GIS and Archaeology: the "Caere" survey

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The "Caere Project"

In 1996, the Italian National Research Council (C.N.R.) promoted, through its National Committee on Science and Technologies applied to Cultural Heritage, the "Beni Culturali" Project, to last a period of five years. Its aim was the safeguard, improvement, and fruition of our national, cultural patrimony, through knowledge, recording, restoration, and conservation (cf. http://www.culturalheritage.cnr.it).

Within this initiative, the Istituto per l'archeologia etrusco-italica (http://soi.cnr.it/~iaei), at that time, directed by Prof. Mauro Cristofani, recently and prematurely deceased, proposed a research project, subsequently approved by the C.N.R. The title of the project was "Establishment of an Archaeological Information System model and its application to ancient Cerveteri" (refered too as "The Caere Project"). Its purpose was to use an archaeological information system, in the study of the ancient Etruscan town, and territory, of Caere, where our Institute had been carrying out surveys and excavations, since 1982, together with the Superintendency of Southern Etruria. Results of these excavations have, in part, already been published (Cristofani *et al.* 1992, 1993), while others are now in the process of publication.

Through an international census of research projects, carried out in this sector of studies, the initial aim of our project was the definition of some methodological and technical problems: 1) data representation and encoding; 2) data structuring and formalisation of procedures; 3) use of descriptive standards; 4) alphanumerical, graphical, and cartographic data analysis, and image processing; 5) application of inter- and intra-site Spatial Analysis; 6) definition and testing of new software; 7) application of our model to Caeretan data; 8) establishment of a parallel, multimedial product, for data diffusion and conservation.

The first step of our project was, therefore, the creation and circulation, on-line, of a questionnaire, whose aim was the preliminary gathering of general information, concerning the research projects, carried out in this sector of studies, relative to the application of GIS in Archaeology, with particular reference to their use in excavations. Our goal was not so much to obtain an exhaustive census of all the projects (difficult to achieve, in any event), but rather, to get as complete a panorama, as possible of the activities carried out in this sector of studies. Above all, we wanted to stress several technical and methodological issues, common to many projects, and to note, where existing, particular trends, within the various countries, that had responded to our initiative.

For this reason, an international Scientific Committee was selected. Its members are among the most distinguished scholars, in this field of studies. They were given the specific task of co-ordinating our initiative, within smaller geographical areas, and of helping us to publish a survey, as complete as possible on GIS and Archaeology. The Committee was co-ordinated by François Djindjian, and its members are Daniel Arroyo-Bishop, Juan A. Barceló, Ian Johnson, Kenneth L. Kvamme, Gary Lock, Torsten Madsen, Tito Orlandi, Zoran Stancic, Albertus Voorips and myself.

Each member of the Committee examined the collected results, and integrated them, on the basis of his own knowledge, with the addition of projects, that were not provided for in the census, and, in any case, quoting the relevant bibliography. Each member then sent us a text, prefacing the list of projects, stressing particular topics, also from a methodological point of view, and above all, synthesising the present situation and future perspectives. All collected information is now published in the ninth issue of the journal, "Archeologia e Calcolatori" (Moscati 1998a), edited by our Institute, since 1990 (http://cisadu2.let.uniroma1.it/iaei).

Before examining the results, obtained through our survey, I would like to note that the questionnaire, simple enough in appearance, was compiled, not so much with a view to scrutinising the description of each project, but rather, to proposing synthetically some precise questions, regarding different issues. Some of these issues were intrinsic to the project (the title, the promoting institution, and the length), but they were also of spatial character (the geographic area under study, and the excavation area), technical character (the hardware and software used), or methodological character (the use of descriptive standards, or rather, the application of Spatial Analysis techniques). Last, they regarded data diffusion, for example, the presence of information on the Internet. A complete reply, to all these questions, obviously presumed research, not in a mere planning phase. This allowed us to limit the panorama of our census, only to those projects already in the course of realisation.

Results of "GIS and Archaeology" survey

Concerning the analysis of results achieved, several general considerations, common to the various geographic areas examined, could be gleaned. One of the emerging issues was that in every country there was a distinction, between projects carried out by institutions, dealing with an administration, and the safeguarding of national, cultural patrimony, generally listed under CRM (Cultural Resource Management), and those carried out by academic and research institutes - Universities, Academies, or other specific centres. Unfortunately, there was often a lack of communication and co-ordination, between the two sectors, which surely could be productive, from a methodological point of view, and which would, in any event, limit, in many cases, double-spending. In fact, co-ordination, between these two sectors, should be interpreted, not as a reciprocal

limitation of imposition of places, times, and methods, by which to carry out projects, but rather, as a mutual saving of energy, and as a possibility to use, each with his own specific goals, specialistically differentiated data, in order to preserve archaeological records, for the sake of knowledge and conservation.

