

GIS application for urban archaeology: archaeological city map

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Abstract: - The Information System of Cultural Heritage (SITBA) conducted by the Municipality of Reggio Calabria (ITALY), captures, enhances and makes accessible to a wide audience the complex work of urban archeology conducted under the scientific direction of Professor Francesca Martorano, from Faculty of Architecture of the Mediterranean University.

Through a careful and scrupulous examination conducted both on archival material that on literature was realized an instrument - a kind of modern "map" - which allows both to scholars and citizens more demanding and attentive, to know the location of archaeological sites in the city, Rhegion Greek, Latin Rhegium until the Byzantine city. The work, which is the first example in Calabria of information and dissemination of archaeological, and thus historical, land knowledge using tools, is directed to the discovery and exploitation of the urban history of Reggio Calabria through the inventory of archaeological sites and artefacts discovered so far in the municipality. This allowed the Municipality, to inhabitants of Reggio who love the roots of their city and tourists to have a modern instrument that indicates the archaeological discoveries in the fabric of the town and also inform on the location of those monuments that have not left any trace except in documents.

SITBA has many aims, one of these very important is to present to the population the great archaeological property, identifying and exploiting the strong witness presence of archaeological evidences of town. Another important aim is to feed and populate Municipal Informative System (SITCO)

In the note, in addition to describing the technical aspects, the integration problematic between and about different informative systems, adopted technology solutions as well as future developments of the project, it has considered appropriate to emphasize the importance and expectations generated by the project by the city Reggio Calabria.

Key-Words: – Geomatica – GIS – DBMS – Totem – Archaeology – Archaeological paper

1 Introduction

The use of Geomatics in projects regarding Cultural Heritage and Archaeology, in its complex, is becoming usual consolidated procedure; according to it, it's sufficient to think the various applications of sector which see, between those characterized by the greater technological innovation content, the use, for the relief operations on the field, of all those technologies, methodologies and algorithms of data elaboration which refer directly and/or indirectly to the Geomatics using GIS as final manifold of all this information. To all that, the municipal administration of Reggio Calabria (Italy) didn't remain indifferent, pointing in fact, to the precious support provided by tools available from Geomatics, and according to the specific demands for knowledge and exploitation of archaeological testimonies, it has promoted, in the project "Archaeological paper of the town", the formation of a GIS for Cultural Heritage (SITBA). SITBA, besides to constitute the first data processing archive with geographic reference, equipped from several documental sources, will be furthermore

inserted in a circuit of tourist promotion; to such purpose a series of multimedia Totem, opportunely implemented with GIS technology, will be arranged in strategic points of town tourist flow. This paper describes the development activities of information technology component of the project concerning the establishment of the archaeological map of the city of Reggio Calabria (Italy).

The work presented is a project of urban archaeology that introduces itself, completely, into the consolidated binomial technological innovations/archaeological sciences, where, Geomatics role is more and more important. The applications in the archaeological field which see, between those to greater technological innovation content, the use of instrumentation, methodologies and algorithms for data processing, refer in fact directly and / or indirectly to the Geomatics (acquisition, processing and return 3D of laserscan data - processing and classification of satellite images - methodologies of survey GPS, PDA – acquisition, processing and return of Georadar data) using GIS as the final

collector of all this information. To all that the municipal Reggio Calabria administration has not remained indifferent pointing (thanks to a cooperation activities with the laboratory of Geomatics Engineering faculty of the Mediterranean University of Reggio Calabria) to the important support stocked up from the tools put at disposal of the Geomatics, and, according to the specific requirements of knowledge and exploitation of archaeological attestations, it promoted, into the project of "Archaeological Paper of City", the constitution of a Territorial Information System for Cultural Heritage (SITBA).

In the note, in addition to describing the technical aspects, the integration problematic between and about different informative systems, adopted technology solutions as well as future developments of the project, it has considered appropriate to emphasize the importance and expectations generated by the project by the city Reggio Calabria.



Fig.1: Floor mosaic. Palazzo Guarna. Reggio Calabria.

