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An Experimental Methodology for the 3D Virtual Reconstruction of Never Built or Lost Architecture

Fabrizio Ivan Apollonio[1[0000-0001-5186-1378]], Federico Fallavollita[2[0000-0003-2916-0262]], and Riccardo Foschi[3[0000-0001-6828-8133]]

[1 2 3] Department of Architecture, Alma Mater Studiorum University of Bologna, Via dell'Università 50, Cesena, 47521, Italy.
[1] fabrizio.apollonio@unibo.it
[2] federico.fallavollita@unibo.it
[3] riccardo.foschi2@unibo.it

Abstract. This paper proposes a methodology to rationalize the process of reconstruction of no more existing or designed but never built architectures. The methodology focuses on the following aspects of the hypothetical digital 3D reconstructions: sources (e.g., gathering, use, documentation), representation method (e.g., geometry, scale, segmentation, 3D modelling), and visualization (e.g., textures, light, point of view, projection method). The method was thought to be as objective, clear, transparent, and reproducible as possible, and it aims to generate 3D digital reconstructions of comparable quality and reusable in various scenarios. It was put to test for several years at the architectural drawing courses of the University of Bologna; one hundred students per class each academic year. The methodology presented is based on an iterative process of calibration of input and outputs based on annual trials. The 3D models constructed were archived in a repository and the retrospective annual assessment fostered critical observations. On the one hand, the method produces, in most cases, comparable, traceable, and reusable models for various purposes (e.g., visualization, semantic analysis, geometrical study, historical study, 3D printing, virtual exploration, etc.). On the other hand, the methodology aims to improve learning and foster architectural cultural heritage knowledge.

Keywords: 3D Modelling Reconstruction, Virtual Heritage, Higher Education, Standardization, C.N. Ledoux, M. Guidi.

1 Introduction

Digital 3D reconstructions have been used as knowledge carriers, research tools and means of representation in architectural history research for more than thirty years [1, 2]. The amount of 3D digital reconstructions has continuously increased in the past years, and they show different technical, graphical, and content-related qualities [3]. In many cases neither the processes of creation nor the quality of the underlying research works is transparent. While a diversity of models and tools is desirable, especially due to the plurality of issues that are investigated, the question of criteria and approaches to evaluate and validate the use of these tools as well as the resulting findings arises.

Fig. 1. Perspective section. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

In this context, numerous research projects emerged with the common aim of systematizing and rationalizing the various issues identified by the scientific community. One of the most prominent and ambitious objectives was the definition of shared good practices as possible standards of reference for the academic/scientific community. The "Arbeitsgemeinschaft Digitale Rekonstruktion des Digital Humanities im deutschsprachigen Raum (DhD) e.V." ("Digital 3D Reconstruction working group" emerged from the 1st Annual Conference of Digital Humanities in German-speaking countries) at the end of 2014 [5] brought together scholars who deal with the topic from the perspective of architecture, archaeology, construction and art history as well as computer graphics and computer science. From this experience, the project "DFG Research Network: Digital 3D Reconstructions as Tools of Architectural Historical Research" (2018-2022) was born. The project aimed to publish a "Handbook of Scientific Digital 3D Reconstruction" that synthesized the topics that arose from the previous initiative [6].

As a direct consequence of the DFG project, the ongoing CoVHer Erasmus + project (Computer-based Visualization of Architectural Cultural Heritage, 2022-2025) can also be mentioned [7,8]. The project is fostering collaboration between seven international partners from all over Europe, whose main purpose is to support the digital capabilities of the higher education sector and stimulate innovative learning and teaching practices. The project strives to define applicable standards and methods for the 3D hypothetical reconstruction, to create a repository of 3D models of CH and to disseminate those outcomes in academic activities, create teaching modules of university courses dedicated exclusively to the virtual reconstructions of CH, and jointly raising awareness among the academic world and the public on the possibility of scientifically reconstructing the past. The department of architecture of the University of Bologna played an active role in both projects.

We believe that research and teaching should be developed in parallel. A methodology can become standard only if it can be easily transmitted and assimilated by the scientific community. The search for an effective and clear methodology, to be shared at an international level, must therefore be tested in smaller contexts, for example with fellow scholars and/or with students. For several years we have been experimenting with a possible methodology in the Lab-based Course on Architectural Drawing (second academic year) of the five-year Architecture Degree course at the University of Bologna. From a didactic point of view, the integration of this experience/methodology in a second-year course of a five-year-long degree in architecture aims to develop skills in the fields of:

- advanced 3D modelling of architecture.
- digital representation, presentation, and visualization of architecture.

