Digitalization of cultural heritage’s tangible & intangible dimensions

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FROM THE WORLD TO POMPEII

La scuola di Pitagora editrice

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Best practices in heritage conservation and management From the world to Pompeii

Le vie dei Mercanti
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Aversa | Capri
June 12th- 14th, 2014

Conference topics:

Heritage

Tangible and intangible dimensions, History, Culture, Collective Identity, Memory, Documentation, Management, Communication for Cultural Heritage.

Architecture

Surveying, Representation, Modelling, Data Integration, Technology Platforms, Analysis, Diagnosis and Monitoring Techniques, Conservation, Restoration, Protection, Safety, Resilience, Transformation Projects, Technologies, Materials.

Landscape

Cultural landscapes, Territorial Surveying, Landscape Projects, Environmental Monitoring, Physical Parameters, Government of the Territory, Sustainable Development, Social Sustainability, Economic Sustainability.

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Scholars has been invited to submit researches on theoretical and methodological aspects related to Architecture, Industrial Design and Landscape, and show real applications and experiences carried out on this themes.
Based on blind peer review, abstracts has been accepted, conditionally accepted, or rejected.
Authors of accepted and conditionally accepted papers has been invited to submit full papers. These has been again peer-reviewed and selected for the oral session and publication, or only for the publication in the conference proceedings.

Conference report

238 abstracts received from:

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China, Colombia, Cuba, Cyprus,
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Egypt,
France,
Greece,
Indonesia, Italy,
Japan,
Madagascar, Malta, México,
Portugal,
Russia,
Saudi Arabia, Slovakia, Spain, Sweden,
Turkey,
United Kingdom, U.S.A,
Yemen.

About 400 authors involved.

196 papers published.

Preface

The XII International Forum Le Vie dei Mercanti has the aim of promoting a debate on local and international experiences relating to the themes of the conservation and management of cultural, architectural, archaeological, landscape and environmental heritages. This debate is particularly relevant in Italy, with it not only being responsible to the world for housing the largest number of UNESCO sites but also having a natural and landscape heritage of great variety and beauty in a region characterised by an intrinsic geological fragility.
The management of this vast heritage requires both a serious planning of the interventions as well as adequate funding. The same goes for the protection of the landscape, which in the past was systematically devastated within a myopic perspective that did not take into account the enormous amount of damage caused by wild speculation and hydrogeological instability.
Furthermore natural disasters, such as earthquakes, have led to the transformation and loss of environments which reflect local identity no less than the cultural heritage, in addition to economic damage and in terms of human lives.
In order to conserve and manage the heritage, it is necessary to adopt an integrated and resilient approach in which different skills contribute to the development of improvement and restoration projects, carried out through knowledge, sharing of decisions and proactive sharing, taking into account the social and environmental sustainability of interventions that should characterise the design method in all its aspects.
The key issue is the exchange of ideas so as to give life to a *technological humanism*, understood as the union between the cultural vitality that has characterized humanism and the Renaissance, producing excellent results in all fields of knowledge, and the possibilities currently offered by technological innovation to create platforms in order to support this knowledge. Thus, Pompeii, the most famous archaeological site in the world, is taken as the prime example of the need to adopt a virtuous cycle of conservation and management, supported by the dialogue between the different skills that interact by sharing the same technological platform.
The international debate can be an opportunity to share prime examples of the conservation, management and development of the archaeological, architectural, landscape and environmental heritage through the integration of ideas and experiences of specialists working in different disciplines as well as geographical and cultural contexts.
The conference is open to multidisciplinary experiences on one or more of the proposed themes. Scholars are invited to present research on either the theoretical and methodological aspects or concrete applications carried out on these issues.

Carmine Gambardella

XII International Forum Le Vie dei Mercanti
BEST PRACTICE IN HERITAGE CONSERVATION MANAGEMENT FROM THE WORLD TO POMPEII
Aversa / Capri, 12,13,14 June 2014

