ARKIS
AN INFORMATION SYSTEM AS A TOOL FOR ANALYSING AND REPRESENTING HETEROGENEUS DATA ON AN ARCHITECTURAL SCALE

Paolo Salonia, Antonella Negri

Istituto per le Tecnologie Applicate ai Beni Culturali
Consiglio Nazionale delle Ricerche
AdR di Roma, via Salaria km 29.300, Box 10
00016 Monterotondo Staz. (Roma)
Italy
e-mail: salonia@mlib.cnr.it

ABSTRACT

In the case of historical buildings and monumental architecture, the analysis and understanding of processes of decay call for an interpretative overview encompassing data which stem from different areas of study but are globally interrelated and constitute essential elements for the purpose of assessing the state of preservation.

The study outlined here was carried out to show how the integrated representation of the monument's geometry together with the morphology and distribution of the damage, the component materials and their physical characteristics, the historico-architectonic analysis and environmental factors can be used to facilitate our understanding of degradation processes.

Identifying the Information Technology (IT) as being able to create environments that are typically suitable for the aims pursued and to use as an operating instrument, it was decided to translate the theoretical disciplinary model into a computer-based procedure in which the functions specific to the GIS- Geographic Information Systems- were transposed to an architectonic scale.

To this end an Information System is currently being configured for development in an AVENUE programming language (by ESRI).

It is designed for the organisation, representation and utilisation of knowledge of data regarding the architectonic item in question, its immediate context and its territorial location.

Experimental results obtained for some actual applications are presented.

Keywords: GIS, Historical Architectural Heritage Recovery, Decay And Preservation, Data Base, Network

1. INTRODUCTION

Correct management of the various aspects of our knowledge of architectural heritage and the evaluation of its state of conservation, which are required for making a plan, implementing it and verifying the results, can only be achieved by constantly matching the specificity of the monument, after its exact geometry has been restored, with the elements obtained from historical-architectural analysis, the survey of the structure, building techniques and materials used, including those which describe its material status, considering individual buildings as a whole and systems of buildings as a group in its context**]**.

To this end, an Information System – **ARKIS** (**A**rchitecture **R**ecovery **K**nowledge **I**nformation **S**ystem), - is currently being set up as an auxiliary tool for the organisation, representation and utilisation of knowledge of data. It regards the architectural item in question, its immediate context and its territorial location in the recovery of historical buildings.

2. THE INFORMATION SYSTEM ARKIS

The innovative aspect of the research consists in transferring the specific functions of the GIS [Hickin91**]**, **[**Maguire91**]** to the architectural scale of

the individual building in the canonical forms of its graphic representation (plans, elevations and sections) just like any other geographical area [Salonia95].

The fundamental structure, upon which the entire methodological system is based, is represented by the extension of the GIS geo-relational model as applied to normal CAD procedures and to the most common types of relational data bases. It follows that every object data base and graphical entities which are typical of CAD, take on the topological/vectorial modalities of the GIS.

This choice has made it possible to link alpha-numeric and geometric data, localising the information in the geometrically exact point (or area), by means of relational space positioning functions for the *geometric characterisation of information*, with respect to the reciprocal *topological* relationship between the various parts of the building. For each knowledge domain, the latter are graphically projected onto the building's geometry and represented on separate layers, each of which contains homogeneous elements and information belonging to the same class. Each layer is associated with tables, data bases and text pages in which the descriptive data, which refer to the image it contains, are organised and systematised, and can be consulted simply by clicking onto the part of interest.

Overlay operations (topological cross referencing) allow the intersection between the different databases to be achieved by superimposing the various graphic-rendered topics and the relative tables of attributes, at the same time ensuring functionality of analysis among the different coverages (information layers) by combining elements that have different common attributes.

The possibility of having several superimposed layers (each therefore with its own associated information baggage) allows several different forms of *knowledge synthesis* to be used and the different phenomenologies to be interpreted.

Its characterisation makes the System interactive in the sense that the data files are not computerised solely for the purpose of consultation but can be manipulated in various ways for interpretative, evaluative and predictive purposes.

In brief then, this system is an instrument for *information analysis*. It allows us to obtain added information of processing of input data: for example *calculation of areas* concerning the same type of decay, *calculation of the number of elements* which are characterised by the same constituent material, *quantification of architectural objects* which are related to the same typological family, *statistics, and so on*. It is also a tool for *information representation* both for input and output.

The innovative aspect can be seen in the use of IT in all phases: *data acquisition, processing. representation, management, transfer*.

