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THE ARCH OF AUGUSTUS IN AOSTA: DATA AND ANALYSIS REUSE FOR A CONSERVATION PROJECT

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Abstract:

The paper proposes a path for the management of the Arch of Augustus in Aosta to exploit the potential of Historic Building Information Modelling (HBIM). The HBIM system acts both as a place where to georeference the available data and as a tool for the elaboration of the conservation project in all its aspects. The system deals with different data from the survey of geometries to that of materials and alterations, up to the conservation project (mainly focused on the surfaces, with the aim of traceability of the events that the monument has lived, lives, and will live). The challenges in this research concern several aspects. First, it will be necessary to adapt the regular geometry of the BIM approach to the complex shapes necessary for the reproduction of surface alterations in the Puddinga stone. In addition, even more important, the ability to manage the monitoring data distributed at different times, comparing and making them available to current and future restorers (and other operators involved in the preservation). These tasks will be fixed by drawing up a dynamic conservation project, i.e. one that can make use of the available data at any time and all those that will become available during the work. Attempts of data digitization to give a shared value to the conservation activities had already been proposed in the past. The new research now starts from the reconnaissance of the weaknesses of the previous proposals, mainly related to the use of tailor-made systems (software) that are difficult to maintain, to implement and use in a very heterogeneous team of operators (architects, archaeologists, engineers, topographers, chemists, historians...)

Keywords: digital architecture, cultural heritage, documentation, HBIM model, conservation project

1. Introduction

As part of its asset management activities, the Soprintendenza della Valle d'Aosta has decided to set up a work protocol with Politecnico di Milano, Mantua Campus and Università degli Studi di Brescia, in order to identify a system that would guarantee the management of the numerous analysis and knowledge data carried out and processed over the years for the Arch of Augustus, as well as preparing the operational basis for future conservation interventions.

The need to identify a new way to manage data arises from the problem of having a summary of a large amount of information. This can also allow preventing the risk of data dispersion, especially when they are no longer shared by those who, in the past, have activated research and enriched the knowledge about the monument. The idea is to create, through new technologies, tools more and more capable of transmitting collected data to other users, overcoming the close link with historical memory and providing that context of traceability necessary for any good conservation practice.

The proposal concerns the possibility of adapting new technologies for architectural design (Building Information Modelling systems) to Heritage conservation and linking the potential of information systems in order to allow the comparison of information through a geo-referenced and dynamically accessible structure (Leon-Robles, Reinoso-Gordo, & Gonzalez-Quinones, 2019).

The experimentation will be carried out on one of the main monuments of Aosta: the Arch of Augustus. The Arch has always stimulated the interest in researchers, historians, and architects of the past because of the architecture, the materials, and the related problems. For all these reasons, including the sum of technical-scientific data available, the monument proves to be particularly suitable to test the HBIM (Historic BIM) approach, which does not want to be identified as a simple container of information, but needs to become a useful tool for the design of current and future interventions.

2. Previous researches

For the position and importance of the monument, the superintendency has always paid particular attention to

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the Arch of Augustus in Aosta as part of the process of protection and enhancement (Appolonia, Migliorini, Idone, & Piccirillo, 2007).

The Soprintendenza della Regione Aosta is provided with an internal analysis laboratory, which aims to document the regional heritage and carry out diagnostic investigations and monitoring to analyze the state of conservation of the various assets of competence. Thanks to this fortunate coincidence, the Roman arch has been the subject of numerous in-depth surveys and campaigns to acquire climatic-environmental data over time.

Among these, the most significant analyses were carried out in the period 2007-2010. In those tests, the arch's microclimatic conditions and its surroundings were evaluated according to the exposure and dust deposition studies (Ponziani, Ferrero, Appolonia, & Migliorini, 2012). We point out especially the chemical-physical study of Pudding stone, the primary "material" of the arch. That investigation is essential for understanding the current

state of conservation of the arch and the definition of the mechanisms of alteration.

