3D PRINTING AND AUGMENTED REALITY: THE PROJECT FOR THE SECOND COMPETITION FOR THE ITALIAN PARLIAMENT BY ERNESTO BASILE.

F. Avella [1], M. Cannella [1], F. Lanza [1],
[1] Univerity of Palermo, Department of Achitecture, Palermo, Italy - (fabrizio.avella, mirco.cannella,)@unipa.it; fabrizio.lanza@community.unipa.it

KEY WORDS: 3D modelling, 3D printing, Augmented Reality, Conjectural reconstruction, Ernesto Basile.

ABSTRACT:

The project for the second competition for the Parliament of the Kingdom of Italy, drawn up between 1888 and 1889 sees Ernesto Basile (Palermo 1857-1932) as winner ex aequo. Basile's project envisages the construction of a large monumental building (182.70 m by 171.40 m), in which the three halls, the Chamber, the Senate and the Royal Sessions Hall, develop around a large central courtyard; it will not be realized due to the fall of the Crispi government in 1891, but presents, in embryo, solutions adopted in the expansion of Palazzo Montecitorio (1903 - 1918), entrusted to Basile, in which the Chamber of Deputies, still existing today, is may consider "a sort of budding, from the organism of his second Parliament Building" (Mauro, Sessa 2000b).
The original drawings are kept and cataloged in the Basile Endowment of the Scientific Collections of the Department of Architecture of the University of Palermo, edited by Professor Ettore Sessa (Mauro, Sessa, 2000a; Sessa, 2014, Mauro, Sessa, 2015).
In a first phase, the conjectural reconstruction and digital modeling was carried out (Avella, 2020), and in a second phase, a first 3D printing model was created, limited to the main front, which involved the design of the decomposition and assembly according to criteria respectful of architectural parties (Avella, 2021).
This work presents the progress of the work, extended to the bodies containing the Chamber of Deputies and that of the Senate and the integration with Augmented Reality systems, in view of the future permanent exhibition at the premises of the Basile Endowment. The integration with Augmented Reality visualization systems stems from the desire to allow the observer to visualize the external envelope of the physical model and the internal spaces of the parliamentary halls.

1. INTRODUCTION

This paper presents the continuation of a process of analysis conducted on the Project of the second Palace of Parliament, drawn up by Ernesto Basile (Palermo, 1857 - 1962) between 1888 and 1889.
The study was conducted on the documentary material, containing drawings and writings, preserved in the Basile Fund of the Department of Architecture in Palermo.
The first steps involved the analysis of the available material and the possibility of carrying out the analysis and construction of a digital model that had a good level of reliability.
The digital model was made in order to achieve various results: in a first step, analytical drawings and rendered views were made includimg perspective views; then the model was optimized for the creation of a 3D printed model, to be made in three stages: the first involved the main front, the second the side bodies containing the Chamber of the House and the Senate Chamber, and the third the rear body containing the Chamber of Royal Sessions. Finally, an augmented reality system aimed at visualizing the interior spaces in superimposition on the PLA model was created; the system was made to be used both in the case of temporary exhibitions and in the final exhibition planned at the Basile Endowment premises.
Here we present the progress related to the implementation of the second portion of the model in PLA and the implementation of the system in Augmented Reality.

2. METHODOLOGICAL PROCESS

2.1 Historical background and building description.

The call for competition for a large palace to become the seat of the Parliament of the Kingdom of Italy is published in the «Official Gazette» of October 30, 1888 and proposes the theme with similar demands to that of 1883.
Ernesto Basile's project is the winner ex-aequo with those of Luigi Broggi and Giuseppe Sommaruga, Gaetano Moretti, Pier Paolo Quaglia and Vincenzo Benvenuti, and Enrico Ristori and is beneficiary of the First Grade Prize awarded by unanimous opinion of the Examining Board (Mauro, Sessa, 2015, p.73).
The competition would not go ahead due to the political crisis following the fall of the government headed by Francesco Crispi on January 31, 1891.
The layout shows remarkable design maturity, gained over the years through participation in the first Competition for the Palace of Parliament (1882-83) and the competitions for the Palace of Justice (1884-1887).
Not indifferent to the design outcome was the study conducted by Basile on the German Parliament Building Project in Berlin, whose competition, of 1882, had been won by Paul Wallot[1]
Basile's Project is praised in the final report of the results of the competition: "Favorable judgment was expressed especially for the 'very airy and illuminated plan in every part' [...]" (Mauro, Sessa, 2015, p. 74).

[1] The study was published in Basile, 1888.

The three-body scheme facing a large central courtyard and the presence of secondary courtyards is justified by Basile himself: "In Rome, indeed, the very mild climate in winter, hot in summer, and the natural need for ventilation undoubtedly advise better recourse to well-spaced and ventilated courtyards, rather than to large glass-covered rooms" (Basile, 1890a, p. 1). He remarked the role of the large central courtyard: "I therefore chose the party of a large central courtyard, which was really a precipitous part of the composition" (*ivi*., p. 2).
The layout includes the placement of the Chamber of Deputies to the right of the main axis, the Senate Chamber placed symmetrically and the Royal Sessions Chamber in the rear body. All three chambers face the large courtyard that is accessed from the entrance located on the main front marked by the large urban tower.
The tower placed at the entrance has an exclusively symbolic value to mark the presence of the nation's most important institutional seat: "I will only mention this that, to qualify the edifice, instead of resorting to a dome, which no matter how bold or immense would hold up poorly in Rome in comparison with the infinite number of them and, whatever one may say, would give the palace a religious character that it must not have; [...] I preferred to stick to a party more justifiable in a palace destined to receive the representatives of a nation, that is, a tower in the upper part of which the bells of parliament should find a place" (*ibid*.).
The used language shows a neoclassicism eclectly declined in in the planimetric layouts: the neo-Romanism of the Chamber of Deputies is flanked by the neo-Hellenism of the Seanate, while the Royal Seating Room is inspired by neo-Renaissance structures (Mauro, Sessa, 2015, p.77). The façades unify the language of the wall masses thanks to neo-Renaissance matrices: "The layout of the elevations, on the whole, recalls Renaissance models of patrician palaces" (*ivi*, p. 78).
The Chamber's Hall takes on particular importance, as it becomes the embryo of the project developed for the enlargement of the Montecitorio Palace, drafted in 1902, in which he will realize the body of the building containing the Chamber of Deputies, which still exists today.
The enlargement of Palazzo Montecitorio does not evoke the one of the second competition only in the structure of the Chamber, but also contains references to the articulation of the wall masses: "Verisimilarly, Ernesto Basile retraces some of the solutions of his older project for the Palazzo del Parlamento, winner of the competition of 1889; in fact, we can see its permanences in the main front, with the two towers and the central projecting party, and in the logic of the distributive plant [...]" (Mauro, Sessa, ed., 2000 b, p. 91).
The area destined for construction is located at the beginning of the Via Nazionale and is adjacent to the Forum of Trajan. Basile's plan shows how the project area has historical emergencies, traced in black ink, including the Torre delle Milizie (Tower of the Militia), which, if retained, would have been adjacent to the main elevation.