The digitalization of Cultural Heritage's tangible & intangible dimensions

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Abstract
The paper aims at discussing the advantages and challenges of the digitalization of the Cultural Heritage. Within the application field, historical and cultural sites are recognized as keepers of traditions and values, which run the risk of extinction due to the fast growing phenomenon of globalization. This essay presents an overview of the strengths and weaknesses of the Building Information Model (BIM) as a dynamic, graphic, and multidimensional platform for the management of the tangible and intangible attributes of the Cultural Heritage and for the generation and dissemination of culturally nuanced information related to materials, the state of conservation and the methods of construction. This paper analyses BIM's potencial when it is applied to new fields such as the Cultural Heritage, its documentation, conservation and management. In addition, it disusses the connection of BIM with the Geographic Information System (GIS) in a multi-scaled approach. The integrated use of these Spatial Information Systems allows us to disclose and explore, new dimensions at an architectural and territorial scale, such as the dimension of time (4D) and of the intangibility of the Cultural Heritage. The integration of these Spatial Information Systems - GIS and BIM - would support the documentation and conservation process. In addition, it would be able to communicate historical, religious and cultural values to current and future generations. These values are intrinsically connected to the Built Heritage. GIS and BIM can provide a platform for the creation of new meanings stemming from the interaction of different users and stakeholders engaged in its preservation and enhancement.

Keywords: Cultural Heritage, documentation, conservation, BIM , 3D content model.

1. Introduction
In the last few years, the acquisition and use of geo-referred data and 3D modelling have become a growing field of interest in architecture and planning.
Currently, these processes are also being applied to the domain of Cultural Heritage.
Moreover, the current innovations in the Information Communication Technology (ICT) field, especially as regards the uses of open and restricted data, have revolutionary consequences on many different sectors of human activities and is also influencing the Cultural Heritage today.
In addition, open-sources and freeware solutions encourage any user to experiment and learn freely.
According to these consideration, it is interesting to explore the advantages and challenges brought about by the so called 'Digital Revolution' for Heritage conservation and enhancement.

2. The challenges of the digitalization of the Cultural Heritage
The use of multimedia technology to integrate and enhance the presentation of complex data was studied and conceptualized since the advent of advanced ways to visualize images and videos (P. Faraday, A. G. Sutcliffe, 1997). Furthermore, the potential of the integration of 3D data with other types of information was clearly set right from the beginning of Internet. Unfortunately, their use was

delayed by the lack of a standard format for data and visualization. Nevertheless, virtual environments enriched with textual information have been thoroughly studied in all their aspects, adding to virtual navigation, the disposition and readability of the text (H. Sonnet et al. 2005; J. Jankowski et al. 2010), and the usability of interaction paradigms (D. A. Bowman et al., 2003).
Large-scale digitization and information aggregation projects for the Cultural Heritage provide an unprecedented wealth of knowledge. Technological advances with new and alternative instrumentation and processing software allow for the creation of immensely detailed 2D or 3D representations of material objects and audio-visual data which allow us to capture events of the intangible Cultural Heritage. Indeed, the understanding of the Cultural Heritage comes from comprehensive access to the diversity of phenomena and plurality of views, as well as from understanding the context of information and the provenance of the knowledge of Cultural Heritage. On one hand, large-scale information integration fosters comprehensive access. On the other hand, it obscures context and provenance. Interpretation of data that is obvious in a local framework may become ambiguous or incomprehensible taken out of context. In order to be able to offer a balanced view, we have to face the problem of objectivity and reliability.
A possible solution to this issue would consist in: disclosing data, communicating procedures and results, getting open solutions, enabling final results to be verified, establishing methods, enabling anyone to be able to reproduce the project's procedures, updating databases and optimizing final outcomes. By making data available and systems interoperable, such a methodology is capable of improving these outcomes and, at the same time, guaranteeing the quality and reliability of the output.
Taking into account all previous considerations, potential perspectives may be studied as part of the research on further methods and instruments, so as to guarantee the conservation of the Built Heritage and the preservation and communication of "The spirit of the Site" (World Heritage Convention, 1972), indicating all those cultural and traditional aspects characterizing the identity of a monument and of a place.
An interesting field of research could be the in depth analysis of BIM's potential, strictly connected to the use of GIS applied to the Cultural Heritage, for its documentation, conservation, management and promotion. An integrated use of both system would have some benefits. Firstly it would guarantee a completed analysis, documentation and representation at both architectural and territorial scale. Secondly the integrated use of these two instruments allows us to disclose and explore, new dimensions, like the one related to time - temporal dimension (the so called 4D) - and the intangibility - immaterial dimension - of the Cultural Heritage.

