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B.I.M. for representing historical building heritage. The survey of Liberty and Art Deco decorated façades

B.I.M. per la rappresentazione del patrimonio costruito storico. Il rilievo delle facciate decorate Liberty e Art Deco

In this paper, it is discussed the application of B.I.M (Building Information Modelling) technologies on the survey and on the representation of the decorations in the façades of late Liberty and Art Deco buildings, built in Sardinian cities. The decorative languages analysed spread in one of the most marginal regions with some delay, by the insertion of serial decorations placed both on existing and new buildings. The study, still in progress, discusses how the B.I.M. can be used in the analysis of the decorated elements that are serially inserted in the buildings, particularly in the perspective of the integration with GIS systems, which can allows the localisation of the elements into the urban landscape, also by using procedural semiautomatic modelling systems of façades.

In questo articolo viene discussa l'applicazione delle tecnologie B.I.M. al rilievo e alla rappresentazione delle facciate riconducibili al tardo Liberty e all'Art Deco, utilizzando come caso di studio le espressioni presenti nei centri della Sardegna. Questo linguaggio decorativo si diffuse con un certo ritardo, rispetto ad altre regioni, all'interno dei centri della Sardegna attraverso l'applicazione di decorazioni seriali su edifici esistenti e di nuova costruzione. La rierca, ancora in corso, discute come il B.I.M. può supportare l'analisi degli elementi decorati che si ripetono in maniera seriale nelle facciate di vari edifici costruiti nei primi decenni del Ventesimo secolo anche nella prospettiva di un'integrazione con sistemi GIS che consentono di localizzare gli elementi all'interno del tessuto urbano anche attraverso sistemi di modellazione procedurale semiautomatici delle facciate.

key-words: HBIM; Liberty, Art Deco, façades
parole chiave: *HBIM, LIberty, Art Deco, facciate*

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This paper presents the experimentation of the application of BIM technologies on the historic building heritage. The aim of this research is to highlight how in these kinds of experimentation it is needed recalibrating the objectives and the modalities of application of technology in relation to the peculiarities of the analysed contexts. The literature on these topics shows that it does not exist a unique method applicable to all the possible case studies. However, it shows a repertory - which is still not very extensive - of various case studies very different from each other as related to the diverse objectives, contexts and formal, historical and stylistic features [1].

1. BIM AND CULTURAL HERITAGE

As defined by the National B.I.M Standard-United State Project Committees (NBIMS-US), B.I.M. is a digital representation of the physical and functional features of a building. Moreover, it is a tool for knowledge sharing that can be used to support the decisional process during its entire life cycle, from its building to its demolition [2]. This definition highlights the role of B.I.M.t technologies in the representation of the graphic and not graphics information of the buildings in a data management system that connects the representation of the objects with the information related to different aspects. But mostly its definition refers to the entire life cycle of the building, underlining its role in building management especially after its completion, thus including its aging until the final demolition.
The B.I.M. is a tool that can play a key role in the management of existing heritage, and in particular those with an historical and artistic value. Although it has been initially aimed to the mere management of the construction process of the architectural artefacts [3] the B.I.M. technology was then widely extended to the documentation and the preservation of the built existing historical heritage [4]. However, despite the growth of the interest of the scientific community towards the application of B.I.M. to the protection of historic buildings, the potentialities of this technology in the documentation and in the management of the cultural heritage remain largely to explore [5].
The historic buildings are characterized by a more complex and irregular shape than those newly built, which requires the construction of 3D model libraries hardly reusable, and difficult to manage through parametric geometries.
In the application to the historical heritage, these technologies are still to be explored such in the case of the management of irregular and particularly complex objects [6] whose modelling is likely to be particularly expensive or can lead to unacceptably simplified results from the point of view of the representation of the shape. For this reason, the researchers are now focused on the definition of interactive parametric object libraries [7] able to facilitating the object modelling process.
The identification of the methods and of the formal and stylistic rules for the representation of the objects in the libraries is one of the most relevant issues. In relation to this particular aspect it has been configured a particular declination of BIM, the HBIM [8] Historic Building Information Modelling, in which the object libraries are derived from the survey of the historical artefacts through diverse methods, tools and technologies such as laser scanning and digital photo modelling. Furthermore, in the HBIM applications are used the historical and theoretical information [9], as in the case of buildings whose modelling is limited to only a partial knowledge of the necessary information which need to be integrated through the comparison with similar buildings or with projects having significant relationships. Thus, the knowledge of the architecture from the historical, geometric and constructive point of views is one of the fundamental elements characterizing the HBIM [10], because from the analysis and from the interpretation of the objects depends the quality of BIM application.

