

## THE "CONTEMPORARY MIND". 3D GIS AS A CHALLENGE IN EXCAVATION PRACTICE

ABSTRACT

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The recent publication of a number of manuals dedicated to excavation highlights a renewed interest in this subject. Nevertheless reference literature fails to address one of the major contributive elements of the last decades excavation practice: the use of IT. On the other hand, dedicated contributions (see CAA papers) tend to focus more on technical issues than on the implications of using IT in humanities.

This paper explores three-dimensional GIS for excavation as a framework within which the integration of theory and practice has the potential of solving practical problems and revising strategic choices during and after fieldwork. A cognitive approach is used to test the response of 3D GIS technology to a more rounded concept of excavation. Conversely, the influence of such technology on our perception of the archaeological record is discussed.

### INTRODUCTION

What do archaeologists do? They dig. Or at least this is what the general public still thinks of contemporary "Indiana Jones". Contrary to this widespread and general belief, archaeology has developed into several branches of research that have little to do with excavation. In particular, in the field of computational research, the study of landscapes and the use of the so-called non-invasive methods (remote sensing) has surpassed what was and is still believed to be the most invasive but also information rich archaeological practice. As a consequence, a discussion about excavation methodology and its implications for knowledge production has been somewhat neglected since the early 1980s, when it was decided that the way forward was the stratigraphic method and the recording had to be carried out using single context planning (Harris 1978).

The recent publication of a number of manuals dedicated to excavation itself (Drewett 1999, Collis 2001, Roskams 2001) highlights the renewed interest in this subject after a period of silence. Following the postprocessual claims of Ian Hodder, a discussion on related issues in monographs and papers (Hodder 1997, Chadwick 1997, Hassan 1997, Hodder 1998, 2000, Andrews et al. 2000) has fuelled the academic debate. Nevertheless, the attention focused mainly on statements of the respective theoretical positions on the topics of scientific versus interpretative, subjective versus objective methods. As a consequence, considerations on the practicality and applicability of the different approaches became a secondary issue.

Reference literature fails (an exception being Ian Hodder 1999 and Steve Roskams 2001) to address one of the major contributive elements of the last decade's excavation practice: the use of IT. An interesting and animated debate followed the application of IT to field archaeology (in particular the use of GIS for predictive modeling, view-shed analysis and so on) and it focused on "the ancient mind". The same cannot be stated of computing and in particular GIS at intra-site

level. Although some causes of this disparity have been identified and discussed (Biswell et al. 1995, Huggett 2000), a further debate on the implications of using IT during all phases of the excavation process has been ignored. In order to overcome this problem, the use of IT in excavation, should, in my opinion, consider the "contemporary mind" of the archaeologist.

Starting from these premises, I aim to shift the attention from current concern with data and accuracy at the core of data collection and management to a broader discussion about world views and metaphors that are involved in the process of using the world of computation for spatial representation of archaeological contexts, in particular that of excavation.

Within a cognitive science framework, the focus shifts from what we perceive to how we perceive it and more importantly how we represent it. The need to understand mental models of excavation and, in parallel, of GIS cannot therefore be understated.

### COGNITIVE ARCHAEOLOGY AND THE CONTEMPORARY MIND

Cognitive archaeology, as defined by Renfrew in 1994 is "the study of past ways of thought as inferred from material remains" (Renfrew 1994:3). Although the focus of cognitive archaeology has always been the "ancient mind" both Renfrew and other contributors underlined that "the analysis has to enfold both 'us' and 'them'. Only by understanding our own perceptions can we recognize the particular way in which we engage with the past and thereby accept that the way in which we listen to them is subjective" (Bender 1993:257). Moreover Renfrew states: "Perhaps we shall soon see some convergence between such fields as cognitive psychology, studies in artificial intelligence, computer simulation and cognitive archaeology. The time may be ripe for a great leap forward. But I don't see this happening until those archaeologists interested in the symbolic and cognitive dimensions devote more attention to the formation of a coherent, explicit and in that sense scientific methodology by

which that dimensions can systematically be explored through the examination and analysis of the archaeological record" (Renfrew 1993:250).

Bearing in mind that "cognitive science is the study of intelligence and intelligent systems, with particular reference to intelligent behavior as computation" (Simon and Kaplan 1989:1), Renfrew's call for archaeologist's interest in an integrated methodology of exploration does not come as a surprise. What surprises nonetheless is the fact that cognitive archaeology has been concentrating on trying to understand how the mind of ancient people worked, disregarding other aspects and implications of using cognitive science in archaeology.

The call for an alternative program in cognition studies in archaeology is clear in Gardin (1992), who underlines the difference between an approach focused on people of the past and one considering researchers in the present. The two approaches are not mutually exclusive, but it seems to me challenging and fundamental to confront the second to better contextualize and therefore understand the first.