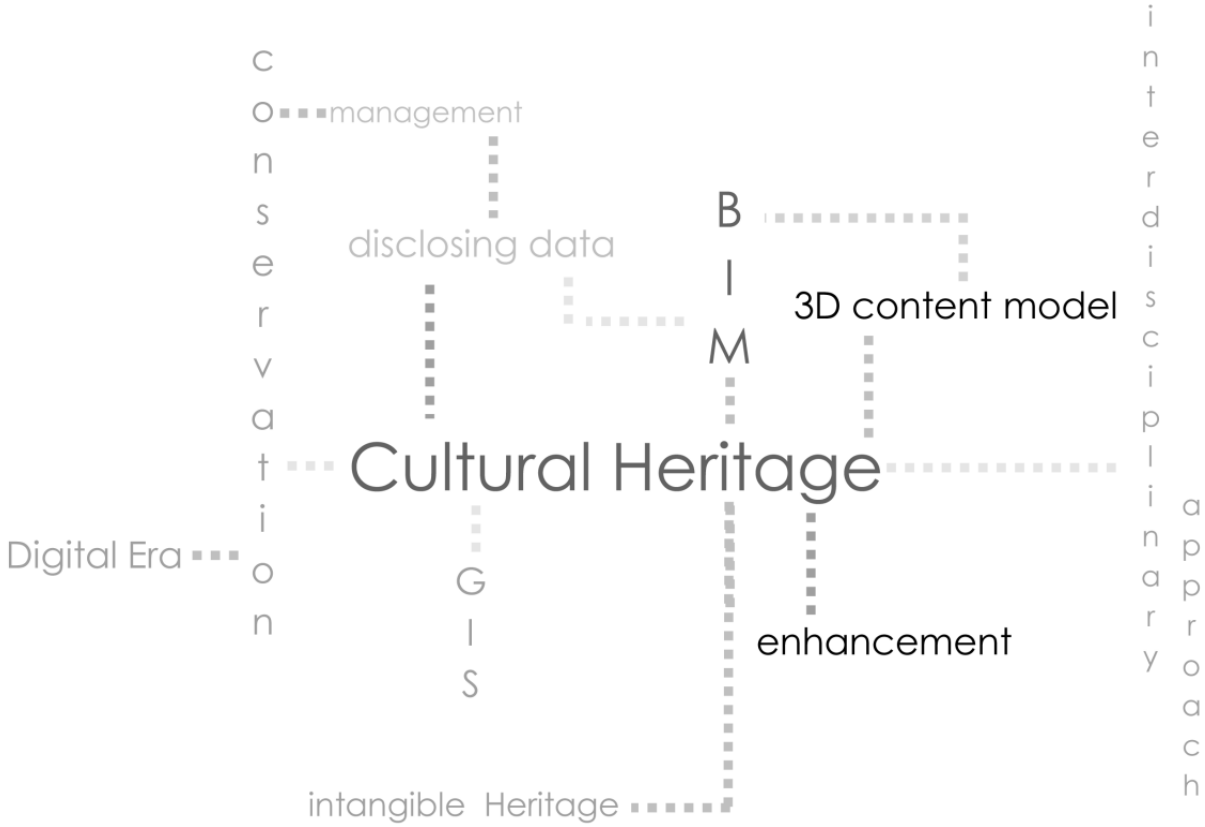

Fig. 1: Features related to the digitalization of the Cultural Heritage.

3. The Building Information Model (BIM) for the Cultural Heritage

Within the framework of the 'Digital Revolution' it is interesting to consider the great challenges offered by Information and Communication Technologies (ICTs) in the documentation, conservation and promotion processes of the Cultural Heritage. This is not just a matter of introducing new Information Technologies (IT) systems (A. Osello, 2012). On the contrary it has much to do with new working methods and allocation of roles developing better integration between the different disciplines to manage and enhance the Built Heritage.

Digital modeling is an excellent tool for learning to visualize complex shapes and their interactions, a skill that is of greater importance than simply tracing superficial information without a deeper structural understanding. Currently, the digital instruments are playing a key role in the 3D modelling sector. Moving from the 3D surface modelling of buildings and urban contexts to a semantic description 3D model it is possible to improve the quality of information, increasing the efficacy of the documentation and guarantying the efficiency of the management.

According to these consideration, the Building Information Model (BIM) system is moving from the application in the Architecture, Engineering and Construction (AEC) sector to the development of the application of new devices for the Built Heritage. With BIM technology an accurate virtual model of a building can be digitally constructed containing any kind of information about the construction, specification and detailed documentation of the features of each building. The system is composed of a set of processes that can be applied to catalogue, record, manage, communicate and disclose information. In other words, the BIM is a data rich object oriented, intelligent and parametric digital representation that can also be used for the Built Heritage.