Among the various activities that have concerned the arch, we finally mention the mapping of the alterations that had two functions: monitoring the state of conservation over time and preparing all the documentation for the drafting of the conservation project. The intense study and analysis activity has also been accompanied by numerous attempts to organize and manage data, aware that this is the fundamental activity for a good conservation project. The most relevant is the attempt, innovative for its time, to manage all the information of the alterations through a GIS approach. The arch's two-dimensional representations have been used as the "territory" on which the information systems map the different phenomena (Fig. 1) in the ARKIS - Architecture Recovery Knowledge Information System applied also on the Roman Theater of Aosta (Salonia, 2003).

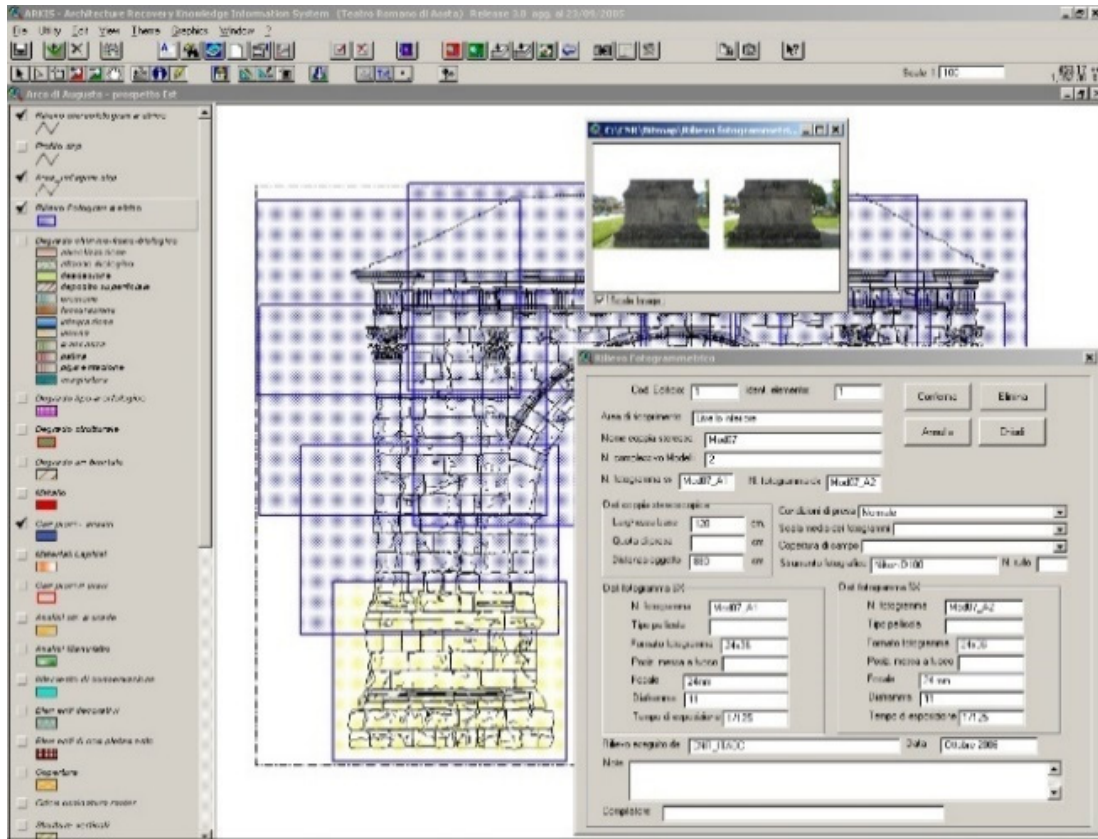


Figure 1: Screenshot of Arkis system for the management of data in a GIS environment.

All these activities developed around the Arch of Augustus have bequeathed a heritage of massive data and decisive in preparing a planned restoration and conservation intervention. However, these actions have also highlighted some aspects that are common in applied research. Among these, the difficulty of finding suitable tools for the management of the existing heritage and the subsequent attempt to adapt software, systems and processes, created for other applications to the conservation needs of the Augustus Arch. We must also reiterate the difficulty in managing projects carried out with excellent tools designed explicitly for this purpose,

which, however, show the major critical issues in updating the systems and their sharing among the various actors of the conservation process.

3. New management tools

Attempts of data systematization, until now conducted, were born from the necessity of an objective and precognitive conduction. Common to other regional monuments, this need brought to the development of instruments to keep under control the widespread heritage on the territory.

