PLANNING A CONSERVATION PROJECT: THE INFORMATION SYSTEM OF THE *INSULA ORIENTALIS I* AT HERCULANEUM

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ABSTRACT

The *Herculaneum Conservation Project* (HCP) is a collaborative venture between the *Soprintendenza Archeologica di Pompei*, the *Packard Humanities Institute*, and the *British School at Rome*. The project aims to halt the progressive decay of the ancient Roman city of Herculaneum, and includes rescuing the archaeological remains from immediate danger and the implementation of a conservation strategy in order to favour the long-term survival of the site. In order to understand the work involved and to establish best practices, one of the first steps taken was the adoption of an entire urban block, the *Insula Orientalis I*, as a case study area. HCP employed a team of multidisciplinary consultants to analyse and record the standing remains of this *insula*; the results of their research are providing the basis for any decision-making in the conservation, restoration and presentation to the public of the *Insula Orientalis I*. From the outset it was evident that a unique information management tool was needed to homogeneously record structured data collected in the field by each specialist. The information system has to provide immediate access to information and a prompt answer to any query made by different specialists on any aspect of the complex. This paper shows how the *Insula Orientalis Information System* manages to integrate specific approaches to analysis by creating a single geodatabase which is referenced to a detailed survey of the buildings with 'fly through' access. It provides useful tools for administrative management, as well as powerful instruments for scientific analysis and 3D visualization of results.

1. INTRODUCTION TO THE *HERCULANEUM CONSERVATION PROJECT*

The incredibly well-preserved archaeological site of Herculaneum, first discovered in the eighteenth century, was excavated largely in the 1930s, and like all archaeological heritage, is vulnerable to decay. However, it is those features that make Herculaneum unique – particularly organic materials such as wood, food stuffs, textiles, papyri – that make this site particularly difficult to safeguard for future generations.

Therefore the *Herculaneum Conservation Project* (HCP) was officially launched in 2001 in order to save the ancient Roman city that was buried, along with neighbouring Pompeii, in the eruption of Vesuvius in AD 79. The project is supported by three partners, the *Soprintendenza Archeologica di Pompei*, the *Packard Humanities Institute* and the *British School at Rome*, and these have chosen a multi-disciplinary team of consultants who, along with an internationally renowned Scientific Committee, are striving to find the best methods for conserving the site.

The project has two main aims: the first is to halt the widespread decay afflicting the entire archaeological site with a campaign of emergency works, and its results are already visible. Propping up buildings in danger of collapse, consolidating decorated walls and floors, weeding and driving away destructive pigeons are an essential first step in ensuring that the delicate ancient remains survive. The second aim is to develop a conservation strategy which will ensure the survival and enhancement of the site in the long term. These ambitious goals require a multidisciplinary collaborative effort involving various specialists: including archaeologists, conservators, architects, engineers, scientists, IT specialists and a project manager. With site operations having gained substantial momentum in 2004 HCP now hopes to dedicate more resources to outreach projects and the involvement of interest groups, starting first and foremost with the local community.

Alongside the site-wide conservation campaign HCP chose a case study area within the city – a block of three Roman houses: the *Insula Orientalis I* – where the project aims to set high standards in conservation work which would be difficult to achieve in a normal public works programme. A careful stratigraphic study of the buildings has shown that this group of houses changed constantly throughout antiquity, which has been essential in helping us understand that Herculaneum in AD 79 was a remarkably interesting and complex situation; and a study of important archive documents has clarified the choices made by excavators and restorers in the 1930s. In these and many other ways this case study continues to produce substantial amounts of information that needs to be managed in the simplest possible way, allowing the results of the project to be stored and accessed efficiently.

2. THE *INSULA ORIENTALIS I* CASE STUDY: WHY A GEODATABASE?

Within the broader conservation project for the *Insula Orientalis I*, an archaeological study of the standing structures was intentionally emphasized and systematic recording of the wall structures was carried out in order to reconstruct their chronological sequence. The history of the *insula* and of its component houses, from the urbanization of the area until AD 79 has been the starting point for understanding the archaeological remains and for all discussions on how to intervene there.