Indeed views and data can be extracted and analyzed by different users (A. Osello, 2012) in order to generate information that can be used for diagnostics, planned preventative maintenance, restoration project and promotion activities.

In addition BIM does not only represent an opportunity to transform the documentation from separate models into 3D semantic models, but it is an extended methodology placing the focus on process improvement, the optimization of documentation and efficient collaboration between different aspects related to the Built Heritage (i.e. surveying, historical analysis, restoration project, economical management, etc.).

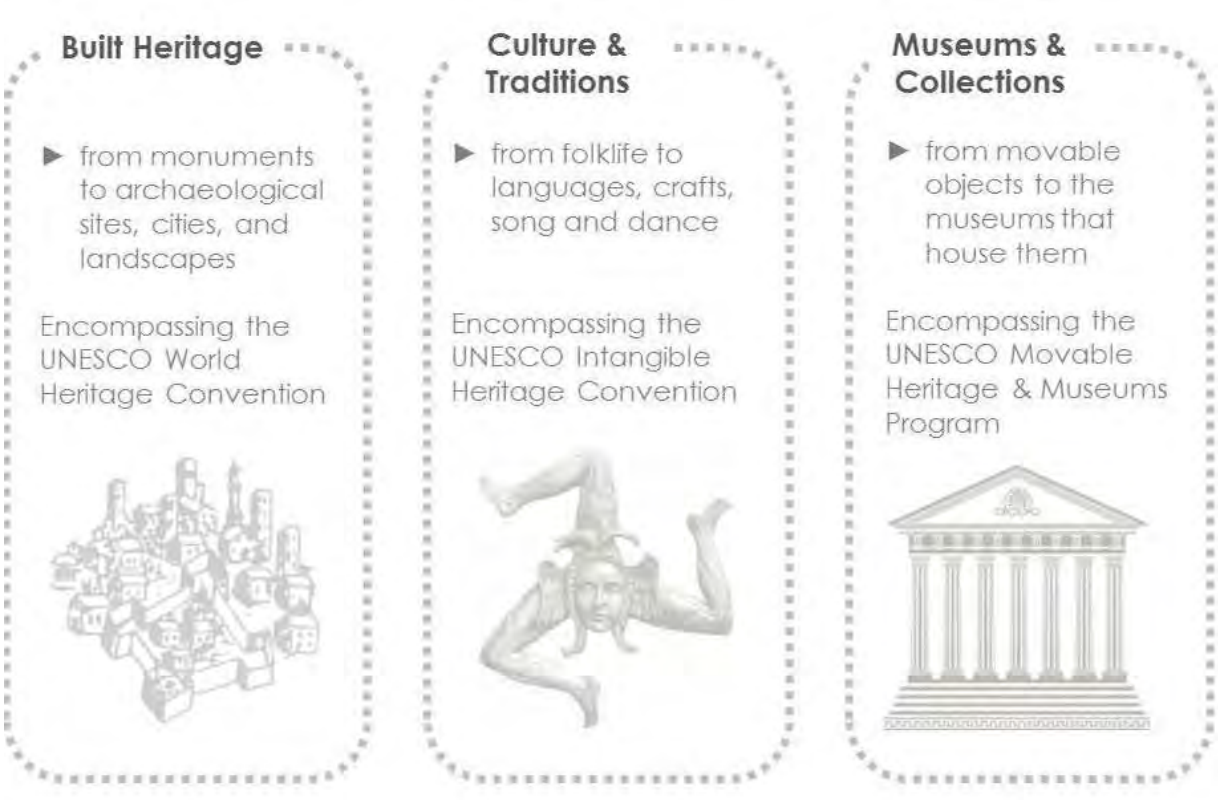

Fig. 2: Possible BIM's application fields within the Cultural Heritage areas.

3.1 BIM's weakness

In writing about BIM, David M. Foxe points out that *"the certainty and precision of the model are only as powerful as the knowledge and accuracy that went into creating it."* This is certainly true, and a primary concern with the use of this technology is the potential to confuse the accuracy of a model with its precision.

Due to the nature of digital modeling, a very high degree of precision is possible -much higher than can be readily measured in the field. Because of this, digitally modeled 3D elements appear to be accurate, but in fact may not be. This is particularly true and evident in the historical buildings characterized by asymmetry, irregular shapes, etc.

