

# ARCHITECTURAL RESTORATION, I.C.T. AND B.I.M. MAT THE “ALBERGO DEI POVERI” IN GENOA AS A CASE STUDY

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## **The contribution of the R.U. of Genoa to the national research program PRIN-2010-11**

The research carried out on listed and unprotected historical monuments - to establish the appropriate management of the restoration and preservation interventions throughout their entire life cycle - aimed at constructing a tool whose effectiveness might be assessed and which could be employed to:

- gather, store and manage the information required for the planning and design process, the execution of the real restoration works (also for drawing up the project cost estimation);
- put them in rigorous reference with the “places”, through parametric and interoperable tools;
- make them updatable in continuous and in simultaneity;
- use them to manage, maintain and conserve the buildings in the future.

The hypothesis at the base of the National Research Programme was that the more recent developments within the Information Communication Technologies allow now the construction of some BIM (Building Information Models), as meta-models in 3D, 4D, and even n-D, also for historical and monumental buildings, based on their volumetric and spatial consistency, constructive consistency and on the relationships between their constitutive parts. These models are not merely representative but could manage, in the long term, information and continually-evolving data collected during the surveying, planning, designing, constructive and management phases of the buildings’ life, undergoing interventions of restoration and of different nature. The primary objective was thus the development of a relational and (if possible) parametric system that could store and organize the information required for the appropriate management of the buildings throughout their entire life cycle (preventive maintenance, refurbishment, conversion, improvement of energy efficiency, etc.).

The Research Unity of Genoa, within the general PRIN framework and with the contribution of two researchers from the University of Cagliari, have in particular worked on a vast and unique architectural complex, the “Albergo dei Poveri” that is however representative of larger portions of the built heritage (Figure 1). The R.U. was characterized by a strong interdisciplinary and transversal approach and acknowledged expertises in architectural restorations, preliminary surveys and diagnostic inquiries in the field of archaeology of architecture, building recovery and refurbishment or retrofitting, environmental sustainability (with particular reference to the compatibility among innovative energy-saving technologies and preservation of the original features of the building), with specific contributions for the construction of a the BIM on part of the complex. The R.U. thus worked on developing a specific informative system (Relational Data-Base and GIS) suitable for collecting and storing various information, with the respective relationships, required for an appropriate decision making process (see the essay on this volume by S. Acacia and M. Casanova). Moreover, the R.U., always worked trying to face and avoid the many risks always emerging while representing the real building in a virtual model. In fact, any undue automatism should have been avoided during the phases of the information – gathering, their elaboration and of the decision-making process, in order to fully and deeply respect the most updated restoration theories of reflections, methods and techniques in this field and not to lose the specificities that make any building with any its component something unique and irreplaceable.

The innovative aspect of the project lied thus in the profound and constant interaction and confrontation between restoration's and ICT' experts, who worked jointly on identifying and validating different methods for implementing some tools that are currently and mainly used in the field of the new constructions, with the aim to protect and enhance the architectural heritage from any automatic extension of their use, as they are today, on artefacts (not only monuments) that were conceived, built and modified during the centuries following a completely different logic and practice.

### **State of the art**

The management of our built heritage, including historical and monumental sites, is a primary field of interest of the construction industry, but still some peculiarities emerge with a negative impact on its results, among which are:

- fragmentation of the know-how involved at various stages of the project;
- extreme variety and variability (by nature, detail, deepness, lasting, and so on) of the data and information involved – required by the process;
- variety of the involved actors, who are often driven by contrasting and conflicting interests;
- need to make the existing buildings comply with laws which are generally conceived for new buildings, and therefore do not take into consideration the character of Cultural Heritage and do not protect it;
- low usual interest in co-related environmental issues.

These factors along with others often contribute to thwarting the project's quality objectives, which results in a longer execution period, unpredictable events and discoveries during the construction phase, with consequent increase in costs and evident difficulties in validating the intervention's results and the following management of the restored building. This is the scenario that the new technologies have broken into and that can hopefully help in solving. The new IC technologies, in fact, offer undisputed advantages to the management of information and data of different nature. They nevertheless also have evident limits or can have undesirable consequences which are often inherent to the development of virtual models that struggle to acknowledge and represent complex real architectural structures, especially if ancient and belonging to our Cultural Heritage. The recent technological innovation was introduced in the management of the information collected on the architectural heritage and useful for its protection at least at the end of the 1990s, with the purpose of developing a culture of maintenance, scheduled conservation, and prevention. This innovation has also improved the organization, effectiveness, and efficiency of the technical and administrative aspects of the designs. This, for example, was the main objective of some specific information systems designed and sponsored by the Ministry of Cultural Activities and Goods. These systems were also meant to make easier the drawing up of the project cost estimation for each project. However, the SICaR (Information System for the Classification of the Restoration Sites) and ARISTOS (Information Archive for the History of the Protection of Historic and Artistic Works) could manage the acquired information only in a 2D environment. Moreover, the SICaR had already been tested by the R.U. in coordination with the Superintendence for Architectural and Landscape Heritage of Liguria, within the restoration of the decorated façade of the Palazzo Del Carretto (a listed monument) in Finalborgo (SV), for the construction of its “consuntivo scientifico” (scientific consumptive), as requested by the Italian “Code of Cultural Goods and Landscape”. The use of SICaR software in the research project is thus important, as it has been used by 12 Superintendences through the project known as ARTPAST (Application of Network Information for the Protection and Enhancement of the Cultural Heritage of the Underutilized Areas), coordinated by MiBAC, with the technical support of the “Scuola Normale Superiore” in Pisa. This project allows users to access (in shared mode, with open source software and high level of standardization) to a vast and implementable archive of data related to several restorations, useful to the professionals in this field as a source of information and of possible comparisons between different interventions. The SIConArt (Information System for Acquiring Knowledge on and