As a consequence, when we consider cognition and the use of GIS for archaeological excavation, we must shift the attention from the ancient mind to that of the contemporary mind: our ways of thought, now, today and as archaeologists.

The spatial nature of archaeology does not need further discussion and it is the very reason why GIS entered archaeology at a very early stage in the history of its application. What needs development is a discussion of spatial knowledge in archaeology, within the framework of cognitive science, therefore in terms of interaction with computation when translating concepts such as vision, touch, experience.

#### SPATIAL COGNITION

"Using a GIS requires the use of spatial knowledge. But what kind of spatial knowledge?" (Nyergers 1993:38). A variety of ways can be used to define spatial knowledge. In this paper a contribution by Mark (1993) is used as a general reference for its classification, which can consider the nature of spatial knowledge, the sources of spatial knowledge for cognition, or experiential interaction and linguistic uses. In the following section try and explore how the first two classifications can help in giving insights into spatial cognition and archaeological research, in particular in excavation practice.

A classification by the nature of spatial knowledge was formulated by Golledge (1990) and it divided spatial knowledge into declarative knowledge of geographic facts, procedural knowledge in terms of way-finding and navigation (the so-called *sensi-motor* knowledge) and configurational knowledge intended as map-like Euclidean geometry which, in its lowest form consists of topology and in its fully developed form would allow a person to estimate absolute distances and directions between known points as accurately as they could while looking at a geometrically correct map.

In connection with the importance of the link between knowledge of space and the use of computer interfaces, Golledge underlines that declarative and procedural knowledge are quite well developed in everyone, whereas configurational knowledge is not developed by everyone to the same extent.

If it is true that different people have different levels of configurational knowledge, how do we deal with it? How can we be sure that any archaeologist in front of a computer is going to be able to explore and understand data with well-developed survey and overview skills? This is an issue when we are designing or we are asking computer scientists to design user computer interfaces for us. Moreover, this is an issue at the very core of excavation planning.

The other classification taken into consideration is the one presented by Mark in 1993. It consists of "three fundamental and distinct concepts of space used in human spatial cognition, differentiated according to the perceptual or cognitive source of that information" (Mark 1993).

Mark divides space into haptic, pictorial and transperceptual, in a hierarchical arrangement (see table 1 for the definition). This classification helps to explain and build the metaphor of excavation, in terms of abstraction and transformation processes from a space that we can directly experience (the haptic space of excavation, where we see and touch and experience) to a superior abstraction that allows us to picture and put together in our mind physical spaces otherwise incompatible (transperceptual space). The transperceptual space does not have any kind of materiality and it can be associated with our mind or the computer (in computational archaeology). Through the metaphor "investigations of space (and excavation, nda) are limited only by the power of intellect and mind" (Golledge 1990:147).

#### EXCAVATION AS A METAPHOR

The concept of archaeological excavation as pure destruction has been recently challenged by new ideas such as explosion (Jones 2002) and displacement (Lucas 2001b). Pushing the boundaries into new conceptualisations of the practice of archaeology, I would here argue that the process of excavation is the creation of a metaphor. The concept of metaphor as a purely rhetoric trope has been challenged and applied to the world of knowledge and comprehension. Metaphor is used by humans to understand concepts otherwise incomprehensible, to put together fragments of unknown information into a known unity (Lakoff and Johnson 1980). Here is the parallel with archaeological excavation. The levels of spatial knowledge listed by Mark are comparable to the different phases of the archaeological excavation from the field to the computer.

The GIS model of an excavation is a metaphor of materiality. If in one way we loose the materiality of haptic space, during the abstraction process, we have also gained new insights through the creation of a metaphor in the transperceptual space. What is interesting and intriguing in using the concept of metaphor for the process of excavation, is that it does not

really matter which new structure we use to represent the original concept. What is important is to maintain the characteristics that Aristotle assigns to metaphors: to be pertinent and vivid. To fulfill the first requirement the need for questioning and making explicit the metaphorical process and its implications in the production of knowledge becomes self-explanatory. The second requirement underlines how, even when we decide to use mathematical models to conceptualize perceptions of the "real" world in synthetic geometric representations, the value is not given by the detail richness, but by the ability to explain reality (Forte 2000).

The preoccupation of the archaeologist with spatial cognition should occur at different levels (at least two). The first level is the excavation. How do we interact with space when we are in the excavation? How does the understanding of space during excavation allow us to record in different ways? This is further discussed in the section dedicated to 3D GIS. The second level is post-excavation. How do we interact with the computer? How much does our knowledge of computer spatial structures and computer environment influences our way of conducting an excavation? GIS is very much embedded in GIS users' minds. When I go out in the field I cannot help thinking of ways of representing what I am seeing and experiencing in the excavation in the computer environment, whereas years ago I was thinking of reproducing this knowledge into papers, context sheets and notebooks. This is a paradigm shift in how we approach excavation, and it should stimulate new ways of thinking.