Understanding of the archaeology has not been limited to this systematic examination of the structures, but has also included an in-depth research project in the *Soprintendenza*'s archives to locate all the relevant documentation from that area of the site: excavation diaries, photographs, finds records, reports on restoration or other interventions carried out in the *insula* from the moment of its excavation until today.

An assessment was carried out on this material, on a room by room basis, of the condition of the wall structures of these houses: the percentage of restoration work carried out at the time of excavation or immediately afterwards, and the reliability of each hypothetical reconstruction, particularly where the original roofing had collapsed during the eruption.

At the same time a group of conservator-restorers started a campaign of conservation 'first aid' to halt the most urgent decay in the *insula*. This lead to a systematic examination of the decay phenomena, particularly of the decorative surfaces, with the subsequent mapping of the state of conservation and an appraisal of the decay, noting causes and relative urgency for intervention.

The preliminary project was therefore based on the identification of areas according to the degree of risk they faced. The solutions proposed have always taken into account the need to keep the original architectural spaces legible, and also retaining their value as a historical witness of a building in constant evolution up to the moment of its burial by the eruption.

The initiatives described so far have produced a huge quantity of information and have required additional documentation, particularly to give them precise spatial references within the *insula*. A lack of precise enough drawings led to new plans and elevations of the archaeological remains being carried out on a scale of 1:20/1:50. Then using Vectar Real View software these were integrated within an overarching structure of the buildings' horizontal and vertical surfaces along with rectified images.

Although all the graphic documentation was created as CAD files, structured in layers corresponding to the stratigraphic wall units which can be correlated to external databases, it became immediately necessary to be able to use a more versatile and open tool that could integrate variations between the documentation, could simplify access to it and at the same time offer a processing tool linking the documented phenomena.

In addition, during a subsequent phase of the project the three teams (working on the architectural project, the archaeological research and the conservation interventions) showed that it was necessary to involve further specialist consultants to find solutions to specific issues, or to lead to a deeper understanding of fundamental problems such as the stability of the standing structures or the management of rain and ground water.

Furthermore, a unique feature of the team of HCP consultants, which was expressly instituted by the project management, is the 'circular' nature of the data acquisition process. This means that there is an equal exchange of results between the various teams; projects, progress reports and results have been periodically made available through a systematic distribution of documentation and regular meetings for open dialogue amongst consultants. The feedback gained in this way can often lead to consultants adjusting their project's design and methodology after having considered other professional viewpoints, and this has facilitated cross-disciplinary assessment and understanding.

It is clear that with the increase in the number of consultants and areas of study, the documentation produced is also exponentially increased, creating a crisis and risking a blockage in the tried and tested system of dialogue and coordination. It has therefore been absolutely necessary to create a database, accessible to all the consultants, that responds in the most simple way to the issue of making data available and linking it.

This database forms an initial 'archive' which was deliberately designed to offer consultants and personnel of the local heritage agency simple access to the information. The connections between the archives were based on the stratigraphic units that make up the walls or a collection of these (an individual wall or room). As these are vertical structural elements, often preserved with complex overlappings, an entry to the archives was chosen that gave a 3D view of the objects. This means that a three-dimensional model of the archaeological structures was created, made up of the individual stratigraphic units 'clothed' with rectified photographs of them. Navigation around the archaeology is realistically represented and at the same time remains structured around its 'archaeological atoms': the stratigraphic unit. This seemed the most straightforward and natural way to orientate oneself within the research and the most scientifically correct way to order that amount of data.

The creation of a georeferenced information container obviously cannot only be geared just towards consultability. However, we should not underestimate the administrative advantages of this 'simple' requirement, in addition to more scientific functions, in quantification during the design stage and in the identification of intervention priorities.

The connections between data are, for the most part, the natural continuation of an interdisciplinary method that was launched in the initial phases of the project. The same consultants propose and construct queries considered important within their disciplines, potentially cross-referencing data from their colleagues' research. The creation of the 3D model of the archaeological remains structured according to stratigraphic units offers, furthermore, an unedited visualization of thematic results, which is particularly important in the evaluation of the state of decay and the phenomena connected to it.

