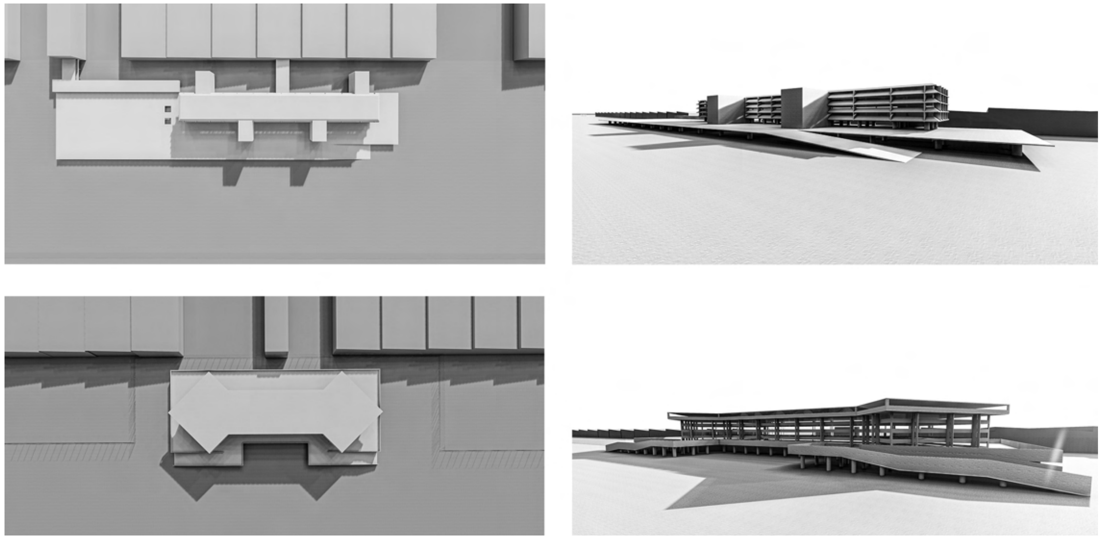

Fig. 14 Rendered Plan of the Alfa Romeo Executive Center in Arese (from top left): floor plan and perspective of the project, competition announcement 1968, floor plan and perspective, final project 1974. Realization by Virginia Droghetti.

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2. The use of parametric digital modeling as a tool for the digitalization and managment of the existing built heritage.

This further experimentation focuses on the Palazzo del Governatore in Parma.
In this specific case study, parametric modeling is intended to be used with the goal of digitalizing the existing built heritage, aiming for its active management.
To achieve this, an intensive campaign was launched to collect the necessary information. Creating a digital database of buildings in the area required the introduction of optimal parameters and constraints.
In fact, the interaction with the Public Administration of Parma led to a series of reflections that serve as the primary stimulus for the research conducted. The need is clear: to identify a method [5], preferably replicable, that can be applied to existing buildings to enable efficient management and, consequently, preservation, in order to develop an effective operational strategy.
The process has been divided into several phases, starting with the definition of digitalization priorities, which were established during the study phase.
Defining a digitalization priority allows for organizing and hierarchizing the heritage, and to this end, a form (Form A) was developed that, once completed for each building, defines a precise list of buildings to be digitalized with priority.
The urgency of digitalizing certain artifacts depends on various objective and subjective factors, such as property type, use, size, year of construction, energy class, and state of preservation, with a score assigned to each parameter: the higher the score, the greater the priority.
The second phase of the process involved acquiring the necessary information for modeling, with the goal of creating a model that functions as a complete "archive" of the building.
A significant difference emerges in this phase, related to the temporal location of the buildings: for recent constructions, data and information are easier to find, while for older buildings, a more in-depth research phase is required, including exploring archives.
Drawings and archival information are carefully examined, using a second form (Form B), which collects the data necessary to determine the reliability of the surveys and drawings obtained, and provides a list of the information acquired. This phase is crucial, as it determines whether a surveying campaign needs to be launched. The foundation of the process lies, in fact, in the geometric and architectural data, which are essential for the creation of the digital model [6]. The archives consulted for this specific case are numerous and located within the Parma area. The State Archives of Parma (ASP) was consulted, including the section dedicated to the Cessato Cadastre; most of the acquired information comes from the ASP, which houses approximately ten million documents.
However, retrieving and researching the material is facilitated by the integration of the SIAS system (State Archives Information System).
Other archives examined include the Historical Archive of the Municipality of Parma (ASCPr), with particular attention to the License Archive, and the Archive of the Palatina Library [7].
In addition to geometric and architectural information, it is crucial to also collect information related to the building's management, which will be useful for its monitoring and maintenance. Collaboration with the client (in this case, the Public Administration) is essential to define the necessary specifications, based on the management needs of each case.

