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LANGUAGES, COMMUNICATION, INFORMATION TECHNOLOGY: AN INTRODUCTION

Since the publication of *Archeologia e Calcolatori* began fifteen years ago, the tradition has been followed to devote at least one issue every five years to a specific theme of current interest in the field of computer archaeology. The idea for this special issue comes from the observation that the problem of language, together with that of descriptive standards – which have characterised the pioneering work of scholars who approached the computer recording and classification of archaeological data – has significantly come back into discussion in light of today's consolidated diffusion of multimedia communication. The web has therefore become a transmission tool, which makes use of today's international standards, solving old problems in innovative ways.

As in the past special issues, the purpose was that of furthering debate and highlighting some of the theoretical aspects of archaeological computing, on the basis of current research projects, bringing together scientists involved in the application of computer methods to archaeology, from the phases of data acquisition and representation to their processing, interpretation and diffusion. In fact, the changes due to Information Technology have given rise to a series of new concerns to which the authors of this publication have offered various answers. Therefore, the division of the volume into six different sections, each evincing a convergence of intent and originality of applications, took place as a natural consequence.

The decision to begin this special issue with articles concerning archaeological publications may seem peculiar, as it reverses the usual research procedure: data acquisition, encoding, structuring, processing and, finally, the dissemination of information. However, this section is not so much dedicated to data diffusion as to the representation of archaeological knowledge by means of the necessary integration of theoretical and experimental aspects, in the light of the development of new transmission tools, and above all, of the complex and much discussed relationship between theoretical archaeology and archaeological computing.

Some of the subjects listed in the articles introduce major features to be discussed later on in the book: *a*) the interaction between theoretical thinking and computer applications; *b*) the nature of language and its relationship with computerisation of archaeological data; *c*) the potential use of the web and its crucial role in a new type of communication based on the principle of shared knowledge; *d*) the transition to an electronic support which forces the writer to reorganise the original texts and change his writing systems; *e*)

the recognition of archaeology in the social world, thanks to its increased visibility.

The section begins with the article by J.-C. Gardin and V. Roux, which proposes an "up-to-date" version of the logistic programme founded by the French scholar at the end of the 1970s and intended to formalise the mechanisms of archaeological reasoning as well as to explore new forms of publication aimed at "reducing" written texts, separating the narrative and cognitive parts of historical discourse. In fact, the novelty of the Arkeotek (Archaeology of Techniques) project consists in the association of these two different aspects and in the publications promoted in the "Référentiels" collection, in which the new editorial formula saw the combined use of the traditional printed text along with the CD-Rom. The CD – which is the core of the publication and intended for researchers alone – does not contain a reproduction of the printed text on an electronic support (something which is very frequent nowadays but of no particular benefit), but rather a "rewriting" of the text in a logistic key which describes the various phases of the cognitive process, built on the interpretation of archaeological data.

The article by T. Orlandi deals with the troublesome relationship between theoretical archaeology and computer archaeology and is based on the idea of applying the Gardin method, but even more than this, the cyclical dynamics of its methodology, in which compilation and explanation come in succession and complement each other. The essence of the question, in fact, is identified in the language used, which varies from a practical (descriptive language) to a theoretical activity (interpretative language). Natural language, in any case, must be replaced by a computer language, through a process of formalisation and with computer procedures. This makes it possible to express the various passages of archaeological reasoning, from the description of the initial data to the interpretation of the pertinent culture. Orlandi himself argues that humanities computing is a pure operative manifestation of a method, better to say, of a language.

F. Djindjian intervenes in his usual pragmatic way, pointing out that the total lack of progress in the formalisation of archaeological publications in the last 150 years is due to two main reasons. First of all, there is no computer device able to transform natural language into a formalised scientific language for which we can validate the internal logic; furthermore, no archaeological discourse in a computer language would ever be successful in the archaeological community. Djindjian's proposal consequently goes step by step considering a series of closely interrelated subjects: the re-examination of the tripartite model of logical reasoning based on the successive phases of (A) Acquisition, (S) Structuring, and (R) Reconstruction (or Modelling); the exploitation of the fractal nature of archaeological objects in order to submit them to a series of levels of systemic breakdown; the axiomatic definition of the cognitive process

with its main stages and elements. Djindjian then starts to rewrite one of his own articles, in which a series of cognitive "instructions" to be submitted for computer analysis are associated and aligned with the corresponding terms in natural academic language. The final proposal is the joint edition of a traditional printed book and a CD-Rom, containing different versions of the same text, as well as other tools and appendices which hardcopy can no longer receive due to both its cost and the type of support.