3. THE ALPHANUMERIC DATABASE

Data collection from previous interventions on the *Insula Orientalis I* was the basis for the formalization of the data. In general it is possible to subdivide the available material into two broad categories:

- information from the historical archive records held in the *Soprintendenza*'s offices (plans, journals and site diaries, excavation photos, detailed reports of restoration work on architectural remains and decorative surfaces). This type of information can be defined as 'static', or rather as 'historical', as it maintains its overall integrity from the *moment* it is gained. Additional information derived from the analytical recording of this material is instead 'dynamic' as this type of documentation has a potential for change. The possibility of supplementing this block of information with new archives and new material will result in a solely quantitative integration to the system without consideration of its contents.
- information from the archaeological recording of the standing structures, of the emergency works and from the systematic survey of the vertical and horizontal surfaces according to new methodologies particular for each sector. This gives a structured documentation that allows for an analytical analysis of the overall situation of the archaeological remains, geared towards an understanding and resolution of conservation issues, research and interpretation.

Following from these general considerations, we went on to formalize the data so that there was integrated management of the overall information system. The creation of both methodological and analytical standards (for example, naming entities) was the first step in designing a relational database. From this point of view the most time-consuming task, which became the heart of the system, was that of identifying all the possible relationships between the available data (in the first instance this meant identifying the smallest reference entities: contexts for archaeologists, wall or floor surfaces for conservator-restorers, areas of intervention and nomenclature of rooms in the historical archive, functional architectural spaces for the architects). This then allowed us to create a general coherent structure that allowed easy access to precise information as well as a complex and integrated analysis in a relational environment.

Both from an archaeological and conservation perspective it was essential to be able to document the entire surface of the standing structures, which still keep almost their entire original height. The work of rectifying the digital images of the individual stratigraphic wall units allowed us to create a digital database of all the exposed surfaces within the *insula*. These images became the basis for the digitization of the stratigraphic units and the mapping of conservation interventions.

From a technical perspective the digitization work produced a series of two-dimensional vector files structured in unambiguous layers which correspond to the polygon of the

