HISTORICAL BUILDINGS AND THEIR DECAY: DATA RECORDING, ANALYSING AND TRANSFERRING IN AN ITC ENVIRONMENT

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KEY WORDS: Historical Buildings, Decay, Restoration, Survey, Web-GIS

ABSTRACT:

ARKIS - **A**rchitecture **R**ecovery **K**nowledge **I**nformation **S**ystem - is an Information System, set up as an auxiliary tool for the organisation, representation and utilisation of knowledge of data in the recovery of historical buildings. It regards the architectural item, its immediate context and its territorial location.
ARKIS is user friendly and represents an operative tool for different Organisation, for example monuments offices or agencies.
To this end, mainly important is to create transfer environments and use of knowledge, through a set up of multi-medial data base in remote access, for disseminating heterogeneous information into Internet (alpha-numerical data, geometrical data, images) which are based upon the needs of potential users (researchers, designers, restorers, decision makers).
ARKIS-NET, here presented, provides the foundation for disseminating high-end heterogeneous data, organised and represented in GIS form, and mapping services via Internet. Clients may display, query, and analysis information in an easy-to-use Web browser, and also integrate local data sources with Internet data sources.
Some case history will be presented.

1. INTRODUCTION

As part of architectonic restoration it is necessary to define the different knowledge paths and relative data bases, identify the reciprocal interactions in order to promote a complex interpretative action on the state of conservation of the historic building object. This is done by using different data acquisition and recording procedures consistent with their nature and referring to the geometric, structural and material configuration, to the study of the historical and architectonic features, as well as to the understanding of the training processes and the analysis of the pathologies of degradation as a function of the typologies of the constituent materials. Likewise, as regards the successive phases of the definition of the intervention and its execution, it is necessary to guarantee a rigorous approach to the knowledge and the management of the data.
A fundamental role is played by the dissemination and utilizability of information.
The introduction of Information and Communication Technology (ICT) also in the sector of Cultural Heritage has led, in recent years, to a still limited and self-conscious transformation of the methods of approach to specific issues in the field of both data acquisition and in that of the subsequent data processing and management (Moltedo et al., 2000).
In other words, there is still no consistent cultural growth in this direction, particularly in those public and private bodies that play a major role in the process of safeguarding and enhancing these assets.
Conversely a number of investigative and experimental initiatives carried on, in the research field are evidence of a fruitful activity aimed at providing the various stages of the process specific to conservation and protection, also at the operational level, with the innovative tools that modern technology can now offer in a very wide range of disciplinary sectors.
The work presented here in aims at studying the ways in which ICT can be used to disseminate the huge complex of information produced in the course of the process of acquiring knowledge about the building heritage. The growth of the Internet has made available huge quantities of data in all fields of human knowledge, encouraging the sharing of ideas, studies and information, and at the same time making it possible also for non experts to approach and discover fields of learning that would otherwise be very difficult to access.
Over the past few years, the research undertaken has been focused on configuring a system capable of merging complex and heterogeneous data produced by using different acquisition methods specific to each particular phase of the fact-finding approach to the building within a custom-designed ICT environment (Salonia et al., 1996).

2. AN INFORMATION SYSTEM: ARKIS

The product developed consists of a software package called **ARKIS** (**A**rchitecture **R**ecovery **K**nowledge **I**nformation **S**ystem) developed in AVENUE, the ESRI

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programming language, and based on the ArcView engine, validated for different research cases and presented at several conferences. Its innovative aspect resides in the transfer of functions specific to the Geographical Information System - GIS - (Hickin et al., 1991, Maguire, 1991) to the architectonic scale of individual buildings, which is interpreted in the canonical forms of its graphical representation (plan views, elevations and sections), as a geographic area included inside a map.
ARKIS represents a modular tool consisting of several sub-systems each of which ensures different *levels* of knowledge through different degrees of detail, aimed at guaranteeing the *organization*, *representation* and *utilization* of the knowledge itself.
The basic structure underlying the entire methodological approach is represented by the extension of the georelational model applied to normal procedures typical of CAD and the more commonly used relational data bases. Consequently each data base of CAD objects and graphical entities acquires the *topological/vectorial features* of the GIS. This option made it possible to interrelate the descriptive data with the graphic data, locating the information in a geometrically exact point (or area) using relational spatial positioning functions for the *geometric characterization of the information*, while respecting the reciprocal *topological* relationships among the various parts of the building.
ARKIS is thus structured in such a way as to provide the necessary integration among heterogeneous data (geometric, raster and vectorial, descriptive, alphanumeric organized in RDBMS and as text, images, in various formats). After the specific interrelated files have been configured for each information type, this then allows the System to be managed, as well as navigation through the various consultation itineraries.
The alphanumeric data are organized and structured into attribute tables, each field of which is flagged with the same identification code as the topological element to which the descriptive data refer. The GIS functions also regulate all the selection and query operations, which are based on geometric or topological criteria, as well as on logico-arithmetic expressions.
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 together elements having different common attributes (figure 1). For lack of space it is impossible to provide further details on the various functions guaranteed by the system (Salonia, 2000).
To mention only the more significant features (Salonia et al., 2000), the functions may be summed up as follows:

- to guarantee on-screen outlining of areas with which to associate specific themes; these are naturally linked to the records inside which the descriptive information referring to the themes are organized;
- to automatically open the records in which alphanumeric data referring to the acquired entity are to be input, guiding the user by means of drop down menus of pre-established items;

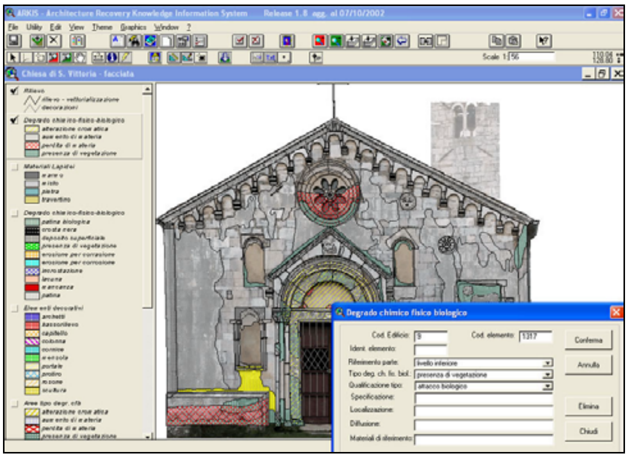

Figure 1 - ARKIS: a consultation data phase on decay situation

- to automatically code each new entity, ensuring links between the various scales and the automatic updating of the RDBMS;
- to activate one or more themes, with consequent overlay operations;
- to open as many attribute/data tables as there are active themes and defined overlays (this allows the description information referring to each single theme to be merged and cross-referenced in a single display);
- to perform query operations and interactive queries both on the graphic representation and on the specific table record, with reciprocal highlighting of both the geometric element in the graphic representation and of the same record in the table;
- to calculate areas, perimeters and percentages in zones affected by the various pathologies discovered (figure 2);
- to call up the photographic image of the detail investigated and/or the rendering of geometric surveys with the relative lists of coordinate points;
- any other interactive analysis operation.

For the purpose of testing the System developed, experiments were conducted using several study cases considered to be sufficiently representative of the object analysed and to be essential examples for validating the theoretical and methodological approach.
The System is user friendly and can be used as a support and guiding operating tool by various different bodies, in particular the Superintendencies. However, it is not enough just to be an operating tool, considering the huge potential possessed by the System.
In this connection it may be said that ARKIS, insofar as it forms the central engine driving a project for knowledge management and for this very reason resident on the desktop of the individual user, must necessarily be

addressed to a specific 'nomadic' use (to continue with the metaphor): in other words, it must be able to initiate a process of knowledge navigation.
This entails seeking the added value contained both in the transfer of information organized by the individual user and in its distribution insofar as it is accessible in remote mode, thereby triggering a multiplying effect regarding the intrinsic meaning of the single information items. It can thus be shared by several users in a network in which planning, comparison, discussion and knowledge are guaranteed.
It was on these conceptual assumptions in the framework of an innovative view of conservation in which the possibility of accessing relevant information plays a fundamental role that the **ARKIS - NET** Project was based.

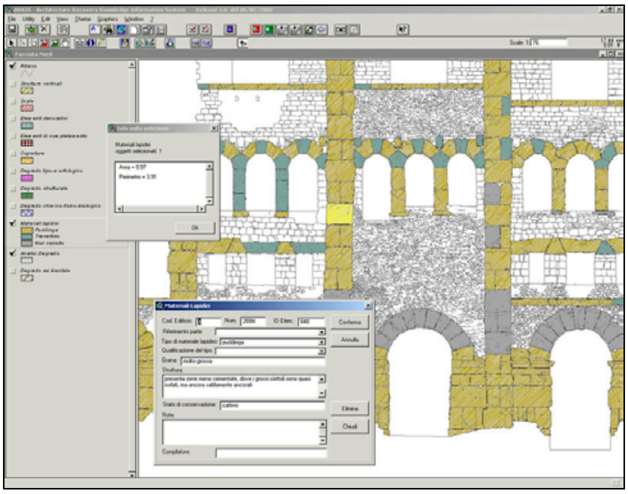

Figure 2 - ARKIS: a consultation data phase on a selected ashlar: information about materials are in the dialog window; in the small box are calculated area and perimeter.