The report by E. Zanini is actually based on several experiences in "writing" multimedia products, one of which was promoted by the Istituto della Enciclopedia Italiana. It offers a new perspective, which is also emphasised in J. Huggett's subsequent article: the relationship between archaeology and information society, and especially the high social profile of archaeological research. The questions that Zanini asks in this crucial stage, which redefines the traditional relationship between author and reader, and between writing and reading, concern the "how", the "what" and the "why" of communication. The answers are not just the usual investigations on this subject – typical of reflections on multimedia archaeological publication – but they are also associated with the broader debate concerning the need to rethink the theoretical and methodological approach to field research; the innovative means of data diffusion offer new possibilities for "illustrating" the past, which should be taken into consideration approaching the very earliest phases of research, from data acquisition to the documentation strategy.

The first section ends with the article by J. Huggett, which focuses on the changes, in particular the sociological ones, which have been brought about in archaeology by computer technology in the last thirty years (even a decade more, we would be inclined to add) and had, and will continue to have, effects on archaeological research, a field permeated by an ambivalent attitude hovering between the desire for innovation and the reluctance to accept its consequences. Technology, on the one hand, appears to archaeologists as "magical", but on the other hand it finds none of them psychologically prepared for the level of integration it requires. This way of looking at the problem perhaps reflects more closely those environments, in which the technological contribution is considered predominant and computer science, which is often the source of financial resources, is confined to the role of a tool, albeit one with wonderful solutions. The contributions to this Journal, and, for that matter, other articles by the same author demonstrate, however, the existence of quite a different situation. In fact, they have always offered, on the basis of serious scientific results, a clear vision of the effects which have already occurred and those made possible by experiencing computer methodologies in archaeology.

The second part of the volume is of great relevance for discussion, since it offers a detailed picture of the evolution of computer languages and

of their possible applications within archaeology. By referring to significant experiments at a national level, this issue is opened also to standards, and their worth even outside national borders, terminological thesauri and, finally, to the dissemination of metadata, which facilitate the search, exchange and transmission of information on the web. While in the preceding section the articles dealt with languages used to formally represent the logical passages of archaeological reasoning, this section focuses on the languages to be employed for the documentation, interaction, exchange, and exploitation of different sources of archaeological data. These can be summarised in three categories: descriptive, geographical and multimedia data.

In this regard, C. Barchesi and L. Ceccarelli consider the main markup languages, as recognised and approved by the W3C (World Wide Web Consortium). The discussion is directed towards the influence of multimedia communication on the new ways of representing and preserving archaeological data, since they have found, as never before, a common operative platform with literary, linguistic, philological, and historical studies. For this reason the term "metalanguage" has been discussed, as a generator of new languages which describe the structure and define the visualisation of data. In this direction, XML has assumed a role of primary importance. In the humanities, markup languages also act as a vehicle for transforming documents into a source of structured, integrated information, independently of computer platform and proprietary software, and to be used by more than one type of application.

The range of discussion becomes broader when moving from languages to heritage management systems for the computer documentation of archaeological data. Three case-studies at a national level are presented in the volume and refer to Italy (M.L. Mancinelli, Istituto Centrale per il Catalogo e la Documentazione), the United Kingdom (W. Kilbride, Archaeological Data Service) and Spain (L. Garcia Sanjuán and V. Muñoz Crux, Universidad de Sevilla and Centro de Documentación dell'Instituto Andaluz del Patrimonio Histórico). In these articles, the authors immediately make clear their desire to go beyond the simple level of computer cataloguing and data management, by performing specific functions and implementing special tools. The aim is to use the web as an environment for consultation of data and sharing of knowledge, in order to facilitate both the work of the institutions charged with monitoring, protecting and recording archaeological heritage, and the use by a wider public. Among the different categories of data, multimedia information also appears, as a sign of changing times and of a type of communication which tends continually to make more use of sight and sound.