2 The importance of the project for the city of Reggio Calabria

The history of the city of Reggio Calabria has always been characterized by earthquakes and calamities that periodically removed its historical memory. For this reason, the City of the Strait shows itself as a "young" city, unfinished for some aspects, regardless of thousand- year history from which originates. For this aspect, archaeological paper's project is particularly important. The intrinsic nature of historical-identity reconstruction of the developments and constant changes of the City was the guidance element of the project promoters, inspired by a cultural need which aims to advance knowledge of the past and of the great archaeological heritage.



Fig.2: Roman Baths. Reggio Calabria City.

Thereof it will be clear to understand importance of the project in fact, in addition to being a first and organic work of geographical cataloguing of archaeological assets, it is deserving to have raised, highlighting the strong presence of archaeological find of the city, the history (past and recent) of a city that often forget its origins and its cultural sources. Rediscovering urban archaeology it permitted to identify, among other things, a fundamental element to enhance the city image, emphasizing potentials in comparison to concrete possibility offering a cultural tourism form. Assumed that culture evolves (it's not reduced only to the past) and tourism is projected (economy and business): for sophisticated questions must correspond complex deals

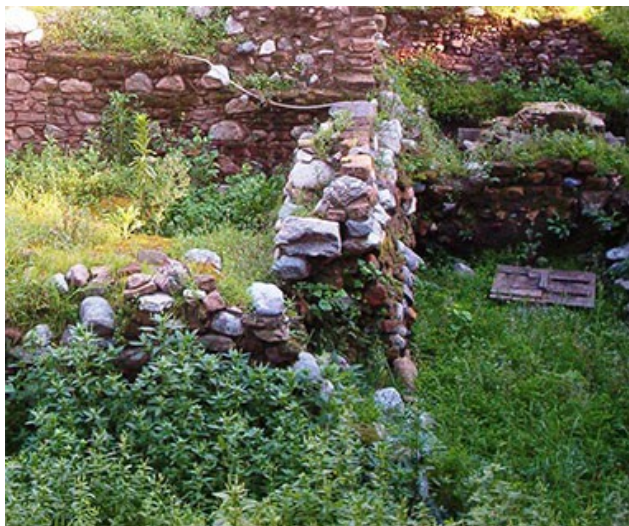


Fig.3: Archeological area Piazza Italia. Reggio Calabria City.

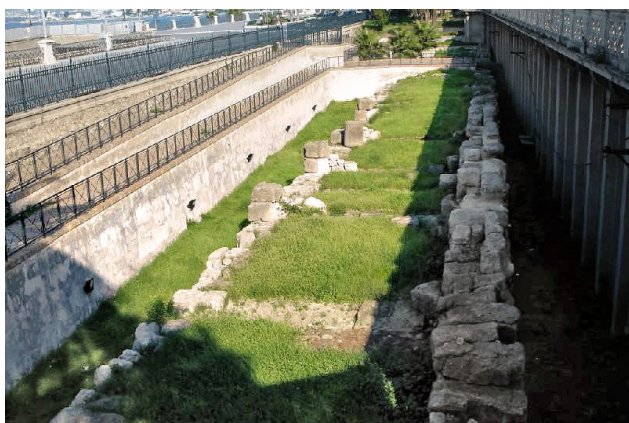


Fig.4: Archeological area, Lungomare Falcomatà. Greek walls.

For the part of its jurisdiction, SITBA will offer a valuable contribution, inserted in a tourist promotion circuit through the provision of dedicated multimedia TOTEM located in strategic points of tourism city.

3 SITBA project

SITBA is developed in two lines of implementation, independent each other from a point of view of the used technology, but at the same time, perfectly adequate regarding informative contents; the first line of development (drawn up in client-server mode) refers to the integration of SITBA in “generalist” GIS - SITCO - Territorial Informative Council System of City of Reggio Calabria; the second one refers to the construction of a GIS application integrated to multimedia station-TOTEM (stand-alone mode).