2. THE CASE STUDIES

The case study of the architectural heritage built between 1900 and 1930 in Sardinia was selected for the discussion of the hypothesis of this research. In particular, the analysis is referred to the city of Quartu Sant'Elena - located near the main city of Sardinia, in the island's southern coast. Here, the nascent bourgeoisie decided to represent their social, economic and cultural standing by means of the insert of Art Nouveau and Art Deco decorations in their buildings (fig. 1). However, as often occurs in marginal contexts, the affirmation of new artistic tendencies is delayed, compared to the places where the new cultural trends born [11]. Furthermore, adapting to different social and cultural contexts, the new aesthetic trends tend to be reinterpreted through peculiar forms and modalities. Thus, the Liberty, establishing itself in Sardinia with some years of delay, overlapped itself with the new forthcoming trends that it will be then described by the name of Art Deco. For this reason, in this research, the attention was focused to the interpretation of the stylistic features related to Art Deco and to Art Nouveau; the first most elusive and ambiguous compared with the latter more explicit and defined.
Then, it happened that some of the typical Liberty graphic motifs continued to be used even after the conclusion of World War I, in the literature considered the watershed between Liberty and Deco. This motifs are considered as own expressions of the latter and often they are combined with elements characterized by geometric compositions distinctly Deco (Figure 2). The difference of the languages spoken by the two artistic movements will make the graphic analysis a key tool to discern the two influences and to interpret the buildings, often difficult to date.

2.1. The historical and cultural context

The architectural cultural heritage built in the early decades of the twentieth century is often a critical and controversial topic. The history - even that of the culture - is written by the winners, and in the case of cultural conflicts the descriptions of the events support the prevalence of a thesis on the others that end up being overshadowed, denied and then forgotten [12]. Specifically, Portoghesi and Massobrio in their "Album degli anni Venti" refer to the opposition between two types of modernism: the rigorous Modern Movement, against the decoration and for the simplification at any price, and the most decorative called Modern Style. Even Rossana Bossaglia [13] identifies two souls in modernism: a "democratistic" tendency focused on art-industry relationship, and another "aesthetic, elitist, decadent" still tied to the handmade craft and the elitist production of luxury goods. This opposition, and then the affirmation of the Rationalism as aesthetic, social

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1. Examples of facades with their typical decorations of the late Liberty style and Art Deco analysed as case studies

and ideological models of modernity, has brought to stay out of history the "another modernity" blurred by the pervasiveness of the Modern Movement. It is the other modernity labelled as "academic" and "eclectic" [14] that nowadays is associated to the word Deco. Also for this reason, the studies, the surveys and the graphical analyses until now published, related to the architectural heritage of those years and in particular to the Art Deco influences, are still few - in Italy, but not only - [15] unlike the large literature supporting the trend that was opposed to it.

The Art Deco can be considered an aesthetic trend born in the time and in the cultural gap between two different tendencies opposed to each other [16]. It is the gap between the end of Liberty and the affirmation of the Bauhaus style. The first was a sort of current of continuity, a kind of coding in a "cubist" language of the earlier floreal motifs; in contrast to the second that was a current of fracture, in which it could be glimpsed the marks of the coming total revolution [17] which it would be soon established eclipsing and dwarfing the decorative trends.

Indeed, to have a conceptualization of Deco it will be necessary to wait several decades after the end of its story. The interpretation of the succeed of what can be seen as a particular evolution of this aesthetic sensibility starts in the sixties of last century, coinciding also with the re-spread of the decorative style, thanks to Giulia Veronesi studies [18] in Italy and Bevir Hillier [19] in the UK which define the character of the Art Deco style. In the same years, in other studies, the same evolution of style was identified with the designation "Stile 1925", by the name of the Exposition Internationale des Arts Decoratifs et Industriels Modernes, held in Paris in 1925. From this world fair's name, that marked the moment of greatest resonance and at the same time to the conclusion of this particular aesthetic trend [20], derives also the name Art Deco. From a strictly chronological point of view, these studies have supposed the period of greater affirmation of the Liberty Style between 1902 and 1914 [21] while it is supposed the affirmation of Deco in the range between 1919 and 1925 [22].