Standards employed in these institutional projects are focusing on the documentation not only of sites and monuments, but also of their relationships with the relevant context. This is effected by issuing a series of guide-

lines for data acquisition and structuring. Furthermore, the interchange of information, although still operating mainly at a national level, is increasingly directed towards a European and even wider audience. At this point however one becomes aware of a deep contrast between advanced technology which makes it possible to reach interoperability with a certain ease, and internal organisation of the individual countries which, for legal, financial, linguistic as well as social and cultural reasons, is unlikely to go beyond national boundaries. For this reason, throughout Europe, one continually finds the term "harmonisation" in practice and policy in all the project proposals and formal declarations related to the digitisation of cultural heritage. The discussion on exchange protocols and metadata standards is therefore particularly intense and XML is by now defined as a transport and storage format.

Moreover, the problem of specialised terminology, which has been a part of all the evolutionary phases of computer archaeology in the search for a homogeneous method of description, acquires new aspects. They broaden the perspectives towards a description of the objects which is not only intrinsic, in that it is also based on the temporal and spatial characteristics (attention should be called to the distinction made more than two decades ago by A.-M. Guimier-Sorbets between the intrinsic and extrinsic descriptive characteristics of the archaeological objects). In particular, it is believed that thesauri can evolve towards "epistemographic" languages, in consideration of the fact that they are flexible logical-semantic documentation tools and very efficient for indexing, querying and retrieving purposes.

In the case of the classification of portable objects and of the compilation of terminological lists for their description, a new interdisciplinary approach, which does not disdain making use of social anthropology and ethnographic studies, now gives priority to functional as opposed to formal aspects. In this regard, it is interesting to note the considerable agreement in the opinions of L. Garcia Sanjuán and G. Semeraro, who associates this change with the evolution of archaeological research and the tendency, inherent in the theoretical premises of the contextual method, to direct one's attention to particular rather than general situations and to favour the functional aspects in the analysis of the artefacts. Bearing in mind the specific needs for the implementation of an archaeological information system for the excavations, Semeraro suggests a controlled vocabulary for ancient pottery, in which the functional level corresponds to the traditional notion of shape, while the concept of type is left with the task of expressing the morphological and stylistic variations.

This section of the book ends with the rather disenchanted article by G. Azzena, which was not easy to place among the various sections of the publication because it is transversal to many of them. The author in fact

touches upon many different subjects, all of them of current interest, some inspired by the content of the European Landscape Convention, and others referring to the common tendency to maintain that a "modernisation" of archaeological cartography is necessary. On the basis of these considerations, Azzena offers his thoughts on standardisation, precision of terminology, and above all on the missed opportunity to reach a systematic methodology, by making, even before the latest developments in Information Technology, a sharp distinction between the language of investigation and the language of transmission. He is, consequently, not speaking so much of communication as of symptoms of incommunicability, to which only interdisciplinarity and integration, together with the ductility of computer technologies which allow us to achieve them, can offer possible solutions.

The third section of the volume includes a series of case-studies which have demonstrated how data encoding and formalisation, in particular during the acquisition stage, constitute an important phase, even in relation to the outcome of the subsequent mathematical analyses or computer elaboration. The need to adopt new solutions already experienced in other more or less closely related disciplines is very apparent also in this section. S. Camiz, who considers the encoding of the information as an interface between the reality observed by researchers and the tools developed by data analysis specialists, gives a systematic synthesis of the problem. Subjects such as variability, redundancy, missing information, uncertainty, which a discipline like archaeology often has to deal with, are the starting point for a description of the new methodological tendencies of the statistical approach. They are aimed at replacing the traditional encoding dichotomy (presence/absence) with the search for more subtle solutions, like those proposed by fuzzy logic, with its degrees of belonging. These are not the only novelties, however, and the author also gives numerous examples of applications. In particular the textual data analysis – recently applied to archaeology for the analysis of iconographic and stylistic aspects – which instead of being based on the constrictions of a numerical encoding makes use of a textual formal description, already experimented in linguistic studies and in the social, psychological and political sciences. Moreover, by using the landmarks technique, shape analysis can be of assistance in the automatic recognition of shapes.