Preserving the Historic and Artistic Heritage) was afterwards developed starting from the SICaR. The SIConArt, in particular, allows users to acquire information in real time and provides some additional consultancy services now also through an on-line open source new release. Once obtained, the information can then be managed, elaborated, diffused, exchanged and remotely controlled. Therefore, there is a growing need to have access to complex yet user-efficient equipment on behalf of the professionals involved in any project, within the actual restoration design and realization interventions and in the future management of the buildings. Suffice to think of equipment that is universally accessible and deeply interoperable and permits the effective and fast linking of information deriving from diverse sources and of diverse nature, acquired during the preliminary analytical and diagnostic stages, during the planning phase, and throughout the realization of the interventions in the construction site. The situation here briefly outlined, deeply changed few years ago and is still changing with specific reference to the introduction of new approaches, new methodologies and tools. The creation of 3D models in the field of conservation and protection of Architectural Heritage is since a while broadly defined and recommended. The transition from traditional 3D modelling to a real BIM (Building Information Modelling), with the same purpose registers rather sporadic examples, because the approach has been applied till now mainly for the design of "new" buildings and in the management of its construction process. For these reasons, the PRIN and the work of the R.U. in Genoa aimed first of all at exploring the real and sustainable possibilities of transferring tools such as the BIM to the complexity of the historical, monumental, and non-monumental heritage overpassing any automatic and potentially dangerous application in this delicate field. The idea was, in fact, to try to use innovative 3D, 4D, and n-D models, to manage diverse categories of information, statistics, and processes fastened to the "three-dimensional spatiality" of the architectural structures and not only to their surfaces. These tools are not widely employed in Italy, but they are in the Anglo-Saxon countries of northern Europe and in the United States, where they are also used for managing the protected historical heritage. Effective coordination of the professionals involved in the construction processes, better consequentialness between its stages and times - not forgetting the costs - by saving its results could be in fact achieved by using the BIM, but the validity, efficacy and affordability of this hypothesis was to be demonstrated and this was one of the main goals of the PRIN. Its basic hypothesis, by the way, was exactly that these tools if properly re-designed and used with reference to the specificities of existing buildings of cultural meaning, could also improve the quality of the works carried out on them, also contributing to eliminate the risky margins for discretionary or invasive procedures, with consequent benefits the protection of the monuments/sites. The so called "Green BIM", afterwards also introduced into the management of the construction process some new parameters linked with the sustainability of the entire life cycle of the buildings and with environmental matters. These themes are not yet perceived as crucial in the traditional architectural restoration field but they will acquire in the future more and more importance and we cannot ignore them or simply delegate them to other subjects outside our direct field of commitment (see the essay in the volume by G. Franco). Until now, the built heritage has unfortunately been excluded from any specific reflection on these aspects. This situation is made evident even by the European Directive on energy-saving measures, which has relieved this heritage from the obligation to comply with the new directive's provisions in this matter, not only due to problems regarding compatibility, respect, and historical and cultural aspects, but also to the evident lack of interest of the scientific community involved in the field towards any technological innovation or enlargement of its traditional perspectives and specific points of view. With the integrated work of some experts belonging to different disciplinary and professional fields, guided by common interests and objectives (first and foremost the protection and appropriate management of the historical and monumental heritage), the R.U. in Genoa thus tried to face also these problems making emerge an innovative research pathway. The result is now a sort of "prototype" of a specific BIM for the "Albergo dei Poveri", rich with data, information, and assessments relating to the history and the building, as well as the constructive elements and materials it is made of (analyzed with the methods and tools employed for the archaeology of architecture) and to the sustainability of each work carried out on it, in terms of resource-saving measures and

impact on the environment, during the entire life cycle of the building, including the disposal of materials and components on the construction site. The Technical Offices of the Genoese Athenaeum should now test this BIM, if possible. In the meantime it is already offered to the control and evaluation of a wider scientific community and can be a little contribution potentially interesting for a wider Built Cultural Heritage.

### **Brief presentation of the case study**

The “Albergo dei Poveri” (“Poor Hostel”) is a vast architectural complex built between the mid-seventeenth century and the nineteenth century, with subsequent and repeated modification, transformations and integrations that must be still rigorously reconstructed (see the essay in this volume by A. Assini, A. Boato, L. Napoleone). They have been partly related to the changing modes of the care and of the assistance, during three centuries of history, and partly have been due to the many repairs resulting, inter alia, also from the deep and diffused destructions of the last world War bombing (see the essay in this volume by S. Acacia and M. Casanova). The owner of the complex is now an Institution of Service to the Person (heir of the original bequest from which the “Albergo” had its origins), but in the nineties of the last century, the University of Genoa has acquired the surface rights for a period of 50 years. The agreement provided that the University should have taken care of the complex (by restoring it) allocating its “empty and abandoned inner and outside spaces to its institutional and educational activities, always maintaining its monumental parts (in particular: the church, the ante-church, the atriums the monumental staircases and other parts) open to the public and, in the case of the Church that is still a parish church in the hands of the Archdioceses, regularly officiated.

The complex has been subjected to some interventions of restoration, consolidation and adaptation during the last 20 years, in this perspective, which are now almost concluded but that involved less than 30% of the available covered surface (more than 60,000 square meters). The rest of the available spaces is still abandoned and subject to the usual and recurrent natural deterioration and decay phenomena. It was thus necessary (and still is) to “imagine” and also programme and design, inside and around the complex, new structures and spaces for new functions, taking into account all the constraints of cultural, technical and functional nature that any intervention on a protected (listed) monument imply. Even more, it was and still is necessary to govern or manage, “day to day”, the life of the complex in the period of time that will separate us from its future full and consistent utilization, minimizing any losses and preserving all its values and potentials. Meanwhile, every day, the state of conservation of the complex progressively worsens, new evidences of its past history emerge sometimes just for a chance, or new constructive features are better understood and all these new elements continuously change the situation, as well as the progressive changes of the requests and assumptions of its future use or the technological possibilities for its effective, compatible protection. Before or more than of “plans” and “projects”, then, we had to talk about the programs and about the capacity or the need for a continuous and dynamic “management” within a constantly changing reality, of what is certain and the uncertain, of what is changing and of what is simply transitional or provisional. More than of individual “actions” then, first of all, there is the need for loud and clear policies as well for some adequate administrative, technical and cultural decisions. The essay thus illustrates how the researchers have so far dealt first of all with the difficult issue of the government of the studies processes and the management of the large architectural complex of the “Albergo”, aiming at its progressive and truly sustainable utilization, respectful of the many cultural values of which it is the depositary, taking also advantage of the BIM and GIS potentialities as other contributions to the volume will explain in detail.