3. ARKIS – NET: METHODOLOGICAL AND TECHNOLOGICAL ASPECTS

A segment of the research is now focused on the **ARKIS–NET** Project, an evolution of ARKIS. It provides the foundation for disseminating high-end heterogeneous data, organised and represented in **GIS** form, and mapping services via Internet. This project enables users to integrate local data sources with Internet data sources for display, query, and analysis in an *easy-to-use* Web browser.
ARKIS-NET is based on the ArcIMS software package, the latest ESRI product aimed at the exploitation and distribution of GIS environments. It consists of a new generation of Internet Map Server (IMS), with functions orientated above all towards an open scalable architecture (Harder, 1998).
There is a *Client* module and a *Server* module: the Client typically requests information from the Server, which processes the query and then sends the information back to the Client. The Server technology used by this application is part of a multitasking architecture, that is, the management of the flow of queries received from the various Clients and organized according to different, simultaneously active, services (MapServer) monitored in such a way as to route the queries to the appropriate Spatial Server *(Image server, Feature server, Query server and/or Extract server*).
The Spatial Server interacts with the WEB Server through the Application Server and its Connectors and sends the response to its Clients.
Several queries may simultaneously be handled by the same Spatial Server, or else multiple queries of each Spatial Server or again one or more Spatial Servers and queries handled simultaneously on more than one machine. This means that clients that are not only powerful but also “intelligent”: the response will be elaborated by the appropriate Server (designed to handle this type of request) and sent back to the Client in real time.
A *MapService* is a process that runs on the Spatial Server. It provides instructions to a Spatial Server on how to draw a map when a request is received. The input to a *MapService* is an ArcXML MapService Configuration File. There are two types of MapServices: *Image* and *Feature*. An *Image MapService* uses the image rendering capabilities of the Spatial Server. When a request is received, a map is generated on the server, and the response is returned as a JPEG, PNG or GIF image. A new map is generated each time a clients requests more information.
A *Feature MapService* uses the Spatial Server’s feature streaming capabilities to bundle data and sent the request to the client. Because more processing is performed in the Java Applet, requests are sent only when additional data is needed.
One of the most interesting functions of the Feature MapService is *extracting* or *clipping* data to create a subset that can be sent back in shapefile format.
The Client may have an *HTML Viewer* or a *Java Viewer*: the fundamental difference lies essentially in the fact that HTML technology is very slim, does not require the downloading of addition plug-ins to display the data queries (Java Applet) and does not require computers with powerful CPUs; however, it only allows display and querying operations. A Java Viewer, although requiring a comparatively powerful machine for processing and additional plug-ins, nevertheless ensures a high degree of interaction with and analysis of the maps.
The communication between clients and servers uses ArcXML. All the ARKIS-NET web pages have been customized with ArcXML, a GIS extension of standard eXtensible Markup Language (XML).
The ArcXML files look similar to HTML pages. The difference is that HTML describes the page structure for display while ArcXML provides the structure for describing the content.
The access to the ARKIS-NET project happens through the pages of the under construction site www.arkis.it (figure 3): there is a special section where you can enter the *online* consultation.

Figure 3 – Home page of the site www.arkis.it

The ARKIS-NET contents are the same as ARKIS, which continues to act as the information "generating" engine (Salonia et al., 2002). The data types available on the ARKIS-NET pages are essentially of the vectorial (shapefiles) and raster (image) types, as well as alphanumeric (database tables) and refer to the case studies so far investigated in the System. The remote user can access geographical information either directly on the national map and by querying the tables, searching by building type, municipality, etc.

Once the choice of case study has been made, he can call up the page dedicated to it using a set of available tools for:

- pan and zoom the map extent;
- query spatial and attribute data;
- create a buffer around feature;
- measure objects on the map;
- merge remote data with local data and save the work.

If the user is configured as a *privileged* Client, that is, if he can navigate using a *Java Viewer* (fast internet connection and a computer with sufficient processing power), he will be able not only to interact with the map through the tools described above, but also:

- add Map Notes, such as text, graphics or images, to your map and submit them for review to the *Expert Team* (that will evaluate the Map Notes received);
- make Edit Notes to map spatial and attribute data and submit the edits for review to the *Expert Team* (that will evaluate the Edits received).