After analyzing the goals and ultimate purposes of the model and defining the level of detail necessary for modeling, it is then necessary to carefully verify the information acquired from the archives to ensure it is handled correctly in the modeling phase.The in-depth archival research phase allowed, in this specific case, to explore in detail the urban evolution in the area surrounding the building under study and its architectural evolution.
The urban evolution and its graphical representation are developed following the principles already outlined in the previous paragraph on non-parametric modeling.
Through the study of historical cartography of the city of Parma, it was possible to focus in particular on Piazza Garibaldi, where the building is located, identifying significant morphological changes over the years. Urban non-parametric modeling is carried out using non-parametric software, aiming to immediately visualize the morphological transformations that also affect the building under study.

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Fig. 15 Abacus of the zenithal cartographic evolution of the city of Parma, in detail: fig. 1 - Map of the city of Parma, Urbis Parmae Romanorum coloniae, Liberati G. A., fig. 2 - Map of the city of Parma, Smeraldo Smeraldi, 1592, ASPr, coll. 02/15, fig.3 - Plan of Parma, Smeraldo Smeraldi, 1601, in Parma e Piacenza nei secoli di Felice da Mareto, fig. 4 - Plan of the city of Parma, ASPr, coll. 02/22, fig. 5 - Map of the city of Parma, 1821, Carta storica del Ducato di Modena, fig. 6 - Map of the city of Parma, 1828, Carta storica del Ducato di Parma, fig. 7 - Plan of Parma, 1847, IGM, fig. 8 - Parma, .

Fig. 16 Abacus of the perspective cartographic evolution of the city of Parma, in detail: fig. 1 - La ville et cite de parme, Michel Sonnius, Sebastian Munster, 1544, Palatina Library (PR) IDD 65, fig. 2 - Map of the city of Parma, 1570, da Parma e Piacenza nei Secoli, Felice da Mareto, 1975, fig.3 - La nobilissima città di Parma, Paolo Ponzoni, 1572, fig. 4 - Perspective plan of the city of Parma, Merian M., 1640, da Parma e Piacenza nei Secoli, Felice da Mareto, 1975, fig. 5 - Perspective map of the city of Parma, Jollain, 1667, da Parma e Piacenza nei Secoli, Felice da Mareto, 1975, fig. 6 - Perspective map of the city of Parma, edited between 1550 and 1650, IGM, fig. 7 - Perspective map of the city of Parma, Marcello da Chioggia, edited after 1567, Palatina Library (PR) IDD 10.

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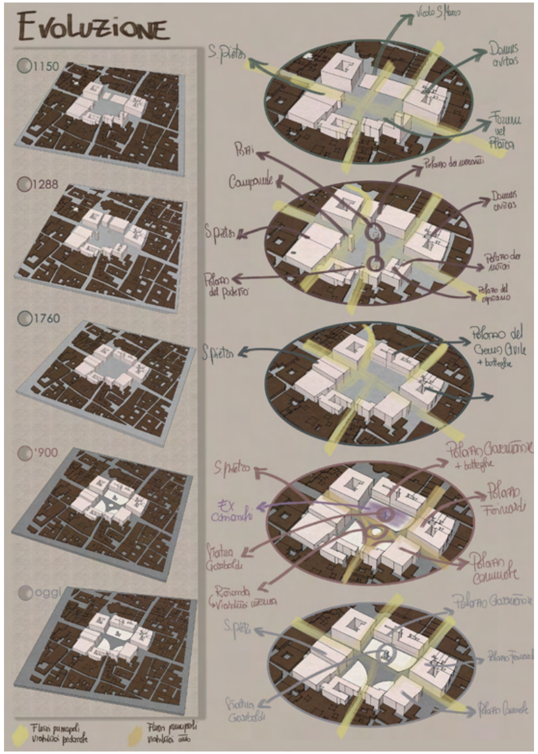

Fig. 17 Modeling and graphic scheme of the urban and morphological evolution of Piazza Garibaldi and Palazzo del Governatore. Realized by Virginia Droghetti.