Although the two periods can not be so rigidly confined - as both are considered as evolutionary phenomena of taste whose roots lie in previous years and whose

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echoes were later extended in the following years - the First World War remains a watershed between the two artistic currents, marking a deep social, cultural, economic, and of course aesthetics scar.
Liberty and Deco had been both adopted by the upper classes as a representation of their own wealth and social position. The appeal to the decoration appeared to be a kind of elitist exhibition of luxury and superfluous to then become, as with all status symbols, widely widespread popular culture. The Deco style ended then to conquer also the underserved classes by producing artefacts that reproduced the graphic-stylistic features of manual craft decorations, but produced from serial production systems and applied to less valuable buildings (Figure 3).
The choice of the case study was made in relation to these cultural phenomena. In fact, the selected urban centre is not the major centre - where the expressions Liberty and Deco are more representative of the aesthetic taste of the cultural and economic prevailing elites of the early decades of the twentieth century - but it is one of the closest to the culture and to the economy of the rural centres.
In the context assumed as case study in fact, the city of Quartu Sant'Elena in Sardinia, the spread of decorations influenced by Liberty and Deco styles occurs in the facades of the houses of the bourgeoisie of the early decades of the twentieth century (Figure 1). To affirm their status, they starts to decorate their homes with decorative elements without changing the typological characteristics, still strongly connected to the nineteenth century rural culture [23].
These decorative elements, although used in a serial manner to connote building types, however poors, strongly still characterize the perception of city centres, giving a peculiar aesthetic and architectural quality to urban public space. For this reason, they deserve to be protected and enhanced.

2.2. Drawings and styles

Although from the chronological point of view the definition of the two styles appears clearer, from a stylistic point of view their features are more difficult to define. As known, the Liberty stylistic references are clearly inspired to the floral and natural world, mostly related to the Symbolist roots [24]. Instead, the litera-