Concerning the consolidation of already mastered skills, this didactic experience aims to strengthen:

- the student's capability to perform scientifically valid and transparent documental research and analysis;
- the student's capability to develop an architectural 3D project reconstruction in its entirety.

Fig. 2. Indoor rendered views. Reconstruction of Mauro Guidi’s project “Palazzo isolato per un nobile” Atlante 46, Carta 193 [4].

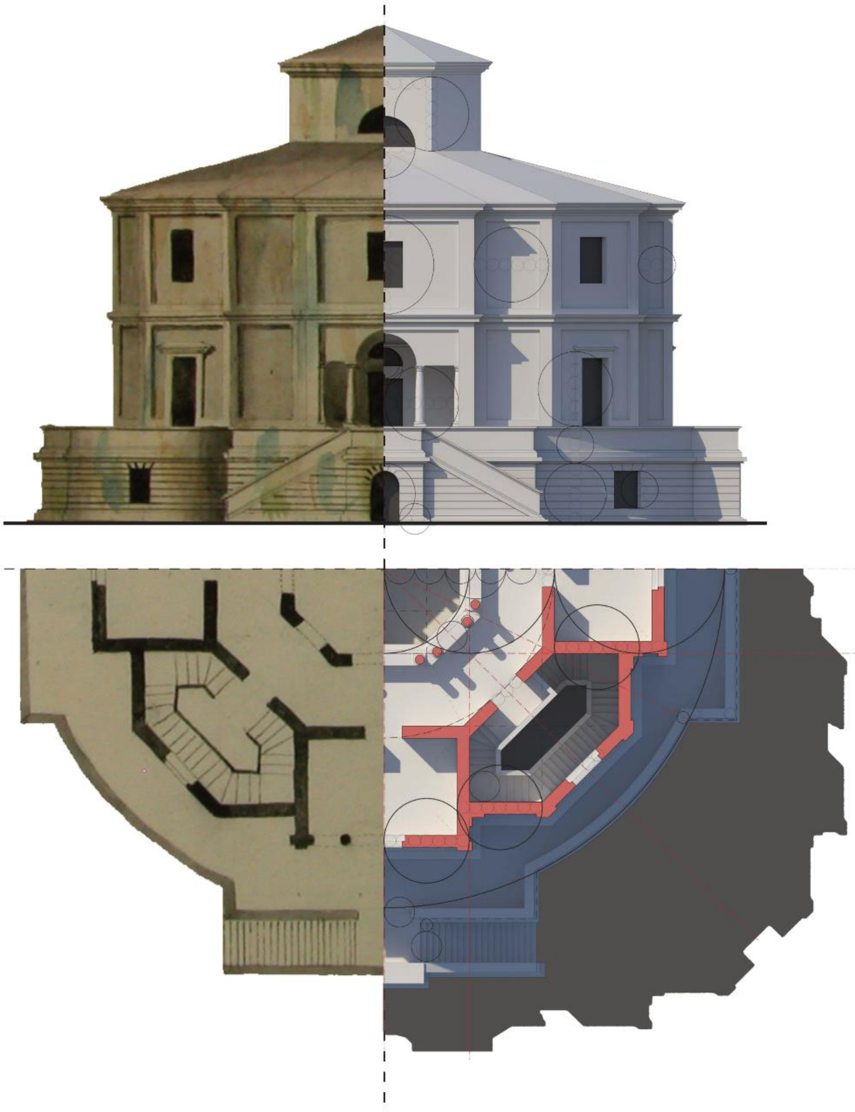

Fig. 3. Elevation and plan. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

2 The Research and its application

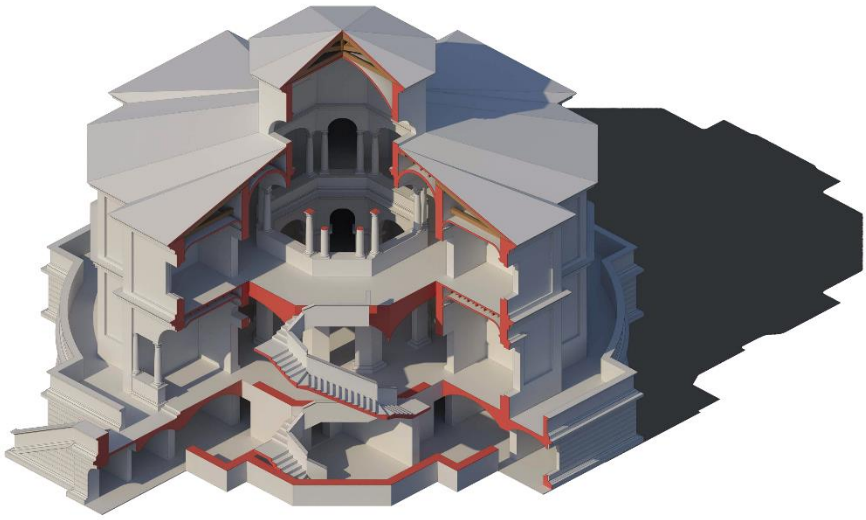

Fig. 4. Cutaway drawing. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

The experimental methodology was proposed for the Lab-based Course on Architectural Drawing [9]. In this course, the students are required to build 3D models of lost or designed but never built architectures starting only from graphical or textual sources, while documenting the reconstruction process carefully (In **Fig. 1**, **Fig. 2**, **Fig. 3**, **Fig. 4**, **Fig. 5**, **Fig. 6**, **Fig. 9** you can see an extract from the work presented by the students M. Barchi and M. J. Davey). Each year the seminar course focuses on a particular architect. For example, in recent years, the case studies proposed were the unrealized projects by Claude-Nicolas Ledoux (1736-1806), and Mauro Guidi (1761-1829). The architectural drawings of these two authors, children of the ideas of the French Enlightenment, are perfect sources of study for the objectives of the experimentation. Both sets of projects are composed of a multitude of different architectures, but with similar complexity and style, most of the architectures in these sets are never realized but are graphically represented in a wealth of detail.