The objectives that characterized the two phases of the informatic project are obviously different; For the part relating to integration with SITCO, the objectives are predominantly management: to feed Informative Council System with important information, useful to municipal technicians involved in the daily activity of monitoring and managing of urban planning, design and programming of construction and public works, and especially the activities related to the management of the subservices network; for the part concerning the implementation of TOTEM are aimed to the improvement of tourist town offer.

3.1 The database

The information collected and available by expert archaeologists permitted the construction of a platform DBMS (Database Management System) implemented on SQL Server Express technology (Microsoft Corporation). The heart of database is constituted from table "sites" about archaeological surveys, the same is connected with all information presented in DBMS, according to classical structuring entity / relationship. Database structure is rigidly formalized according to the criterion of nomenclature and terminology of archaeological surveys imposed by archaeological experts (Fig. 5).

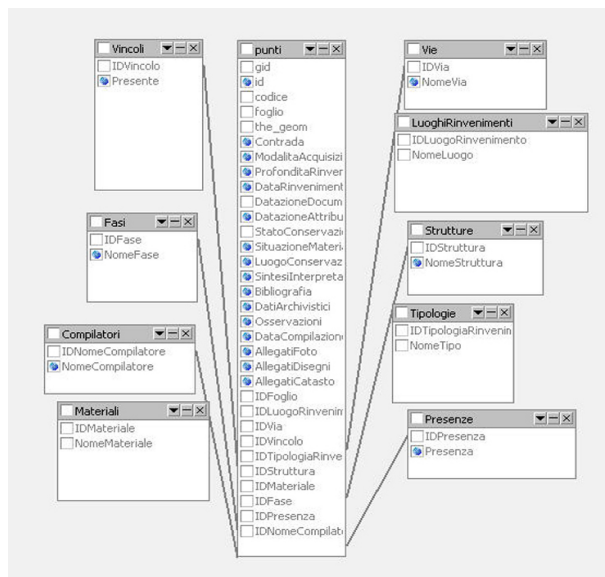


Fig.5: Database Structure (Entity-relationship model).

Data is structured in three ideal containers (areas) according to more or less descriptive nature of the data. The first area contains all the essential information that constitute an identity card of the site: the identification codes site (primary key), the general identification data of place, the procedures to acquisition of archaeological goods, the protection

status. The second area is dedicated to archaeological discovery description with its date, the state of conservation assessment, and to news about materials found. About their possible existence there is the place, where they are stored, that inform us. A descriptive field allows to include a brief summary on discovery and archaeological context, on bibliography or archive sources. The third area concerns the documentary archive and illustrations about site and the archaeological good, like plans, photographs and / or drawings. So structured, DBMS has positioned at base of developed applications, described briefly in the following paragraphs.

Fig.6: Data entry form

3.2 SITCO Implementation

SITCO, acronym of Territorial Informative Council System, represents infrastructure that support the Geographic Information of Council of Reggio Calabria. Hardware part consists of dedicated servers pair (IBM): an application server (that ensures the applications distribution) and a Data Server (data storage) with backup systems, and a firewall filter between the Data Server and WEB. The client-side component consists of three workstations and two PDA devices; software platforms are specifically Windows client / server (Windows Server 2003) with the exception of firewalls that have open source operating system LINUX. GIS system is of Intergraph Geomedia pro and Geomedia Web Map, assisted by the engine DB ORACLE 9.1 including Spatial component.

Thanks to strong intrinsic interoperability of council infrastructure, the phase of integration between SITCO and SITBA component was much easier, preparing, therefore, in GEODB only Feature Class "sites" with its primary key (site code). Through ODBC connection (natively managed by the GIS Geomedia software), council GIS system is able to spatialize information present in DBMS SITBA.

The adopted integrative solution allowed to organize the informative content in non redundancy and consistency modes for all normal GIS operations about archaeological goods and documentary annexes archives (various documentation, photos, videos, etc.) related to all other data in SITCO. Thanks to standard package at disposal, personalization interventions were reduced to minimum, in fact, queries' Informative System BA are in standard mode, through geoprocessing operations (spatial query) and through tools of "selection by attributes" (query alphanumeric) interacting with appropriate SQL operators.