3D GIS AND EXCAVATION: AN IDEA

When comparing the computer data structures used in GIS and the archaeological data forms used to represent archaeological excavation it is interesting to notice that a parallel can be created between vector model and stratigraphic method, raster model and spit method.

The stratigraphic method, which stems from the principle of superimposition and from the concept that people lived on surfaces, is concerned with recording surface entities. The data structure that geometrically supports representation of surfaces is the vector one, not only in a computer environment, but also on traditional paper support. Euclidean space is used to contain points, lines and surfaces. In terms of volume organization, there is still a problem of its representation and manipulation, both in terms of paper records and computer environment. Raster data models, which are the structures reflecting space in terms of continuous Cartesian coordinates in two or three dimensions, are discretised in terms of grid cells (pixels). They intriguingly reflect excavations carried out using the spit methodology, where the explored area is divided up in a regular grid and the material is lifted using discrete units. This latter method, which is usually employed in sites "without features" (Drewett 1999:118, is generally

considered a refuge (Roskams 2001:112), when the stratigraphic approach fails. Moreover it is considered simply as an alternative find recording system.

As a matter of fact, archaeological excavation methods tend to underestimate the importance of deposits. Raster models have developed into voxel models, which are particularly suited for representing and analyzing volume data. We are therefore provided with a way of representing volumes that could be a challenge in excavation methodology. Obviously this is not a straightforward process and there are implications in this way of approaching excavation, the challenge this time being to learn something new about deposits. And "to learn a new field, according to the cognitive science approach, is to build appropriate cognitive structures and to learn to perform computations that will transform what is known into what is yet not known" (Posner 1989:xi).

Everyday life makes us experience surfaces. The volume within which we travel is empty and is usually the air. Although the stratigraphic method's aim is to record and study surfaces, under the assumptions that people lived on surfaces, the deposit in its volumetric status has been subjected to transformations through time. Excavation is a unique opportunity of experiencing volume in terms of materiality in the haptic space and transform it into the metaphor of the transperceptual space, in order to infer new information about the present and the past.

RESEARCH ON GIS: SETTING AN AGENDA

Archaeologists have been accused of using GIS "as little more than a mapping system" (Goodchild 1995:46) and geographers seem to have monopolized areas of research on GIS. The goals of 3D GIS should therefore be not only to explore excavation data with GIS as just another tool with which to collect and analyze data. The archaeologist must understand

Category	Geographical definition	Archaeological metaphorical stage
<b>Haptic</b>	Sensi-motor and haptic perception is the most important early form of spatial information that reaches the mind, and in many ways are the most basic. Defined by touching and bodily interaction Solid-body motion is central to haptic space. With Newtonian physics this leads to Euclidean geometry. Euclidean geometry applies to haptic space	Space of excavation at a human scale (small-scale)
<b>Pictorial</b>	Based primarily on visual perception and indirect sensing. People talk about the visual scene in part using the language of touch and manipulation, which is one form of evidence that pictorial space is metaphorically grounded in haptic space	Space of site excavation at a superhuman scale (large-scale) Landscape archaeology
<b>Transperceptual</b>	Transperceptual It is composed or assembled in the mind from a number of independent haptic and pictorial spaces or objects experienced over time. Ability to walk through mental maps Spaces not perceived all at once	In archaeology associated with our mental space and models. In the field of computational archaeology it is the computer. Space where the metaphor becomes explicit. )

Table 1 A summary of Mark's classification of knowledge of space and, in parallel, the creation process of the archaeological excavation metaphor

how GIS (in particular multidimensional GIS<sup>1</sup>) interacts with the way we do research and produce knowledge.

A preliminary set of question may be posed, such as:

- What are our ways of engaging with the space of excavation?
- Can multiple ways of knowing be integrated in a GIS? How?
- What types of knowledge and forms of reasoning are not well represented within GIS?
- What are the consequences of their exclusion?

Another priority in the agenda should be the study of the dynamics of metaphors. How do they interact with each other and how do they influence our way of producing knowledge? The engagement with the space of excavation has varied through time, from the era in which the archaeologist was in his study and the material was collected by fieldworkers under his<sup>2</sup> sporadic supervision, to contemporary practice which seeks interactivity and reflexivity of participants (Lucas 2001a). Today, the use of computers allows for a completely different engagement. One of the priorities of meetings such as the CAA Conference should be to create discussion groups in order to address research on GIS tailored to archaeological research.

<sup>1</sup> For a thorough treatment of theoretical aspects of multidimensional GIS, see Raper 2000.

<sup>2</sup> and I leave his deliberately, as it is almost always male figures that represent the "Golden age" of archaeology.

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