A second general shortcoming of BIM, especially in regard to recording historical structures, is the inability of BIM to readily model non-planar surfaces. Another concern with the use of BIM is the digital obsolescence (M. Hedstrom, 1998), a problem shared by all rapidly evolving electronic media. While the digital model may be useful today, it will be worthless tomorrow without the means to read the file.

Beyond the above general limitations of BIM, there are also specific limitations to the use of BIM in the field of the Cultural Heritage.

First and foremost, it is important to outline the interoperability issue. Indeed, only one member of the recording team is usually a trained operator of the software. This is a problem because it greatly slows the input of data. If more than one team member could use BIM, multiple aspects of the building could be recorded simultaneously, either in a single, shared file or through the use of multiple files which could be later combined.

BIM's weakness	General BIM trait	Specific to Built Heritage application field
Confusion of precision and accuracy	⊗	
Inability to quickly model uneven surfaces	⊗	
Digital obsolescence	⊗	
Too few trained software operators on project		⊗
Difficult to operate in inclement conditions		⊗
Difficult association of pure geometry to irregular objects		⊗
International Framework for Dictionary (IFD) not exhaustive per the historical building domain		⊗

Fig. 3: Table of the BIM's limitations.

3.2 BIM's strengths

Beyond the obvious visual and spatial comprehension benefits of using a 3D model to describe and exchange information, it is interesting to deepen the usefulness of some general characteristics of BIM for the Built Heritage.

Firstly, the model itself serves as the single repository of all information and this attribute is useful for its economy.

Secondly, the model is the only basis for all outputs that are internally consistent.

Thirdly, BIM can rapidly generate any 2D view (elevation, plan, section, perspective or axonometric projection) and 3D view (internal, external, section, etc.) of the model that is desired. Finally, BIM can export to compatible software for further manipulation and interpretation such as the creation of 3D animations, demonstrations of construction sequencing, or any number of lighting, energy, or materials analyses.

BIM's strenghts	General BIM trait	Specific to Built Heritage application field
Model is single repository of all information	☑	
Consistent basis for all output	☑	
Generate any 2D and 3D view	☑	
Model can be widely shared	☑	
Consolidate collected data		☑
Demands understanding of 3D structure		☑
Walkthrough inspection for completeness		☑
Simultaneous cross-check of measurements		☑
Expand from isolated data		☑
Interoperability instead of a documentation coming from separate sources		☑
3D manipulations to compare it to the building itself and inspect it for accuracy and completeness		☑

Fig. 4: Table of the BIM's benefit.

Used as a tool for the exploration, recording, and analysis of a historic building, BIM serves as a single, unified, and consistent repository for information on the dimensions, location, condition, and any number of additional parameters on elements of the subject building as they are being discovered or uncovered.
Additionally, the creation of a BIM model simultaneously allows and demands the user to understand the elements comprising the totality of the actual building as its virtual simulacrum is assembled, piece by piece. As eloquently expressed by John A. Burns, "*there is no way to appreciate an existing, working structure…like making a careful drawing of it."* This statement is even more true when the construction of a fully articulated 3D model of a structure is undertaken. The model can be viewed in any of a multitude of projections and sections, and subjected to 3D manipulation to compare it to the building itself and inspect it for accuracy and completeness.
In addition, the BIM model allows for the simultaneous cross-checking of measurements across multiple dimensions.
For example, measurements taken of interior rooms can be easily compared to measurements taken from the exterior of the building, not one elevation at a time but as a volume. As John A. Burns has noted, *"with the help of architectural and engineering documentation one can study a building…without necessarily visiting it".* Constructing a detailed model of any sort is an excellent means to understand a building. It is a methodology of visual and cognitive dissection, a protocol for the careful examination of a building. John A. Burns writes in *Recording Historic Structures,* "*quite apart from whatever value measured drawings may have as a historical record, the process of measuring and drawing careful records to scale is the most effective way to gain an understanding of a building's fabric.*" This perceived value is noted elsewhere by Edward A. Chappell, who writes that *"measuring a building encourages the recorder to recognize relationships among different parts"* and that *"doing measured drawings of a building is the best way to discover some of its consequential secrets."* A key to BIM system as an approach to studying and operating on Built Heritage is the thorough understanding of the fabric and its parts, through a careful and detailed inspection and recording of all elements that contribute to unveiling the features and the meanings (the "secrets" of Edward A. Chappell) that they hold.