2.2 Archival source analysis.

The archival unit comprising the project drawings is part of the *Basile Fund* (FB D'ARCH UniPa), part of the *Basile and Ducrot Collections* (former *Basile- Ducrot Endowment*), whose Scientific Head is Prof. Ettore Sessa; it is part of the Scientific Collections of the Department of Architecture of the University of Palermo. The Fund consists of the *Archivio Disegni Progetti* (ADP), the *Archivio Disegni Miscellanea* (ADM) the *Archivio Fotografico* (AF), the *Raccolta Documenti* (RD) and the *Biblioteca* (B) (Mauro, Sessa, 2015, pp. 13-39).

Figure 1 General planimetry, scale 1/1000, pencil, India ink, red and blue ink and watercolor on cardboard.

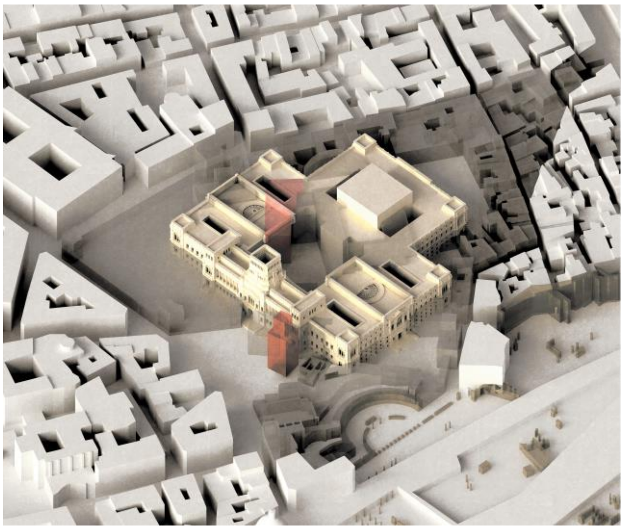

Figure 2. Inserimento del modello digitale nel contest urbano in base alle indicazioni della planimetria originale di Progetto (by Fabrizio Lanza).

The archival unit includes 19 documentary units, ranging in size from 70.5 by 68.2 cm. of the topographical framing to 81.0 by 187.6 cm. of the main elevation inventoried from ADP No. 208 to ADP No. 226 (boards and illustrations in Sessa, 2014 and Mauro, Sessa, 2015).
Two versions of the plan exist, but already in the first the general layout is well visible. Among the few changes is the rethinking of the side bodies of the main elevation, initially conceived with six openings that are reduced to five in the final version.
The configuration of the final version is derived, in addition to the drawings of the final plates described in the *Memoir attached to the Project*, drafted in October 1889, from what is reported in two publications, signed by Basile himself: the *Project for the Palace of the Italian Parliament awarded in the national competition of 1889*, published in Rome in 1890, and

the article *Project of a Palace for the Parliament*, present in the *Proceedings of the College of Engineers and Architects of Palermo*, 13th year, published in Palermo also in 1890.
In the latter, one can see the presence of some arrangements made with a view to its eventual realization, such as the articulation of the ground plane.
The drawings of the first version and the preparatory drawings were helpful in understanding the layout and inferring the design process that led to the final version.
For the reconstruction of the model, reference was made to the drawings considered consistent for the purpose of drafting the submitted project. Specifically: the floor plan at a scale of 1:1000 (ADP 210); four floor plans at the various levels, inked on cardboard, at a scale of 1:200 (ADP 213, 215,216, 217, 218); three floor plans, of the Chamber of Deputies, the Senate Chamber and the Royal Seating Room, inked on cardboard, at a scale of 1: 100 (ADP 218,219, 220); the main elevation and cross-section, in pencil and ink on cardboard, scale 1:200 (ADP 222); the side elevations, in pencil, ink and watercolor on cardboard, scale 1:200 (ADP 225); the rear elevation and cross-section, in pencil and ink on cloth paper, scale 1:200 (ADP 214). In the case of the latter drawing, it is a preparatory drawing, unshaded, unlike the drawings of the other fronts.
Information inferred from the drawings of the first variant and those of the second variant were interpreted in order to make the ensemble of planimetric and altimetric dimensioning coherent and homogeneous. In this way it was possible to correctly dimension the drawings from the 1890 publications, assumed to be definitive for the creation of the vector drawings.

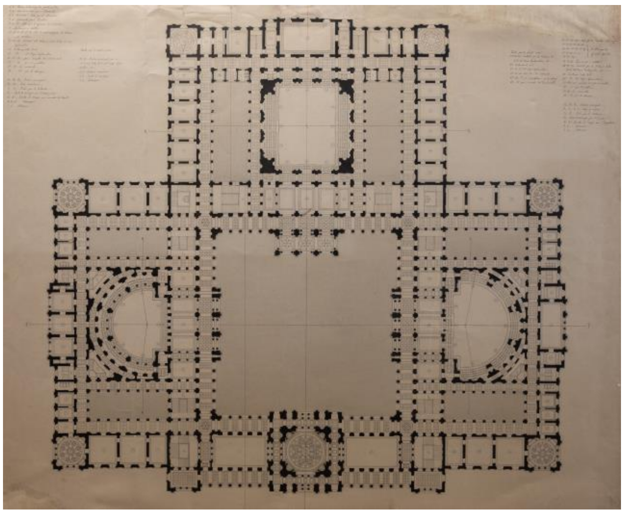

Figure 3. Floor plan of the second floor, scale 1/200, pencil, red ink ink and watercolor on cardboard.