The article by A. D'Andrea originates from the need to employ models and procedures for data representation which are not neutral but more flexible, namely those offered by the fuzzy approach and the Bayesian method which make it possible to insert human experience – namely that of the archaeologist – into data description and analysis. It is necessary, however, that some traces of this intervention remain and that the procedures used be clearly indicated; in fact the acquired information influences the final results, in a progressive succession which from data description proceeds to the process

of formalisation, and finally to the formulation of archaeological theories. This acceptance of new approaches is part of a vision which sees the need to broaden the research methodologies towards other types of knowledge and other forms of information representation. This seems the only solution, if we wish to avoid that spontaneous evolution of systems from order into disorder, which is part of the laws of entropy.

The articles which follow give a detailed account of some case-studies of computer analysis in diversified sectors: from the statistical analysis of human dental morphological traits in a Prehistoric community in Spain, to the study of problems related to textual, epigraphic and numismatic documents. In the first case, J.A. Esquivel, I. Al Oumaoui and S. Jiménez-Brobeil demonstrate how the traditional statistical approach, based on the choice and encoding of qualitative variables and on the application of multivariate data analysis, has turned out to be a useful method for obtaining morphological indications, especially to draw more general conclusions about the condition of the teeth, the food eaten and the methods used for its preparation, and for identifying differences between members of Agaric and non-Agaric cultures.

S. Marchesini applies chronological seriation, a procedure scholars of Prehistory are well acquainted with, for the investigation and periodisation of Messapic inscriptions. The analysis of the statistical sample, from which spurious and uncertain specimens have been carefully removed, is based on the typology of each individual letter, considered in its diachronic development. For example, elements that are relevant to the identification of a standard writing model are, besides the type of writing surface, the roundness or the angularity of a particular part of the letter; on the contrary the variations in the angle of an intersecting line have not been considered functionally relevant for the identification of a type. The results offer an overall reading of the corpus of data, and enable the author to make a more detailed analysis of the historical factors which bring about the evolution of an alphabet, involving the development of shapes, with the appearance of new graphemes and the disappearance of others.

A joint team from the Universities of Pisa and of Calabria and the Istituto di Linguistica Computazionale of the National Research Council, composed of E. Bresciani, A. Menchetti, A. Bozzi e G. Fedele, presents their own system of computer philology, which has been formulated for the purpose of creating a digital library of demotic texts. The sample analysed consists of the ostraka from the Fayum region going back to the II-III century A.D. A neural network was used to automatically recognise and classify the characters in the texts by means of a neural component which is able to "learn" the graphical features of each demotic symbol taken from a sample of symbols which are significant from a stylistic point of view. Since this procedure is very long and

complex, it is important that the electronic data recording respect international standards to make it compatible with other databases, and not just suitable for use by those who are promoting it. These standards must operate both for the cataloguing system (metadata compatibility) and for the data encoding (texts and images acquisition).

Section three ends with the article by P. Serafin on the project for the cataloguing of the coin jewellery in the Castellani Collection of the Etruscan Museum of Villa Giulia in Rome. The project involves an application which is, in itself, composite, and, through the use of a relational database, requires the integration of different kinds of data to be placed in relation to each other as well as to other inherent documents (images and archival information). In an analysis and synthesis continuum, the use of the computer gives rise to increasingly specific and ambitious queries, whose answers shed new light on the individual objects, as well as on coin collecting and antique dealing in Rome in the XVI century. According to Serafin, the meaning and the value of the man/machine interaction is to be found in the difficult balance between a possible, or meaningful, question and the level of the answer.

Most of the articles in the fourth section are devoted to a type of application which has aroused particular interest and has been received with considerable favour by archaeologists since the 1990s: the GIS. The reason for this section is neither the technology, nor the evaluation – which has already been debated at great length – of the originality of these systems, considered by some scholars to be containers of pre-existing technology, and by others an innovative study method. On the contrary, interest has been directed to a particular unifying element which has emerged: the important role of the spatial datum. It becomes an integral part of research, an indicator of choices for settlement and of their relations, a source of a visual language and of an integrated knowledge of the territory and of the excavation, which become meaningful within their geographic context. Some of the yet unsolved problems are related to the diverse procedures for the formal representation and transmission of spatial data.

