The Eurialo Project: a Vector GIS for the Integrated Management of the Archeological Data of Pontecagnano (Italy)

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Introduction

The interest of archaeologists in computational applications, especially during the last decade, has given rise to a multidisciplinary horizon, marked by a close relationship between computer science and archaeological research. The contribution of information technologies to archaeological investigation, besides yielding significant scientific results, has also radically renewed the contents and methodological perspectives of archaeology. Computers have an especially prominent role in archaeological research and the management of cultural heritage. Speaking on this phenomenon, F. Djindjian pointed out the connection between the diffusion of computer techniques in archaeology, and the coming to the fore, during the Nineties, of "computers without computer experts", as computers and their programs become increasingly easy to use, no longer requiring the aid of specialized technicians (Djindjian 1996: 1259-1262).

In spite of these encouraging beginnings, which have seen archaeologists become increasingly familiar with computational instruments, it must be said that computers are still not regarded as a fundamental operative resource for archaeological research.

While the Eighties witnessed a search for experimental computational techniques, as an alternative to traditional methodologies of investigation, the Nineties, instead, have inaugurated a new scenario, marked by the coming to the fore and rapid diffusion of market software, providing standards for data recording. This technological phenomenon, a consequence of the growth of a software industry, capable of guaranteeing the development of applications, has favored the setting up of computer-based archaeological projects, notably those based on GIS.

Until a few years ago, the connection between spatial data and alphanumerical attributes was performed, by software tailored by expert programmers to the needs of specific research projects, and hence structured on the base of exclusive, final objectives. This precluded the possibility of using them in another research context. Furthermore, due to their experimental nature, these programs had a serious limitation: it was impossible to export their archives, without considerable additional costs, to more modern and simple operative environments. With time, in spite of the inevitable multiplication of computational applications, an increasing need has been felt to establish common methods for the normalization and formalization of data. An especially innovative role is being assigned to computer techniques, favoring the diffusion and exchange of information, through the definition of standard formats, for the storage of archaeological records (Gottarelli, 1997: 10).

Apart from these considerations, in the present paper we present some synthetic, operative, and methodological guidelines for the development of the data model, applied, in this specific case, to the analysis of funerary contexts - a task, not devoid of difficulties.

The sample

The selected sample belongs to the necropolis of Pontecagnano, a prominent Etruscan-Campanian center, lying about 70 kilometers south of Naples. In more than thirty years of investigation, a substantial archaeological documentation has emerged, comprised of an extensive settlement and a vast necropolis. While the exploration of the ancient town has been limited to part of its center, the necropolis, having been overrun by the urban expansion of the modern town of Pontecagnano, has been investigated more thoroughly. To face this rapid urban expansion, since the Sixties, a systematic excavation of the funerary evidence has been going on. Up to now, over 7,000 burials, datable from the Iron Age (9th century B.C.) to the 4th century B.C., have been brought to light (d'Agostino 1996). This impressive archaeological sample, spanning six centuries, is documented by a wealth of plans, drawings, and photographs.

The need to record, analyze, and visualize this abundant and diverse material was the stimulus for the creation of the Eurialo project, involving the application of a vectorial-type GIS, to the integrated management of funerary archaeological data. Eurialo is based on the development of a cartographic database, containing the spatial and topological information concerning the burials, associated with the description of the individual funerary contexts. The system has been adjusted to the needs of different users: on the one hand, scientists interested in the reconstruction of the social, economic, and cultural organization of the ancient community, and on the other, operators involved in the preservation of our cultural heritage, through the promotion of a careful policy of development, integrating the archaeological patrimony into urban planning.

One of the main objectives of the project was to develop a digitized, archaeological map, indicating the position, with respect to the modern urban layout, of the over 100 cemeteries brought to light, up to now. The adoption of a data model, with distinct logical and graphic layers, reflecting the superimposition of the modern town over the ancient contexts, allowed experimentation of new methods for the control of the territory, based on the up-to-date image of the excavated archaeological evidence, recorded on the cartography, used by our territory-planning institutions (Cattani 1997). We also felt the need to develop a common strategy to attain, through the creation of a common working tool, other aims and objectives as well: scientific research, museum management, urban planning, and general public information.

Methodological preliminary considerations

To coordinate these manifold levels of interest, which, at least in Italy, are not always harmoniously integrated, we chose to employ a GIS, a tool allowing an adequate synthesis of historical, geographical, and environmental historical analyses.

GIS applications comprise of several different functions, including spatial analysis, location analysis, predictive models, and 3D simulation. All these functions depend on the software's ability to reconstruct the relationship, between archaeological finds and the intra- and extra-site, spatial distribution of data. A GIS consists of a representation of information, independent of physical reality. The data system must be able to include all the objects existing in the physical world, adapting them to the combinations, actually occurring in reality.