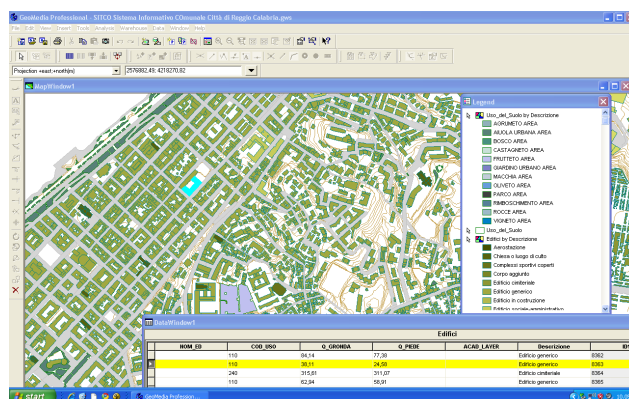


Fig.7: GIS SITCO. Themed buildings for use classes.

For all users (council employees) that are not much inclined to the SQL language it was implemented a special form, made in VBA environment, allowing data access quickly and easily (Fig. 8). In Figure 8, it is facilitated the research of the archaeological goods both identification code, and for structural type and phase.

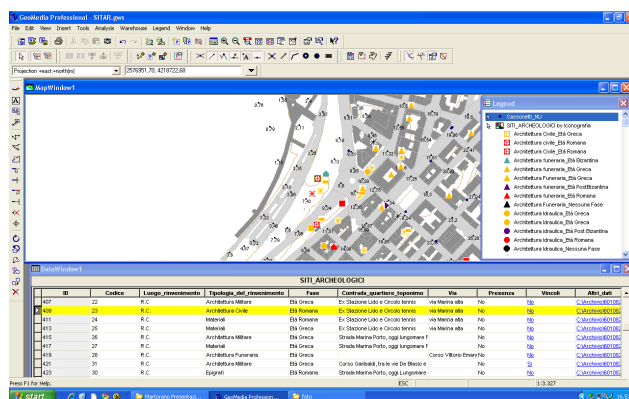


Fig.8: GIS SITCO. Layer SITBA. Layer punctual themed by type and year of discovery of the archaeological. The GIS software allows the display of data in the database.

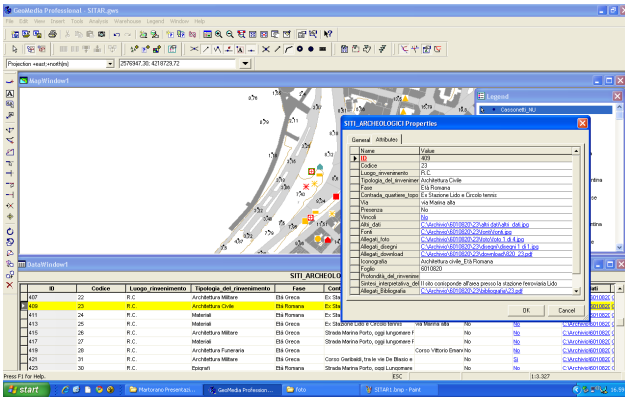


Fig.9: GIS SITCO. Tool for direct display of tab of site.

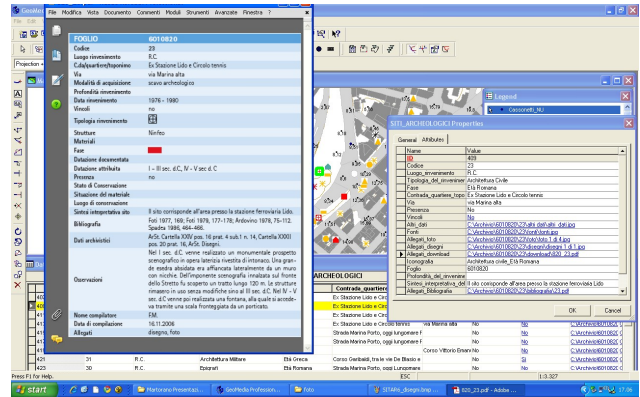


Fig.12: GIS SITCO. Deepening information. The figure shows how to display all the information and summary of the archaeological site with the link to download the pdf document.