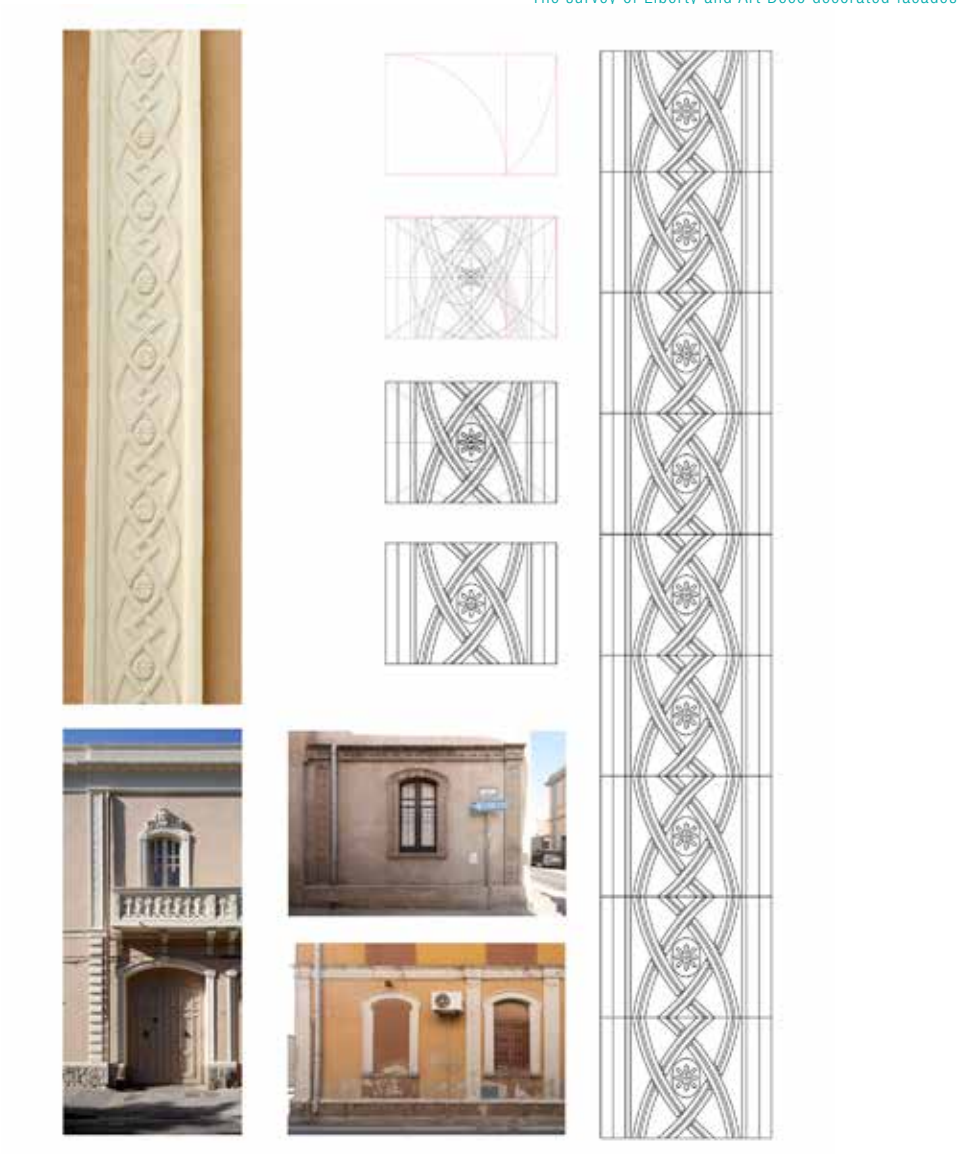

Fig.2. Example of a recurring decoration (type A). Examples of different contextualization, graphics and composition analysis.

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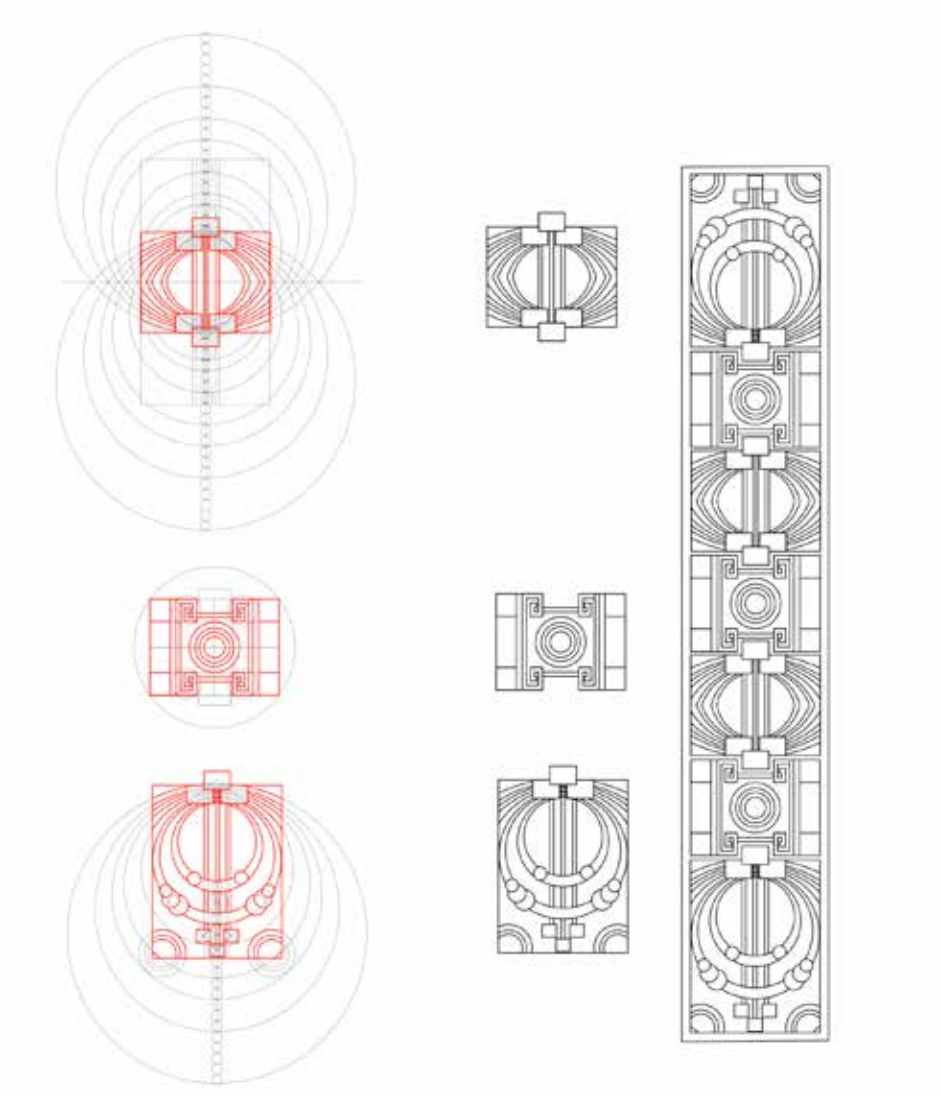

