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CULTURAL HERITAGE DESIGN: THEORIES AND METHODS FOR THE PROJECT COMPLEXITY MANAGEMENT

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Abstract

The contribution focuses on the design project in particular in relation to the existing Cultural Heritage. The principle aim is the investigation and the analysis of a complex as an indispensable relationship between the phase of building knowledge and that of intervention. Methodologically this question will be addressed firstly through a historical excursus through the main restoration theories with the aim of understanding how this aspect has always been perceived as a fundamental element for the success of the project; then it will be addressed towards the study and investigation of some more recent methodological solutions. Outcome, still open to development and progress scenarios, is the evaluation of how the most recent technologies and information systems can be able, if wisely used, to became tools able to assist the designer in the synthetic control of the management of the building process.

Keywords: Knowledge; Restoration; BIM; Conservation.

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1. THEORETICAL SCENARIO: THE REASONS FOR COMPLEXITY

This paper focuses on Cultural Heritage; firs of all it is considered useful to give a definition of Cultural Heritage also in order to understand the strong heterogeneity underlying this term and consequently clarify the possible actions of intervention. The Italian reference legislation is the Code of Cultural Heritage, issued in 2004 which establishes what is meant, or not, for Cultural Heritage, defining its constraints and the possible actions of protection and safeguard. Cultural Heritage concerns the recognized and well-known monumental building but also the minor buildings complexes or the industrial heritage. This makes, a complex approach to the building precisely because the preliminary knowledge process is complex. Secondly, it opens the cultural debate around, albeit important, long-standing questions concerning to provide a single, unambiguous and universally shared definition of some of the fundamental terms concerning the protection of Architectural Heritage such as Restoration, Recovery and Conservation.

Particularly significant are the words expressed by Benvenuto and Masiero who, in the incipit of one of their essays, declare "Tradition, conservation and restoration seem friendly words, joined together by bonds of consanguinity and alliance" (Benvenuto, Masiero 1997: 103). The authors define the relationship and the link between these terms almost immediately: if tradition brings together the traces of the past and the historical and cultural testimonies of past generations, the priority task of conservation action inevitably becomes that of guaranteeing, preserving precisely, the traces of the past, as a memory from which our generation descends. So, the restoration is the result of the set of techniques and design actions that allow to achieve the conservation objective. It means that it is not possible to solve the problem in such a simplistic way. The cause derives precisely from the radical upheaval of speculative models of which contemporary culture has been reduced, which have made it difficult to formulate a single definition.

1.1 RESTORATION

Regarding the first theoretical formulations in the field of restoration, it is possible to quote the statements proposed by Viollet Le Duc around the early XIX century. Until that time, the restorative designers worked without any codified methodology of approach to the project and on poorly known monuments. The main and priority objective was to reconstruct them, so "for a certain period the restorative architects should proceed by trial and error without any general rule that could have been determined by some tradition" (Ceschi 1970: 66).

What is important is that in Viollet Le Duc's statements it is instead possible to find some fragments of theories now commonly shared in the culture of the restoration project. First of all, he declares the need to approach the monument to be restored with profound humility, working only taking care of the building and demonstrating an extreme meticulousness in understanding the intentions of the ancient designers during the creative phase. Therefore, the restoration project must follow the spirit of the monument, in order to be correct from a methodological point of view, able to lead the project.

The theory expressed by Annoni (1882-1954) is interesting as placing the monument itself at the center of the restoration project, considering it as the object capable of providing the interpretation key for a correct intervention; "by this I mean the direct test on the monument, rather than as a historical document and an expression of art, as a constructive fact ... only if one penetrates the sometimes unexpected meanders of the ancient buildings, and bricks and stones, beams and paintings, organisms and forms let them say their unchanged word, just so the monument ...reveals its reason, and also that of those who made it and wanted it" (Annoni 1929: 81-82). Following these premises, he hopes "the respect to the monument that eschews sterile mummified conservation... [since] before the monument it is the master".

So, he declares, just as Viollet le Duc had previously stated, the peculiarity and specificity of each restoration intervention, according to which it is necessary act *case by case*. So, Annoni's thought takes up what Boito (1836-1914) had already asserted, that is the active and real interest of the monument, seen as a historical and cultural testimony of an era. It is seen as design value and therefore as architecture lesson necessarily belonging to its environmental context and that, for this reason, has a reuse possibility, since "our architectural and building works must be for the use, of their citizens, and at the same time for the city ornament". So, restorer must act as a surgeon making the additions perfectly legible and distinguishable, respecting the monument historical stratification.