### **Brief historical profile of the “Albergo dei Poveri” deriving from edited sources and studies.**

The historical monumental complex is listed and protected according to the Italian “Code of Cultural Goods and Landscape”. For its size, the architectural compound can be likened to a part of the city, more than a simple building, a structure or infra-structure at urban level and thus implies several problems both at the building and

at the territorial scale, being also part of the Cultural District of the historic buildings of the University of Genoa (the so called “Pole of via Balbi”).

The “Albergo dei Poveri” was built between the second half of seventeenth century and the middle of the nineteenth, but has never been completed according to the original plan and design (Figure 2, 3). Further, it knew during the centuries several modification, adaptation and even deep transformation, mainly in its internal structures and spaces, due to the changing, over times, of the social asset of the town, of the sensitivity and the evolution of the scientific, social and political thinking and, consequently, of the methods of hosting the poor and taking care of them, within the institutions of the Republic. It is in fact now a monument but, above all, it was an Institution of “Public Munificence” that, under the label of a charity body, hid also a strong program of social control of those whom declared to take care of (poor, unemployed, strangers, homeless considered as a secluded part of the social body of the city). For these purposes the “Albergo” was founded by Emanuele Brignole Sale, a representative of one of the richest and outstanding noble families belonging to the exclusive circle of those who ruled the Oligarchic Republic since the times of its “father” Andrea Doria. As a monumental structure for charitable and social purposes, during the periods of maximum expansion and activity, it hosted almost three thousand of persons, recovered or working here, and it closed its doors every night, as it were a place of reclusion. It thus represented for centuries, till the recent abandonment and thanks to its strategic position and scale (dimensions), an important urban and territorial (infra) -structure. The model assumed for its design was directly linked to the schemes of several welfare architectures mainly deriving from Antonio Averlino’s (known as Filarete) architectural theories, like the Major Hospital in Milan. It also recalls the great Monastery and Royal Palace of the Escorial, for emperor Charles V<sup>th</sup> and, in a way, it anticipates in a sort of reverse way the famous idea and the forms of the “panopticon” that in the nineteen century changed the concept of several architectures devoted to the control of prisoners, or sick people, by ensuring the chance to see every part of the complex they were hosted in, from a single central point. Here the visual, symbolic and functional centre of the entire monumental complex, in particular, is the main altar of the Church that was visible from all the four arms of the cross designed by the internal wings used as ante-church (towards south, and the monumental atrium and the external), the two Oratories for males and females (towards west and east) and the infirmary (towards north).

The wide complex was built in a natural valley immediately out of the second city walls of the town (Fig. 4), dating from the end of the sixteen century and remained out of the urban settlements till the destruction of those walls at the half of the nineteen century to allow the growth of the city towards north, occupying the first slopes of the hills that surrounded it. This means that the architects had to conceive and design, first of all, the deep modification of that piece of natural land, by deeply and hardly re-modelling the valley itself and, with the reduction and partial destruction of their rocks sloping sides, the covering of their river(s) and the successive filling of the natural basin, in order to obtain a regular and flat surface upon which founding the new complex. For these reasons, we are not simply in front of a building, even if huge and vast, but a real urban structure that deeply affected and modified even the landscape of the town. The main steps of its construction date thus between 1656, year of the complete acquisition of the land, and 1696 when the east and north wings were completed (at least according to the edited documentary sources and literature). The construction ended only in 1832 with the west wing, never completing the original plan towards west, for technical and economical reasons, and thus reducing its dimensions.

The research showed in any case that this already apparently “known” history has to be profoundly revised: new documents have been discovered in various archives (Historical Archive of the Municipality of Genoa, State Archive, E.B. Sale Institute’s Archive, archive of a Religious Order of Nuns that inherited part of the historical documents of the Institute), analyzed and interpreted and are still under elaboration. In the meantime, the main important ones have been recorded, listed, ordered, scanned and in some cases copied, transcribed and inserted in the general data-base interlinked with the GIS system and to the BIM prepared to manage all

the information about the architectural complex (see apropos the essays in this volume devoted to historical enquires and elaborations: S. Acacia and M. Casanova, A. Assini, A. Boato, L. Napoleone).

### **Status of the complex**

At the end of the nineties of the past century, the complex was assigned by the legitimate owner, that posses it in force of an “eternal juridical obligation”, to the University of Genoa, through the juridical medium of an Agreement that assured to the University the “surface right” on the complex for 50 years. The original prevision of the Genoese Athenaeum was to transfer in the complex all the Faculties of Humanities, Social, Political and Juridical sciences hosted in some monumental palaces of the close Seventeenth century “via Balbi”, around the ancient Jesuits convent where the “Rectorate” of the University is hosted. For several general reasons (that is not the case to highlight here), that original plan-programme was slowly developed during the past decades and with several stops, due to different problems of economical and technical nature that in part derived also from a lack of consistent and affordable knowledge of the architectural complex, of its real consistency and state of conservation. The insufficient knowledge brought, in fact, to parallel insufficiencies of each following design and plan. In the mean time, the impossibility of occupying the entire complex in the same phase and to reuse it as a whole, determined the uncontrolled development of the decay phenomena and of the structural diseases that affected the complex after a long period signed by total and diffused lack of maintenance and abandonment. This situation deeply affected, in fact, almost all the roofs and the covering structures, the frames, windows and doors, the plasters, the internal installations and finishes, but also the external spaces and those of the inner courtyards. Uncontrolled infiltrations of rain waters, of animals, homeless and vandals, the disordered growth of infesting vegetation and other similar phenomena that were already evident when the University received and took under its own responsibility (economical, technical, administrative...) the complex, but they continued worsening after that crucial moment and unfortunately in some cases are now even more dangerous and irreversible. Quite absurd, also the few and limited parts that have been till now “restored”, rehabilitated and refurbished to host didactic activities, a library, administrative offices and the staff ones, are already in critical conditions, above all in functional and comfort terms, independently by the evaluation that we could express about these interventions under the point of view of their architectural quality or of their cultural premises.