Fig. 3. Example of a recurring decoration (type B). graphic and illustrative composition analysis.

ture on Deco style lists a long series of iconographic references and inspirations as ethnic influences (African tribal art, Aztec and Mayan architecture, Far East), the revival of historical styles (Egyptians, Babylonians, Aztecs, Mayans, Roman, Greek, Byzantine until arriving at the Louis XV and Louis XVI), the art movements (Fauvism, Futurism, Constructivism, Cubism) and peculiar social phenomena (Russian ballets) [25]. The transition from Art Nouveau to Art Deco is thus marked by an enrichment of the iconographic and cultural references as well as by a different use of the line. It moves away from the sinuous and irregular forms of nature that inspired the Art Nouveau, becoming more rectilinear into more regular patterns and geometric forms inspired from time to time by Cubism, Futurism, Constructivism or also often by a combination of these with each other and with also other elements related to other influences. The line starts its path towards the essential and minimal forms of the functionalist style, moving from being superfluous decoration to being the limit and boundary of essential surface areas. The straight line, together with geometry and proportion, returns to be expression of beauty, as well as the return of the rigidly symmetrical compositions that characterize not only individual decorative elements (figg. 3 and 4), but also their composition and the entire design of facades (fig. 1). This symmetry constantly draws the typological models of Art Deco buildings with one, two and - rarely - three floors, whose rhythms are marked horizontally defining a multiplicity of compositions still attributable to a small number of basic compositional schemes (Figure 5).

3. OBJECTIVES AND METHOD

In this article is presented the first part of a research still in progress. It is aimed to the identification, to the catalogation, to the documentation, to the representation and to the interpretation of the architectural heritage built between 1900 and 1930 [25]. In particular it analyses some case studies in the town of Quartu Sant'Elena, (Sardinia- Italy). The selected case studies are significant of the use of Art Nouveau and Art Deco decorations in new or already existing buildings to represent the taste and therefore the social position of the new middle-class families who, at that time, were

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establishing themselves. In particular the specific research objectives are:
- The exploration of the urban territory, aimed to the identification of the relevant case studies for the purpose of the general research objective;
- The cataloguing of the decorative elements, in order to classify the different typologies;
- The study through the graphical analysis of the decorative motifs in order to deduce the stylistic clues able to link the building with the hypothesised architectural styles through a comparison between the drawings, the cultural characteristics and the iconographic references that characterised the aesthetic sensibility of the time;
- The dating of the buildings, through the comparison of the drawing of the decorations with the technological choices made for the construction of the buildings and of their parts (as building techniques and materials), and also with the building typologies and with the historical characteristics;
- The representation of the research results through the use of B.I.M. also in function of a possible future integration with a GIS system for the spatial referencing of analysed objects and with a semiautomatic procedural modelling of facades. In particular it will be used the B.I.M. for the management of object libraries able to represent the various serially repeated decorative elements both within the urban fabric and the largest territory.

The identification of the case studies was conducted starting from an investigation in the historical archives, through the analysis of historical and photographic documentation and of the existing literature on the historic and geographic context. Then, this preliminary phase was followed by a photographic survey campaign, which allowed to indicate the presence of significant buildings, or also of traces related to significant pre-existing buildings, within the entire urban fabric. The recognition of the decorations on the buildings was carried out through a comparison with the iconography from literature on the subject, previously analysed and registered in particular concerning the graphic characters of the decorative motifs that represent the most visible clues of the theme investigated.

Fig.4. Examples of decorative frames on the doors of the buildings.