They deal with different and well-defined typologies and experimental/practical use of the classical language of architecture. These graphical sources sometimes present inconsistencies and missing parts which foster critical thinking and require dealing with the topic of uncertainty and subjective additions. Both authors are known to be utopian and among the multitude of designs that they produced, only a minority was realized. Ledoux gathered and published numerous of his neoclassical designs in the book "*L'Architecture considérée sous le rapport de l'art, des mœurs et de la legislation*" [10]. Guidi, similarly, produced a multitude of projects (more than a thousand), civil and religious buildings, monuments and colonic houses, which mostly remained unrealized.

All these projects, collected into eleven "*Atlanti*" now preserved at the Biblioteca Malatestiana in Cesena [11], document his ambitious dream to realize a new urban renewal of Cesena and Cesenatico cities which he was never able to realize.

The experimentation, carried out also in form of didactic activities, has allowed us to evaluate the progress and the results achieved concerning two main topics:

- the Applied Methodology for the virtual reconstruction of 3D models of architectures from the past;
- some Theoretical Aspects aimed at defining virtual 3D reconstruction as an autonomous discipline.

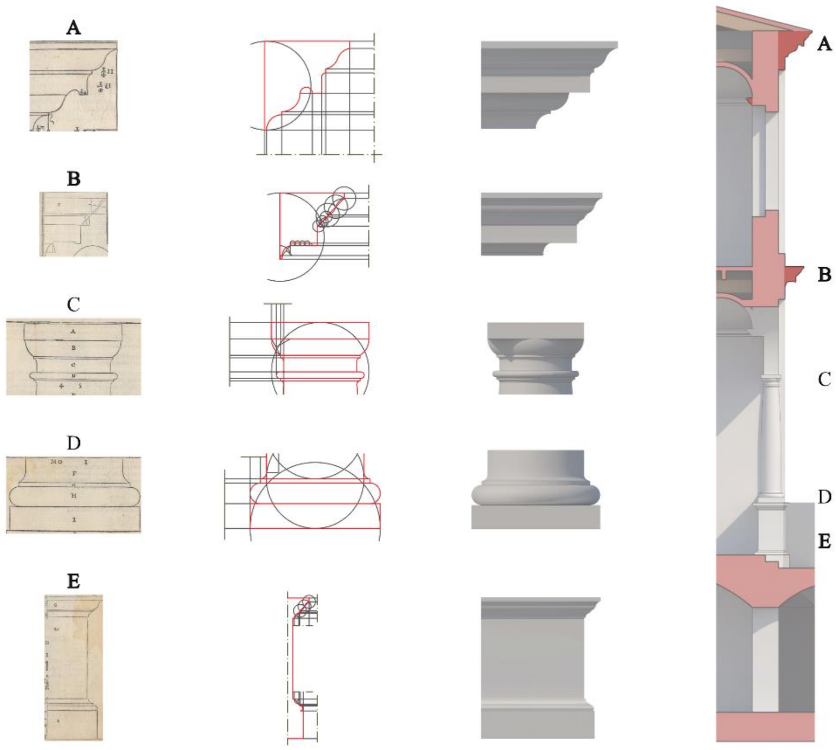

Fig. 5. Architectural details. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