For this reason, the section begins with the article by C. Orton, who founded Spatial Archaeology in the 1970s; he describes the historic stages of point pattern analysis and its latest developments due to the links with other disciplines like ecology. In fact, from an ecological software package come some programs useful, even from an educational point of view, for the introduction of Spatial Analysis at a post-graduate level, by an interactive approach based on a hypothesis testing paradigm. The application of the analysis concerns the Danish Mesolithic site of Barmose I and has been conducted on point pattern data, i.e. on the basis of information which favours the point location of artefacts (tools and ecofacts), the distribution of which has been important to find out if the same space has been used for different functions or different types have been associated in the same function.

The articles by M. Cattani and A. Fiorini and that by M. Valenti and A. Nardini both refer to the influence of GIS on excavation methodology. The first article deals with the debate on the relationship between archaeology – more specifically, the stratigraphic method – and topology. The main purposes are the qualitative definition of space, the analysis of the spatial relationships among objects or systems of objects, the different methods of formal representation of these relationships, through deductive-graphic schemes and logical-spatial hierarchies. Experimentation of topology within the excavation GIS of an architectural complex of the IV-III millennium B.C. in the Sultanate of Oman has suggested new methods for the logical description of spatial relationships, the results of which will certainly be employed in the new generation of "geoscientific" information systems. The Sienese team, which has been involved for many years in the digitisation of archaeological information from the Medieval era, concentrates their attention on "data models". These are architectures including several archives, which can converse in a common language from an archaeological point of view: a kind of digital atlas in which data can be stored and searched. In this approach to the problem, technology is nothing but a stage in the evolution of the methodologies of documentation. Technology must now be directed towards a process of integration into a global system of data presentation and to the "socialisation" of knowledge.

A practical example of the creation of a digital atlas is the one promoted by the Seconda Università of Naples (L. Petacco and L. Sasso d'Elia) for the computer analysis of the archaeological and artistic heritage of the Caserta Province and for the contextualisation of the works of art coming from this area and now in foreign museums and collections. In this case the territory is seen as a kind of substratum of anthropic activities, and the sole element of continuity between the past and the present; consequently, it is a multiform container of the information which has become stratified in time and space and which only a relational logical scheme, within a GIS platform, could adequately represent.

Other applications presented here concern various environments and chronological periods: Magna Grecia and Sicily with the towns of Entella, Segesta and Kaulonia (M.C. Parra, A. Arnese, M. Gargini), the Italic environment of central Italy with the towns of Nepi and Gabii (U. Rajala), and finally the city-state of Segeda in Spain, an important Celtiberian settlement that defeated the Romans in 153 B.C. (F. Burillo Mozota, S. Escolano Utrilla, E. Ruíz Budría). Multiple issues are dealt with: the knowledge of the territory – the chora – with its multiple historical and cultural facets and its importance in modern landscape planning; the distinction between "place" and "space" in relation to visibility analysis, the way past communities perceived their environment, and the natural boundary which was created in the landscape by visible/non-visible duality; the analysis of landscape and its relation-

ship to the city, even from an administrative point of view, as a result of the interaction between individuals, society and nature. As the Spanish example fully demonstrates, this requires the insertion into the analysis of some variables borrowed from disciplines such as geography, psychology of space, landscape ecology or spatial economy.

Along with the GIS, Virtual Reality has been another major issue which since the 1990s has taken a pre-eminent position among computer applications to archaeology. Two articles dedicated to this subject, one by M. Forte and the other by M.A. Anderson, are included in the fifth section whose principal theme is visual communication. In particular, M. Forte analyses the revolution brought about by the definitive migration of Virtual Reality to Personal Computers. This has implied an increase in the number of users and developers; the effects on cultural transmission as well as on the rules of learning include the full immersion of the user inside networks of information and visual data. According to the author, the elaboration of information modifies the character, the interpretation and the value of cultural heritage; its translation into a digital information object is a process aimed at augmenting its reality in that it recapitalises the object itself by disseminating and diffusing its message and its content. Virtual Reality, therefore, should not only be admired for its technological solutions; it should also be analysed for its epistemological value and its communication aspects which, once again, imply the integration of different types of knowledge from disciplines like neuroscience, cognitive psychology, philosophy, and epistemology.