3.3 On-going development

BIM is more than just impressive renderings representation. It is the creation of a common database that can be shared by all project participants in both two and three dimensions. Further, as George C. Skarmeas wrote: "*if the model is properly structured and can be used in the future, it can be the proper vehicle to monitor the behavior, performance, and deterioration of a building, using meaningful metrics that can help its long-term preservation.*" It is certain that a well-constructed and supported BIM model can have an extended and expanded utility in the service of Built Heritage Preservation. Each building component can be accurately measured and located in a complete digital model that emulates the original construction very closely.

In addition BIM's potential consists in the ability to query the parametric model with hypothetical '*What if…?'* questions (F. Lèvy, 2011). To this potential we have to add the benefits of the BIM model as a data base for the systematization of the information within a 3D semantic model to extract views from.

This powerful tool would also allow us to explore and visualize the so called fourth dimension – the time – and the intangible one, revolutionizing the approach to the research and the work on the Built Heritage.

Through this instrument of multifunctional representation it would be possible to preserve and bequeath the density of tangible and intangible (cultural, historical, ethno - anthropological) meanings of the Heritage to the future generation.

4. Integrated and multiscalar Spatial Information System for the Built Heritage

The cultural significance of the Built Heritage is what guides the management policy and consequent strategies for protection and preservation. To aid this task of cultural resource conservation, management and enhancement, many planning tools are available.

The Spatial Information System: Geographic Information System (GIS) and Building Information Model (BIM) are such tools for putting policy into practice. The Geographic Information System is a set of computerized tools to collect, archive, manage, retrieve, analyze and output geographic and associated attribute data.

While GIS is already used to assist Cultural Heritage managers in a wide variety of applications (P. Box, 1999) the BIM systems has not yet been applied to the Cultural Heritage field but is now under development.

The BIM is based on simplified parametric models - suitable for: archeological sites, monuments, ancient buildings and historical compounds, that can be applied constructively to Heritage documentation and management of the data on conservation and enhancement practices.

Moreover, a Building Information Modelling could be implemented in order to collect different kinds of specific data on historical areas (i.e. dimensional, geometrical, state of conservation, historical information, intangible values and constructive techniques).

As already said, BIM could support preventive conservation, information sharing and knowledge dissemination of both tangible and intangible Heritage dimensions for professional and non-professional users, researchers, local administrators, for institutions and experts involved in decision making process.

Preliminary studies showed the adaptability of some BIM's function related to heritage documentation and specifically to:

- Decomposition of building elements into categories;
- Contextual creation of graphic elaborates in 2D and 3D;
- Obtaining information from associated database;
- Interdisciplinary work settings.

As far as the potential of GIS is concerned, such technique may turn out to be particularly suitable to the documentation and the restitution of information in time and space dimensions. GIS may also be able to integrate History with Geomatics, by creating a multidisciplinary platform for the innovation of development strategies for the knowledge and use of the Heritage.

Furthermore, the integrated use of these systems would allow us to understand the outstanding value of the site by answering questions. Some examples are: Is the place associated with a historically significant theme, person or event? If it's a building, does it possess any specific features of interest for its architecture or design? Does the place have special meaning because of its landmark, spiritual or cultural associations? Consequently, the integration of more datasets within a unique conceptual system, able to provide simultaneous consultation to a wide range of users and stakeholders, who in turn can become providers of further information and interactive feedback on experience of the use of Cultural Heritage.