In the past, GIS programs were employed, especially to highlight the relationship between geomorphologic factors and archaeological settlements, to the purpose of developing predictive models, based on the hypothesis of specific relationships, between environmental variables and the distribution of ancient settlements. In this field, raster techniques were most often employed, and have renewed the traditional methods of photointerpretation, through the application of image processing and pattern recognition software. Less used, are Cultural Resource Management applications, analyzing the interaction between archaeological finds and their impact on a modern, densely inhabited territory. In these cases, the GIS takes on a fundamental role, as an instrument for the recording of cultural patrimony and the creation of archaeological maps (Kvamme 1997: 45).

One of the main differences between these two systems, lies in the way that they formalize data. While in the treatment of raster data, the archaeological information is the final result of a cognitive process, guided by the computer, in vectorial analyses, the archaeological record is already known to the operator, as he sets out to develop the project. Working with a vectorial GIS, it is necessary, at the beginning of the planning phase, to work out a precise definition of an operative procedure, to normalize on distinct levels, the diverse items of information and the final objectives (i.e., the reconstruction of a topographical, historic base, the position of ancient structures on modern maps, and the recording of alphanumerical data, associated to spatial information) (D'Andrea 1997) (Figure: 1).

Moving from these methodological, preliminary considerations, the following work stages were planned:

1) creating one or more databases, to code the information and structure the alphanumerical archive;

2) developing control vocabularies, to facilitate and guide data-entry;

3) converting cadaster maps and the plans of individual cemeteries into vectorial forms, arranged on different layers;

4) adding geographical references to this digital cartography, and attributing a numerical code to the graphic objects, defining the burials;

5) integrating the alphanumerical information and the graphic data, by means of a vectorial GIS;

6) creating a user interface, to simplify the search for and the viewing of data.

(A.D'A.)

Organisation of data

Archives and data-entry system

The first stage of our work was the planning of the archives. This phase required a long period of analysis and an evaluation of the problems, connected to the formalization of the data. Working from the premise that information should be organized, to meet the needs of different types of users, we chose to employ a relational architecture, comprised of three archives, connected by tomb number. The first archive contained general information on the tomb; the second one registered the osteological remains and other organic materials; in the third, every single grave-good was recorded.

Since the organization of our work was based on a vectorial GIS system, to plan our archives we needed a relational, database software, functioning in the Windows environment, and hence, allowing export of the database, and the cartographic information, associated with it. Microsoft ACCESS was an obvious choice, as it is a simple database, integrated with word processing and computational applications, which has become a standard in public administration, both in Italy and abroad.

To simplify data entry, we used a VISUAL BASIC program, to manage hierarchically some of the modules of the three ACCESS databases. This solution, besides allowing the creation of user-friendly screens, also guided the operator through a series of interdependent, alternative choices, selected during the programming phase.

The first stage of data-entry was the recording of general information, concerning each burial (Figure: 2). The main module was divided into three sections: the first contained information on the excavation (topographical location of the burial, inventory number, existing graphic and photographic documentation, available bibliographical information); the following section was devoted to chronology (stratigraphic relations, and the grouping of burials on the basis of spatial, cultural or physical relationships); the last section provided the dimensions and orientation of the tombs (gender and age-group of the deceased, when inferable from grave-goods, as well as tomb typology, roofing, and burial ritual); for these last fields, the control vocabulary varied, according to the selected chronological span.

Through the main module, one could access the other two databases. When bones and grave-goods were absent, entry of the string, "YES", in the field "empty tomb", set off a control routine, introduced in the programming phase, which terminated the recording of the burial. If one or both databases were selected, instead, the system opened the selected modules, automatically entering the tomb number, in the first field.

The second module contained information on osteological remains, including the sex and age of the deceased, in cases in where the bones had been studied by specialists (Figure: 3). Their museum location was also specified, as well as the paper files, where they were recorded, and their bibliography. In the case of the presence of other animal or organic remains, apposite recording fields were provided.

The last module recorded each object found in the burial (Figure: 4). Object description was standardized, by means of a chronologically differentiated vocabulary, accessible from the menu bar, divided according to time spans, corresponding to culturally homogeneous phases. Vocabulary control was limited to object classes and forms, while the specification of typology was left to the operator. The choice of classification criteria required a complex, preliminary systematization of the data. As we did not have at hand, a detailed inventory of all the objects, the information had to be garnered from publications, on the necropolis of Pontecagnano, and the analysis of an extensive sample of cemeteries, to make the vocabularies as adequate as possible, for the task of recording the whole of the funerary evidence. This working phase, although long and delicate, enabled us to homogenize the data, a necessary condition, to guarantee the validity of any successive, thematic investigation. Assigning a more synthetic code, comprised of the acronym of the object class and the typology of the artifact, facilitated the export of data, for statistical, mathematical, or spatial inquiries. The database also indicated the position of the object within the tomb, thus, providing essential elements for a functional analysis of the burial equipment. Finally, the archive provided information, on the location and state of preservation of the artifacts, and was, thus, a valuable instrument for museum management and, in general, for verifying the condition of the objects, and, hence, for the burial equipment of each tomb.