Another aspect of the incredibly difficult situation the University faced when the research begun (and still faces), is provoked by the fact that during the past decades all the technical regulations set by the State and by different Authorities, for example within the field of the tutorship of the safe use of the buildings against the risks of fire or of earthquake, or that of the workers and of the work places, or even about their comfort, are now completely and deeply changed. It has been a constant process towards higher levels of control in each field involved by the re-use of existing buildings, This regulation development imposed progressively new standard, parameters and requirements that the original projects did not of course respect and that now involve compulsorily any new hypothesis regarding the “re-use” and adaptation of the ancient structures and spaces of the “Albergo”, while their status is permanently worsening and also the evolution of these phenomena should be taken under control, continuously recorded and updated. The relational database, interlinked with the GIS and, for the experimental part, also through the BIM, are now luckily helping the University in answering also to this task.

### **Strategic plans for the future of the complex: the contribution of the research activities**

The University, after many years of casual addictions of separate and partial projects, had decided to change the way in which the problem could have been faced and hopefully managed and solved. For this purpose the Athenaeum first of all tried to re-formulate and update the agreement with the Institute “Brignole Sale”, in order to prolong its validity till 99 years thus making more reasonable and sustainable the further investment

of public economic resources that, in any case, must be searched because the needs exceed the normal balance of the University. What was clear enough when the research began was that it was impossible to go on following the same paths of the recent past and a general strategic plan was needed, funded on a clear vision of the future not only of the architectural compound in itself, or even as a simple new siege for the University. It was in fact necessary to consider it as a fundamental part of the town, a resource of life that could maintain the values of its layered history whilst forgetting the sense of sadness, of sufferings and seclusion that its spaces knew and embodied in the past. Student could not be a new separated and controlled part of the city life and it is up to any future program and design to ensure that this condition will never repeat in the future. In this perspective, anyway, the University of Genoa could not face on its own the fate of this vast architectural complex that represents a "unique" in the panorama of Italian cities. Abandoned for many years, the "Albergo" is still mostly unknown to the same Genoese, relatively little studied by historians and, moreover, its recovery would be a great operation of cultural and urban planning of major importance. For this, the University promoted and still tries to propose a coherent and sustainable strategic plan of restoration, reuse and management of the monumental complex of the "Albergo", involving the Municipal, Provincial and Regional Administration, along with other local actors and the Ministry for Cultural Activities, Goods and Tourism. Given its impressive size and location in the heart of the city, the architectural complex could in fact represent a fantastic opportunity for the urban renewal and valorisation of this part of the town and of its whole (Figure 5, 6, 7, 8). Therefore, a restoration/renovation feasibility plan, during the development of this research and in coordination with it, has been prepared by the technical offices of the Athenaeum with the technical and scientific support of its School of Specialization in Architectural Heritage and Landscape (director prof. Stefano F. Musso, with prof. Giovanna Franco), in order to allow a complete re-use of the building as a university campus (Schools of Humanities, Foreign Languages, Political Sciences and Law) within the city core. Nowadays only 30% of the available (abandoned) space has been recovered and is regularly used for classrooms and didactic activities, libraries, department offices and other university functions. The remaining parts, especially in the north, east and north wings and in their upper floors, is dangerously and continuously exposed to the actions of all the imaginable causes and agents of material and physical degradation. Further the ancient inner spaces have strong morphological and organizational features (large rooms, in some cases fragmented during the past decades, covered with complex vaults in the lower levels and with flat ceilings in the upper ones, monumental stairs and lack of safety exits...) that make very difficult to modify them to be adapt for new uses, saving their architectural values and architectural characters. The PRIN research thus helped in completing and implementing an integrated and interoperable information system (relational database, GIS., BIM), in order to manage the complex of information necessary to develop such a kind of ambitious program. Thinking to the future uses, the "Albergo", with its morphological constructive and spatial features, finally rises also deep problems about the needs to be heated, insulated and cooled, so that also the improvement of its energetic behaviour is a real and crucial challenge for the University in the future. The organized database, interlinked with the general GIS and the partial BIM, can thus help also in managing the future decision making processes in this particular matter and perspective.

### **Research aims and developed actions**

For these reasons, a "Strategic Plan" (or "Master Plan") was designed, aimed at the full use of the complex, respectful of its features and of its several values and that can be implemented through phases spread over time and that contains the following main information, regularly inserted in the general informative system (database, GIS and BIM):

- distribution layout of the complex, and its modifications, with the identification of the possible future uses of the covered spaces, of the open and closed ones, with respect to the needs of the University and, potentially, also of the city;

- Identification of the system of accesses from the outside, of the inner and outer journeys associated with the foreseeable new uses of the single spaces and with the possible escape routes in safe conditions;
- identification of the main interventions of constructive nature and of architectural character needed to bring the available space in safe conditions, distinguished into:
  - Interventions of pure conservation and restoration;
  - Intervention of functional nature;
  - Intervention of structural impact;
  - Interventions on plant and technology or sanitary devices;
  - Interventions of totally "new architecture", strictly functional to the foreseeable new uses.

The Strategic Plan is still the basis to which to anchor the continuous updating of data derived from the studies made and still in progress and also the ongoing confrontation with the governance of the University. All these elements seem to configure an innovative "good-practice" for the University in the field of management, including economic, of the process of restoration / recovery / reuse of the monumental complex, subtracted from the random addition of several autonomous projects, uncoordinated and that are simply summed each other during the time.

### **Description of the main results of the research**

The whole work designed four years ago, now almost completed but still subject to continuous updating, was organized into the following main phases, never isolated or separated but deeply and continuously interlaced:

- identification and recording of all the spaces existing within the complex and of their morphological features, dimensions, constructive characters, state of conservation and environmental performance;
- inquiry and simulation about the potential use of the single spaces, in relation to their features, conservation and conditions of risk/safety;
- systematic identification and localization of the risk factors, structural or related to the storage conditions of spaces and structures and to their presumed future use;
- systematic identification of structural characteristics and of the conservation conditions of the different parts of the complex, particularly with regard to:
  - phenomena of structural instability still ongoing or ceased;
  - degradation of the built matter, still ongoing or past, affecting the various parts and components of the complex;
  - unsanitary conditions and sanitation deficits of the various indoor environments;
  - deficit technological and of installations, failures and malfunctions of the individual constructive and technical components;

All these thematic inquiries have been recorded and visualized through appropriate media (restitutions of architectural surveys of different origin, characters and detail, thematic maps, drawings, photo documentation, documents, etc.) that have been inserted in the general informative system (database, GIS, BIM). This system allow the storage of these information, their updating and also their preservation in "historical" sections in order not to loose the information every time they are for several reasons updated thus maintain the memory implicit in their sequence (see the essay by S. Acacia, M. Casanova).