3 The methodology

The course is aimed at second-year architecture students. After completing the course, students acquire the knowledge to analyse, decompose and represent the complexity of architectural projects through drawing. This acquired knowledge will allow students to

use representation methods as graphic languages aimed at guiding the creative process of architectural design from its implementation phase to its execution.
The course includes one hundred hours of teaching: about a half dedicated to theoretical and practical lectures and the other half dedicated to laboratory work: in which students independently work on the assigned topics, assisted by teachers and tutors. The theoretical and practical lessons are dedicated to two fundamental topics: the first is descriptive geometry and the second deals with the theme of virtual reconstructions. The former is necessary to acquire the theoretical and practical concepts to control and visualize geometric shapes in 3D space (3D modelling is an integral part of this first topic); the latter is aimed at understanding the theoretical and practical aspects of the world of virtual reconstructions.
From a research point of view, the important aspect (onto which also the didactic is focused) is the systematization of the main concepts that can help to share 3D models as scientific products. The innovation of this research, therefore, does not consist in the methodology itself but in the analysis of the theoretical and practical aspects of the discipline. Virtual reconstruction is a mature enough field that could and should start to be considered as an autonomous discipline, but a systematization and rationalization effort should be made and should be shared at the international level.
The methodology used for the virtual reconstructions of the 3D model is divided into various phases of which the main four are:

- gathering, analysis and 2D redrawing of the main sources;
- critical virtual reconstruction of the 3D model;
- analysis and visualization of the 3D virtual reconstruction;
- documentation of the reconstruction process.

The first phase is dedicated to the analysis and redrawing of the 2D sources (see next paragraph). In the case studies addressed, the main sources are the digital reproductions of the original drawings of the projects. The digital images are obtained directly from the original sources: in the case of Mauro Guidi the sources are digital photographs of the original drawings conserved in the Malatestiana Library in Cesena [11]; in the case of Claude-Nicolas Ledoux the sources are the digital scans of the tables of the projects reported in the book "*L'architecture"* [10]. Whenever possible, it is advisable to obtain digital reproductions of the sources directly from the original drawings to avoid interpretation errors due to the scarce quality of digital reproductions or unknown eventual mistakes committed by the operator during the acquisition phase.
The 2D redrawing is performed with the method of continuous/mathematical representation (see next paragraph). The study and construction of the plans and elevations from the original drawings are carried out using the author's original construction module and the original most plausible reference historic units of measurement, however, this 2D critical redrawing is later transferred into the contemporary metric system right before starting modelling. This allows both to check the dimensions of the architecture in a system more comprehensible nowadays and to produce models that are easily comparable since they all have the same measurement system and scale.
The 3D model is reconstructed from this preliminary 2D redrawing. Sometimes the drawn references can be incomplete; e.g., plans or elevations may be entirely missing;

or a section, a façade, or a plan might not be finished properly. Furthermore, the drawings are often not consistent with each other; e.g., there may be inconsistencies between the plan and the elevation: some dimensions may be different, or the plan may show windows that are not present in the elevation, etc. The most relevant problems are generally found in the design of the stairs, vaults and roofing. For example, both Ledoux and Guidi, in their projects often report the position of the stairs in plan and section without developing properly their features and correctly dimensioning them; or they do not show the design of the vaults or the roofs in elevation. These missing or inaccurate parts must be redesigned to make the 3D reconstruction coherent and functional.
The 3D model is semantically organized [12] by building each 3D element that makes up the architecture as independent geometries (e.g., column, architrave, tympanum, wall, roof, etc.) Furthermore, the various elements, when the sources allow it, are divided into sub-elements (e.g., the column consists of base, shaft and capital, etc.). The semantic organization is essential because it allows any user of the model to analyse and design the construction of the 3D model rationally and makes it possible to recognize the elements of the architecture without ambiguity. To improve the analysis possibilities and versatility of use, these elements must be watertight 3D models without self-intersections and assembled without overlapping (see next paragraph).
The Documentation/Visualization process [13] consists of describing textually the process of reconstruction and presenting visually the 3D outcomes of such process by producing graphical outputs such as images, mock-ups, videos, or interactive experiences. In the experimentation with the students, they were required to produce several graphical outputs where they had to present visually the 3D models and explain clearly, synthetically, and unambiguously the reconstruction process starting from the study of the sources, up to the reverse engineering of the details and the documentation of the subjective interpretations. In this last step, the use of abstract shading techniques such as the colouring of the surfaces with false colours was recommended to communicate visually various types of information such as the type of sources used to reconstruct each element or to estimate the level of uncertainty of the reconstruction (see next paragraph).
For visualization, the NURBS mathematical model can be projected into a plane to extract wireframe technical drawings or can be tessellated and transformed into a MESH polygonal model to make rendered views. An important part, therefore, is dedicated to the coherent and critical use of traditional and digital methods of representation which, for lack of space, we omit to describe here.