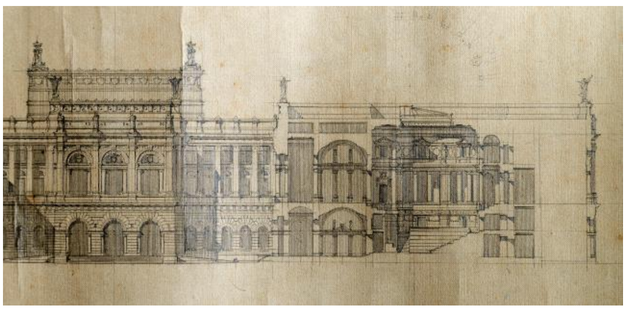

Figure 6. Portion of the cross-section with part of the front on the courtyard and the Chamber Hall, second variant, scale 1/100, pencil on cloth paper.

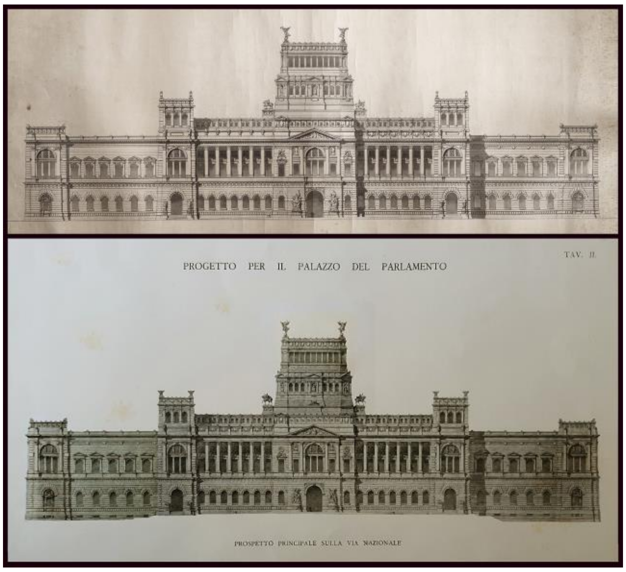

Figure 4. Main elevation. Top: first version, scale 1:200, pencil, India ink and watercolor on cardboard; bottom: final version published in Basile 1890 a).

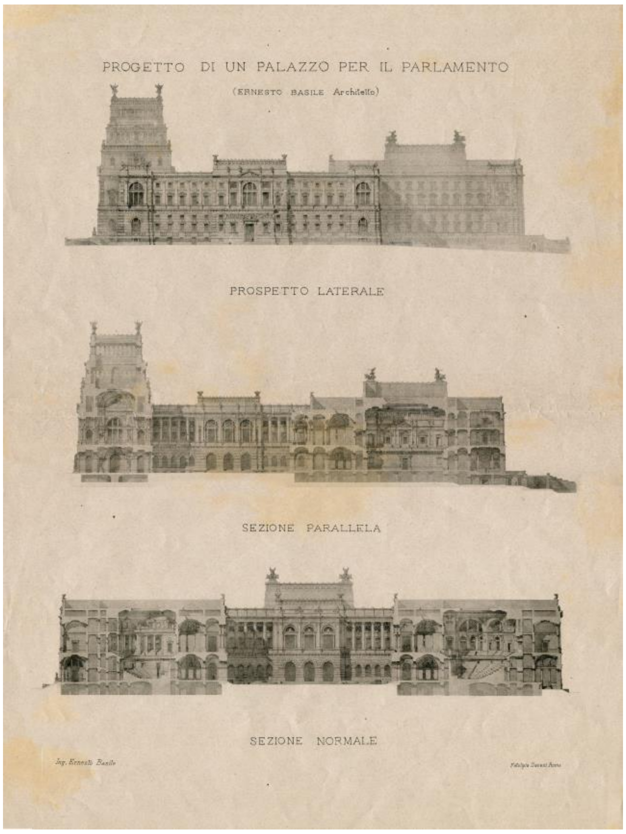

Figure 7. Side elevation, longitudinal section and cross section, extracted from Basile 1890 a).

.

2.3 Survey, analysis of iconographic sources vectori-zation and 3D modeling.

The original drawings, as seen, are drawn in decimal scales, and the mensorial system applied is undoubtedly the metric one, which was adopted after the unification of Italy in 1861[2]. The

[2] In 1877 the *Tables comparing the weights and measures in use in the various provinces of the Kingdom with those of the metric system* were published by the Stamperia Reale in Rome.

https://doi.org/10.5194/isprs-archives-XLVIII-M-2-2023-129-2023 | © Author(s) 2023. CC BY 4.0 License.

scans provided by the Basile Fund, at 300 DPI in 1:1 scale, were reliable, but we still wanted to carry out the direct surveying on small-scale copies of the drawings to verify the dimensional correctness of the drawings. The vectorization phase of the raster images took into account the modular parties considering only clear modules, as those of intercolumns or windows’ rhythm. The set of two-dimensional vector drawings includes the plans of the four main levels, the longitudinal and cross sections and the four fronts.
The schematic plans showed the functional organization, the analysis of functional cells and the scheme of horizontal and vertical distributive paths. (Avella, 2020).

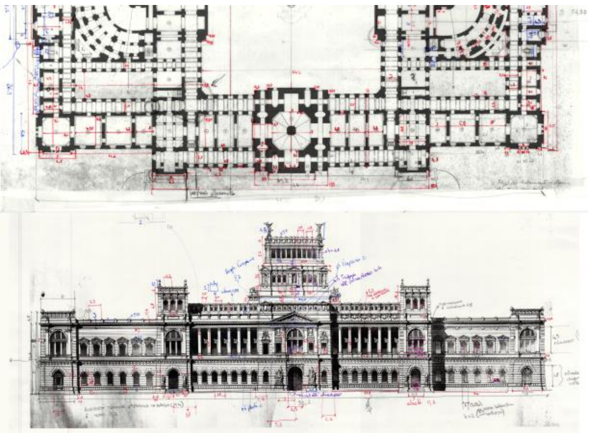

Figure 8. Manual survey performed on copies of the original drawings.