This work allows now different elaborations or extraction of single thematic set of information of the collected data such as:

- reconstruction of the history of the complex based on archival and documentary (indirect) sources and on the building itself considered as direct source of its material history through the methods of the building archaeology and the constant comparison between direct and indirect sources, localized in the space thanks to the interoperability of the informative system;



- restitution of the survey realized in different moment but linked to a general system of reference (topographic, rigorous analytical and digital simplified photogrammetry, 3D laser and Z-scans);
- building description (morphologies, extensions, spaces layout, constructive features, building physical parameters describing its behaviour...)
- analysis and diagnosis of materials, constructive techniques and components, structural elements and parts, also related to the historical and documentary sources that have been collected and stored in the system and that could be found in the future
- non destructive diagnosis of the conservation conditions of each part and component of the complex and of its technological and hygienic deficits”;
- analysis of the environmental conditions (also thanks to on-site or remote monitoring, with static and dynamic systems) and qualification/quantification of the comfort parameters characterizing the present status of the “Albergo”;
- description of the condition of the complex before any future intervention and evaluation of their impact on the “Albergo” stratified matter and values but also on its energetic behaviour (see. essay by G. Franco)

All these data have been already organized and recorded in a relational database able to collect information of different nature and provenience, ensuring their storage and their continuous updating. This data-base (easily transferable into different software packages and tools) is now the basis for the attempt to build up a BIM (Building Information Model) to be experimented on a part of the complex that is now chosen in such a way that it comprehends some of its more monumental spaces and some normal ones, in which some interventions are really foreseen for the near future.

### **Construction of the parametric meta-model 3D tool (BIM)**

The management of any restoration/renovation process of existing buildings and of large monumental complexes, in on the other hand, poses evident challenges as compared to the new construction. These challenges concern, first of all, right the crucial phases of the information-gathering, the preparation of the contracting procedures, the management of the construction site, and the successive life cycle of the asset.

According to literature and to some already consumed and well documented experiences at international level, the BIM (Building Information Modelling) can make the management of data during the design phase and during the life cycle management of a buildings easier. Nevertheless, BIM have been so far mainly used for planning, setting up the construction site, and managing new buildings. *“Originally 3D was a visualization tool, but it has developed into a tool with information on quantities, factory production, schedules, production data, energy balances and management information (4D and 5D). Building information management (BIM) is a structure and [an] approach that, not only shows what the [building] looks like, but also reduces the risk of coordination misses [...]. Working with BIM provides project advantages. In particular, it gives increased and easier information to all stakeholders”.* (Hans Ottosson, *Practical Project Management for building and construction*, ESI International, Arlington, Virginia, USA, printed in USA by CRC press, 2013, pp. 25-26.)

In this perspective, the Research programme assumed that the gathered information (dimensional, geometric and technical – of different nature) could have been hopefully helped by realization of specific 3D models and using some parametric software for the management of the several data of different nature, origin and derivation referred to it (see the essay in this volume by R. Babbetto). This is a crucial task, also because those data are for their own nature extremely and continuously variable and mutable in time, reflecting the parallel change of the context depending from the works in development. For this circumstance, they must be continuously updated (without losing them) as they can derive from different survey campaigns and from various analytical or diagnostic phases even during the interventions stages. It is in fact necessary to allow a correct and always controlled management of the restoration/renovation projects along their entire development and realization (from the previous analytical phases to the design of the interventions, from their

realization as “pilot projects” to the assessment and evaluation of their outcomes and the following management of the renovated building).

The major difficulties that the Research Unity of Genoa, tried to face and solve, in this perspective, in fact, emerged first of all from the needs to:

- manage a considerable amount of information, of diverse origin and nature, that is always implementable and changing over time, without ignoring or changing their proper specificity;
- manage this information and their variability during the study and planning stages, on the construction site, and during the successive management of the building;
- match the different kinds of information, refer them to their exact location within the complex (when possible), and record the variations which the project and the construction site induce upon the buildings, always maintaining their memory in order to could allow (for the past but also for the future) the “reconstruction” of the historical, archaeological or stratigraphic layers of the building and of its past, present and future physical status and knowledge;
- make this information reusable in the decision-making processes, which are open and cannot be determined in advance;
- organize the preventive and scheduled maintenance operations required after the interventions are completed.

### **New issues and research perspectives**

For all the highlighted reasons, our work also aimed at understanding “if” and “how” tools like the BIM could have been “adjusted” (adapted, modified, implemented...) in order to meet all the theoretical, cultural, technical, and operational needs and requirements of the present culture of restoration, with direct reference to the complex situation of an architectural and urban complex, built centuries ago and modified over time.

In synthesis, the BIM tool we realized, could hopefully:

- reduce the duration and cost of the operations that may be required during the life cycle of the buildings;
- reduce the risks and minimize the contingencies pertaining to all restoration projects and to the ordinary management of the buildings;
- avoid excessive and unsustainable degrees of discretion in assuming the needed choices during the planning stage, or at least create a “tool” for their explicit control, during the administrative process and the contacts with all the administrative authorities or bodies responsible for the approval of the various foreseeable, designed or programmed interventions, while carrying out the works and during the following management of the complex and of its uses.

One of the first step of this activity has thus been the use of already existing architectural-geometric surveys and the execution of new campaigns, also using rather diversified instruments, from the simple ones up to highly sophisticated ones, in order to check and evaluate the real performances of the new model.

The strong interdisciplinary character and structure of the research program have been in this perspective very helpful in developing a system that is now suitable for collecting and storing all the information (with the respective relationships) required for any effective decision-making process.

Moreover, we always tried to face and to neutralize the many risks involved in any attempt of representing the “real building” through a too simple “virtual and exclusively visual model”, especially if based on parametric (standardized) premises and requirements. In fact, any undue automatism had to be avoided during the gathering of information and even more the decision-making phases, not to lose or deny the many unpredictable, irreplaceable e irreproducible specificities of any historical artefact.