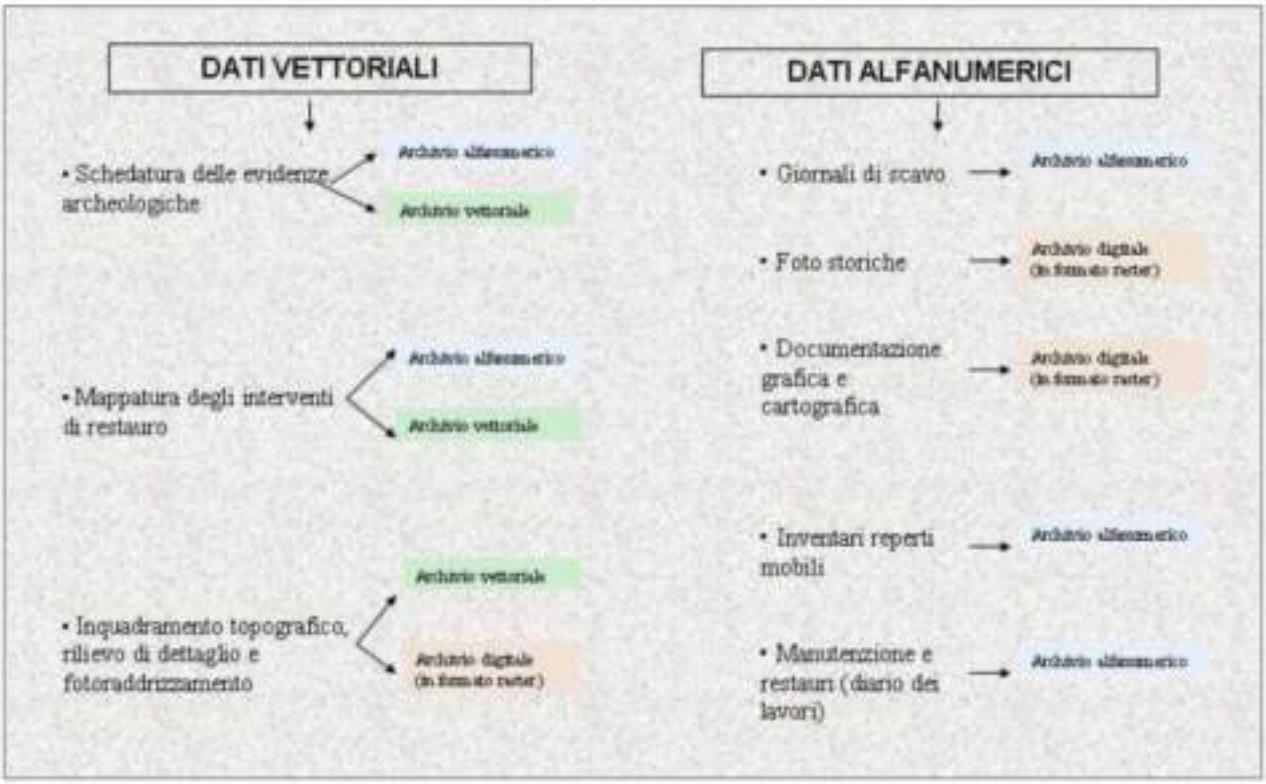

Fig. 1: General diagram of the two data typologies

4. THE VECTOR DATABASE

Plans (at various heights within the *insula*) and elevations have been drawn up for the entire *insula* block. Processed and structured numerical mapping was the basis for creating a vector archive of the information from the analyses of the standing remains and their state of decay. Detailed plans (at a scale of 1:20) allowed a more accurate reading of the documented archaeological evidence; the survey data acquired had to be filtered according to the relative height of the chosen horizontal plan. In a traditional (2D) information system the percentage of missing graphic documentation is easily integrable by overlaying the entities on the projection layer of those already documented. Due to the architectural complexity of the *Insula Orientalis I*, which extends over three different floor levels with a height difference of almost 16 metres, it was decided to develop the information system in a three-dimensional environment so as to aid the critical interpretation of queries through the capability, even if only on a perceptive level, of an all-encompassing 3D view.
documented entities. The vector database was inserted into the geodatabase and, appropriately indexed, it was linked to the alphanumeric database. The topological relationships between the various entities are those commonly used in geographical information systems: ‘overlapping’, ‘adjacent’, ‘sharing common boundary’. Using simple calculations of the objects’ geometries allowed us to easily quantize areas and boundaries of homogenous contexts creating a base of quantitative data for areal analysis of recurrent phenomena.

As previously mentioned the need to have three-dimensional graphic support for the visualization of data made another editing process necessary. This allowed us to rotate (on three axes) all the polygons derived from the two-dimensional digitization in order to get a three-dimensional vector ‘skeleton’ of all the documented elements. In this graphic support a texturized three-dimensional model was built of the entire *insula* that became the virtual navigational space for the end user.

The new version of the ESRI™ (ESRI™ ArcScene 9) software allows you to import into your own work interface a three-dimensional model (for example, a 3DS file) completely constructed outside the application. Within the application it is possible to navigate and query the system, which allows easy consultation for less expert users and guarantees a constant perception of the monument’s architectural complexity as a fundamental element for the interpretation of analytical data.