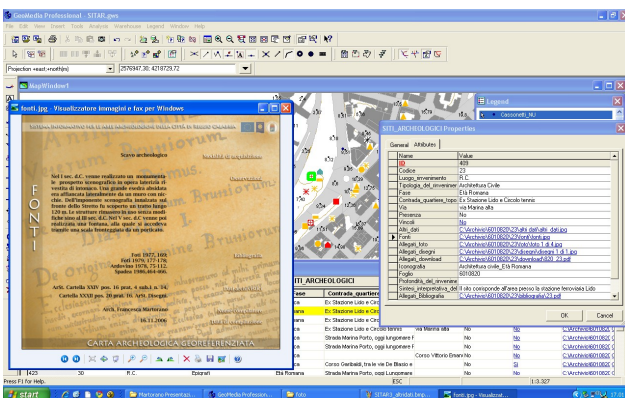


Fig.10: GIS SITCO. Deepening information. The figure shows the section for displaying the "sources" and archival literature that enabled the preparation of the tab.

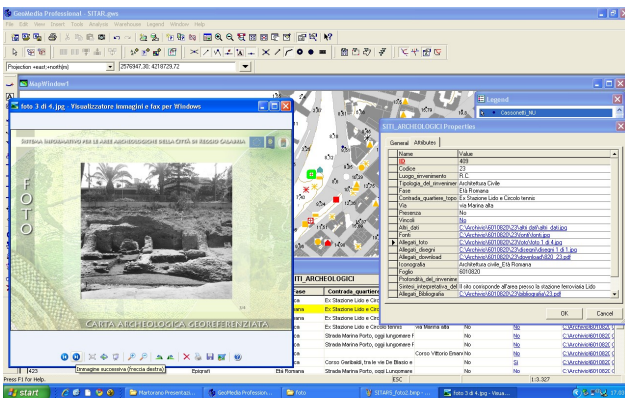


Fig.11: GIS SITCO. Deepening information. The figure shows the section for displaying photographic repertoire of archaeological site in question. Geomedia via hyperlink uses the software for the submission of images that are in the Windows OS..

3.3 The GIS application for the Multimedia Totems

The GIS application for the multimedia totems adopts the same DBMS used for the application client server SITCO previously described, with an essential difference: the technology used for the implementation of the spatial component (cartographic motor). In fact, the application, developed in modality of use "stand alone", founds itself on the MapWindows technology, developed in Visual Studio.NET (VB.NET) on ActiveX control mappings. As for the integration to the SITCO, the connection with the data bank is obtained by devoted strings of ODBC connection. In other words, realized the spatial informative layers (shp) the GIS/Totem application allows the visualization of all the present data in the DBMS in an absolutely gradual way and directly managed by the navigator user.

The formalities of "navigation" are regulated by a series of "filters" that give the possibility to effect different queries of the archaeological datum. The interface of start, principal menu, allows the user to perform a first selection (typology or discovery phase), through which he passes to a visualization of detail of the select category: "typology" will have some under-menu called "sacred, funeral, military", "civil, residential", "industrial, hydraulic", "material, epigraphs" and "phase" will have other under-menu called "pre-protohistorical", "Greek", "Roman", "Byzantine", "post-Byzantine" (fig. 13)

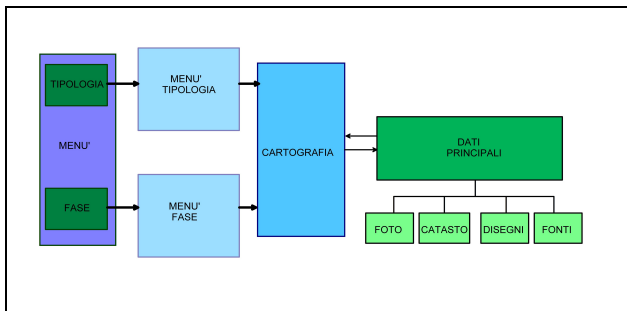


Fig.13: Flow chart software structures

The following selection allows the visualization of the archaeological paper with specification of the features planned in the previous forms. Thus, the user will have available a limited number of tools able to guarantee a complete interaction with the cartography: "Zoom in", "Pan", "Zoom out" respectively to magnify, to move and to reorganize the zone of interest.