4 Theoretical Aspects

Concerning historical sources, the methodology proposes a first classification, and in the course, the students deal with the following two types: paper documents (e.g., the autographed original architectural drawings or written testimonies of the time, etc.); or real remains (e.g., the column of a specific reference building by the same author, etc.). In the case studies presented, the primary sources are the digital reproductions of the architects' original drawings: the unrealized projects by Ledoux and the unrealized projects for the cities of Cesena and Cesenatico by Guidi. For both types of sources, it is necessary to preliminary acquire them digitally.

4.1 Raw Model and Informative Model

Concerning the acquisition step, it is important to mention a novel classification: the Raw Models (RM), and the Informative Models (IM). RMs are digital models obtained through quasi-automatic procedures that process raw data captured from real sources (digital photogrammetry or laser scanning technology). In the first case, the raw model would be a 3D model (i.e., a point cloud or a textured mesh model). In the second case, the raw model would be a bidimensional object (i.e., a Raster image at a certain resolution). The IM is a 3D digital model that is enriched with information processed and interpreted by an author.

The main difference is conceptual: the RM represents only physical data transformed into digital raw data. The IM, on the other hand, represents the complex process of the interpretation of the sources. The IM is a model obtained through a reverse engineering operation. In this sense, the RM is used as a source for the latter operation: it represents the digitization of real sources (whether they are real archaeological remains or paper documents).

Concerning the generation of the IM, the method takes into consideration several formal aspects:

- the scale (level of detail);
- the semantic segmentation (a subdivision of the model into nominable sub-elements);
- the level of discretization of the geometry (approximation of continuous curve surfaces with a certain amount of flat faces);
- the study and use of the composition rules (e.g., the modularity, the presence of axes of symmetry, the presence of ratios or geometrical constructions, etc.);
- the use of historical units of measurement.

4.2 Semantic segmentation

The semantic segmentation aspect is a fundamental step for the creation of a scientifically sound reconstruction. The organization of the model must comply with the analysis and construction of the various architectural elements that compose the 3D model to make them easily identifiable and univocally nominable (**Fig. 6**). The level of detail of these elements is linked to the concept of the scale of the model. The architectural elements, therefore, can be made up of doors, windows, walls, beams, roofs, etc., or more specific elements such as pillars, columns, lintels, tympanums, frames, etc. Each element or sub-element must consist of non-self-intersecting and watertight 3D models; for example, if the 3D digital method used is the NURBS mathematical method, the individual elements must be made up of manifold closed poly-surfaces.

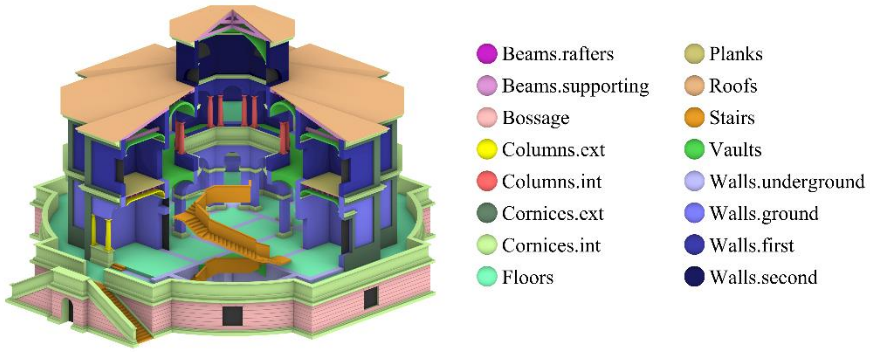

Fig. 6. Semantic segmentation. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

4.3 Digital Representation Methods

The concepts of "Digital Representation Methods" and "3D Digital Modelling Techniques" are often used as synonyms, however, in the presented method these aspects are differentiated into two distinct families. The formers (namely, NURBS and mesh modelling, etc.), according to some authors [14], are related to the concepts of traditional methods of representations (axonometric projections, perspective projections, double orthogonal projections, topographic terrain projections), thus they can be considered as representation languages. On the contrary, the latter are all those practical processes that are used to produce a 3D model by using specific tools (e.g., parametric modelling, handmade direct modelling, algorithmic computational modelling, automatic reality-based modelling, etc.) and are comparable to the traditional drawing techniques (e.g., ruler and compass, free-hand pencil drawing, watercolour painting, etc.).

There are several ways to classify Digital Representation Methods. **Fig. 7** shows some possible classifications of architectural reconstructive 3D models, it shows their classification into the RM and the IM; the classification based on their Configuration Space; the classification based on the 3D Modelling Techniques and Representation Methods.