The exploratory photographic campaign allowed to make a catalogue of case studies and ornate details that were then compared with each others by isolating recurring types both in terms of the facades composition, both in terms of elements decorated in them composed.
The recurrent types of the compositions of the facades and of their decorated details have been graphically represented to verify the existence of compositional and geometrical rules and in order to highlight the recurrence in the different cases of study through several combinations that use the same decorated elements.
The graphical representation of these elements has highlighted the distinction between decoration strongly characterized by a distinctly geometric layout (figs. 3 and 4) and decorations totally disconnected from geometric rules, as well as the relations between the motifs of the two different types.
The catalogation has made possible to verify the materials of the decorative elements, comparing the elements in which the reading of the material is not possible - because of the overlap of coatings and dyes - with other elements having the same drawing but placed in buildings characterized by a greater degradation of the surfaces that allow to read the raw material. Then, the collected data were interpreted by comparing the graphical analysis of ornate elements, the composition of facades, the building techniques, the materials, the historical stratifications, the cultural and historical characteristics of the artistic movements analysed and, also, with the history of the territory in which they are located.
The previous analysis has enabled the identification of the typologies of the recurring decorative elements and the knowledge of the structural, historical and stylistic characteristics both of the buildings and of single decorative elements. The elements of facades have been classified into families of objects in relation to a limited number of recurring types on the basis of which the objects are been organised into the B.I.M. libraries.

4. BIM for the architectural cultural heritage of Art Nouveau and Art Deco

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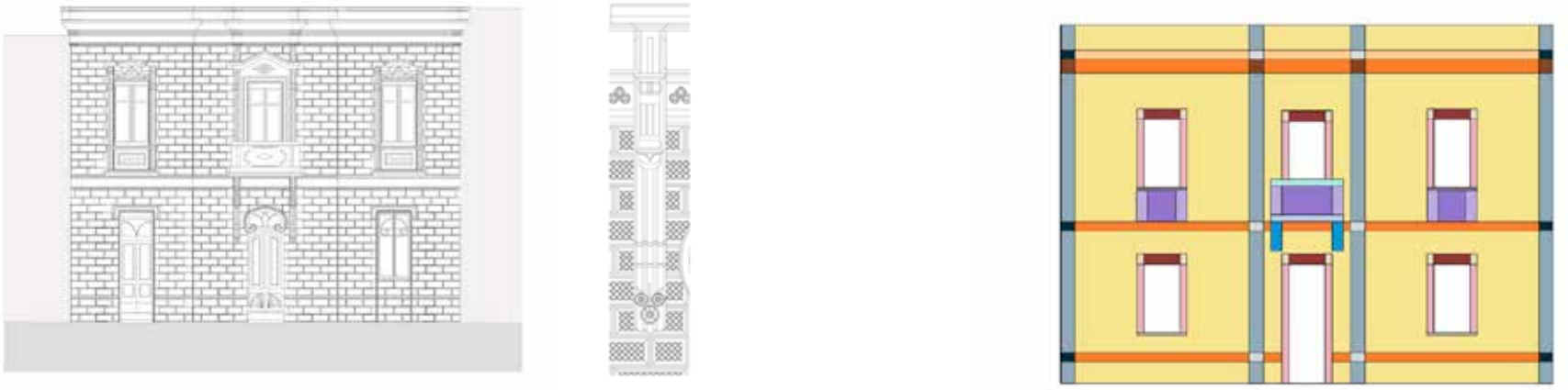

Fig. 5. Disassembling into basic components of the facades in relation to the types and positions of the decorative elements. Example and diagrammatic scheme.

Some research has experienced the cataloguing of the decorative elements that characterize the urban landscape [26], the systematization and the generation of 3D models in reference to the historical character of the heritage and of the elements decorated inserted into the buildings [27] as well as the parameterisation of facades [28] and integration of BIM with G.I.S spatial referencing systems [29].
After concluding the historical and stylistic analysis of the Liberty and Deco decorations in the chosen cases of study, all the basic knowledge are now available for the design of a system of representation based on B.I.M. technologies that can be realized through the following phases:
- Analysis of the geometry and of the information of the elements
- Processing of the libraries of decorative elements serially repeated in the facades of buildings
- Processing of a parametric model for the facades modelling;
- BIM integration with a GIS spatial referencing system.
The first two phases, in particular, are under development and the first results are presented in this article. Referring to the peculiarities of the cultural heritage of Liberty and Deco architecture, in the context considered as case study, the adoption of B.I.M. technologies allows an optimization of the modelling procedures, as well as of the analysis and of the protection of the most valuable buildings. Indeed the serial repetition of the decorative elements and the possibility of a parametric representation of elevations are configured as suitable characteristics to the use of such technology.