A new chapter in the restoration theory starts with Gustavo Giovannoni, who sets the theme of multidisciplinary restoration. He defines restoration as a technique, or rather as an organic and coordinated set of different procedures, with explicit means and ends. Giovannoni considers the use of the different methods, such as those of architectural survey, construction techniques, archaeology instruments for the restoration project. Moreover, he is strongly convinced of the need to consider restoration as a discipline, as it stands as the "intrinsic end of the monument project action" (Torsello 1988: 46).

Boito declares that the intervention on the existing must be *modern* precisely because it must differentiate itself in everything from the context and above all because of the sincerity or constructive frankness in the intervention on ancient buildings. They must necessarily be explained by the material and by the technological-constructive solution used that reflects the era of intervention, differencing itself from the original architectural building. He formulates the need to proceed through a meticulous respect for the monument towards which the restorer must guide himself, "the more the contemporary artist bows, kneels down, annihilates himself against monument, the better he does his duty. The day when, raising his forehead, he exclaims - I am there too - that day, the old building trembles" (Boito 1988: 120). Aspects and problems that are part of the modern conception of restoration are outlined and systematized for the first time inside the Charter of Athens (1931). It is assumed that the methodological foundation of restoration theory must be based on the investigation of pathologies and the state of degradation of the monument; this therefore means paying attention to the cognitive diagnostic phase and to the valuable information that it can offer if carried out correctly. Starting from this, a new method can be established based on scientific rigor and on a new trust in investigative techniques, already placed by Giovannoni, which shows how rapid and exponential their evolution is thanks to the very rapid increase by technology and by modern industries. In the Universal Encyclopaedia of Art, Bonelli gives his definition of *critical restoration* declaring that the monument is itself a testimony value, a document and the necessity to know the building completely in order to be able to understand and intervene on it.

1.2 CONSERVATION

Today the contemporary debate and the most recent regulatory instruments address, in order to define a correct practice of restoration, new questions complementary to the restoration one. These aspects derive mainly from the evolution and from cultural and technological development that led to a re-reading of the most modern restoration theories and, consequently, to a greater awareness of their potential inherent. A new attention has been introduced to the concept of conservation as indispensable tool for a correct intervention on a historical building. This has allowed us to tackle the diagnostic phase with greater methodological and cognitive rigor, as a fundamental and essential moment for the building conservation. The study of the diagnostic phase and of its tools useful have opened the field of restoration to an increasingly interdisciplinary sector, dictated by the numerous areas of investigation necessary for a correct knowledge of the building.

Consequently, designers are not as the undisputed protagonist in the choices of intervention but will have to collaborate with other experts in different sectors, in order to reach a synthetic knowledge of the building and to formulate correct and conscious hypotheses of intervention. The Charter of Venice considers the preservation and restoration of monuments as a discipline with the aim of contributing to the study and to unique preservation of the Cultural Heritage, declaring that "the conservation and restoration of monuments aim to safeguarding both the work of art and the historical testimony. The conservation of monuments requires, first of all, systematic maintenance. The preservation of monuments is always favoured by their use in functions useful to society. The conservation of a monument implies the environmental conditions one" (Charter of Venice, 1964, articles 2-6).

Subsequently, with the European Charter of Architectural Heritage of Amsterdam in 1975, an absolutely preeminent role is assigned to *integrated conservation*, understood as action capable of removing threats from all forms of degradation. It is defined as “the result of the combined use of the restoration technique and the search for appropriate functions … integrated conservation must therefore constitutes one of the preliminary components of urban and territorial planning …does not exclude contemporary architecture in ancient areas, but it will have to take into account the existing environment, respect the proportions, the shape and the layout of the volumes as traditional materials … requires legal, administrative, financial and technical means” (European Charter of Architectural Heritage, Amsterdam, 1975, Article 7).

Dezzi Bardeschi also declares central and fundamental the role of the conservation project. He defined restoration as “a patient but obstinate search for permanence, that is, with the effective preservation of the physical city” (Dezzi Bardeschi 1988: 8). Subsequently he underlines the coincidence between the action of restoration and that of preserving. This implies a radical change in the perspective and objectives: conservation means the set of all the actions that allow to guarantee the physical persistence of the building aimed at containing its structural decay, obsolescence and biological degradation without this becoming embalming and fetishism. The goal is therefore to add with caution without making subtractions respecting stratifications, complexity and heterogeneity of the heritage. This implies the affirmation of a new culture of conservation that demands an absolute respect for the integral permanence of the monument-document.