The architectural evolution of the Palazzo dei Mercanti (now Palazzo del Governatore), built between 1283 and 1285, began on the northern side of Piazza Garibaldi (formerly Piazza Nuova). Originally in late Romanesque style, the palaceconsisted of two separate sections divided by a courtyard.
Over time, it became the seat of various civil authorities, losing its mercantile function. After the collapse of the civic tower, which was part of the neighboring Palazzo Comunale in 1606, the building was renovated, unifying the structure; in 1673, a new tower was added. In 1760, the neoclassical appearance of the palace was reformed by Ennemond Alexandre Petitot. In the 20th century, the interior was renovated in a rationalist style. The palace was restored between 2000 and 2009 and became a 'Place of Modern and Contemporary Art.'
The building has maintained a dual function, with private ownership on the ground floor and public functions. The modeling of the building and its preliminary understanding were made possible through basic bibliographic and archival research. In this specific case, the surveys were directly provided by the Public Administration, while useful maps for the study of urban and architectural evolution, historical cadastral documents, and building practices (useful for verifying the operations of redevelopment and restoration carried out) were researched and obtained from the relevant archives (ASP and ASCPr). The survey within the studied process is based on a methodological approach that refers to pre-acquired information at the time of modeling. In this context, it is assumed that the survey may be total, partial, or absent, depending on the specific circumstances of the building under study. Information regarding the type of survey acquired must be explicitly stated in a specific form called "Form B," which is a fundamental component of the applied method. This form serves to collect and organize all available information related to the building in question, providing a comprehensive and systematic view of the existing knowledge.
In particular, the distinction between total, partial, or absent surveys helps clarify expectations regarding the available data, offering a clear picture of the completeness of the information and any potential gaps. This classification is also useful for defining the path to follow in the "methodological protocol," which also depends on the type of survey acquired.
For example, if the survey is total, a complete modeling phase can proceed after a site verification to check for any inconsistencies or discrepancies; in the case of a partial survey, missing information will need to be integrated, or, if the survey is absent, a new survey campaign must be initiated. All collected information, both historical and documentary, has been uploaded to a cloud platform, directly linked to the created model; immediate access to this historical, documentary, and technical information, directly associated with the model, allows for more efficient and comprehensive data management, with the advantage of reducing the risk of errors or loss of crucial information.
This approach not only optimizes workflow but also allows for real-time management of updates and changes to the model, ensuring that every piece of data is always updated and in line with the most recent information collected.

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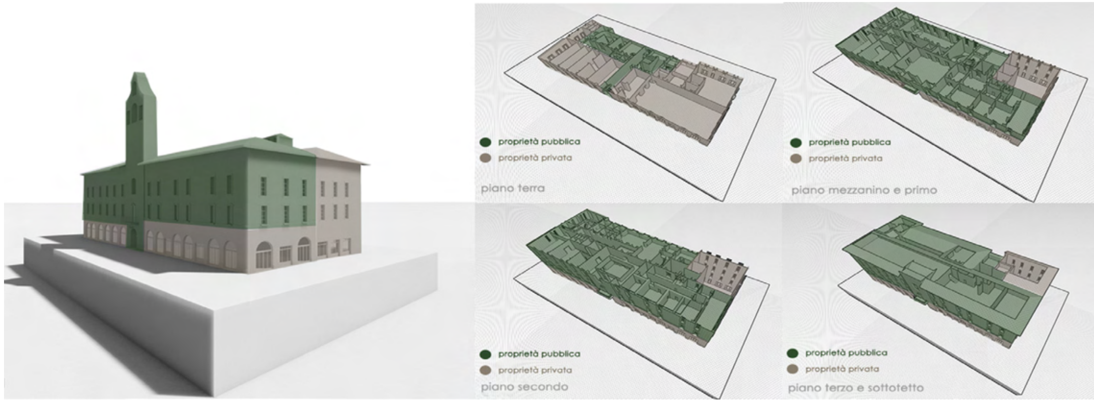