The three chambers facing the main courtyard are inserted in bodies that are well highlighted volumetrically and are flanked by rectangular courtyards illuminating and ventilating the rooms facing them. The system of courtyards and classrooms is entirely connected by galleries with the function of horizontal distribution, while vertical connections are allocated in the intersection areas of the walkways. The elevation analysis also showed how the functional structure is manifested with extreme consistency by the volumetric parties.
The main front is vertically tripartite: the tower-like forepart of the entrance is flanked by two columned wings enclosed by angular turrets, at three levels on the forepart and at two on the side bodies. The side fronts have slightly projecting avant-corps at the classrooms and two windowed wings with giant order at the upper levels closed by corner turrets.
The presence of the classrooms is emphasized, in addition to the slight overhang, by a higher elevation development and the attic wall that repeats the decorative motifs of the main elevation. The courtyard fronts also denote the presence of classrooms thanks to projections that mark the access loggias.
The entire wall perimeter is treated according to a very strong hierarchical system: the front façade is treated with monumental emphasis, and the two side façades manifest the political equivalence of the Chamber of Deputies and the Senate.
The rear front is characterized by the protrusion of the entire volume in which the Hall for the Royal Sessions is allocated and emphasized by the presence of a monumental pincer staircase that, again, becomes an urban sign.
The construction of a congruent system of plan drawings enabled the construction of three-dimensional models realized by integrating different techniques.

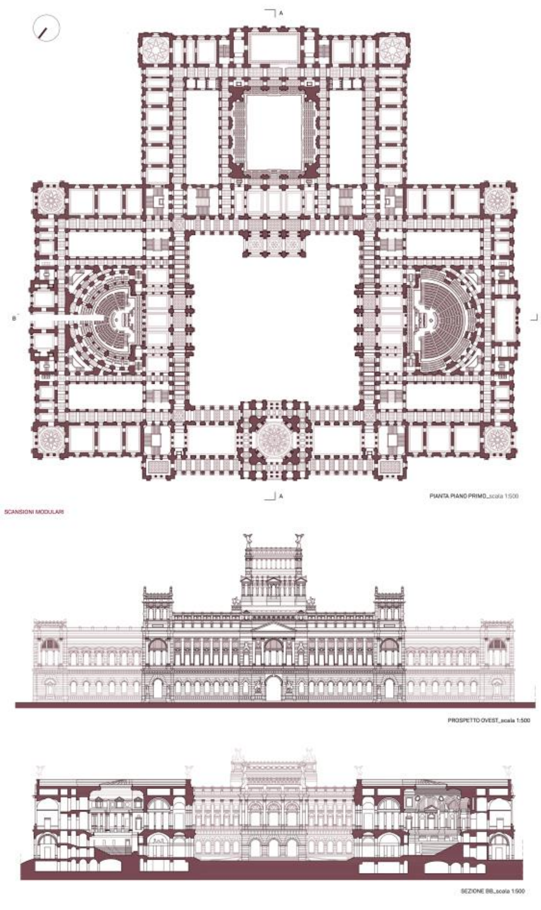

Figure 9. Vector drawings: second floor plan, main elevation, cross section.

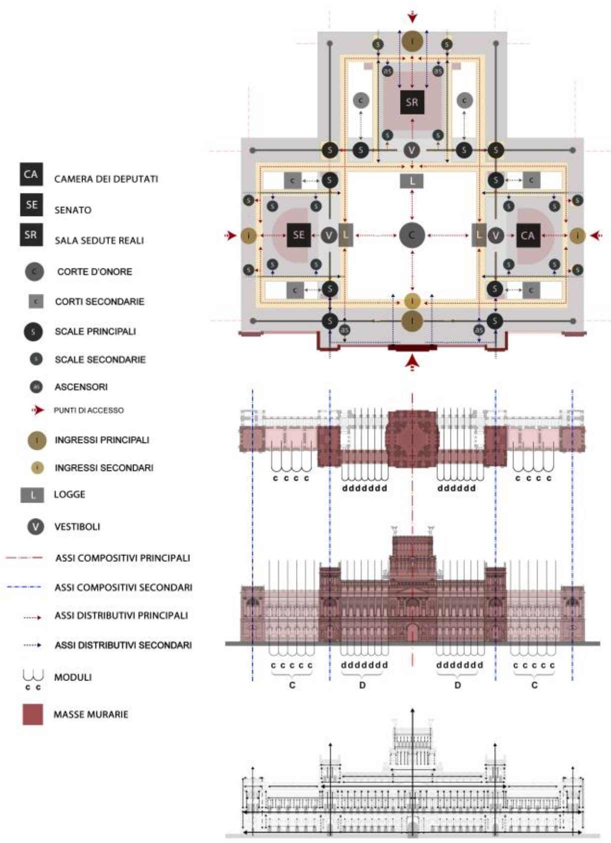

Figure 10. Analysis of functions, paths, modularity, and wall masses related to the main front.

Figure 13. Main front (by Carla Verace).

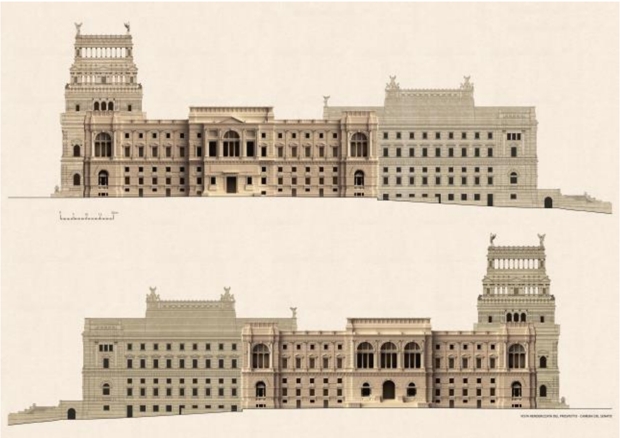

Figure 12. Side elevations: top the one facing the Chamber of Deputies, bottom the one facing the Senate (by Fabrizio Lanza).

Figure 13. The Chamber for Royal Sessions (by Irene Accurso).

Solid modelling was used for the masonry apparatus, NURBS modelling for moldings and vaulted systems and polygonal modelling, for those elements with a complex geometric shapee, as in the case of the Corinthian capitals and statuary[3].

For the views of the three-dimensional model were made elevations, axonometric and vertical-frame perspective views, and some perspective cross-sections, of the Chamber, the Senate and the Royal Seating Room.