Furthermore, the author defines restoration as an action that “has the primary purpose of preserving the material, the physical consistency of the building to which it applies” (Dezzi Bardeschi 1991: 127) as it has come to us. So, conservation is a science that “deals with analysing the degradation of the components, preventing it identifying the cycle of evolution, finally containing it through the development of the most correct and appropriate strategies of intervention” (Dezzi Bardeschi 1991: 72). To conclude, he underlines the importance of conservation for four specific purposes: to preserve in order to know the monument, to preserve to respect that involves the choice by the designer of functional destinations compatible with the building and, finally, to preserve to transmit or maintain the continuum with history that has come down to us and consequently to future generations and, lastly, to preserve to prevent, or to delay or to slow down with natural care the natural and unstoppable process of degradation and therefore the loss of the architectural building. The practice of conservation “privileges accurate preventive investigations, structural surveys and, above all, qualitative and quantitative knowledge of the processes of degradation and degenerative cycles of the components, and that finds its outlet in minimal but timely interventions in punctual microsurgery operations, conducted with experimentally advanced techniques, avoiding the generalized, uncritical renewal of structures and materials” (Dezzi Bardeschi 1991: 152).

A reversal of the restoration concept starts with the Charter of Krakow (2000), which places the concept of memory as a trace of the past at the center of the restoration. This involves making a choice action, about what and how this should be preserved. "It is necessary to choose and from the choice, therefore, inevitably derives the concept of project, because conservation is no longer technique, it is the end".

1.3 REUSE

Finally, it is possible to introduce the concept of reuse; Dezzi Bardeschi states that it is necessary, ie that it is not possible to guarantee effective protection and effective conservation without reuse “because use values are the main guarantors of a building's future” (Dezzi Bardeschi 2004: 247). “The reuse therefore imposes itself on all of us as an inescapable problem, which deserves full recognition both for historical awareness, and for the maximum design attention for the existing …; without the reuse, every project of conservation would be equally senseless because it could perhaps satisfy a naive image fetishism, but it would lack the real goal of dealing with the society of today and tomorrow who use it and enjoy it” (Dezzi Bardeschi 2004: 250). The monument can continue to live as a concrete material that becomes a testimony and memory of the history and brings with it a new character. It’s important to define what are the limits of acceptability for new reuse hypotheses, according to the concepts of compatibility and adequate destination that refer to the designer's responsibility to act as an interpreter and guardian of the safeguard and protection of the existing heritage, respecting its materiality and its historical past. “What then will be the limit condition for intervention, the tolerable threshold beyond which in our use is inevitably transformed into abuse and misunderstanding ...of the text?” (Dezzi Bardeschi 2004: 255).

Therefore, to save a *text-monument*, it is necessary to know it in all its specificities by resorting to a profound and integral reading so that the possibility is guaranteed that other users and interpreters may in the future continue to read its specificities for by means of its tracks which therefore should not be confused or recklessly overwhelmed. The building must continue to be available for careful future use, in respect of its own specificity and integrity of material in which the users-interpreters themselves will preserve the historical memory engraved in its walls. So, the question “what will happen?” means to consider the destiny of the monument linked to the laws of nature and independent of human will, can be reformulated in “what do I want to happen?... so, the act of will determines the choice, one of the many possible, and considers the why and how it should happen” (Torsello 2006: 146).

The design action linked to the reuse definitely brings the human needs but, at the same time, invests the designer of an important responsibility linked to its destiny after the decisions and choices made during the design phase. In fact, thinking about the theoretical and technical feasibility of a reuse on a historical building means carrying out both important assessments about the insertion of additional new functions essential to revive the building after the regulatory adaptation and the evaluation linked to the addition of a new function that is in any case compatible in terms of safeguarding the building identity itself and of technical concreteness for the real feasibility of the project without changing the building.

From a critically re-read theories, it can therefore be stated that different ways of approaching a building can be done. If in the restoration project the main objective is to protect the signs of the past, in the conservation one, the primary objective is to defend and prolong the physical life of the monument. It is also true that, to achieve both these aspects, it is necessary to mobilize all the techniques available today which are increasingly refined and constantly being perfected and sufficiently numerous to allow the designer the possibility of deciphering the monuments signs. “Architecture, among all the objects handed down from the past, is the one that most strongly demands a constant reuse or, according to a recent expression, a *recovery of the functions* connected to living” (Torsello 2006: 156).

Reuse today is understood as a necessary and unavoidable action since only with use can the building be preserved, whose respect for the historical and cultural value will guide the action of the project. This means that the intrinsically summarizes in itself the methodological process underlying the conservation interventions, aimed at the complete knowledge of the building preliminary to any choice of intervention.

The designer is faced with a building that represents an *unicum*, a result of an original design around which successive modifications and stratifications both on the building itself and in the relation to the surroundings and to the environmental context. The building is presented to the designer as a *text* characterized by multiple rewrites, gaps, additions whose result handed down to us, made of all these overlaps and modifications, makes the approach to the building uncertain and unaware. Only by degrees, through a progressive deepening of knowledge, the designer acquires all the information in order to clarify and understand the complexity and the relationships between the historical building, the materials, the construction techniques and the surroundings.