4.1. Analysis of geometry, and of information

The graphic analysis was conducted on decorations of the buildings facades built between 1900 and 1930. In particular, the analysis reported in this article refers to the buildings located in the town of Quartu Sant'Elena, near Cagliari, the main city of Sardinia. The observation of the details of the decorations made it possible to highlight how the elements recur over several buildings within the town and also in a wider regional context. From public records are not until now emerged the design drawings of such artefacts. For these reason, the exact dating of the buildings are not known in almost all of the case studies. However, the cataloguing of the drawings of decorative elements allows to hypothesize the date of the building, or at least the date of the redefinition of the elevations through the application of decorative elements. Indeed, in large part, they are adaptations of facades and decorations inserted after the first construction of the buildings, according to the dictates of the new taste that was becoming so popular. The decorations made of terracotta are characterized by a higher three-dimensional development and were most commonly used for the representation of floral, natural or anthropomorphic shapes, typical of the first Art Nouveau and Liberty styles. The decorations made of cement tend, instead, to have two-dimensional shapes and their motifs often have a distinctly geometric structure. It is possible to assume that these two kinds of decorations refer to two different periods, even if this division must not be considered so strictly. By crossing these data with historical and theoretical information such as the dating of the first factories in the island for cement production, referable to the early twenties of the twentieth century, It is possible to confirm the assumption of the subdivision of the analysed case studies in two categories:
- Liberty decorative elements: made of terracotta, with three-dimensional development, representing natural

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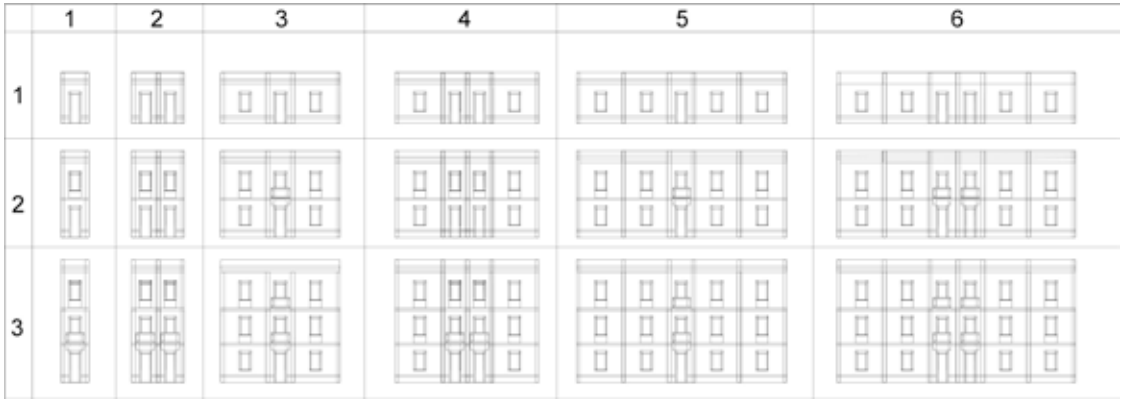

Fig. 6. Analysis of the modular composition of the facades in relation to the diagrammatic patterns of decorative elements

and anthropomorphic forms inspired to the Symbolism and devoid of geometric structure.
- Art Deco decorative elements: made of cement, with two-dimensional development, representing geometric motifs referable to the cultural influences already analysed in the previous paragraphs of this article as the ethnic arts, the historic styles and, of course, also the Art Nouveau.
The survey and the catalogation of the repertoire of the drawings of the Art Nouveau and Art Deco decorative elements can be a valuable support to the conservation of the buildings in the numerous cases of degradation due to time and to natural
decaying.
Since the decorative elements tend to recur in different buildings, as well as the general composition of the facades follows recurring patterns, it is possible to re-interpret the original shapes of the elevations through the comparison of the cases of study relating to the same type and the same drawing of the decorated elements. Even within the same building elevations there are often degraded decorated elements that can eventually be subjected to interventions of restoration on the basis of identification of the type of decoration and the comparison with others of the same type still clearly legible.

4.2. Modules and bjects of the facades

Also in function of a procedural modelling [28] it is possible to define a classification of the elements composing the facades in the following categories (Fig. 4).