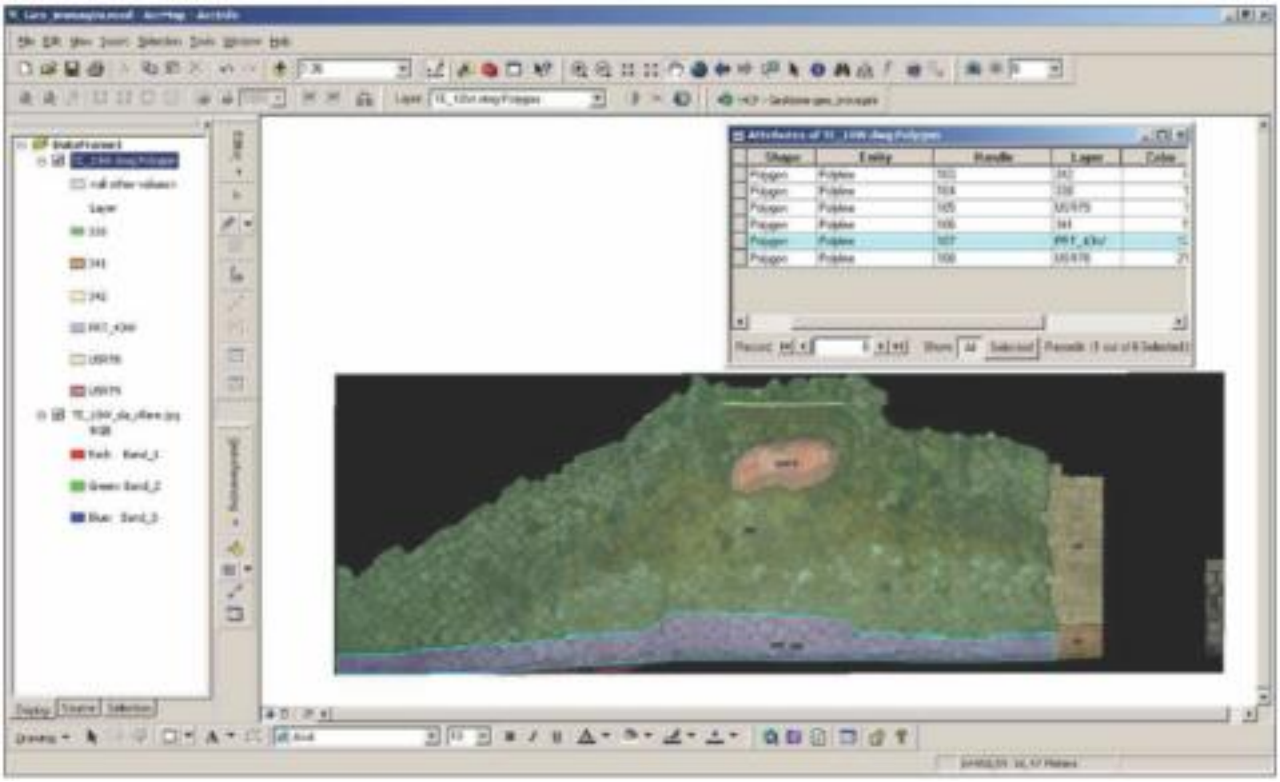

Fig. 2: Example of managing the mapping of the stratigraphic units

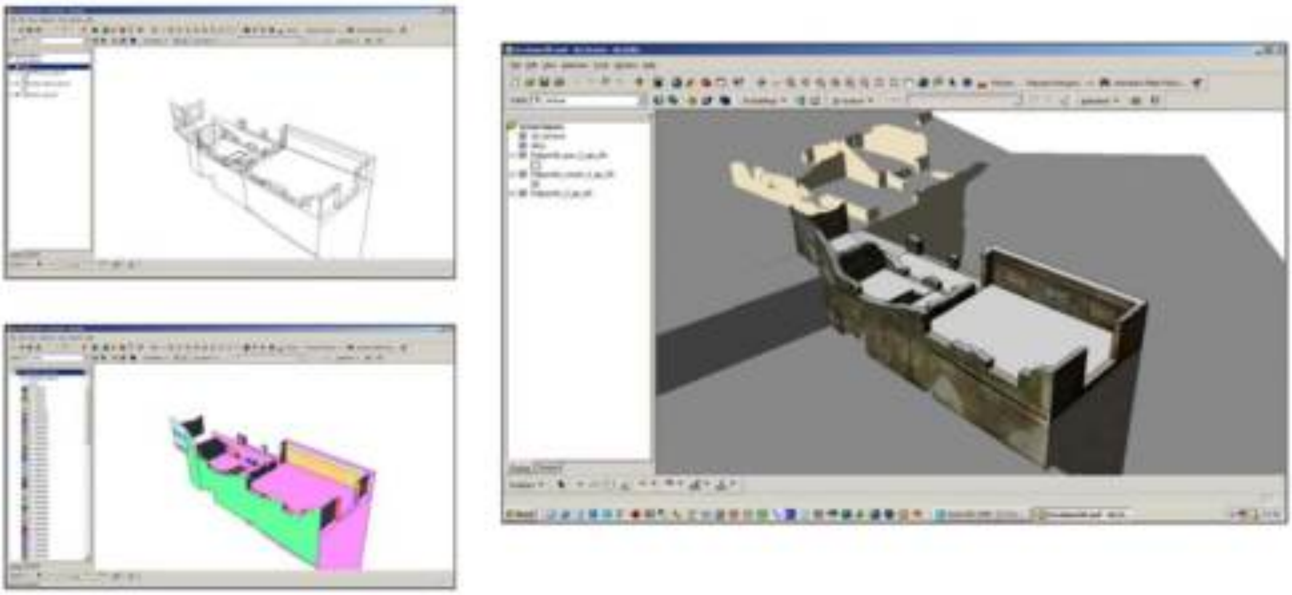

Fig. 3: Texturizing the three-dimensional model of *Insula Orientalis I*

5. RDBMS MANAGEMENT

The information system currently being created allows for the management of structured data in a GIS environment. In this context the overall management is delegated to the geodatabase that ensures the indexation of the entities and the topographical relationships between them. The development environment (Microsoft™ SQL Server) has allowed the creation of a robust database structure that guarantees the integrity of the data as it is entered, the archiving of historical data, and complex querying of attributes, geographical and topographical locations.

In general terms we can describe the various types of query within the three-dimensional graphic interface:

. • 'identify' – identification of the object met whilst navigating;

. • 'query by attribute' – search for objects on the basis of one or more attributes (e.g. wall + reticulate + first-style wallpainting);

. • 'query by location' – search, on the basis of the associated geographical record, for topological links between the object in question and other entities (a certain type of decay that 'is found within a certain distance from' another type of phenomenon).

For the sake of brevity only these three fundamental query typologies have been described; their capabilities lie in the possibility of bringing data together according to their individual, geometric and spatial attributes, and of generating new cartography in a provisional logic with respect to the needs of the conservation interventions to be adopted.

The management system was designed to guarantee, on a strictly computing level, standards that allow porting of data between various applications. The hardware is made up of three desktop stations (two PCs with standard configurations and a dedicated graphics workstation) connected through a local area network to a central server. Access to the database has been designed with a user-friendly graphic interface which can be activated on the client side with a browser (Microsoft™ Internet Explorer). Currently a separate section is being created for consultation only of three-dimensional GIS data through the creation of an ActiveX component that exploits the capabilities made available in the development environment of GIS software (cf. ESRI™ ArcObjects). In this environment it is possible to navigate in virtual reality within the *Insula Orientalis I* querying object attributes.