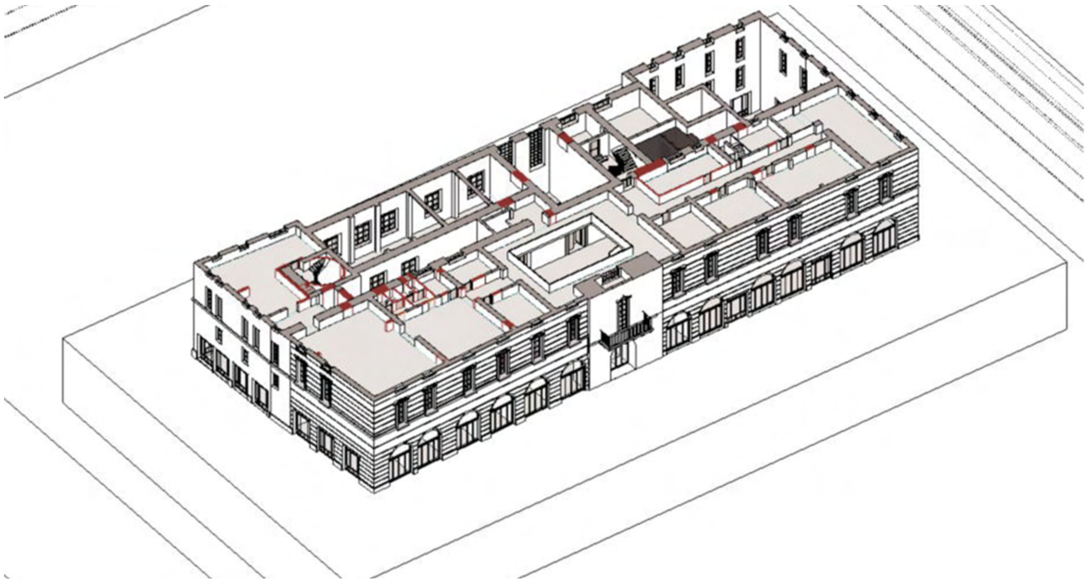

Fig. 18 Modeling and graphic scheme of the different types of properties within Palazzo del Governatore. Realized by Virginia Droghetti.

Fig. 19 Excerpt of the BIM model created with Autodesk Revit 2025, highlighting certain elements of the building dating back to the latest restoration. Realized by Virginia Droghetti.

RESULTS

The integration and comparison of the two modeling techniques highlight how, in the first case, archive information can be leveraged, even though it is less complete in terms of technical and construction aspects, to complete the visualization of the project being studied.
This type of process involves fewer requirements but requires a careful typological and geometric understanding of the building. In contrast, the second case study emphasizes how this specific process allows for the use of an informed parametric methodology applied to existing structures, enabling their digitalization and large-scale management. Transforming this approach into a semi-rigid protocol to follow makes it possible to adopt a replicable method that leads to an in-depth understanding of the element in question, while also allowing the grouping of all the information necessary for managing the asset. In this context, a significantly higher level of accuracy is required, along with more relevant and precise checks.

CONCLUSIONS AND LIMITATIONS

Both 3D modeling techniques offer exciting opportunities for the enhancement of architectural heritage, positioning them as primary sources of information for knowledge, dissemination, and management. The drawings contained in archives, whether historical, design, or documentary, are a fundamental resource that can be transformed into a dynamic and accessible digital heritage through these modeling techniques.
Non-parametric modeling can faithfully represent architecture, even in the case of demolished buildings or unbuilt projects. The ability to reconstruct lost or unfinished buildings is a key aspect of cultural heritage preservation, as it allows for the visualization and analysis of how these buildings appeared in different design phases. This type of modeling, which does not follow a rigid logic of parameters, is particularly well-suited for representing complex structures

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or elements that do not lend themselves to geometric standardization.
Parametric modeling, on the other hand, focuses on aspects that are often repeatable and more modular, making it particularly useful for the management of existing buildings.
Finally, integrating these models (complete with references to archival drawings) with digital platforms allows not only for preservation but also for the dissemination of cultural heritage. The creation of interactive 3D environments, which allow users to virtually explore a building or site, offers an immersive way to understand and appreciate not only the building itself but also its contents. The proposed case study further demonstrates the use of the BIM parametric model of Palazzo del Governatore to design and plan exhibitions in the relevant exhibition spaces, thanks to interaction with other software; this not only enables the forecasting of how a potential exhibition will be realized but also makes the setup virtually accessible to anyone, breaking down any type of barrier.
To address this challenge, it is crucial to adopt innovative solutions for the long-term preservation of digital data. The use of cloud technologies, with particular attention to security and storage reliability, can ensure that digital information is protected from potential loss. The creation of digital archives where both parametric and non-parametric models, historical drawings, and documentary information are regularly updated is an essential step for the preservation of heritage over time.