The most important aspect for understanding how to operate on the existing is to directly face the theoretical and operative node, between the cognitive phase and the design phase. This moment summarizes a high degree of complexity precisely because it is not possible to refer to absolute and universally valid theories as each project has its own specific characteristics. One possible way is to initially work with distinct disciplinary fields without losing sight of the final objective. The cognitive and diagnostic process is a real phase of the design process proceeding with an initial breakdown of a problem and, once understood and interpreted, it is subsequently recomposed in an operational and effective way for defining the project choices. Hence the importance of tests and investigations already in the preliminary design phase, aimed at acquiring elements of judgment for the choices of types and methods of intervention.

2. METHODOLOGICAL PROPOSAL

The main purpose of this paper is to propose a methodological solution for designer as a tool to manage the complexity of the project, which descends, as seen, not only from the building itself but also from the complex relationship between the cognitive phase and the design application. Indeed, there is a substantial detachment between the design processes that, very often, generate improper architecture solutions.

Knowledge, diagnosis and project synthesis are the main keywords around which the design project moves. The term *knowledge* refers to the documentation and acquisition phase of all the knowledge inherent to the building, that is to say its historical, cultural and morphological aspects and those concerning materials and construction techniques. It is clear that this phase includes a high degree of complexity as it deals with different disciplinary areas ranging from the simple difficulty of finding archival sources or construction events to an exhaustive understanding of the building (Fig.1).

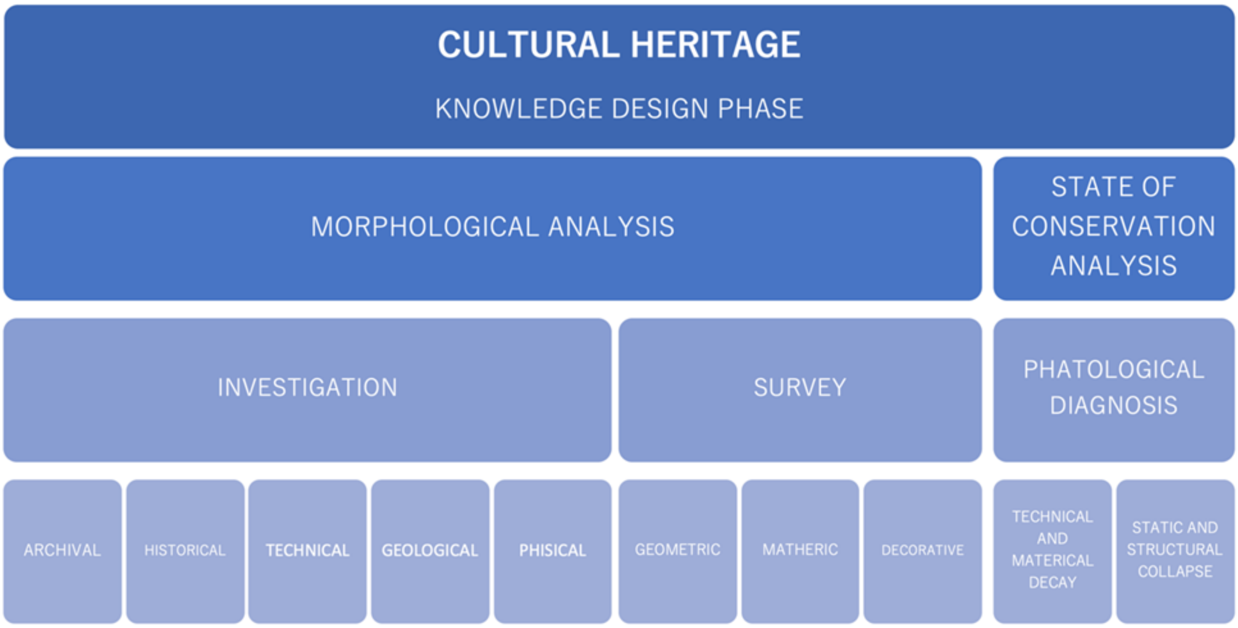

Fig. 1. knowledge design phase (Source: own's).

The complexity of the diagnostic and investigative phase lies instead in the impossibility of adopting a universally usable methodology, leaving the design and management of the process to the experience and competence of the designer. On the one hand, therefore, the possibility of being able to dispose of a high number of sophisticated investigative techniques could be a lifeline for the designer who entrusts the correctness of the data and of the results from technology; on the other hand, instead, a total and complete trust in the technique, without an overall view of the problem, could lead to obtaining data, certainly correct and precise, but not useful and effective for the solution of a specific problem. In fact, the detection of the same symptomatology, linked to a particular form of degradation, can derive from the same pathological picture, evidenced through appropriate tests, but be triggered by different causes.