### **Provisional conclusions**

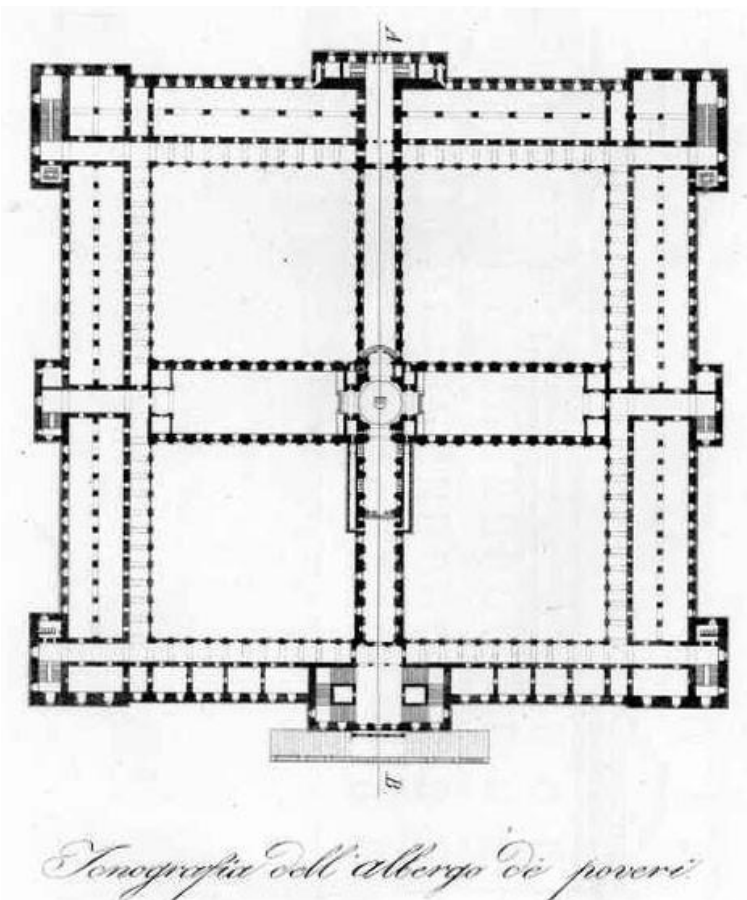
As a sort of provisional conclusion, we can say that the amount of intellectual, technical, operational and also economic and time resources invested in the Research bring to affirm that:

- only a radical change of mentality can help in adopting in a conscious way, thus preventing any unforeseeable and dangerous consequences, the BIM technologies within the field of the existing architectural heritage,
- in any case, the BIM technology by itself (and the correlated models) cannot ensure the total covering of the needs here briefly described and this pushes towards the adoption of several integrated systems (databases, GIS...) that in any case need to be deeply interoperable.
- In order to avoid the risk of over-imposing (or substituting) the virtual model to the real building, a lot of work has to be done every time for any specific artefact and this apparently is in radical conflict with the “parametric” logic of any BIM till now experimented for the new buildings where everything can be chosen/decided making reference to pre-established libraries (sets) of materials, elements, components, parts, and so on, whilst every window coming from the past, even if similar or originally intended as identical to another one, is now inevitably different from it.
- This means that, at least now, such a kind of work and effort can have a real meaning and a chance to be realized and adopted only if, for example, the University decide to adopt it as the main instrument to rule all the future life of the big complex of the “Albergo”, investing the necessary resources in implementing the prototype now realized through this research and in training his offices in order to ensure its future use and continuous updating.
- Only in this case the “scale economy” factors can justify the enterprise and this implies, first of all a political and cultural investment and then also an economic one that could ensure, in the future, a sparing of other resources, avoiding the continuous loss of information, the repetition of surveys, analysis, diagnosis as the world has to begin any time from the “origin” or from the empty space on a blackboard. We have in fact to avoid the risk that knowledge does not stratify and last thus allowing a real, consistent and useful process of accumulation and of awareness about the real status, consistency, value of any historical building, perceived as belonging to our Cultural Heritage that must be therefore carefully preserved and transmitted to the future the more intact is possible.
- The possibility to realize 3D information modelling (BIM) with different and progressive steps of refinement, deepening and enrichment in terms of information should be analysed and experimented. We experimented how difficult can be the sudden and definite construction of such a model (of informative and not simply representative nature) and how, in any case, some information (geometrical, material, constructive, historical, and so on) can be acquired in different times and along the entire process. Also this opportunity can facilitate the adoption and diffusion of these kind of tools, if rigorously controlled of course that also means, denouncing the real nature, precision, deepness and affordability of the single data and information and its validity over times.
- One real risk, in fact, must be carefully avoided: that the adoption of these kind of instruments can give life to a sort of passive acquaintance of their future users. If a BIM is confused with a sort of “Expert (or-self intelligent) system” one (technician, designer, administrator, and others) can be pushed or brought towards a lowering of their “attention threshold”, with unacceptable automatism in using and managing the system or in simply deriving from it conclusions and consequent decisions that in any case ask for a clear and constant assumption of responsibility.

The essential bibliographic references, for each treated topic, are comprised in the single essays of the volume devoted to the elaborations that the R.U. of Genoa realized about the “Albergo dei Poveri”.