The politics of activation \ deactivation of such tools (that means, in graphic form, in disappearance and appearance of the same ones) and the quantity of contained information in the cartography are dependent on the scale factor of visualization.

To improve the reading of the paper, they are planned three passages of scale: *initial state* (nominal scale of the cartography 1:170.000 and scale 1:25.000), *intermediary state* (nominal scale of the cartography 1:5000), *state of detail* (nominal scale of the cartography 1:500).

In the *initial state*, the borders of the commons with ends to Reggio Calabria, the archaeological sites, the buildings of the City will be visualized ; jointly the user will visualize on own screen only the tool to magnify the map (Fig. 14).



Fig.14: Form of visualization cartography. Initial state, scale of visualization scale 1:25.000.

In the *intermediary state*, the cartography (scale to urban level 1:5000) becomes wealthy of information as the roads, the green spaces, the curves of level; the buildings and the archaeological sites are distinguished in accurate way and the user will still visualize only the tool "zoom in".

The last level of visualization (scale of detail 1:500) is the more complete of informative contents both for quantity and for quality with respect to the graphic details and the tools, which the users have available.

They visualize the altimeter information (rated points) and text "label" information of the principal place names, and, that's is the main point, the archaeological sites are distinguished in "real time", thanks to the icons of project which they give an immediate decodes through the legenda placed to the right of the screen. In this level, it starts, for default, the possibility of "to question" the map, clicking on the icons directly, or it' possible to move (tool "Pan") zone by zone of the City in order to question and/or to visualize other sites or, in case of new search, also it's possible to return to the initial visualization pressing the key "zoom out" (Fig. 15).

Individualized the archaeological site of interest, through a light pressure with the finger on the screen (obviously in correspondance of the icon representing the archaeological site) it accesses the form where the principal data have placed.

This last one has composed, also from a graphic point of view, as way card (Fig.16). Aloft to the left the map is brought with indication of the selected site. The central part has dedicated to the principal information as those of the typology, phase, land\quarter\place name, Street, interpretative Synthesis of the site. Aloft to the right the informative contents are brought related to the possible presence and the place of maintenance, to the formality of acquisition and date of discovery and finally to the possible burdening ties on the archaeological site.



Fig.15: Form of visualization cartography. State of detail (nominal scale of the cartography 1:500).



Fig.16: Form information of detail archaeological site.

The form is closed by the buttons of access to the various and possible informed attached contents: Sources, drawings, Land register, Tie. Also in this case the visualization of the buttons is conditioned from the presence, or not, of attached information. In other terms, for instance, if there are photos attached to the selected archaeological site, the button photo will be activate / visualize. From this last, obviously it will can access to the form related to the photographic collection. The same principle of operation is also for the other buttons.

To finish the discussion about the strictly functional character notations, an other element worthy of note is that of the visualization of the photos and the attached drawings. From a structural point of view the Form are identical, they change only obviously about the informative contents: all the present photos (and drawings) in the DB are visualized in "miniature" in the left part of the screen; in the

central part it's visualized, in format "real" the first photo in list. To visualize in "real" the other photos in list (miniatures) it is necessary to transfer (on the photo that it wants to visualize) a simple pressure with the finger on the screen. The form is completed by the information related to the attributed dating and to the observation to the site; these last ones have placed in the right part of the form (Fig.17). A special button (of spherical form with a glass in middle, placed under the form) has been inserted for giving the possibility to activate a real magnifying glass (Fig.18). This tool has been thought to help all those people which wanted to gather every least detail of the photos and \ or drawings attached to the sites of interest.



Fig.17 Form of visualization photo



Fig.18: Form of visualization drawings.