When carried out, the usual management has long been based on methodologies developed at the national level, with systems such as the Carta del Rischio (Accardo, Cacace, & Rinaldi, 2005) or the SICAR method (Siotto, Baracchini, Santamaria, & Scopigno, 2016), tested by some Superintendencies in Italy. However, the value of these systems is affected by the costs necessary to repeat the assessments (not always accessible or traceable).

These problems make these systems too "static", rigid and unsuitable for planned conservation programs or the preparation of conservation and restoration projects.

For these reasons, most of the management activities still occur with more or less continuous analysis and inspections, which was also the case at the Arch of Augustus until the beginning of the study campaign. The inspection value remains one of the limits of the asset control method, although often the most accessible. The inspection, however, presents several problems that cannot be solved.

The main one concerns the training of inspection operators. In fact, the restorer should define the evaluation of the state of alteration; but even in this case, we should take into account some variables. First of all, the ability of objective reading. The reading of the alterations is easily linked to a perceptibility factor, i.e. the state of knowledge and sensations that the reader has at the precise moment of the evaluation. These conditions can vary over time, also depending on data interpretation capabilities and data memory, especially when it is necessary to establish a link between one inspection and the other. It is evident that a further degree of variability can occur if the reader changes, as well as if the inspections are carried out in different environmental conditions. Even the light and the point of view can influence the evaluation. It should also be taken into account the difficulty of proper verification and evaluation for large monuments, such as the Arch of Augustus.

From this list, we can understand the complexities of managing a monument and how informative systems are fundamental. However, it is necessary to add the possibility of repeatable evaluations to have an objective but economical, synthesis framework.

4. The research project

This paper describes the research project involving Soprintendenza di Aosta, the Università degli Studi di Brescia and the Politecnico di Milano. The research aims to identify effective systems for the management of data for conservation.

For this reason, we have proposed the use of informative systems, which must be adapted to the needs and have different characteristics suitable to facilitate the preservation of the asset through interoperability and integration of different knowledge (Bruno & Roncella,

2019). First of all, the proposed system should work with very different data (by nature, origin, period, and time of acquisition), progressively integrating them into a single environment. Secondly, it is fundamental to be able to manage data in a dynamic and shared way; allowing their continuous updating, making them accessible, according to certain rules and degrees of interest, to the different operators involved in the process.

The proposed project, also aware of the technical difficulties related to the implementation and management of dedicated software, aims to test BIM systems' adaptability in a preservation approach. Such system starts from the concept of the informative model. They allow to manage very different data, using the three-dimensional model, at different levels of complexity, like an index, a starting point from which to access all the data (Adami et al., 2019). To enrich the model, a first step is the collection of information and its systematization according to linear, sequential, and complete criteria. In particular, it is necessary to proceed to the abstraction of information in order to identify the best method to find it easily in the model. Furthermore, the definition of a ID that identifies uniquely the object to which data are connected (semantic classification), in order to set the biunivocal relationship between information level and representative geometry (Adami, Bruno, Rosignoli, & Scala, 2018). These steps must occur with a close synergy between those who realize the model, those who know the data's contents and quality, and those who manage the asset. The comparison between these three managers of the model allows deciding the level of information to be reached.

The informative model, synthesis of geometric content and information, plays the role of the index and works to facilitate design choices. All data (reports, diagnostic analysis, etc.) must be immediately understandable to the designers to become useful materials for the elaboration of the intervention. This phase appears quite complicated because the operations planned on the Arch of Augustus mainly concern actions for the conservation of surfaces, since from a structural point of view there are no emergencies. The challenge is to exploit the model's utilities, representing the time sequences of the planned actions and/or the multidirectional paths that can be predicted according to the architecture's responses to the proposed solutions.

Finally, maintaining one of the characteristics of BIM, i.e. the management of the entire life cycle of the building, the system is an effective tool to set up systems suitable for planned conservation. This allows to project and schedule the necessary conservation interventions in the fourth dimension (time), but also to record all future events that affect the architecture itself (through reports of maintenance interventions, updating data and photographic collections over time), thus enriching the monument database.

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