The achievement of this first prototype model arrived as a result of careful definition of the characteristics which it had to fulfil, both from the point of view of functionality in computing terms (organisation of information of a differing nature and the subsequent continuous inter-relationship and management), and from the architectural discipline which concerns the definition of the structure of the data (classes and sub-classes of the types: architectural, construction techniques, materials and decay) and then onto defining the differing acquisition modalities of descriptive and geometrical data.

3. DATA ACQUISITION MODULE

The data acquisition phase is characterized by essentially interactive procedures to allow the various different kinds of data types to be recorded (geometric, in raster and vector form, descriptive, in alphanumeric form structured into RDBMS and as texts, various image formats) in integrated environments in modes that guarantee the simultaneity of the various acquisitions that will thus be generated in an already interrelated form.

Data collection is subdivided into three separate, although closely linked, scales of investigation:

- individual building scale
- urban sector scale
- geographic scale

At the individual building scale, the data complex to be collected (*descriptive, geometric, iconographic*) , refer to:

- general information
- iconography
- geometry
- structure, construction technique and materials
- historico-architectonic analysis
- decay (cause/effects)

At the geographic scale, the overall pattern of the urban sector and the geographic surroundings are built up through summatory processes involving several different modules of the scale of the individual building, supplemented by other more specific ones for the collection of additional, more specific data referring to the different scale.

The data set is combined with others which may be defined as referring to the *environmental context.*

The required preliminary operation for this module consists in identifying the new entity to be acquired in the field. To this end the system allows the user to procedure in a highly user-friendly way, suggesting the window with the national territorial map and a limited number of tool buttons.

Of fundamental importance among the latter is the one linked to the "new entity" function. This tool has different modes according to the active map scale, inside which the individual identifications are to be developed: from a simple symbol on the geographic area (country, region and province) to the selection of polygons on the building units to be acquired (from the land registry map level to architectonic scale, down to the construction details).

Returning to the initial phase, you proceed by clicking on the geographical area concerned. The system will place a symbol on the centroid of the area and open a window displaying relevant structured fields in which the user can enter the alphanumeric data needed for a preliminary, essential identification of the building to be included.

If it is then required to descend to the cadastral plan level, as the relevant view is initially empty, the user will be shown a warning message and at the same time, the function key dedicated to importing the cadastral plan data from a vector and/or raster source file will be activated.

Using the "new entity" tool button described above, the user can outline and select the building in question. After concluding the operation by closing the polygon, the System automatically assigns to the area identified the colour previously selected for the legend and, in the same screen display, will highlight the structured record for the purpose of recording the full descriptive data referring to the building itself (fig 1).

The record form is divided into different fields and will appear with several of the fields already filled in. These are the fields referring to the region, province and municipality that the System has already been able to code automatically during the previous stages of inputting the new entity at the higher scales. It is precisely these codes, which will continue to appear in subsequent records referring to the gradually more detailed information of an architectonic nature (structural elements, construction techniques, materials, degradation) that will ensure the links among the various different scales and the automatic updating of the RDBMS.

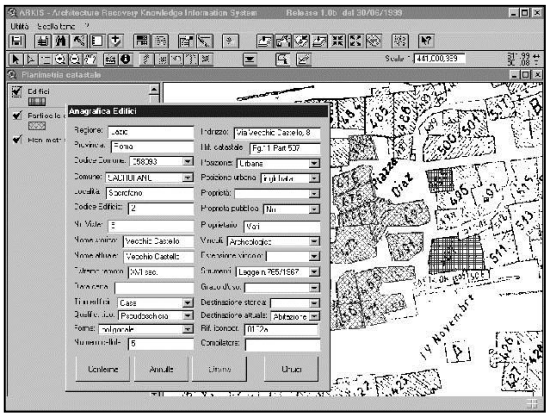
Also automatically, by means of a resident numeric counters, the code number of each single building entered will be updated.

The information record will be compiled by making interactive selections inside the active drop down windows for each of the specific fields of which it is composed.

Using procedures similar to those described above, the user can then proceed to the next levels, where other specific functions will be activated according to the specific data to be acquired.

Some of the latter will in fact require pre-processing before recording (e.g. orthoprojection procedures to render the photographic images of the views metric, digitizing the latter in CAD environments, and so on). In these cases, by means of special function buttons, the System, opens up the environments in which this processing may be done.

In other words, the data acquisition module of ARKIS is structured in such a way as to guarantee the required integration between heterogeneous data which, by configuring specific interrelated files for each type of information, will then allow the System itself to be managed by navigating through the various consultation itineraries.