Figure 1. Aerial view of the Albergo dei Poveri and its surrounding



*Planografia dell'albergo de' poveri*

Figure 2. Original plan of the Albergo dei Poveri – end of XVII Century

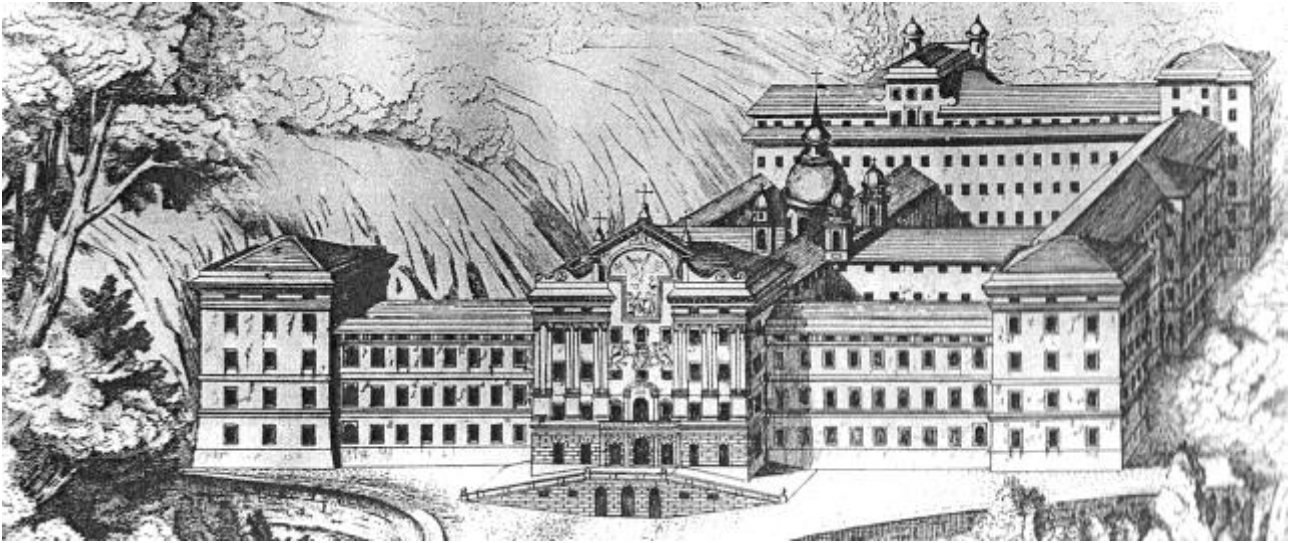


Figure 3. Perspective view of the complex – B. Cervetto, 1835



Figure 4. Historical map before the demolition of the City Walls

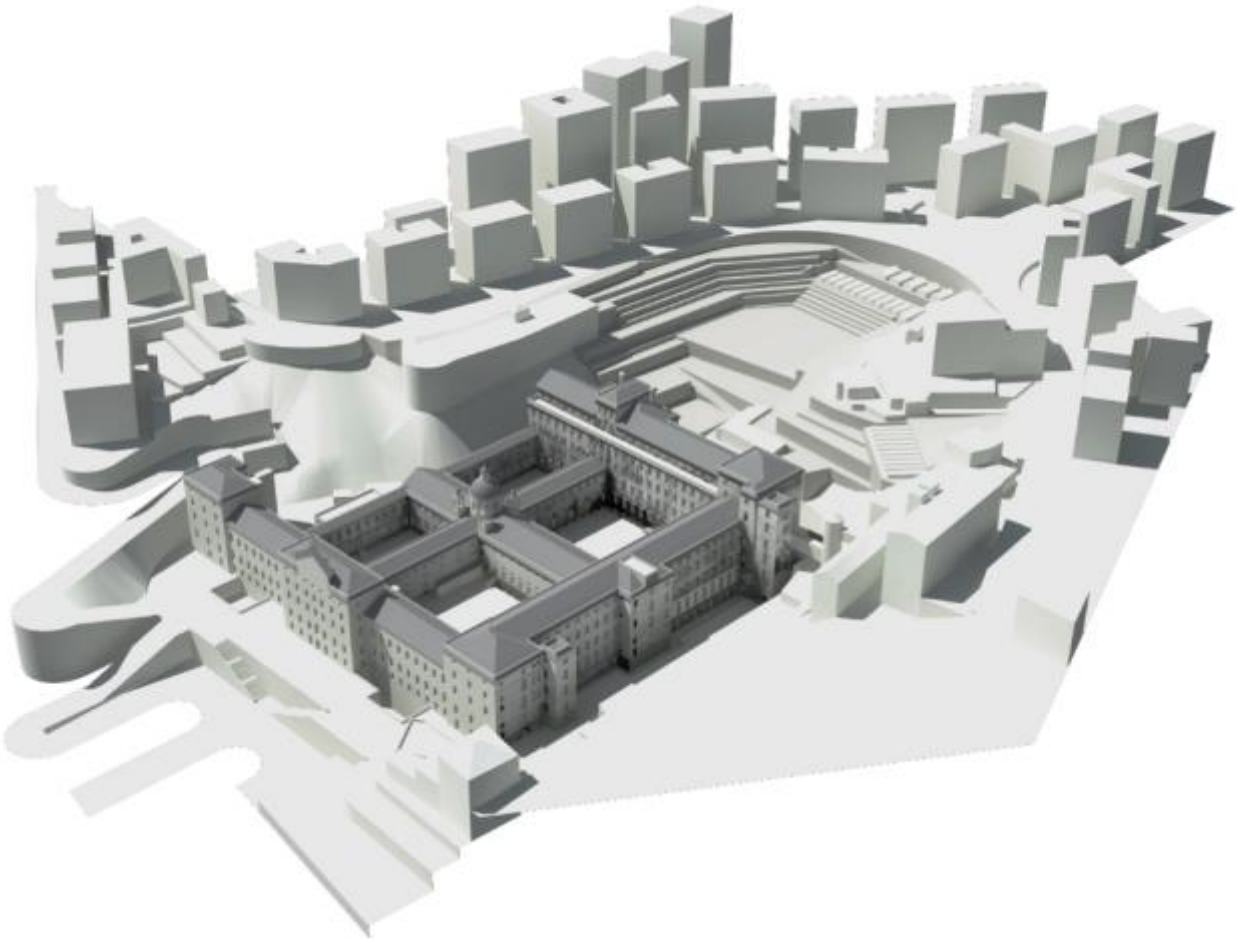


Figure 5. 3D model of the complex and its environments nowadays (E. Macchioni)



Figure 6. Restitution of the survey of the south façade in 2D digital photogrammetry