Subdivision into modules:
- Horizontal modules
- Vertical modules - floors

Elements of the modules:
- Doors and windows
- Vertical frames
- Vertical closure frames
- Intermediate horizontal frames
- Horizontal closing frames
- Connecting elements between intermediate vertical frames and horizontal intermediate frames
- Connecting elements between intermediate vertical frames and horizontal enclosing frames
- Connecting elements between the vertical frames of closure and intermediate horizontal frames
- Connecting elements between vertical and horizontal frames of closing of closure frames
- Filled surfaces
- Isolated decorations
- Vertical frames of the openings
- Horizontal frames of the openings
- Balusters of the balconies
- Support of the balconies
- ...

5. CONCLUSIONS

This article has highlighted the potential and the limits of the use of BIM for the representation, the analysis and the management of the historic architectural heritage of the Art Nouveau and Art Deco facades. The use of B.I.M. has been discussed with regard to the peculiarities of the analysed case study. It has been discussed that it is necessary to readapt the procedures starting from the survey phase, which will be different from time to time depending on the types of objects to be modelled. In particular, the analysis of historical characteristics, formal and stylistic of the heritage analysed allowed to take advantage of the potential of B.I.M. in the representation of the objects that are repeated serially either within a single building or in several buildings within a broader territory.
The characteristics of the objects and of the buildings examined do not allow to take full advantage of the potentialities of the tool for the parametric representation of single objects that can be attributed to a limited number of types having constant geometrical characteristics since they have been realized through serial production processes. The processing of specific libraries of objects representing ornate elements also allows to make available and to share the knowledge related to these objects, fostering their conservation and their protection for the benefit of all stakeholders involved in the recovery processes which can be extended to the entire urban landscape. Thus, it appears as a collaborative process in which knowledge sharing is of fundamental importance. In a later phase, that is beyond the specific objectives of this article, It may be used as a function of a procedural modelling of facades integrated with G.I.S. systems.

6. FURTHER DEVELOPMENTS

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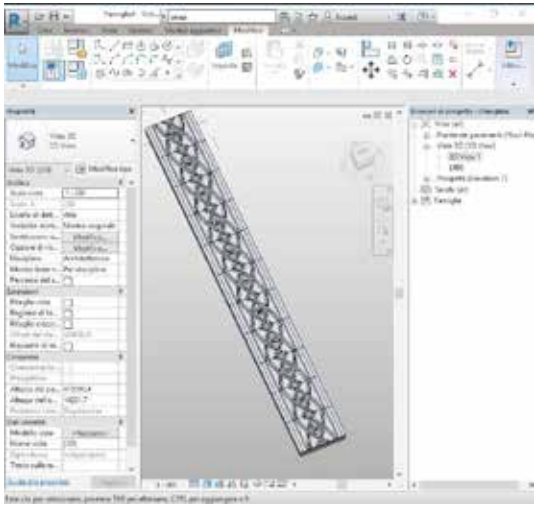
The research conducted so far can be further developed by applying semiautomatic procedural generation techniques through the use of G.D.L. encodings (Geometric Description Language). Moreover, further developments may occur both through the extension of the study to other territories, both through the application of G.I.S. technologies aimed to the localisation of the buildings within the urban landscape. Furthermore, it can be a useful tool to relate the diverse typologies of motifs surveyed in different buildings where the decorative elements recur, although composed in different ways.
Through this application of B.I.M. it can be made available a repertoire of replicable models aimed at the integration of the motifs and compositions no longer fully legible due to degradation, also through the application of 3D printing techniques.



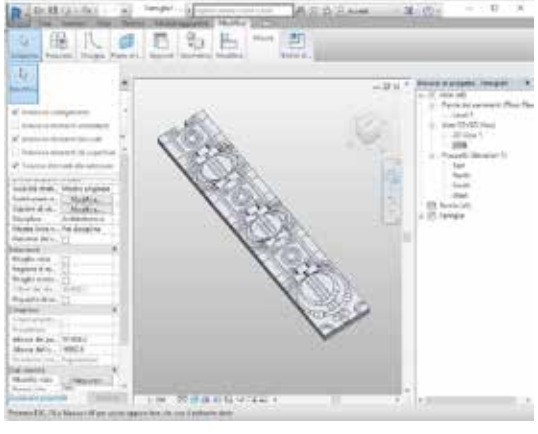


Fig 7, 8. BIM models (type A and type B) of the decorative elements previously illustrated in Figures 2 and 3.

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NOTES

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