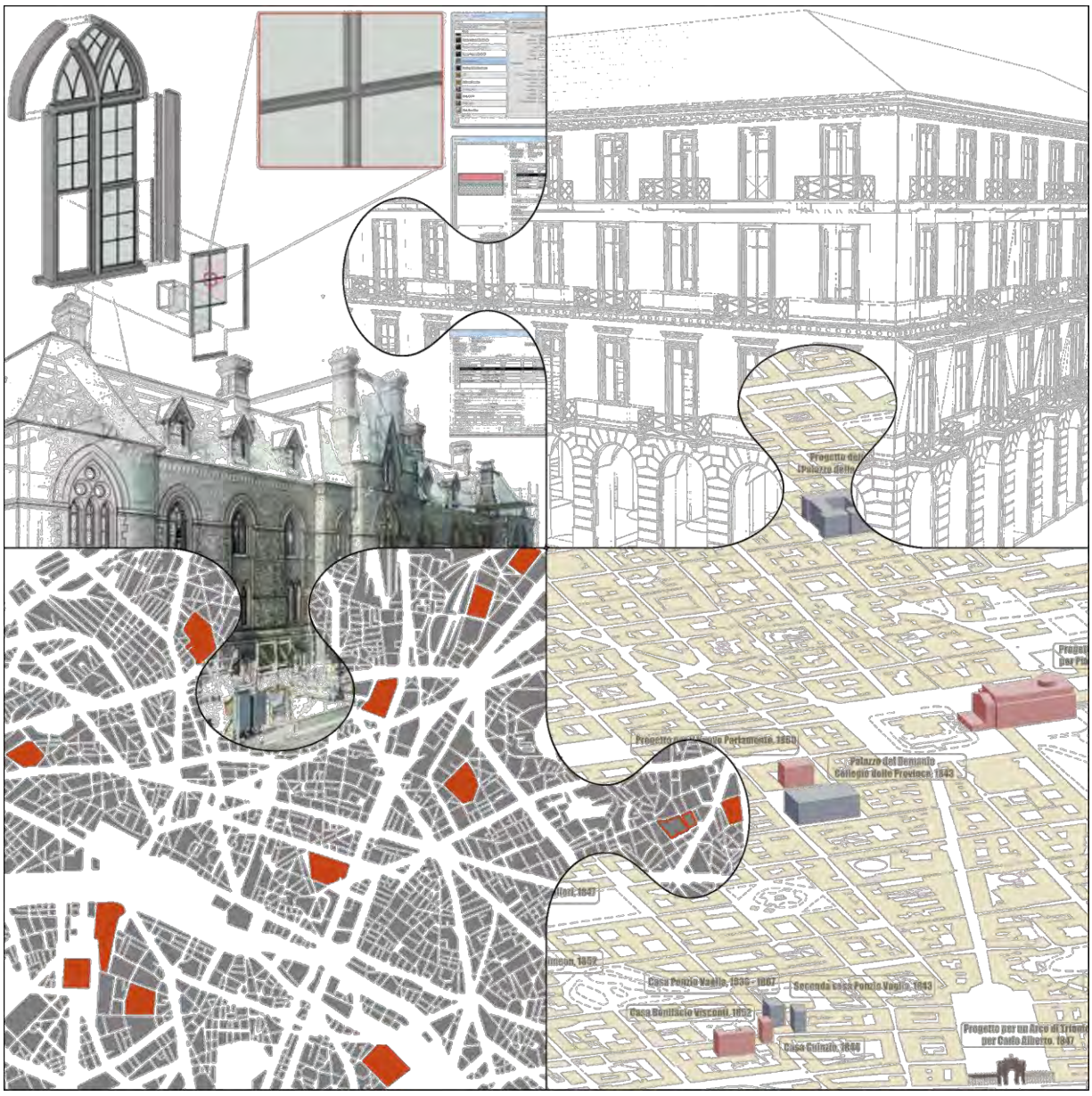

Fig : Representation of an integrated multi-scalar Spatial Information System for the Built Heritage.

5. Future perspective

Currently the historical and cultural sites which are recognized as keepers of traditions and values run the risk of extinction due to the fast growing phenomenon of globalization. However, they should be understood neither as static relics of a distant past nor as the passive objects of techno-bureaucratic knowledge and expertise. On the contrary, the act of conserving and enhancing tangible and intangible “goods” confers to Cultural Heritage an agency that is strictly associated with discourses of remembrance, techniques of governance and the affirmation of social, cultural and political identities enacted by the communities engaged in the endeavor preservation. Nowadays, as already mentioned, the use of 3D digital tools for recording, documentation, and information management for Built Heritage (e.g. Building Information Models, Computer Aided Drafting applications, 3D modelling, active and passive web–design, surveying instruments, photogrammetry, image processing, 3D laser scanning, and digital presentation) is demonstrating an incremental growth. According to this trend, it will be interesting to deepen the investigation on how to combine a bi-dimensional Geographic Information System (GIS) and a 3D content model with a Building Information Modelling (BIM) for an improved documentation, conservation, management and enhancement of the Built Heritage. Finally, according to the smart city’s context, an integrated and multi-scalar system would lead to a more efficient management of the urban historical centers through a more efficacy and interoperable documentation of all its elements.

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