M.A. Anderson, in turn, uses as an example two projects applying Virtual Reality to the city of Pompeii, a favourite site for experiments in virtual visits. To examine the potential offered by the Internet for the dissemination of spatio-visual information, one should rely on the development of new standards and new paradigms in order to keep up with the changes that are occurring. On the basis of his own experience, the author discusses the advantages and limitations offered by this new interactive, multi-user form of presenting and consulting information.

The volume concludes with the theme of web publication, which is in several ways related to some of the subjects discussed in the first section. The perspective which unifies the various articles is in this case primarily directed to the potential of the web for the dissemination and sharing of information. In fact, the article by J.A. Barceló, I. Bogdanović and R. Piqué on tele-archaeology relates to technological renovation, which accelerates knowledge sharing and circulation. Considering the contribution of Information Technology as a way of producing archaeological knowledge, technology becomes the medium for a cognitive process based on formal knowledge. Among the possibilities offered by technological development, the authors propose the exploitation of telescience solutions in order to create a new kind of interac-

tive "face to face" consultation to bring the knowledge when and where it is needed in a Collaborative Virtual Environment. Although the prospects are certainly state-of-the-art, as demonstrated by the presentation of the DIAspora project (Distributive Interactive Archaeology-synchronised platforms of research activities), the methods required for implementing them recall problems which have already been discussed: the use of a standard descriptive language for information sharing, and the creation and web distribution of databases containing data from laboratory research.

M.P. Guermandi has taken on the task of making a critical survey of the state of the art of web communication of archaeological data, based on the three key concepts which characterise this new type of digital culture: interactivity, hypermediality, and connectivity. Despite the freedom which is typical of the web, and which by itself tends to generate new forms of language, the traditional language maintains the predominant nature, together with the traditional division of knowledge by subject. This brings up the old problem of information standardisation, which cannot be solved only through the help of technology; at least as long as the new means of communication continue to be used for the transmission of contents which have been arranged according to traditional methods, and the logic of integration has the effect of creating more of a juxtaposition of various data sources than a systematic logical procedure. As a consequence, from the very first phases of research the documentation should be organised for hypermedia translation; furthermore, integration is needed between the traditional cognitive system – of the symbolic-reconstructive type – and that promoted by the multimedia approach – of the perceptive-motor type.

The next two articles deal with specific projects which exemplify the use of web both as a means of consultation and for in-depth research: the web sites of the Oxford University's Beazley Archive of Classical Archaeology and Art (D. Kurtz) and the Area di Archeologia Medievale of the University of Siena (R. Francovich, L. Isabella). The digitisation of the Beazley Archive, started at the end of the 1970s, is a model example for its continuity of intent, for having known how to adjust new technologies to the requirements of archaeological research, while, at the same time, being able to adapt to their evolution, and for the large number of archives which have been digitised and made available for on-line consultation since the 1990s, thus offering the scientific community an incomparable research tool. The Sienese web site was also created in the 1990s on the basis of experience acquired in the digitisation of archaeological data; thanks to the success achieved, it is now evolving towards a portal dedicated to Medieval Archaeology, which has an architecture that follows specific principles which take into consideration the requirements of researchers, as well as general users: high quality content, frequent up-dating, minimum downloading time, facility of use.

The last article in this section, by F. Ulisse, covers the problem of web distribution of geographical data, and especially of archaeological cartography, with particular reference to their use. The criteria of usability, together with that of the quality and accessibility of web sites, is much debated, since it defines the degree of usability of a product by specific users in order to reach a well defined goal efficiently, effectively and satisfactorily within a specific context. The results that have emerged are not exactly encouraging, and despite the fact that we are dealing with a limited field of research, the perception is that of a combination of advantages and limitations for this new form of knowledge communication.

In conclusion, it can be observed that the semantic web, with its ontological approach, seems to haunt the publication, like a mirage or a ghost, as a means to facilitate knowledge management and the preferred and more effective pathway for information representation, and especially for its retrieval. If the possibility exists to evaluate, in the short-term, the real success of this "evolution" of the web, perhaps another special issue of our Journal will be devoted to this theme.

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