3.1 Current configuration: the example of the Roman Theatre of Aosta

In the following, in order to complete what has been illustrated so far, it is deemed of interest to provide a brief outline of the present configuration of ARKIS-NET, using as example the data referring to the Roman Theatre of Aosta. It thus becomes possible to examine also the interface used by the client user, making the previously illustrated concepts even more explicit.

The page providing access to the consultation of the data referring to the south facade of the Roman Theatre of Aosta (figure 4), configured with a clientside Java, displays in the centre the *frame* containing the view with the representation of the geometric model of the facade and the various layers containing the polygons relative to the information layers related to materials and degradation of the individual ashlars. In the top right of the frame there is the navigator (in this specific case, the representation of the entire south facade) that is updated dynamically according to the zoom of the central frame. Below the navigator the Table of Contents (TOC) is illustrated, with a legend for each topic (layers of graphic objects belonging to the same class: polygons, lines, points) present in the view. On the left side of the frame there are a series of navigation, query and data analysis tools.

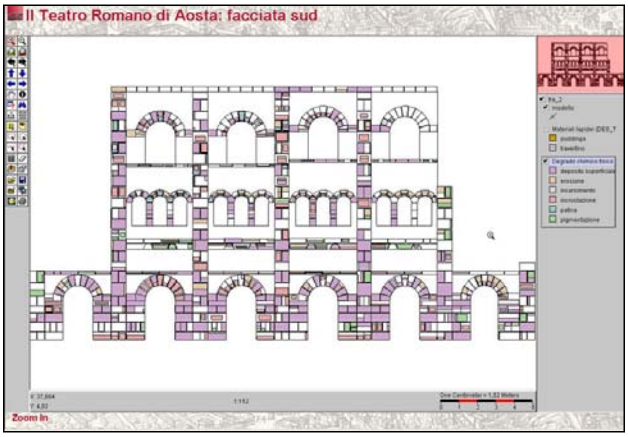

Figure 4 - ARKIS-NET: the access to the consultation of the data. Roman Theatre in Aosta, south facade

Multiple actions may be performed inside the page, from the various types of zoom and pan to reach the area of interest, to the activation of one or more themes in the TOC, the querying and extraction of information concerning the *table of attributes* of the topics, a feature that is fundamental in a GIS environment, which contains the alphanumeric information related to the graphic objects present in the theme (*features*).

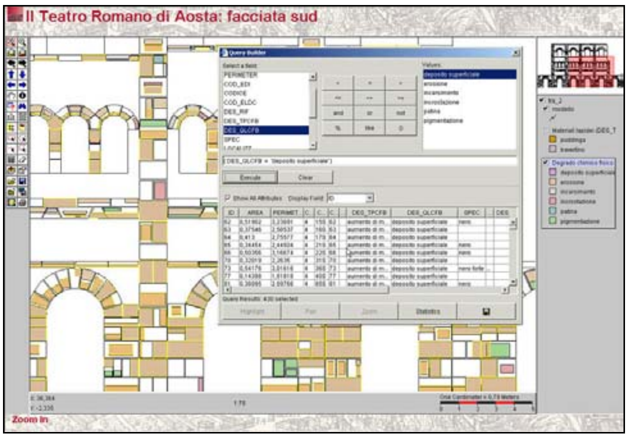

Figure 5 – ARKIS-NET: the *Query Builder* tool

In figure 5 it is shown how to use the *Query Builder* tool to seek graphic objects (*Features*) corresponding to certain selection criteria, inside the active theme. In the window a search string is constructed that is based on the fields in the *table of attributes* of the *Physico-chemical degradation* theme (active theme), requesting all the ashlars displaying an *Increase in material.* By clicking on the *Execute* button in the window a list appears of the ashlars corresponding to the query criteria. It is also possible to save one's search in a text file by clicking on the *Save* button in the *Query Builder* window. The polygons of the ashlars extracted are shown in the view.

4. CONCLUSION

In conclusion, ARKIS 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* and to extend the system in 3D.
ARKIS-NET can be a valid tool for network information sharing, but not only for this purpose. The system must become a vehicle for the dissemination of a culture of the approach to the topic of the knowledge of historical and architectonic artefacts: there must of course be a data flow from the Server towards the Clients, but also and above all, from the Clients towards the Server; the latter will elaborate and expand knowledge, disseminating it and thus acting as one of the exchange nodes.

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