Among Basile's original drawings, whether preparatory or submitted, there are no perspective views, often found in his production and present in the designs for the competition for the Palace of Justice. Perspective views thus make allow to visualize spaces and volumes masterfully described in the original drawings but not visible in their three-dimensionality.

Regarding the techniques of representation it was considered that, both The drawings and the documents do not provide sufficient indications to assume the material finishes.

Therefore, it was decided, both in the digital renderings and for the PLA model, to use a monomateric representation.

In the case of the rendered views, the intention was to reproduce the chiaroscuro of the original watercolor drawings. The effect was achieved by inserting a sunlight that, in the case of the plane views, reproduces the academic rule of the inclination of the rays of a light source at an infinite distance inclined 45° on the horizontal plane and 45° on the vertical plane[4].

2.4 3D printing process.

The phases for the realization of the physical model were developed by the transformation of CAD files in Stereolithography (STL) transferred in G-Code and printed with a Creality CR S10 Cartesian printer (300 x 300 x 400 mm.).

The criteria chosen for prototyping are the result of a methodological process aimed at optimizing the result with the available tools. It was immediately evident that the dimensions of the building (187 x 200 x 55 m.) in its reduction to a 1:100 scale, was decidedly larger than the printing plate. Therefore, a process of decomposition was developed to allow the aggregation of single pieces by minimal visibility of the joints: the classical language of the architecture suggested the partitions dictated by the elements of architectural order[5].

The decomposition identified 144 pieces for the first phase and 96 pieces for the second. The technical choices such as the extruder (Hotend group, Ø 0.2 mm), the printing settings (fills, structural mesh and layer density) and especially the use of the material (PLA filament, 1.75 mm) were configured according to the purpose and characteristics of the desired final result.

The model used for 3D printing, derived from the ones made for he rendered views, was modified to make it compatible with the printing process: for example, all continuity solutions, incompatible with the requirements for prototyping, have been eliminated and the polygonal surfaces were designed to reduce visible discontinuities as much as possible, thanks to horizontal and vertical capping planes, appropriately positioned to reduce visible fractures and simplify the gluing of the parts, carried out with cyanoacrylic glue. To obtain continuity, cuts were made in correspondence with moldings, bases and terminal parts of the architectural orders in order to reduce visible fractures.

To solve the problem of the angular joints, it was decided to use 45° joints, in order to avoid pieces with a horizontal L-shaped section that would have involved many supports to be removed during the post-production phase. To stiffen the entire structure the whole model is supported by a wooden skeleton to avoid warping and bending and, in many cases, "male - female" elements have been created to avoid slippage during the jointing and the gluing phases.

The dimensions of the printing layers which concerned the dimensions of the structural walls (low LOD) and the decorations (high LOD) were set in intermediate settings, obtaining acceptable printing times for the masonry masses but also to make the details of the classical moldings appreciable.

In the case of some single pieces with very high levels of detail (such as columns, pilasters and the relative capitals) it was decided to print them with specific settings and glue them later.

The width of the line of the external and internal walls has been set to 0.2 mm, while the thickness of the horizontal walls has been set to 0.8 mm, values deemed satisfactory for the print quality but such as to contain both the printing time and the quantity of filament used. To stiffen the individual pieces and

[3] Autocad was uswd for solid modeling, Rhinoceros for NURBS and 3D studio Max for polygonal modeling.

[4] The introduction and the paragraphs 2.1, 2.2, 2.3 was written by Fabrizio Avella.

[5] The first phase of this process was described in Avella, 2021.

avoid deformation from bending and torsion, it was decided to insert a filling with a "crossed cube" pattern, inclined at 45°.
During the import process on the slicing software (carried out with the software Cura), the printing parameters were set in order to achieve savings in terms of time and material.
The first phase concerned the orientation of the surfaces and the insertion of supports: the pieces were positioned so that the inner parts were parallel and adhering to the printing plane, avoiding, in this way, the visibility of the raw initial printing layer, and limiting as much as possible the use of supports, the removal of which could have ruined the finished product.
For example, for adhesion to the initial printing plate, the brim was used with the supports created at the edges of the walls so that the possibility of warping is decreased, i.e. the warping of the ends of the bases that do not adhere to the plate.
The design took into account a number of choices regarding the settings as several tests were carried out before the finished product was obtained; the starting layer height was set to an average of 0.24 mm to ensure better adhesion to the top.
The dimensions of the printing layers concerning the sizes of the walls (low LOD) and the decorations (high LOD) were set in intermediate settings, with printing times and accuracy acceptable in both cases.

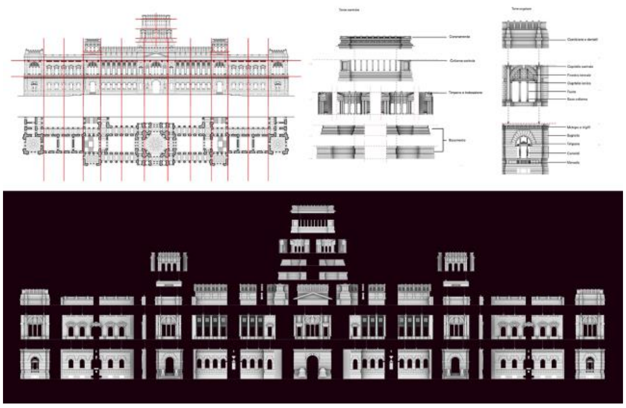

Figure 15. Partitioning of pieces to be printed for the main front (by Gabriele La Barbera).

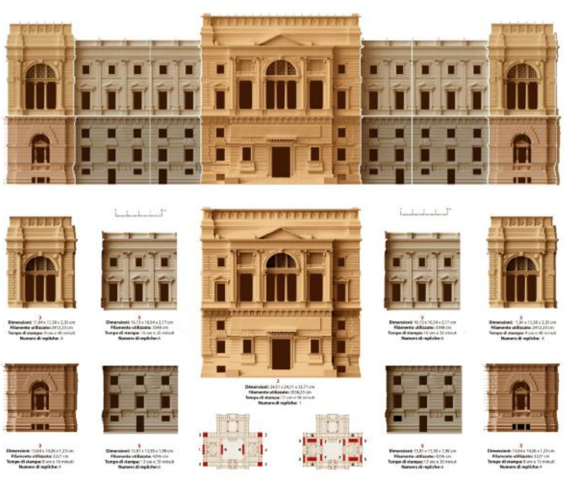

Figure 16. Partitioning of pieces to be printed for the front of Chamber of Deputies (by Fabrizio Lanza).