In the development of software it has been given much attention to the composition and the study of the graphic interface. Overall the graphic development has crossed different evolutionary phases.



Fig.19: The study of the graphic interface. First prototype with no graphical elements of the original form.

Every single form has suffered some refinements of detail having care, in particular way, to the "effects" on the keys (the click on the buttons reflects the change of form and colour of the pressed key).



Fig.20: The study of the graphic interface. Second prototype of the initial form. We notice the presence of the background and buttons decorated with pictures of archaeological remains.



Fig.21: The study of the graphic interface. Third prototype of the original form.



Fig.22: The study of the graphic interface. Final version..

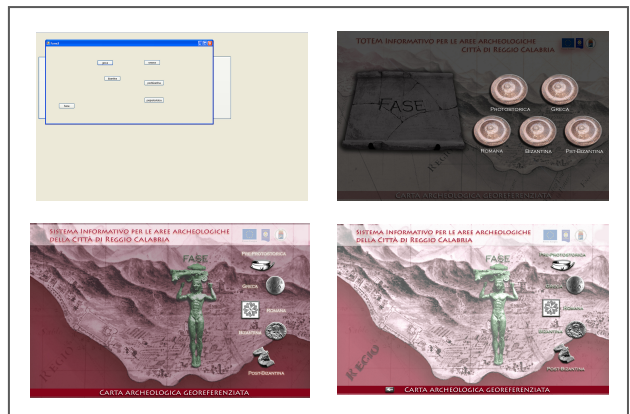


Fig.23: The study of the graphic interface. Several prototypes of the second form



Fig.24: Testing totem in the laboratory of Geomatics

These last ones are accompanied by different sounds according to the associated action of the key. There are two typologies of sounds: a melodic one differentiates all the buttons that allow the access to other form, a briefer second sound is related to the event back or home (to return back or to the initial screen).

The TOTEM (Fig.24), endowed with an industrial monitor with active matrix 17" TFT, is shown suitable to the demands of graphic visualization of the contents even if endowed with a HW parts production not expensive (personal computer Intel Celeron 2.8 GHz. HD 80 MB, Memory RAM 512 MB). Besides, thanks to the integrated speakers it will be possible to listen to the filed audio contents, everything to guarantee a maximum involvement by the user (tourist).



Fig.25: Totem working at the National Archaeological Museum of Reggio Calabria

4 Future developments

The project of computerization of the archaeological paper is meeting with a notable interest by town administration and it is not excluded a continuation of the same. In the specific one the future

developments, that interest Geomatic laboratory directly, are concentrated on the relief through laser-scan of the present archaeological sites in the city to complete accurate works of restoration and besides to integrate, for tourist purposes prominently, 3D animations in the SITBA and in the TOTEMS.

Besides, to widen the offer of interactivity to the user tourist, it is hypothesizing the development of a guide on PDA with integrated GPS, creating so a sort of virtual companion. Planned some specific "archaeological" itineraries, the user can be followed step by step thanks to the position obtained in real time from the GPS, and in the points of particular interest the possibility to consult the images of a photo library that facilitate the recognition of observable phenomena can be offered and besides to listen to the spoken comment and to read pages of close examination directly from the PDA equipment

5 Conclusions

As pointed out in the introductory paragraph, there are many applications of sector which concern the field of Geomatic. The challenge, the scientific world must be able to gather above all, is to use the GIS also like a tool able to support the archaeological analyses and not only as geographic storage of the data more or less enriched of multimedia contents. In other terms, it's necessary using the GIS technology, like tool able to put into the system the analyses led on the available data provided by various type sources. The "historical" town of Reggio Calabria continue always to provide the researchers new archaeological finds, the our wish is to be able to support also in this sense the experts of the archaeological sector.

Acknowledgments

We thank the company Kosmos S.a.S. for collaboration in the application software development and for the courtesy of the images. Also, special thanks go to Professor Francesca Martorano, Professor of the Faculty of Architecture of the Mediterranean University of Reggio Calabria (ITALY), scientific director of the project.

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