It is clear how the reading of data and information, obtained during the diagnostic phase, and above all the interpretation of the data meaning, left completely in the hands of the designer, become absolutely important. To increase the difficulty of the process, the designer, following the technological innovation, has at his disposal an increasingly wide range of tests to be carried out, making it therefore necessary to have an increasingly targeted control on the effectiveness of the actions to be interpreted and of the correct reading of the results obtained. A correct design strategy cannot therefore be limited to a simple chase, as sterile as it is unstoppable, of technological innovation. It may be necessary to try to understand the potentialities and the information that can be obtained from them, leaving to specialized technicians the use and the study of the physical or chemical principles linked to the tests themselves, in the awareness, however, that, without the aid of these investigation tools, it would be very difficult to make a correct and conscious choice of intervention.

Although knowledge of the investigation methods and of their application areas is important, it is understandable that the knowledge required to the restorers cannot be highly specialized in all the multiple fields of application; however, they must be known in their peculiar characteristics and in their potential in order to allow designers to choose the most suitable techniques to solve the contingent problem. Since it is clear that a specific restoration project cannot be subjected to standardization procedures deriving from a generalizable model, it is fundamental to define a methodology for carrying out investigations so that the data collected are qualitatively and quantitatively representative of the characteristics of the building. Alongside the theoretical model, the return of the experimental data obtained during the diagnostic phase helps therefore to describe real situation. It is for this reason that potentially the tests are great tools, because they lead to a complete building reading. "Structural forms, materials, construction techniques constitute a knowledge fortune that allows us to have a privileged observation point for the knowledge of the technical heritage of past eras and also for the study of solutions that can still be widely valid" (Monaco, Santamaria, 1998: 12). Also Dezzi Bardeschi considers as fundamental the role of preliminary investigations and historical reading conducted on archival sources, considering as “an excellent investment … between the minimization of the intervention and the accuracy of the preliminary investigations” (Dezzi Bardeschi 1994: 383-384), that is to say therefore that more a cognitive process is well conducted, more conscious and effective the intervention project will be.

2.1 DIAGNOSTIC TECNIQUE

Certainly, it is possible to state how important but at the same time complex is the diagnostic process, which is increasingly assuming a central and fundamental role for the definition of design strategies. Annoni, in the thirties, in order to define a possible methodological approach for a correct restoration project, argued for the need to proceed by “direct interrogation of the monument, first as a historical document …, as a constructive fact” (Annoni, 1992: 81-82). It means investigating the building in its complexity, that is taking into consideration all the elements suitable for defining its overall framework, starting from the survey phase, assessing its state of conservation and residual performances both of the structural elements and of the materials, the state of degradation and instability in order to define the possible design actions respectful the building.

However, the technological question has always divided scholars into two different groups: those that highlight the extremely positive aspects of developing the investigation phase for understanding the monument (nda. Maltese, Giuffrè Marconi, Elia, Caniggia) and those who called for a return to a so-called *intelligent dexterity: dexterity* underling the importance of manual work in the face of excessive mechanization; *intelligent* because manual work had to be lightened precisely by modern technology, adapted, thanks to its development, to all those operations that could be easily replaced by machines and also the use of programmable computer systems in their operations. In Marconi's words, for example, there is a still unresolved doubt about innovative materials that still leave a large margin of unreliability on their reliability and durability over time.

Thanks to technological development, the areas of application of the survey techniques are extremely varied and diversified. Knowing therefore means analysing the historical constructive structure by performing a precise geometric and material survey through specific investigation instruments, but also investigating the physical-chemical characteristics of the materials, performing geological-petrographic analyses, evaluating the state of preservation and residual performances, that is to carry out a diagnostic process that allows to investigate the state of degradation and the static and structural failures in progress through specific tests.

Each of these aspects requires the most appropriate investigative techniques and above all it must be read not as stand-alone information but integrated and correlated with the set of results obtained in order to reach the synthesis of the building knowledge, identifying the causes of alteration detected and then proceeding with the choice of solutions to be carried out during the design phase. “The historical buildings appears to us then as an enigma whose opacity can become gradually transparent with the refinement of the analytical gaze, with the widening of scientific curiosity, with the improvement of the instruments of investigation" (Torsello, 1997: 199).

So, tests cover the entire design process, precisely because of their constant and transversal presence. Torsello had declared that “analytical work emerges as a structure of the project and it prepares to assume a triple function: it is a cognitive approach to the work, before any operational decision; it is a recording and study instrument during the construction site, it is an action of control and verification, but also of continuous reopening to research, after the intervention” (Torsello, 1988: 40). The need to use tests as transversal tools throughout the restoration project can also be found in the text of the Krakow Charter, point 10, which states that it is “necessary to provide for continuous monitoring of the results obtained, taking into consideration their behaviour over time and the possibility of feasible reversibility” (Krakow Charter 2000) of the new techniques used.