If one examines the projects, that come under CRM, in which computer application assumes a mostly documentary character (for the most part, these deal with the inventory of "objects"), connected to archaeological maps, they are geo-referenced, and thus, assume a precise spatial connotation. Only rarely do they offer, starting with archaeological cartography, the provision for danger factors, that should instead, constitute one of the principal aims. In the research sector, on the other hand, several projects are dedicated to the study of landscape and regional population, as well as to that ancient towns and of their surrounding territory. However, there is a rather limited use of GIS, in the field of archaeological excavations.

As far as the technical aspect is concerned, the hardware tools used are, in a third of the cases, Unix stations, and for the rest, PCs (the use of Apple Macintosh seems to be limited to the French, or to specific academic projects). These choices respect current market tendencies, with the growing use of increasingly powerful PC work stations. As far as software packages are concerned, there is a wide panorama of solutions, and this underlines the primary necessity, within an archaeological information system, to confront the problems connected with integration. Work stations generally are comprised of a GIS, to which a database and CAD (Computer Aided Design) or CAM (Computer Aided Mapping) software, are connected.

The choice of software packages appears to be strictly linked, to the distinction of the two above mentioned sectors. CRM projects are usually lengthier projects, with permanent personnel, and sound financial budgets. In these cases the most used solutions are ArcInfo, for GIS, and Oracle, as a database, running on a Unix work station. The projects, carried out in the framework of research institutions, are usually of a shorter duration, in strict connection with the available budget, and are managed by a single researcher, or a very restricted group of them. In these projects, generally run on PCs, the most used systems are ArcView, for GIS, or other university software, available to the public (and, therefore, not too expensive), and as a database, Access, which is rapidly substituting the preceding products, such as D-Base, Filemaker, etc. Finally, for CAD products, AutoCAD seems to be the most popular.

In addition to a general outline of the ongoing projects, and a specific survey of the situation in different countries, our initiative constituted the starting point, for the investigation of specific topics. Before proceeding, I think it convenient to dwell upon the important problem of a general definition of GIS, a term that is today, over-used; in fact, it describes a number of demands, computer technologies and applications, that share the necessity to record, process, and retrieve different types of graphic "objects". According to the definition by F. Djindjian, GIS are, in the strict sense, software that can process the overlay of thematic maps of "objects", in the widest sense of this term, originating from different sources, and recorded in different files (Djindjian 1998). For a correct and useful application, a sound knowledge of their basic methodology is fundamental: if GIS are used exclusively for simple mapmaking tasks, in order to produce a set of superimposed graphic maps, they are not being utilised to their full capabilities. The results produced in the form of thematic maps, must become a tool for improvement of research, and not only for reproduction.

A deeper investigation of the central problems, relative to archaeological cartography, a theme particularly dear to the Roman school of Ancient Topography, is therefore essential. In this school, the principle of the need for operative, computerised cartography, seen as a basic instrument for a policy of on-site intervention, safeguarding, and improvement, as well as knowledge, prevails (Sommella, Azzena, Tascio 1990; cf. also http://web.tin.it/tabularium). The establishment of an archaeological information system, therefore, becomes an instrument of communication, other than of data processing, in which the initial plan of research, and the explanation of the aims pursued, become a priority. A vision of this type necessarily implies that archaeologists must know how to use the instruments at their disposal; technical staff may be employed for routine work, budget permitting, but for the analytical part, the archaeologist, himself, must intervene. Thus, there is also the necessity for specific education and training of new students.

Let us go back to the replies to our questionnaire, in which two aspects were poorly represented: one was the use of descriptive standards, for the registration of information, while the second was the use of Spatial Analysis techniques. Interest in the use of standards, for the normalisation of recording and data description procedures, is mostly felt in those projects, that operate at a central administrative level, that is, strictly connected to activities delegated to central and local offices, under the direction of the Ministry of Cultural Heritage. In the projects carried out by research institutions, however, scholars are more likely to create their own criteria of standardisation, related to the goal of the research itself.