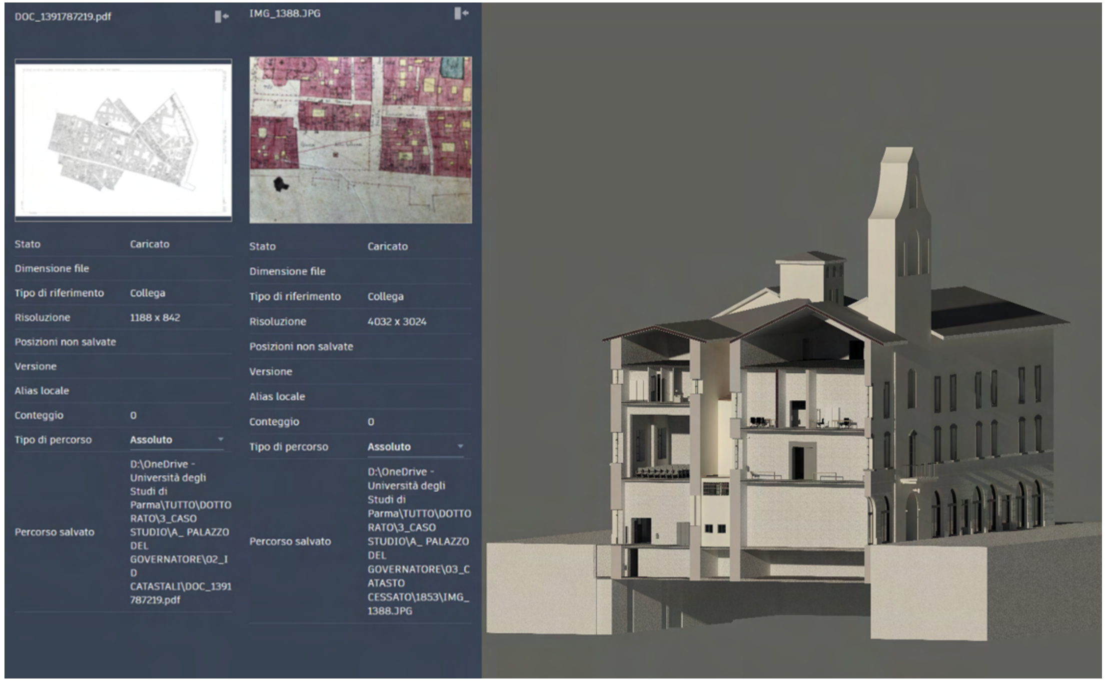

Fig. 20 BIM model excerpt created with Autodesk Revit 2025, highlighting some building elements such as furniture, and on the left side, emphasizing some documents directly linked to the interior of the model, particularly current cadastral identification and historical cartography from the "catasto cessato" (1853). Realized by Virginia Droghetti.

INNOVATIVE AND ORIGINAL ASPECTS

Thanks to the reproducibility of the execution method for both modeling methodologies, with particular emphasis on parametric modeling, it is possible to develop processes aimed at optimizing the management, control, and verification of the entire building heritage.
This approach enables faster results, with reduced costs and a significant decrease in the likelihood of errors or inaccuracies.
For the process to be truly effective, it must begin with archival research, which not only provides the best "starting point" for the project but also offers the opportunity to delve into the formal and constructive reasons behind the original design. Managing such a large amount of digital data presents a significant challenge.
Ultimately, the enhancement of historical drawings through the use of 3D modeling, both parametric and non-parametric, offers a powerful tool for the preservation, management, and dissemination of architectural heritage.
Digitalization not only facilitates access to information and its preservation but also creates opportunities for a deeper understanding of the heritage and its cultural valorization.

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NOTE

[1] Charles M. Eastman, a pioneer in the field of Building Information Modeling (BIM), is recognized as one of the key figures in introducing and developing concepts related to digitization in the construction industry. In 1974, during his research at Carnegie Mellon University in Pittsburgh, Eastman published a paper titled “An Outline of the Building Description System,” which is considered one of the first contributions that introduced concepts similar to BIM.

[2] The level of definition to be adopted for the model is a mandatory choice regarding both the geometric and informational aspects. Evaluating the final purpose of the model is certainly central. The UNI11337 standard defines the LOD (Level of Development) in the American scale, which refers to the qualitative and geometric development of the model.

[3] A result defined as satisfactory is subject to variations depending on the final goal pursued; in this case, a simple result in terms of modeled elements is considered satisfactory but rich in dimensional coherence and its relationship with the surrounding context.

[4] Selected images of conceptual models are presented, with particular attention to planimetric visualization, where various formal changes in the project are clearly visible. The nomenclature of the different phases in which the images are defined in the captions was chosen by the research group to facilitate identification.

[5] The developed method can be applied in small and medium-sized municipalities (small municipalities are defined as having populations of 5,000–10,000 inhabitants, considered urban centers; municipalities with populations between 50,000 and 250,000 are identified as medium-sized cities).

[6] Defining the necessary and suitable figures in the BIM process, within public administrations and beyond, is addressed in Section 7 of the UNI 11337 standard, which is the first structured standard that clearly defines BIM professional figures.

[7] In this paragraph, when referring to archives, the previously mentioned context is recalled.

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