Interesting considerations are also explained in the Icomos Recommendations (ISCARSAH - International Scientific Committee for the Analysis and Restoration of Structures of Architectural Heritage) of 2003 which, in section 3, states that it is necessary to proceed with the intervention on the building with the purpose of maintaining it over time. To achieve this goal, it is necessary to use the most modern techniques of investigation and analysis, respecting the materials and the building construction rationality and aiming at the maximum degree of project reversibility.

It is essential to make specific preliminary considerations, case by case, in order to choose the best intervention technique, traditional or innovative, but which respects the monument, guaranteeing maximum durability and, the least, possible degree of invasiveness. The knowledge of innovative survey techniques therefore widens the range of possibilities to tend to the best solution and allows constant monitoring during and after the intervention phase. From this it follows how, only once the potentialities offered by the investigation tools are recognized, is it possible to program a conscious and effective application. The information that can be obtained is valuable, as they guarantee a high level of knowledge and of building control and allow, thanks to technological and IT innovation, ever increasing levels of accuracy together with faster data acquisition and processing times.

The need to use of increasingly innovative techniques is always strongly stated in “Principles for the conservation and restoration of built heritage" (Charter of Krakow 2000), which states that “the role of techniques in conservation and restoration is closely linked to interdisciplinary scientific research on specific materials and specific technologies used in the construction, recovery and restoration of the cultural heritage”.

The main techniques are based on principles that embrace different fields of knowledge, such as physics, chemistry and mechanics. However, due to their high number and above all to the degree of technological specificity and innovation, there is the risk of incorrect use of their inherent specificity, with the consequent disorientation of the designer who is sometimes unable to choose the most suitable tests for design purposes. The positive aspects of the high degree of technological innovation therefore risk losing much of their effectiveness, in the absence of a correct interpretative framework.

If “in the past the restricted number and the scarce complexity of materials and techniques for building consented to the formation of a homogeneous, widespread and shared technical awareness among the various operators, the current technological opulence, both in terms of materials and their different connection possibilities, makes difficult the formation of a technical culture" (Campioli, 1994: 9-10). So designers seems exposed to the risk of not grasping the proactive dimension offered by the widening of the technical possibilities and, on the contrary, having understood the technological development as a tool able itself to resolve the complexity of the design process losing the need to reach the synthesis of the collected multidisciplinary data.

Starting from the observation that contemporary technology seems to break down any limit of non-compatibility, the infinite possibility offered by technological development and the lack of a limit become the problem of the progress of science. It is without border but, however, according to Campioli, it must not lead to the suspension of the project activity, but rather to the need to define criteria according to which it is possible to express the design project plan (Campioli, 1994: 9-10).

For Crespi the field of architectural technologies must be understood as the moment in which we get the transition from the field of knowledge of the techniques to that of the design process. "The objective of technical knowledge is thus configured (for the architect) with the instruction to use, as unprejudiced and possibly unpublished as possible, of the existing technical tools and with training to develop sufficient imaginative skills to identify and describe the technical requirements so that, where the instruments do not exist, these can be invented or "re-invented" according to new objectives" (Crespi, 1990: 19). These considerations lead, within such a complex scenario, to a necessary rethinking of the role of the designer who must act as a director of the various project phases being able to deal interdisciplinary with the specialists of the different sectors. Otherwise, a possible risk is to obtain results that, although scientifically correct, are not actually useful to the project. Only in this way, "the monument/document is configured [nda. correctly as] theatre of analytical and interpretative attention, but at the same time ... exercise of innovation, of the most advanced technologies ... and of the actual spatial conception" (Torsello, 1997: 199).

3. COMPLEXITY MANAGEMENT TOOLS

Quoting Bardelli's thought is possible to define the existing building as a "complex system understood as a connection of elements in an organic whole, elements that can be independent or interrelated and complementary to each other, internal to a specific reality or within a specific activity. Complex system that can also be understood as an entity that, at every slightest solicitation responds to a precise reaction according to its own laws that are not easily recognizable. Regulations that has to be known in depth by those who intend to control and to manage complexity" (Bardelli, 1999: 197).