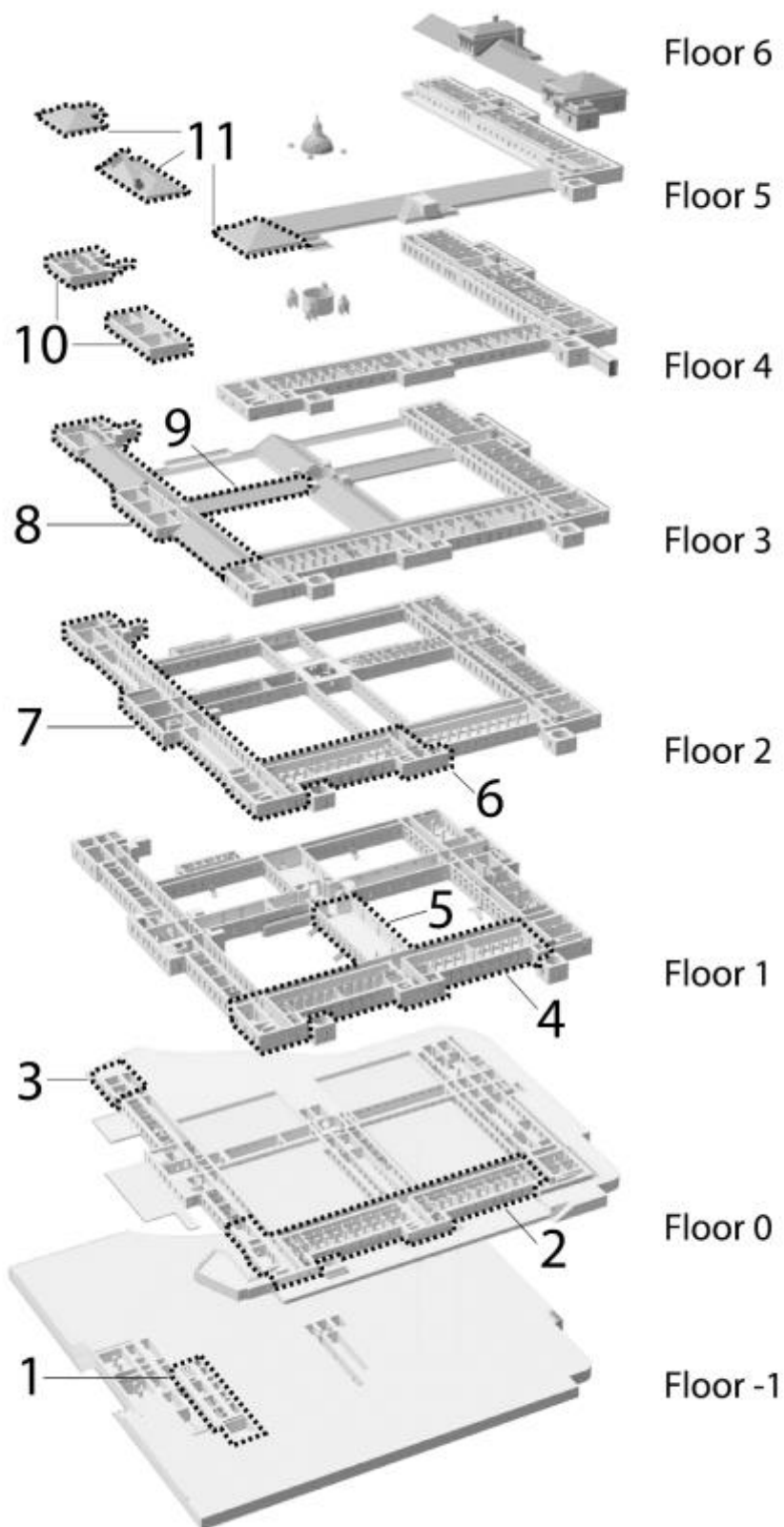


Figure 7. Exploded 3D model of the complex (E. Macchioni)

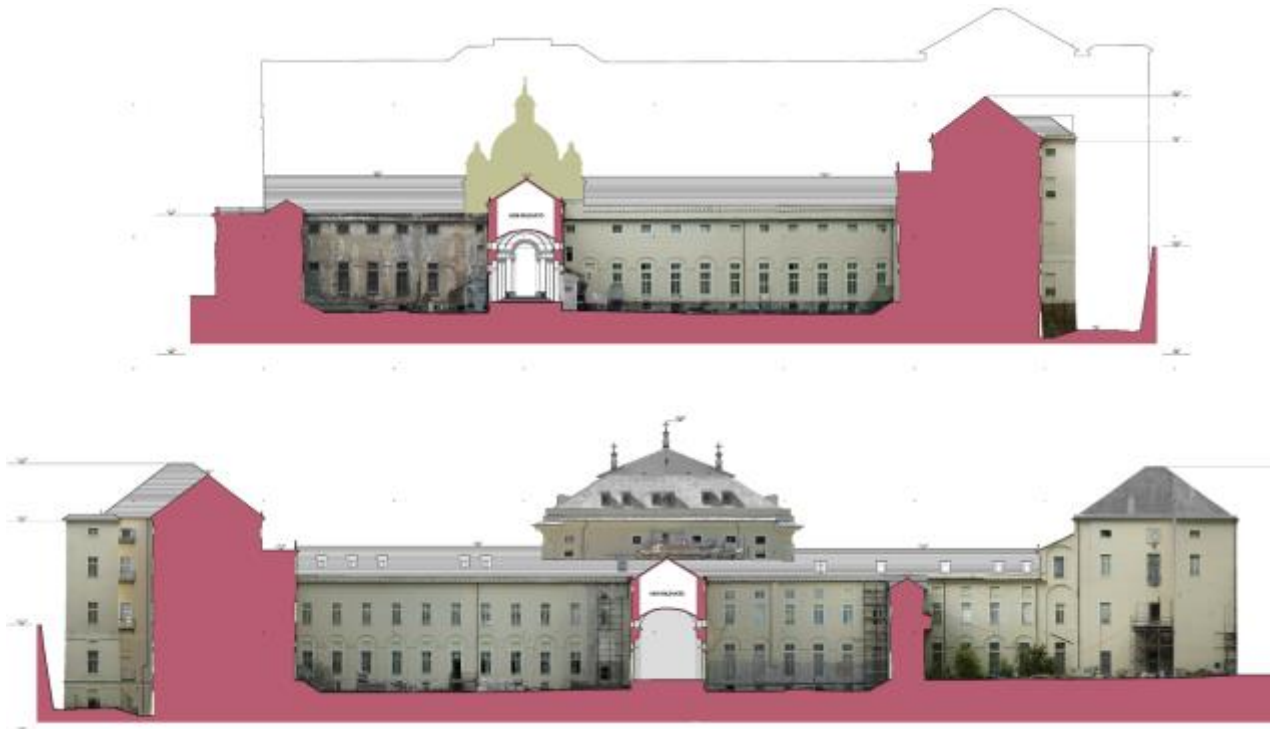


Figure 8. Cross sections of the north-south wing facing north and south