Cadastral plan with general data acquisition mask
Figure 1

4. DATA CONSULTATION MODULE

As soon as the data consultation module is opened, there is a window which allows the user to choose between two consultancy alternatives.

The first follows the route of the map-making representations of differing scale, while the

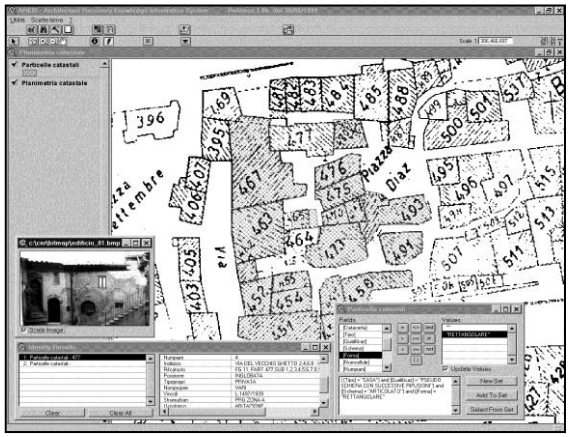
second allows the user to make a choice based on alpha-numeric data.

Following the research on the map-making representations, this leads us from the entire national territory scale to the single building scale, passing through successive openings of interactive windows which are relative to regional levels, to those of provincial and city levels.

In quick succession, using the described keys and scale passages, we approach our selection of the building to be consulted. In fact, in the next frame, where we have the city subject, it is possible to open a window, where there is a list of historical centers, the building units and single monuments collected in the same city.

Through selection, we go on to analyse the scale level of cadastral plan: there, the analysed buildings are high lighted. There are lists of elevations, plans, sections (fig 2).

In fig 3, 4 we can see two consultation windows of the building. On the tool bar there is a typical series of function and tool buttons. Laterally, there is the list of themes which are present, which may be accessed at will. These correspond to all the relevant subjects of every reading made during the



Cadastral plan with data consultation windows and hot-link with raster data (Sacrofano)
Figure 2

acquisition of data phase (register information, construction type, materials, decay situations and so on).

As described in the part relative to the different functionalities of the system, we can activate one or more topics using the overlay function, open attributes/data tables, defined overlays. These allow us to link and cross reference information described by each single theme in a single reading, carry out interactive questioning both upon the graphic pictures and on the specific record in a table data, using reciprocal ignition both of the geometrical element regarding the graphical picture and of the same record from the table and carry out query operations (fig 5, 6).

Using a specific button function, we have the possibility of entering RDBMS at any moment. This was created in the ACCESS environment and used in the loading of the data.

Evidently, inside the system, the data base is related to the single terms of the GIS.

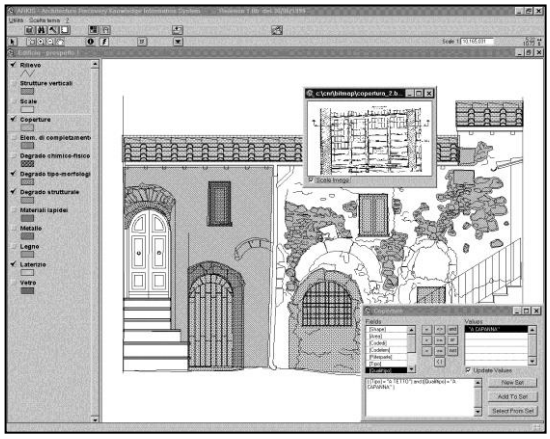
5. THE APPLIED CASES AND PROTOTYPE VALIDATION

In order to validate the first prototype form, a fact-finding survey was performed on two cases study deemed representative of the object of the analysis.

The first is represented by a series of buildings of lesser historical importance surveyed in the historic centre of Sacrofano, a mediaeval township situated north of Rome **[**Salonia95**].**

The geometric survey operations were carried out using a non conventional photogrammetric survey system based on a semi-metric Rollei 6x6 camera for the photographs and Rollei MSR software for image rendering. Using digital image processing, the Rollei MSR software converts, by means of orthoprojective and orthomosaic processes applied to the images, the perspective of the object photographed into an orthogonal projection provided that the coordinates of a sufficient number of coplanar points which identify the rectification plane are known. The 'rectified' and thus metric raster image is then digitised on screen in an MSR-CAD environment of the Geotop in order to produce the relative “vector” image. The final operations involved the construction of selections, reports and thematic topics for the consultation of the graphic and alpha-numeric data in the ARKIS multimedial environment (fig 3, 4).