The Digital Representation Methods concern the intrinsic mathematical/geometrical nature/language of the 3D models and are the following:

- continuous methods: the geometry is described in a non-discrete way with continuously defined mathematical equations, the Mathematical/Surface Modelling is part of this category (for example NURBS modelling, Bezier modelling, Spline modelling, etc.);
- discrete methods: the curve geometry is approximated with a finite amount of non-curved elements (points, segments, planar faces), thus it is described numerically, not with equations, but with points identified by their coordinates (vertices), lines (edges), and planar faces (triangles/polygons); the Numerical/Polygonal Modelling is part of this category (for example Mesh modelling, Point Cloud modelling, Voxel modelling, etc.).

3D models can also be generated with Hybrid Methods (i.e., a model can be made of continuous and discrete surfaces at the same time). This also happens in traditional representation methods: for example, in the perspective section where the section is in true form (as in double orthogonal projections) and coexists with the perspective view of the inside space. All methods have a specific vocation, and one might be more effective than another only in some contexts. That is why they should all be mastered properly and chosen case by case.

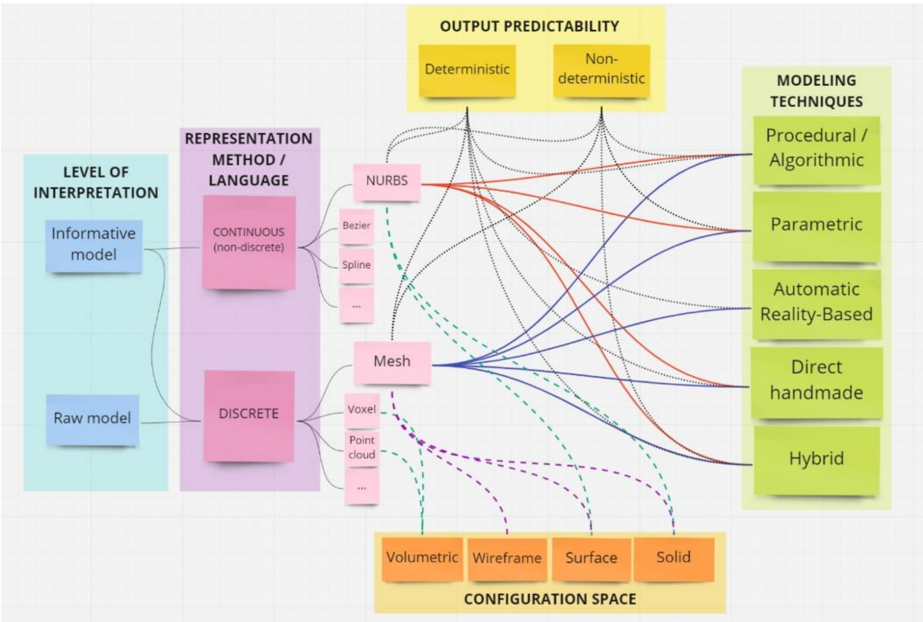

Fig. 7. Classification of different types of 3D modelling, in the field of 3D hypothetical architectural reconstructions.

4.4 3D Modelling Techniques

The 3D Modelling Techniques are those practices, processes and norms that are used to create the models. To make an analogy with traditional drawing: the watercolour technique, for example, can be used to draw and add a shading effect (chiaroscuro) to scenes that follow the rules of perspective projections, axonometric views, or double projections. Analogously, the direct handmade modelling technique or the procedural modelling technique, for example, can be used to generate models described by different Digital Representation Methods, such as Mesh and NURBS.
Given this assumption, the following approaches can be considered modelling techniques:

- procedural/algorithmic modeling (Rhinoceros+Grasshopper, Revit+Dynamo, Blender+Geometry Nodes…);
- parametric modelling (Inventor, Catia, Creo Parametric…);

- automatic reality-based modelling (Agisoft Metashape, Reality Capture…);
- direct handmade modelling (Rhinoceros, Autocad, Zbrush, Blender, 3Dmax, C4D…);
- hybrid modelling (Almost all commercial software packages nowadays support hybrid modelling);

Some 3D digital modelling well-known techniques that do not appear in the list (e.g., digital sculpting, subdivision surface modelling, etc.) aren't mentioned here because they can be considered as sub-groups of already mentioned techniques (e.g. both sculpting and subdivision surface can be subgroups of direct handmade modelling).

It is important to note that the classification proposed here on modelling techniques is "provisional". Professional 3D modelling applications are constantly evolving and there is no shared terminology. This proposal is based on the general concepts that each technique represents, and it is not linked to particular software. The computer applications in parenthesis were added to help the reader orient, but those applications are not exclusive to only one technique.