Figure 17. The PLA model.

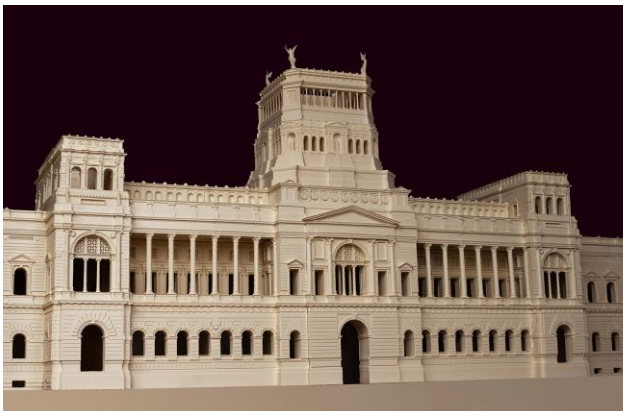

Figure 18. PLA model: main front.

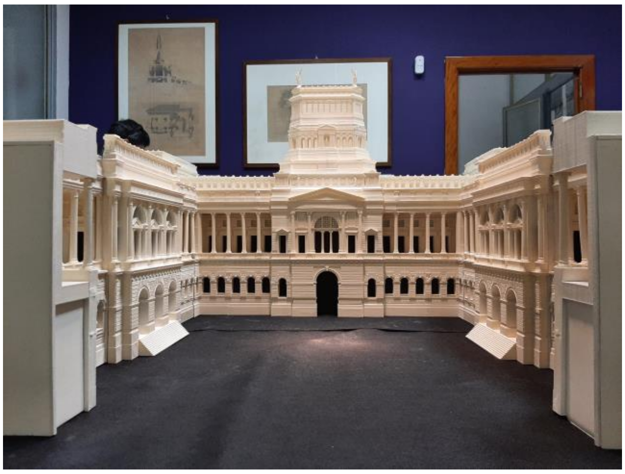

Figure 19. PLA model: the courtyard.

In the case of some individual pieces with very high levels of detail (such as columns, brackets and their capitals) it was decided to print them with specific settings and glue them later.
Some choices were made regarding the settings as several tests were carried out before obtaining the finished product; the height of the starting layer was set on an average of 0.24 mm to ensure better adhesion to the printer plate.
The printing temperature was set with values between 200° and 215°C depending on the characteristics of the filaments used (while for adhesion to the printing surface the temperature was always around 65°C) as well as the flow used when running it varied from 100 to 110%. For the execution speed a value of 60 mm/s was used, a filling speed of 100 mm/s and a speed of the upper and lower walls equal to 50 mm/s; in order not to

https://doi.org/10.5194/isprs-archives-XLVIII-M-2-2023-129-2023 | © Author(s) 2023. CC BY 4.0 License.

influence the quality of the print during the deposit of material, the speed of the extruder movements has been set to 200 mm/s to avoid the residual transport that can remain on the extruder (Bañón, Raspall, 2020).
Although the measures adopted have greatly reduced the visibility of the joints and the printing irregularities, some imperfections were still visible after assembly. Therefore, it was decided to carry out local manual grouting and sanding operations to cover the joints and make the surfaces as homogeneous as possible. The final finish involved painting with acrylic colour, both to cover the irregularities generated by the grouting. An ivory color (RAL 1013 code) was chosen for the paint, applied both by spray and with brush retouches.
The model is currently visible at the exhibition “Palermo and the plague of insomnia. Memory and oblivion in the drawings of the scientific collections of the Department of Architecture of the University of Palermo”, in the Gallery of the Collections of the Department of Architecture[6].

2.5 Augmented reality visualisation.

The Augmented Reality application was developed specifically for exploring and discovering the interior of the building, using the physical model developed in this research. Specifically, two different AR technologies were tested: one based on the use of persistent anchors stored on the cloud, and the other based on object tracking and recognition. Although the solutions tested employed different approaches, they both allowed digital models to be referenced to real space with automatic and instantaneous processes, making the AR experience persistent over time and easy for users to access (Cannella, 2022).
Part of the research was focused on preparing and optimizing digital models for visualization in AR, specifically to simulate the cutaway of the PLA model.
A visual and metric check of the printed prototype revealed a slight and unavoidable discrepancy between it and the overall digital model used for 3D printing.
This inconsistency was mainly caused by the operation of juxtaposing and assembling the many pieces, resulting in imperceptible misalignments between different blocks of the model. Although not noticeable to the naked eye, they could compromise the AR experience.
This inconsistency was mainly caused by the operation of juxtaposing and assembling the many pieces, resulting in imperceptible misalignments between different blocks of the model. Although not noticeable to the naked eye, they could compromise the AR experience.

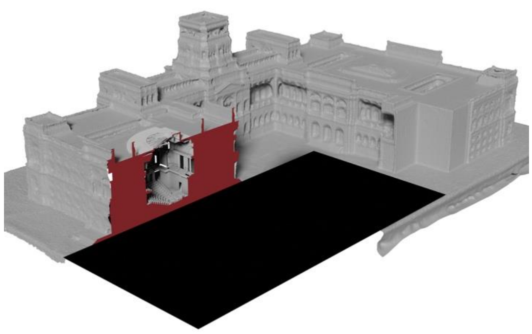

Figure 20. Positioning of the inner space model into the surface mesh of the PLA model.