(A.D'A, R.D.N., A.G.)

Base maps and vectorial data

The following phase of the project was the conversion of the cartography to a vectorial format (Figure: 5). This operation was crucial, as it involved the digitalization of abundant cartographic documentation, produced in the course of over thirty years of research. The excavation plans were drawn exclusively on paper, with a reference to the cadaster, to place them on the map. The vectorial transformation of the maps was necessary, to allow correct placing of the finds, and an integral visualization, of existing graphic information at different scales, without compromising the overall readability of the data. Due to the extent of the finds, it was not possible to represent the burials in a single plan on paper; hence, we chose to represent them on extrapolated parts of 1:500 cadaster maps, to provide an overall image of bordering, explored areas.

Thus, we proceeded to computerize, on a 1:5000 scale, the general cadaster map. Successively, we added geographical references to it, and superimposed it onto the photogrammetric map (the cartographic base used in urban planning).

Next, we proceeded to mark the necropolises on the map, first by means of appropriate symbols, and then by reproducing the actual areas of the cemeteries, brought to light (Figure: 6). The last operation has not been completed yet, and has proved especially complex, because it was not possible to use topographical landmarks, to transfer excavation plans onto the digitized map.

After creating the new reference map with AutoCad, we proceeded to attribute a numerical code to each vectorial object, to provide a connection with the databases. More specifically, we marked the polygons, defining the perimeter of each burial, with the tomb number.

MapInfo software

For this specific phase of the work, we preferred to use a market software, instead of developing a custom application. Our choice was MapInfo, a vectorial GIS, widely used for the management of infrastructural networks (MapInfo 1995).

Ian Johnson recently pointed out that this software may represent the future of GIS applications in archaeology. Although it is classifiable among desktop mapping programs, rather than actual GIS programs (as it cannot process spatial information to obtain new data), it offers the possibility to combine relational databases with maps, and has the advantage of being user-friendly. Thus, it allows even non-specialists to process and manage data, in every conceivable way (Johnson 1996). This software integrated in a transparent fashion, both the alphanumerical data on the necropolis of Pontecagnano, recorded in ACCESS, and the graphic objects, elaborated with AutoCad, creating tables, which geo-codified database records, on the basis of the tomb number, assigned to the vectorial polygons. Through a simple procedure, it was possible to create new archives, combining database information with the maps. Any database query could be visualized in a new table or a new map, highlighting the chosen theme. The data could then be processed or exported, for more in-depth, statistical analyses.

(A.D'A, R.D.N., A.G.)

The Prototype

Since we did not yet have at our disposal, at that stage, a complete database of the existing alphanumerical and graphic data, we tested our system on a sample of about 400 tombs, discovered at the western border of the western necropolis (Figure: 7). This sample comprisd over 10 distinct cemeteries, reflecting different historical phases, and hence, featuring an ample funerary variability. The selected area was reproduced in the digitized map, using different layers for the excavation limits, of the investigated areas, and for the ensemble of the sepulchral pits. Successively, we geo-coded the archives, according to a one-to-many relationship, enabling queries based on the SQL language. Specific thematic searches resulted in the creation of a new data table, and a map, visualizing the requested information.

(A.D'A, R.D.N.)

The future of the project

The final phase of the work, still incomplete, was the construction of a user-friendly interface to simplify data retrieval, by providing Boolean selection fields and parameters. The programming routines, we are in the process of developing, are meant to answer the queries of different potential users, and allow various uses of the recorded data. The future development of the project will probably involve the creation of a CD-ROM, containing the graphic and alphanumeric information, stocked in the archives. This medium could be easily distributed, with a short accompanying text, allowing the scientific community to check the accuracy of the data and the validity of the recording procedures (Guimier-Sorbet 1996: 992-993).

In conclusion, it must be said that the ambition of this project is not to open new frontiers, in the management of archaeological resources. On the contrary, it attempts to lay down operational guidelines, on the basis of the premise, that only a multidisciplinary initiative, leading to the definition of common operative standards, can guarantee the integration of data and the exchange of information, between field archaeologists and potential users of the information.

We hope that the further development of our system will allow more effective, territorial management, on the basis of the archaeological map. Such maps are one of our most important and precious instruments for the preservation and management of our cultural heritage.

(A.D'A.)

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Figure 3. Data-Entry: the second module for osteological remains.

Figure 4. Data-Entry: the third module for each object found in the burial. Description is standardized by means of a chronologically differentiated vocabulary, accessible from the menu bar. Vocabulary control is limited to object classes and forms.

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Figure 6. The ancient settlement and the cemeteries of Pontecagnano, superimposed on the cadaster map. The black points mark the areas of cemeteries, brought to light.

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