4.5 Scale of Uncertainty

The scale of uncertainty is a common tool often used in the context of 3D reconstruction of lost architecture or designed but never built architecture. A colour is assigned to each level of the scale, and each level has a textual description that clarifies the level of uncertainty sometimes related to the type and/or quality of the sources (**Fig. 8**). Each element of the 3D model is then coloured with one of the colours (**Fig. 9**), this kind of abstract shading gives information about the level of uncertainty of each element and of the overall model at a single glance.

Several scales of uncertainties were developed over the years [15,16,17, 18], for example, the scale presented in **Fig. 8** was developed to minimize ambiguities and overlapping between the different levels, it is based on the presence/absence of preserved/damaged sources and their authors [19].

	Real object	Direct \ Primary sources		Secondary sources		Uncertainty
		Clear \ Consistent	Damaged \ Unclear	Same author\s	Other author\s	
1	✓ available	\	\	\	\	Reality (objective)
2	✗ unavailable	✓ available	\	\	\	Conjecture (reliable)
3	✗ unavailable	✗ unavailable	✓ available	✓ available	\	Conjecture
4	✗ unavailable	✗ unavailable	✓ available	✗ unavailable	✓ available	Conjecture
5	✗ unavailable	✗ unavailable	✗ unavailable	✓ available	\	Conjecture
6	✗ unavailable	✗ unavailable	✗ unavailable	✗ unavailable	✓ available	Conjecture
7	✗ unavailable	✗ unavailable	✓ available or ✗ unavailable	✗ unavailable	✗ unavailable	Conjecture (subjective)
\	\	\	\	\	\	Abstention

Fig. 8. Example of a scale of uncertainty where the uncertainty is measured from the type and authorship of the reference sources [19].

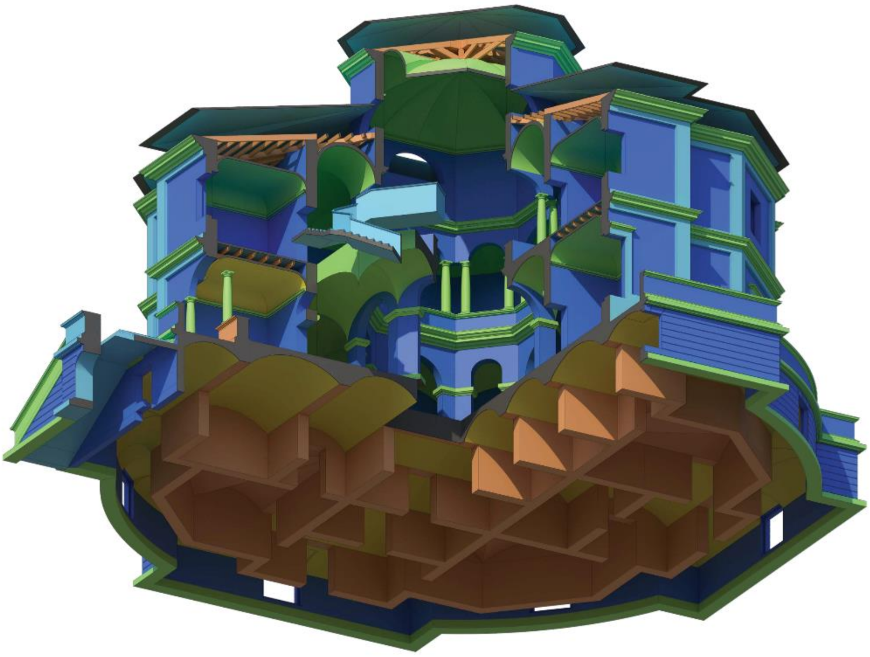

Fig. 9. False-colour shading representing the level of uncertainty of each element of the 3D model. Reconstruction of Mauro Guidi's project "Palazzo isolato per un nobile" Atlante 46, Carta 193 [4].

5 Iterative improvement of the methodology

The experimental methodology was proposed as a didactic tool at the academic level for more than ten years and the results of each year were assessed and rediscussed iteratively year after year to improve the methodology itself, i.e., to limit eventual errors by the students and various problems concerning readability, shareability and reusability of the archived 3D models as much as possible.

The results were evaluated based on several aspects:

- formal geometrical accuracy (geometry, scale, level of detail, etc. had to comply with the good practices taught, this would guarantee interoperable 3D models for various uses);
- description of the methodology adopted (Description of the design process to create the 3D model, including technical indications such as the method of digital representation used, etc.);
- clear and transparent documentation (all the sources used had to be clearly reported and related to the relative elements);

- visualization of the 3D model (creation of images, animated videos or interactive navigations to communicate the formal aspects and other information of the virtual reconstruction).