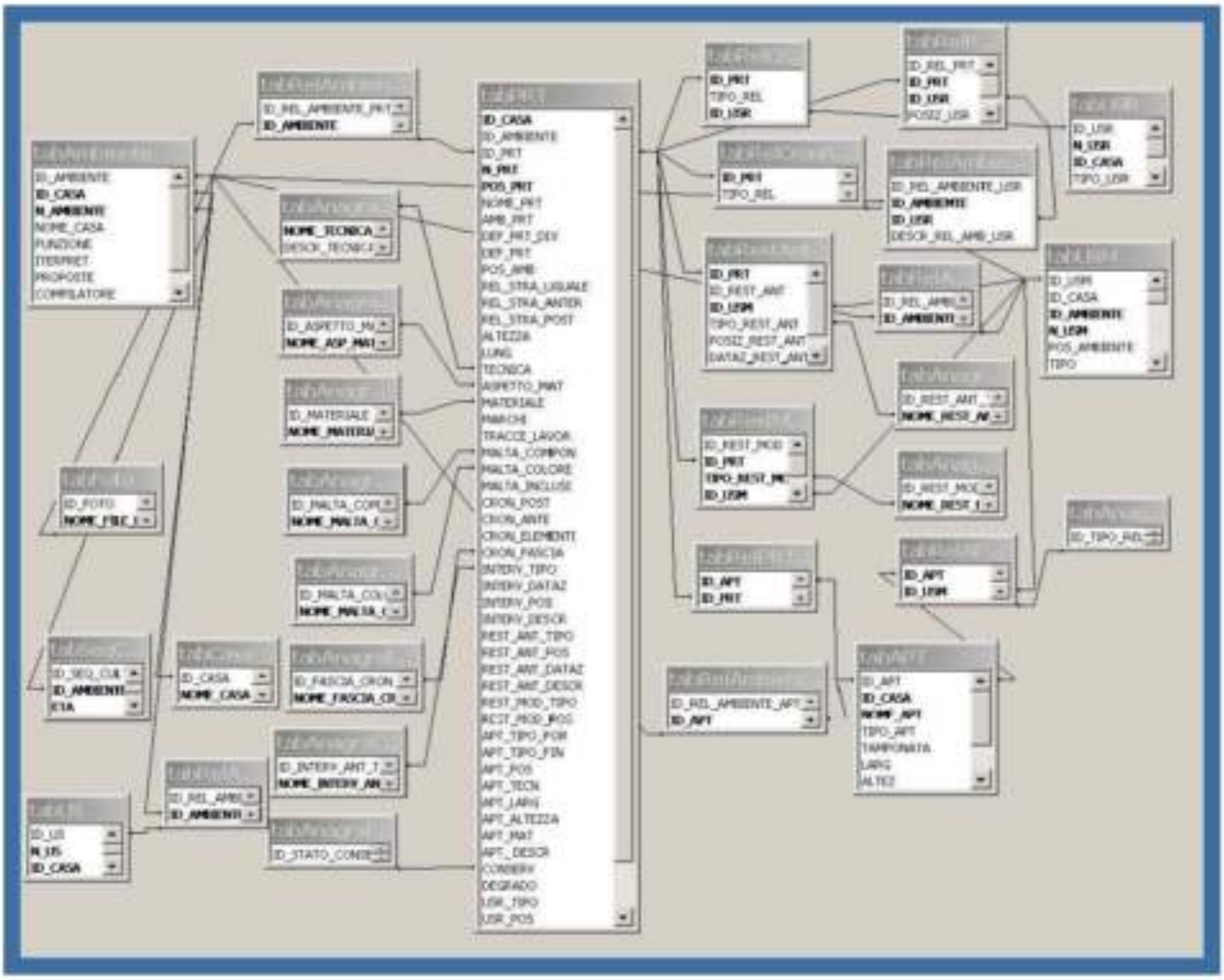

Fig. 4: General structure of the logical connections

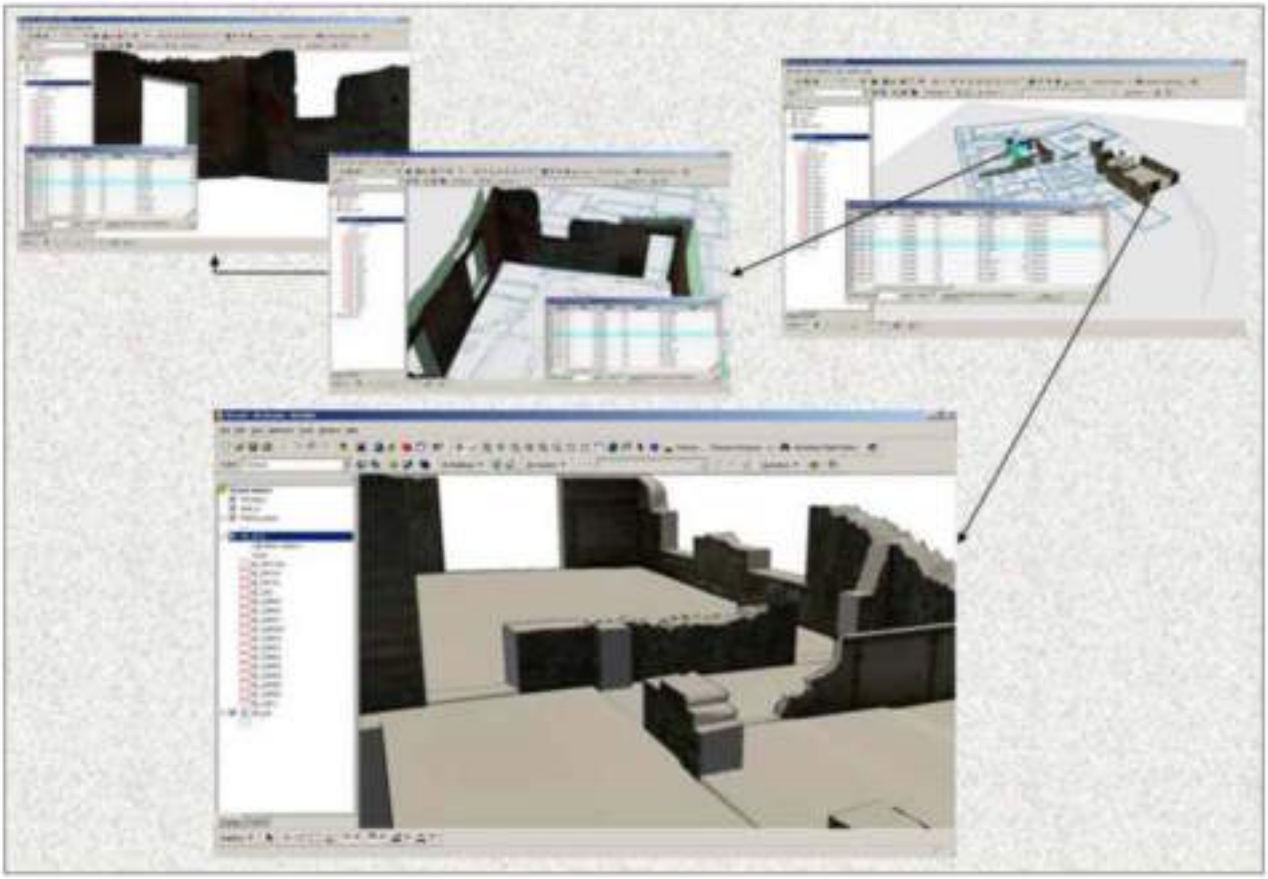

Fig.5: Construction of the digital model and management within the GIS software

As for access, different levels have been established according to the level of authorization granted. In general terms they can be summarized as: a base level for consultation purposes in which it is only possible to visualize entered data; a more advanced level that allows the entry of new data (in this case there is also the option, for example, of limiting the ability to edit and delete records); and an administrator level that allows total access to the system.

The management of an RDBMS (relational database management system) in multi-user environment, even though it is an established technology, has proven to be particularly demanding when considering the amount of logical connections which exist in the structure (in most cases they are many-to-many relationships). Particular attention has been given in the design of the entry and testing phase of the records with the aim of conserving the formal integrity of the data. Simple filters allow lean navigation throughout the entire system for the search of specific information or the automatic creation of inventory lists.

The possibility of carrying out more complex queries using available GIS data was completely delegated to the ESRI™ ArcView 9 software, exploiting the analysis capabilities available within that programme. Within the GIS environment a part of the application was customized with macros created in VBA (Visual Basic for Applications) to allow less expert users a minimal level of interaction with the programme.

6. CONCLUSION

The information system for the *Insula Orientalis I* represents a case study within the broader HCP project. As previously noted the ultimate aim is to guarantee a continual exchange of information between the various professions that are working simultaneously within the project. Starting from this point of view the entire architecture has been structured in the most dynamic way possible so as to allow expansion beyond an unambiguous topographical base. In cost terms a three-dimensional GIS structured in this way foresaw a huge outlay of energy in the construction of the 3D graphic basis (which involved the use of several softwares and technologies). The process of formalizing the data, which lead to an extremely robust database structure, has allowed us to establish and share high standards of documentation that will make future digital archiving and any type of analytical approach much easier in the future.

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