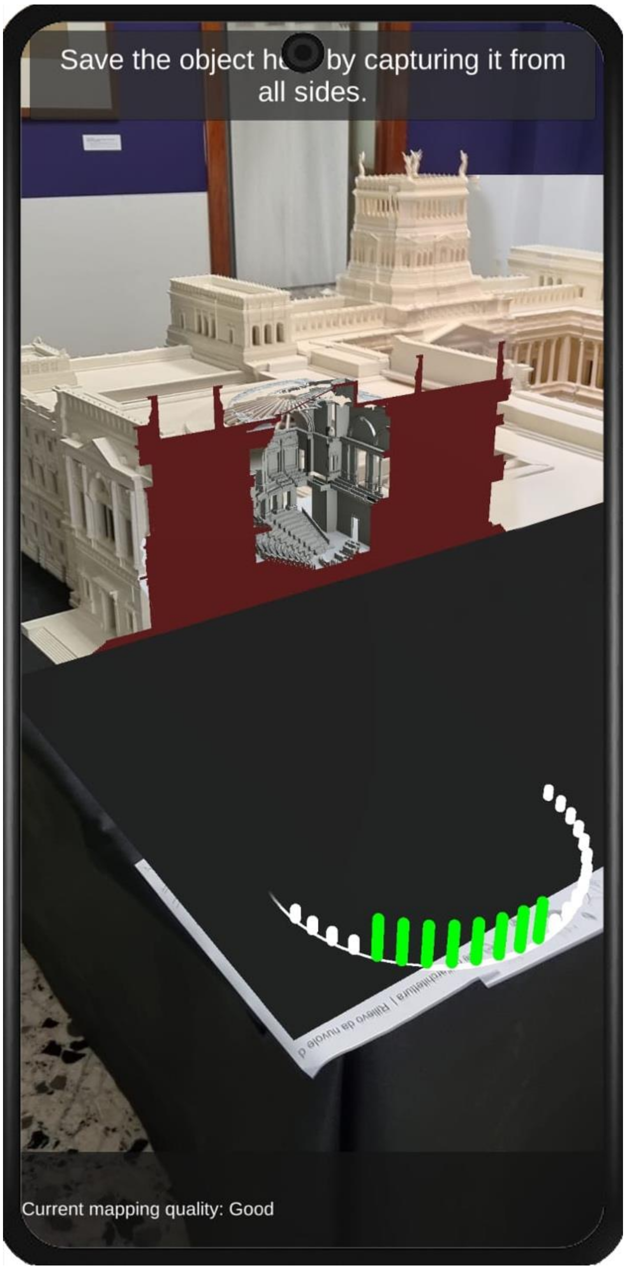

Figure 21. Anchor placement.

For this reason, a laser scanning survey of the maquette was performed to obtain a mesh model of the exterior surface which was used as occlusion mask (Alfakhori, Dastageeri, Schneiderand Coors 2022).
This model was then used to make minor adjustments to the digital models, ensuring they were dimensionally consistent with the physical model. The geometries of the digital models of interior spaces were optimized to achieve an appropriate trade-off between the number of triangles and the level of detail, which was necessary for managing and visualizing these models through mobile devices.
Finally, the models were textured using Blender software and specific textures were elaborated through a baking process.
This process allowed shading information generated through Ambient Occlusion calculation to be recorded on the models.
The first test was built using the Google ARCore development platform and the Cloud Anchor API (Voinea, Girbacia, Marto Postelnicu, 2019).

[6] The paragraph 2,4 was written by Fabrizio Lanza.

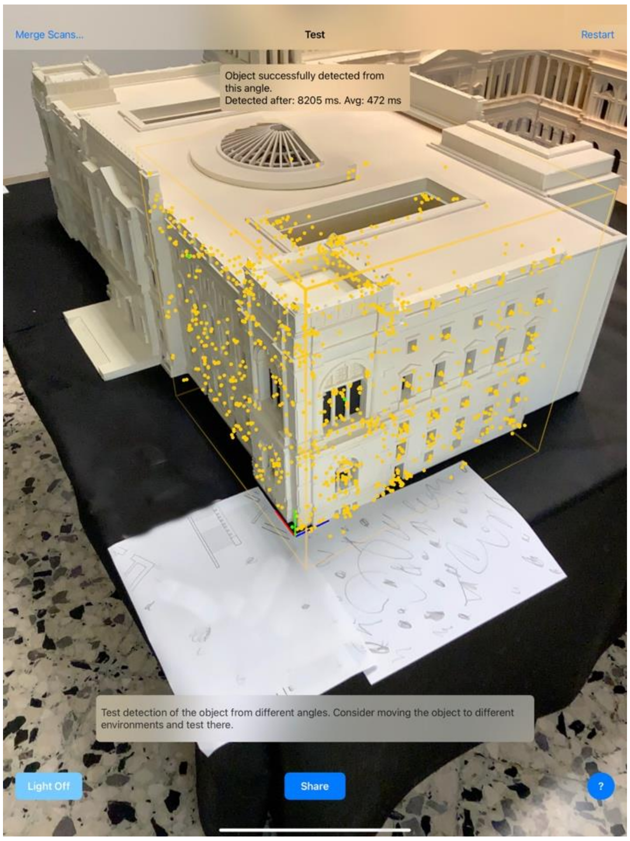

Figure 22. 3D object scanning with the App ARkit Scanner.

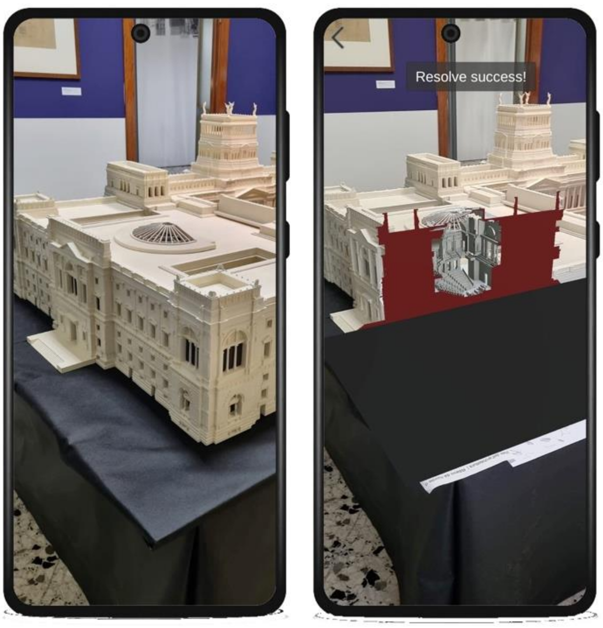

Figure 23. AR visualization of the interior of the PLA model.