The students were required to present their 3D models through bidimensional visual outputs carefully designed (e.g., orthogonal views, perspective projections, renderings, etc.) proving to a commission that they followed a scientifically sound process of reconstruction. The reconstructed 3D models and the appended documentation were archived in a local repository (following the assigned archival guidelines) and inspected one by one by a trained commission. After a few years, some models were inspected again to see if they were still comprehensible and reusable in different contexts.

The retrospective annual assessment fostered critical observations. If a particular iteration of the method did not guarantee the 3D models to be: comparable, traceable, and reusable for various purposes the reconstruction method taught was adjusted accordingly.

In the first few yearly iterations for example the students were allowed to use any type of digital representation method to build the models (NURBS or Mesh) and it was observed that mesh models were hardly reusable for other applications at different scales unless heavy manual modifications were carried out (because the tessellation level wasn't always modifiable from the provided files). Furthermore, mesh models weren't suitable for the extraction and backtracking of the original generative curves, this limited the possibility to project them into a plane and extract vector 2D technical drawings of the models and thus it limited the geometrical analysis opportunities. Lastly Mesh models were much heavier to archive. The NURBS modelling was adopted as a better option to make more versatile reconstructions reusable in different contexts.

Another improvement carried out over the years regarded the adoption of non-self-intersecting watertight volumes, because these types of 3D models were necessary for 3D printing, and, most important, helped the scholars and the students to understand the three-dimensional relations of the architectural elements.

This research could produce some appropriate insights in terms of the analytical approach adopted to systematise the reconstruction process for a specific purpose aimed at producing a clear and transparent sharing of knowledge.

This systematisation effort should be a focus for all the research environments that aim to produce and archive comparable reusable and scientifically valid 3D reconstructions. Not every 3D modelling methodology returns the same level of overall quality concerning, geometry, documentation, traceability, and interoperability. Rising awareness about this aspect would help to start building an autonomous discipline for 3D reconstruction at the international level, and maybe it could set the basis for the standardization of the reconstruction processes according to various contexts and needs.

6 Conclusions

The proposed methodology aims to rationalize and systematise the 3D hypothetical reconstruction and sharing process of lost or designed but never realized architectures. The method, tested in a higher education architectural drawing course, proved to be an effective didactic experience that encouraged the students to focalize their attention on crucial aspects such as geometry, semantics, topology, and historical aspects; bringing forward the knowledge of the manufacts and fostering critical thinking about architectural composition. In a more general research context, it also proved to be effective in the production of uniform, transparent, comparable, interoperable, reproducible, and reusable 3D outputs for various needs.

The novelty of this experience does not consist in the methodology itself but in the analysis and systematisation effort of the theoretical and practical aspects of the discipline. This could help to share 3D hypothetical reconstructions as scientific products and could contribute to rise awareness that not every methodology produces results suitable for every type of scientific use. The presented discussion could foster and encourage standardization for scientific 3D reconstructions at the international level and would contribute to defining the 3D reconstruction of architectural models of the past as an autonomous discipline.

Acknowledgement

Some figures (**Fig. 1**, **Fig. 2**, **Fig. 3**, **Fig. 4**, **Fig. 5**, **Fig. 6**, **Fig. 9**) were extracted (and elaborated) from the case study curated by the students Matilde Barchi and Molly Jade Davey of the University of Bologna.

CoVHer (Computer-based Visualisation of Architectural Cultural Heritage) is an Erasmus Plus Project (ID KA220-HED-88555713) [7, 8]. It is a 36 monthly project and it started in February 2022. There are seven principal partners from five different European countries. The partners are University of Bologna (Bologna, Italy), Hochschule Mainz University of Applied Sciences (Mainz, Germany), Politechnika Warszawska (Waraw, Poland), Universidade Do Porto (Porto, Portugal), Universitat Autonoma de Barcelona (Barcelona, Spain), Tempesta Media SL (Barcelona, Spain), Interessengemeinschaft für semantische Datenverarbeitung e.V (München, Germany). The scholars currently involved in the project are (the order of persons follows the institution to which they belong): Fabrizio Ivan Apollonio, Federico Fallavollita, Riccardo Foschi, Irene Cazzaro, Piotr Kuroczyński, Jan-Eric Lutteroth, Igor Bajena, Krzysztof Koszewski, Franczuk Jakub, Karol Argasiński, Joao Pedro Sampaio Xavier, Clara Pimenta do Vale, Hugo Pires, Juan Antonio Barceló Álvarez, Evdoxia Tzerpou, Marc Hernández Güell, Raquel Garcia, Pol Guiu and Mark Fichtner.

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