Complexity is an important source of information and of suggestions; so, it is important that designers learn to control it and to consciously manage it in order to make the development of the project design profitable and not difficult and tortuous. Not being able to manage complexity involves an uncontrolled and uncontrollable way of operating that can lead to contradicting and distorting the spirit of the original project. Precisely for this reason Bardelli affirms the absolute importance of carrying out a continuous, constant and progressive control with repeated and crossed checks by the project team in which each actor has a specific role but, at the same time, is aware of the activity of the other specialist recognizing a fundamental and indispensable role for any person involved. "It is possible to control complexity through a design method that is able to identify a hierarchy of problems, progressively break them down, in individual aspects without, however, neglecting an overall view and the individual specific interconnections. A sort of iterative process can arise which alternates moments of in-depth analysis with global synthesis ones, thanks to recurrent checks on the different levels of design development, from the original concept to the scale of the single detail" (Bardelli, 1999: 201). In conclusion, this means tackling the existing project design deconstructing the process into parts that are simple to analyse, study, learn and resolve individually without ever losing the whole and the interconnection between the parts.

It is therefore considered important to understand which aspects should not be neglected precisely because through their understanding it is possible to define a possible approach to the project. A possible response to manage the complexity of the project may arise using a tool that can organize and catalogue all the information obtained during the design process. These data must serve not only as sources for the implementation of knowledge but must be decoded and interpreted. Furthermore, they will themselves become part of a background of information that can be used again for future interventions or for comparison with other case studies.

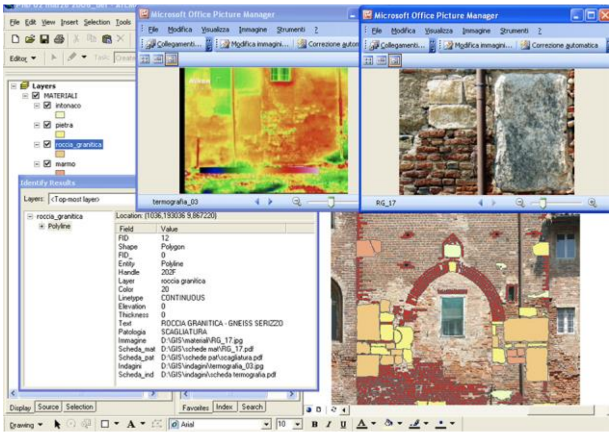

Fig. 2. GIS case studies on the Lardirago Castle, Pavia. (Source: own's).

exhaustive and complete knowledge of the monument (Fig.2-3).

This need to summarize the information obtained during the knowledge process, has led to the use of modeling software precisely as a complexity management tool. The building modeling constitutes the schematic representation of a complex system, which must be implemented as a synthesis of the monument cognitive phase. It realizes the element of conjunction between survey and analysis, being the virtual space of collection, organization and elaboration of all the information collected during the building investigation phase. The management of this information volume requires the implementation of a database capable of coordinating multidisciplinary and multi-scale information, represented both in geometric and textual form.

For this purpose, the use of Building Information Modeling (BIM) for the representation of the built heritage is extremely useful (Fai et al. 2011).

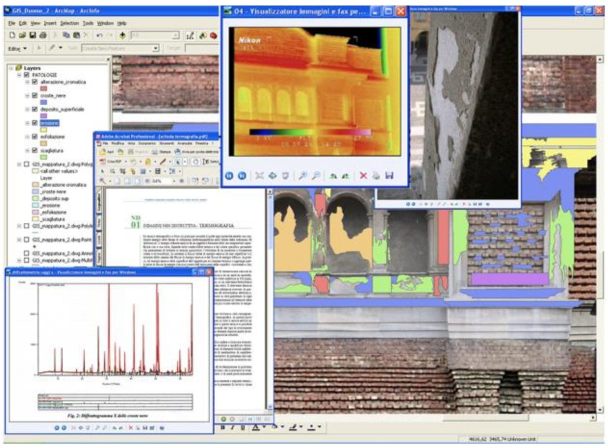

Fig. 3. GIS case studies on the Cathedral of Pavia. (Source: own's).

It means, for example, to the possibility of using GIS, i.e. computer databases, currently on the market or built ad hoc, that can place all the data collected on an IT platform, so that they can always be updated and implemented because no moment of the process, being it the cognitive, diagnostic or investigative phase, can be considered never concluded and final. This increases the degree of uncertainty in the designer who is called to make precise project choices based on the results obtained during the diagnostic-cognitive phase, while it allows a constant and progressive data integration and updating in the time, in favour of an increasingly,

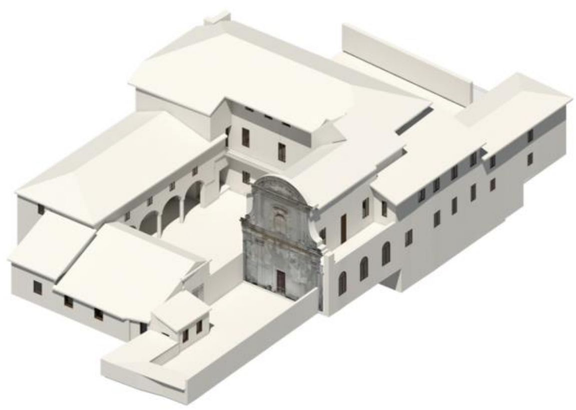

Fig. 4. HBIM model of the Certosina complex, Pavia. (Source: own's).