The AR application was specifically developed using the Unity development editor and the AR Foundation framework (Torresani, Rigon, Farella, Menna, Remondino, 2021), as well as the Google ARCore XR Plug-in. The additional package "ARCore Extension for AR Foundation" was imported to enable the use of Cloud Anchor. To use the Persistent Cloud Anchor technology, the Google Cloud service ARCore API was enabled for 3D feature hosting (Agnello, Cannella, Geraci, 2022).
Two separate applications were developed: the first one was intended for the operator to place anchors and digital models and store 3D features on the cloud, while the second was dedicated to end-users. The first application allows anchors to be placed through a hit-testing procedure, which is the ability to associate the anchor with geometry. Anchors allow the AR application to permanently fix the position of virtual objects in the real world.
Specifically, they were placed on the horizon plane, which was placed to support the physical model and recognized through processes of “Environmental Understanding”. Once the anchor's position was defined, its registration and storage on the cloud were done through a wizard that assisted the operator in the acquisition of 3D features.
An AR histogram placed at the anchor allowed the operator to correctly record the area of interest by making slow movements around the anchor while constantly framing the insertion point. Following this procedure, the spatial information was sent and stored on the cloud (Cannella, M. 2022).
The second application, specially designed for end-users, allows them to access the AR experience by resolving the anchors and visualizing the different digital models of the interior environments consistently arranged on the PLA model.
The second experimentation was based on the use of Apple's ARKit framework, specifically developed for the creation of AR solutions usable through iOS devices. As in the first case, the application was developed using the Unity editor and the AR Foundation framework. In particular, the potential of the Object Tracking feature was tested, which allows the recognition of a physical object previously scanned and the visualization of the virtual elements associated with it in AR. The ARKit Scanner app was used to acquire the 3D characteristics of the physical model and define a reference system. The scan was imported into Unity and used as a reference to orient the digital model of the interior spaces accordingly. In both cases, the anchor resolution and object recognition processes are completed quickly, enabling accurate geo-referenced AR visualization aligned with the model.
The solution proposed by Google allows for the development of applications for both Android and iOS systems, but it requires an internet connection to resolve the anchors. Furthermore, in this specific case, the placement of the anchors was not always effective because the supporting surface had a homogeneous texture that created difficulties in recognizing the surface. The use of temporary supports characterized by a heterogeneous texture improved the anchor placement process.
Moreover, the ARKit Object Tracking feature can work in offline mode, but it is only compatible with iOS devices. In this operational condition, the framework proposed by Apple offers a more effective solution; despite unfavourable lighting conditions and the uniform colour of the PLA model, the scanning process was carried out correctly, although in this case the black support caused some difficulties in defining the origin of the reference system, which, as for the system proposed by Google, requires the identification of a reference plane[7].

CONCLUSIONS

This study suggests a methodological approach of representation techniques integrated to obtain several purposes and different users: supporting scholars in historical studies through analytical drawings and visualizing aspects hidden in project drawings; proposing to non-expert users easy-to-understand display systems. In this sense, the creation of easy-to-understand rendered views, physical model and Augmented Reality systems seem to be very effective dissemination tools.

[7] The paragraph 2,5 was written by Mirco Cannella.

REFERENCES

Agnello, F., Cannella, M., Geraci, M.R. 2022. AR/VR Contextualization of the Statue of Zeus from Solunto. In *REPRESENTATION CHALLENGES: New Frontiers of AR and AI Research for Cultural Heritage and Innovative Design*, Franco Angeli, Milano, 237-244.

Alfakhori, M., Dastageeri, H., Schneider, S., and Coors, V. 2022. Occlusion screening using 3d city models as a reference database for mobile AR applications. *ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci*., X-4/W3-2022, 11–18, 2022.

Avella, F., (2021). Il secondo concorso per il Parlamento di Ernesto Basile. Criteri di modellazione e stampa 3D. In AA.VV., *CONNETTERE: un disegno per annodare e tessere CONNECTING, drawing for weaving relationships*. *42th International conference of representation disciplines teachers congress of Unione Italiana per il Disegno proceedings,* Messina, Reggio Calabria, 16-17-18/09/2021, Franco Angeli, Milano.

Avella, F., (2020). Il secondo concorso per il Parlamento di Ernesto Basile. Analisi e ricostruzione congetturale. in AA.VV., *CONNETTERE: un disegno per annodare e tessere CONNECTING: drawing for weaving relationships*. *42th International conference of representation disciplines teachers congress of Unione Italiana per il Disegno proceedings,* Messina, Reggio Calabria, 17-18-19/092020, Franco Angeli, Milano, 1622-1643.

Bañón, C., Raspall F. (2020). *3D Printing Architecture. Workflows, applications, and trends*. Springer, Singapore.

Basile, E. (1890a). *Progetto per il palazzo del parlamento italiano nel concorso nazionale del 1889*. Stabilimento Tipografico. Italiano, Roma.

Basile, E. (1890b). Project of a Palace for the Parliament, in *Proceedings of the College of Engineers and Architects of Palermo*, 13th year.

Basile, E. (1888). Il Palazzo del Parlamento di Berlino in the *Annali degli Ingegneri e Architetti Italiani*, III, II, Palermo.

Cannella, M. 2022. AR methods for the visualization of the lost marble “Tribuna” in the main apse of the cathedral of Palermo, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci*., XLVI-2/W1-2022, 129–134.

Mauro, E., Sessa, E. (2015). *I disegni della Collezione Basile*. Officina Edizion, Roma.

Mauro, E., Sessa, E. (a cura di). 2000 (a). *Giovan Battista Filippo Basile ed Ernesto Basile: settant’anni di Architetture: i disegni restaurati della Dotazione Basile, 1859-1929*. Novecento, Palermo.

Mauro, E., Sessa, E. (a cura di). 2000 (b). *Ernesto Basile a Montecitorio e i disegni restaurati della Dotazione Basile*. Novecento, Palermo.

Sessa, E. (2014). Secondo Concorso per il Palazzo del Parlamento a Roma, area dei Mercati Traianei, 1888, Ernesto Basile. In E. Mauro, E. Sessa (a cura di), *Collezioni Basile e Ducrot. Mostra documentaria degli archivi*. Edizioni Plumelia, Palermo, 214-218.

Torresani, A., Rigon, S., Farella, E. M., Menna F., Remondino, F., 2021. Unveiling large-scale historical content with V-Slam and markerless mobile AR solutions. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVI-M-1-2021*. 761-768.

Voinea G.D., Girbacia F., Postelnicu C.C., Marto A., 2019. Exploring Cultural Heritage Using Augmented Reality Through Google’s Project Tango and ARCore. In *VR Technologies in Cultural Heritage*. Springer International Publishing, Cham. 93-106.