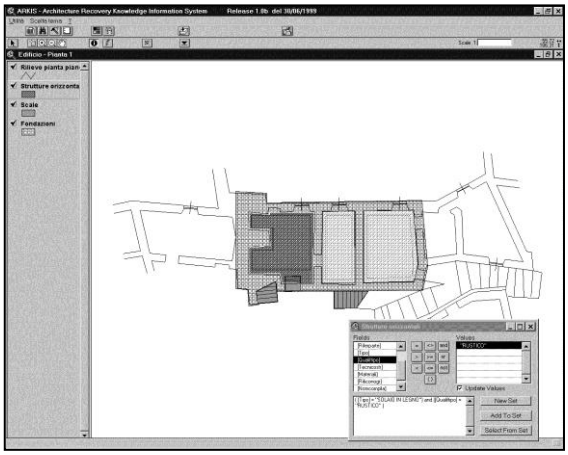
The system structured is currently being further tested and developed in another application selected in conjunction with Istituto Centrale del Restauro, to the Roman Theatre in Aosta, a monument dating back to the Augustan age and a rare example of covered Roman theatre architecture.



ARKIS interface. A consultation window of the building with defined overlays. (Sacrofano)
Figure 3

The geometric basis of the monument surveyed was used as a topographic reference to form spatial and topological relations among the descriptive data, deriving from the optometric examination and collected in harmony with the NORMAL recommendations (CNR/Istituto Centrale del Restauro Commission) **[**CNR-ICR88**], [**Corti92**].**

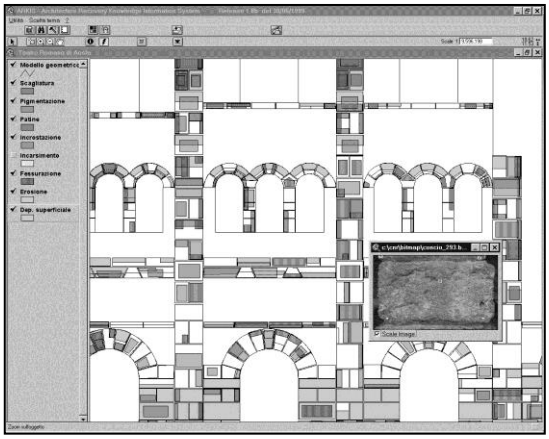
The entire information set, geo-referenced on the configured GIS coverage, can be consulted at each single level for several of them, by means of overlay operations (fig 5, 6).



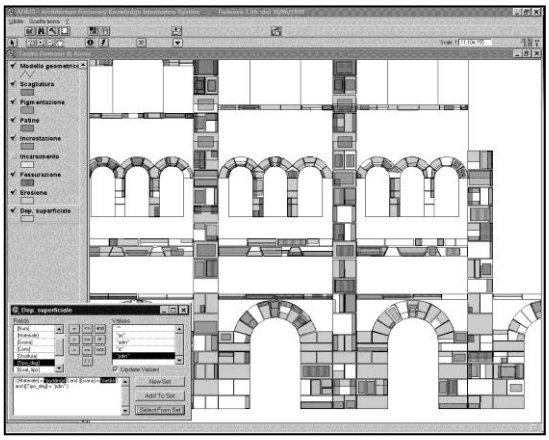
ARKIS interface. A consultation window of the building (plan) with defined overlays. (Sacrofano)
Figure 4

6. CONCLUSION

In conclusion, the system is user friendly. It represents an operative tool for different organisation, for example monuments offices or agencies. To this end, possible development could be to specialise some of the modules for the management of: utilisation of the *topologic* requirement on *raster data*, extension of the system in 3D, outline of raster 3D model with topology control, integration of techniques for acquisition of geometric data (*classical photogrammetry, simplified and multi-camera shots*) in order to obtain useable information with different reconstruction systems (2D and 3D), measurement protocol and introduction of innovative modality into the monitoring systems.
It is mainly important to create transfer environments and use of knowledge, through a set



Hot-link: using raster data
(Roman Theatre in Aosta)
Figure 5



ARKIS interface. Query operations
(Roman Theatre in Aosta)
Figure 6

up of *multi-medial data base in remote access*, for the *dissemination* of heterogeneous information into INTERNET (alpha-numerical data, geometrical data,pictures) which are based upon the needs of

potential users (researchers, designers, restorers, decision makers).

In the near future, we will experiment with both a connection to INTERNET and a series of peripheral points which will be connected to a central managing operator.

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