In order of its different potential use, it is in fact possible, in a pre-design phase, a modeling able to act as a synthesis action of the knowledge learned up to the present moment, with the aim of creating a realistic model, but at the same time schematic and light. It also possible to create a modeling of the main building categories attributing greater importance to dimensional properties than to detail and to formal or typological qualities. The flexibility of the system also derives from the possibility of being able to develop unique models for example through the preparation and compilation of data and extraction of them or through the insertion of some information in a manual way in specially prepared fields or through calculation in a semi-automated way thanks to the implementation of scripts created in a VPL (Visual Programming Language) environment. The use of visual programming can, for example, allow the extraction from the digital model of data that is stored in tabular form for consultation and management in software tools more familiar to the actors involved, such as spreadsheet programs (Fig. 4-5).

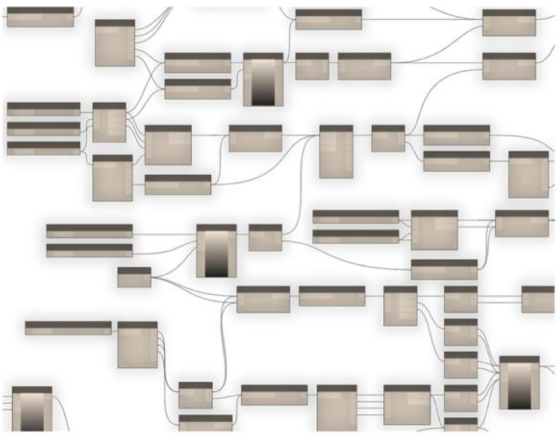

Fig. 5. HBIM integration such as with VPL software of the Certosina complex, Pavia. (Source: own's).

This process of simplification through computer models is also functional to the management of the processes and of the different subjects involved in the design project, particularly if on an existing building. Several design figures find themselves having to talk, often with a completely different language, with the ultimate and joint aim of proposing an aware and operational design solution. Heritage architectural projects involve collaborative work between different stakeholders. Traditionally, each discipline works independently, generating dispersed data.

Another useful tool is BIM defined by UK Government as "a collaborative way of working, underpinned by the digital technologies which unlock more efficient methods of designing, delivering and maintaining physical built assets. BIM embeds key products and asset data in a 3D computer model that can be used for effective management of information throughout an assets lifecycle" (Architectural, Engineering and Construction (AEC) Initiative, 2015). With this definition, BIM has evolved into a more open concept since it takes into consideration the management of the whole lifecycle of the buildings, adopting the same concept also un this research approach.

BIM application to historic buildings, named Heritage Building Information Modelling (HBIM), has shown benefits in managing heritage projects. The HBIM literature highlights the need for further research in terms of the overall processes of heritage projects, its practical implementation, the need of simplifying the laborious modelling task, and need for better standards of cultural documentation.

Murphy defined HBIM as a new system of modelling historic structures creating full 2D and 3D models, which include detail behind the surface of the objects concerning its methods of construction and material makeup. According to Volk, HBIM is the dynamic database of a historic building with an improved coordination of construction documents, in which geometry, spatial relationships, geographic information, and other quantities or properties of building components are structured and documented.

HBIM has been recently defined as the recording and modelling of existing buildings, generating BIM geometry from point clouds (Dore and Murphy, 2017). So, using HBIM and online work platform prototype the interdisciplinary stakeholders can unify and synchronize heritage information.

It is composed by the broader categories of building (walls, floors, roofs, windows, doors and rooms) by giving space to the formal and typological than to the dimensional properties. Once completed, this kind of model, which can be used to perform different kinds of analysis.

4. CONCLUSION

The technology can become a useful tool for designers able to synthesize all the information obtained and potentially obtainable over time in a single support or model allows to have, on a single platform, a synthetic vision of the knowledge acquired on a product. This system becomes fundamental, as advocated by Annoni, not only for the knowledge and diagnosis phase but also and above all for the planning, execution and management and maintenance phases over time. These models can be implemented over time, becoming a database, a box in which it is possible to contain all the information on the monument.

This is in other words and with a technology already advanced as expressed by Dezzi Bardeschi that explicitly states the need to obtain a clinical record of the monument-patient, a useful tool for the knowledge phase and a tool for guiding and supporting the choices of intervention and conservation on building. Through these modeling systems it will be possible to read the data either individually or in an integrated way, for the purposes of the project, of the cataloging and, last but not least, of the management and programming of maintenance over time.

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