This is due to the set up, followed in the inventory of the national cultural heritage, which has given rise, in general, to criteria aimed at knowledge, in the sense of documentation of cultural patrimony, rather than to its diagnostic analysis, a fundamental step for the improvement of heritage. As far as the methodologies used for the definition of centralised standards are concerned, there have often been objections to their too general set-up, which has penalised several study tendencies, such as, for example, the typological and chronological analysis of single classes of artifacts, or the topographical analysis of ancient landscapes and sites. In fact, when facing the necessity to index the entire national patrimony, the greatest efforts are directed towards a system, which will safeguard the correlations, existing between objects of a different nature, relative to a single cultural context, rather than towards the characterisation of specific artifacts or monuments, and the demands of each branch of archaeological research.

On the other hand, as far as the use of Spatial Analysis techniques are concerned, both inter- and intra-site, they are still considered the necessary completion of research using GIS, as the spatial element constitutes the very innovation, produced by these tools. Notwithstanding this, there are, in general, few projects that reach this phase of experimentation and that, in any case, show the necessity to investigate topics, connected both to the modelling of settlement distribution

within a territory, or of archaeological records within a settlement, and to the simulation of settlement processes. This last step is fundamental to the aims of heritage safeguarding, and planning purposes as well, through the identification of variables, that characterise the choice of place, and the distributive parameters of features, in correlation, also, with the factor of time.

An Archaeological Information System for Caeretan excavations.

We now come to the characteristics of the "Caere Project", itself (Moscati 1998b). From an archaeological point of view, our survey allowed us to identify those sectors, whose automatisation has brought real benefits to research aims, and to verify the extent of common problems in each project, also related to the choice of specific geographical areas and cultural environments.As we intended to show, the computer system model foresees the computerisation of different archaeological issues: from survey to excavations, laboratory analyses, documentary research, information diffusion, and safeguarding of archaeological heritage. Subsequent operating stages are, therefore, aimed at developing the following points: integration of different systems, normalisation of descriptive language, and standardisation of technical and methodological tools.

It was the enquiry, itself, that suggested our procedure, along certain successive, well-defined phases. First of all, to achieve rapid results, it was decided to limit our research initially, to the plateau of the ancient town of Cerveteri, and to consider the problems regarding the surrounding territory, only in a second phase. With this in mind, an *ad hoc*, low altitude flight, over the area of the ancient settlement, and the necropoli, on the overlooking hills was planned. The successive phase envisaged the aerophotogrammetric restitution of data, in a digital format, on the scale of 1:1000. This restitution was carried out by specialised archaeologists, who were able to point out details, often underrated by technicians, but which were of particular relevance, in topographic research. They were also able to include marks from preceding air photographs, information from bibliography and archive documents, as well as results from geophysical prospecting already carried out in the area under study.

The two areas under excavation, led by our Institute in co-operation with the Superintendency of Southern Etruria, were positioned, based on this cartographic basis. These excavations have led to the discovery of the remains of temples and structures, of the ancient urban area (Cristofani 1996). This allowed us to test the potentiality of GIS, in the field of archaeological excavations, a sector that, as we said, is today poorly represented.

With regard to the alphanumerical database, we followed two distinct procedures. In the excavation at St. Antonio, a relational database using Access, was set up. The central nucleus comprised of Stratigraphic Units, recorded, according to the rules of the Istituto Centrale per il Catalogo e la Documentazione. There were also numerous correlated tables, regarding the recording of excavation areas, the objects organised in typological classes, and the artifacts, as well as the archives, containing graphic and photographic documentation.

However, in the excavation at Vigna Parrochiale, we propose a different innovative procedure. The yearly excavation diaries are now being recorded in hypertext form, using the SGML encoding system. The aim is to visualise the text, in an easily transferable HTML format, illustrated with photographic and graphic information, which will be immediately available on the Internet. This kind of text will permit us to test new forms of queries and information retrieval, that will enable us to diachronically examine the successive stages of our excavation, and to organise the documentation relative to different areas, until we finally reach the essential association and the subsequent study of the artefacts. In the future, this type of procedure may become a model, for the retrieval of information from excavation diaries, dating, for example, from the end of the last century, or from the beginning of this one: a period of deep investigation, both for Caere, and for the Etruscan area, in general.

Finally, the archaeological information system model, which will constitute the scientific product of our three year research, will have a double aim: it will be used as a research tool, but it will also be supported by a multimedial version, for a wider public. The purpose is to favour widespread information, and at the same time, to safeguard the Caeretan, archaeological patrimony.

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