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Spatial technology and archaeological theory revisited

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15.1 Introduction

This paper returns to the theme of a previous paper (Wheatley 1993) in which the claim was made that the use of Information Technologies within archaeological research, specifically Geographic Information Systems (GIS), required theorising and that GIS (and by analogy many other information technologies) could be made to contribute to a wider area of archaeological analysis. There are several reasons to revisit this subject. Firstly, I am no longer satisfied that the earlier paper makes a very coherent statement about archaeological theory as applied to spatial technologies in archaeology, or even that it was possible to write one in 1992. The adoption of GIS, CAD and modelling technologies within archaeological research has progressed considerably since that time, with many more applications of such technology, so that it may be possible to make a more considered statement now.

Most importantly, there has now been opportunity for others to express opinions about the same subject, often with different theoretical positions and correspondingly different agendas for archaeology as a whole. At the time, virtually the only explicit statement about the relationship between theory and GIS methods was that of Zubrow (1990). Now, however, there have been a number of published contributions to the debate, and frequent unpublished discussions. Some recurrent themes are beginning to emerge.

Perhaps more important, however, is that the 'centre of gravity' of the theoretical debate within archaeology has now shifted somewhat. Discussion which was previously focused on developing a critique of functionalist archaeology, particularly environmental determinism, has now taken a more positive note by concentrating on what can be done rather than what should not. The pluralistic notion that there are many different 'truths' which might stem from different theoretical perspectives is rightly gaining credence, leaving the contradictions between processual and post-processual approaches to archaeological interpretation intact but less problematical.

15.2 The need for theory

The need for a theoretical underpinning to the use of spatial technologies within archaeology is not self evident, even though recent contributions by, for example, Zubrow (1990), Wheatley (1993), Verhagen *et al.* (1995), Boaz & Uleberg (1995) and Claxton (1995) have explicitly recognised the rôle of theory within the analysis of archaeological remains with spatial technologies. The need stems from the tendency, in the absence of conscious theorising, for the available technology to dictate the questions which archaeologists investigate. Zubrow (1990) recognised the falsity of the belief that GIS is simply a tool with no theoretical or methodological importance observing that, beginning to use GIS within archaeology: "one rapidly discovers that it is not equivalent to a mechanic changing wrenches. The changes are more profound" (p. 67). He went on to argue, using radiocarbon dating as an example, that new methodologies tend to evolve to take advantage of certain tools to the extent that the nature of the questions which are asked become different: "Even the theory changes" (p. 67).

The process of technology introducing a bias into the subject matter of archaeology is not an exclusive feature of GIS analyses, and is equally apparent in the use of, for example, reconstruction modelling. This is easiest to undertake with buildings and monuments which can be represented as consisting of regular geometric shapes, with the result that there has been a preponderance of Roman or Medieval architecture over all other types of archaeological remains. It is not necessary to regard this particular bias as good or bad, to understand that without some strategic input in the form of theory, there will continue to be an unintentional drift towards an 'archaeology of least resistance', driven by the available technology.

It might be argued that archaeology has never felt the need for theories about other technologies, such as radiocarbon dating, but this would be to miss the point. Archaeology and anthropology have found a need for theories about time (*e.g.,* Gell 1992) which provide a framework within which it is possible to begin to meaningfully use the results of radiocarbon dating. By analogy, therefore, it is not theories about spatial technologies *per se* which are needed, but theories about the spatial organisation of culture without which such technologies would be of limited benefit.

Wheatley (1993) argued that GIS technology tends to privilege the analysis of a particular subset of ar-

chaeological themes — ecology, economy and subsistence — over social and ritual analyses; a process which has led to a predominance of settlement studies of a very particular kind. These are either in the form of highly deterministic predictive models (*e.g.,* Brandt *et al.* 1992; Kohler 1988; Kvamme & Jochim 1989; van Leusen 1993; Wansleeben & Verhart 1995; Warren 1990) or of site catchment analyses (*e.g.,* Gaffney & Stančič 1991; Hunt 1992) based on optimal foraging theories. Since the early 1980s, this kind of processual archaeological theory has been the subject of a rigorous critique by, for example, structuralist (papers in Hodder 1982), contextual (Hodder 1987) and hermeneutic (Shanks & Tilley 1992) schools of theory. While none of these approaches has found universal acceptance, the critique of processual archaeology raised in these contexts has meant that a great many archaeologists would reject such explicitly functionalist approaches as, for example, environmental determinism or optimal foraging theories as largely unprofitable avenues of research.

Recently these arguments have been rehearsed within the context of spatial technologies, rejecting some deterministic or simplistically functionalist studies as undesirable. For example, Verhagen *et al.* (1995) are critical of site catchment studies concluding that:

> Perhaps the worse failing of site catchment studies is their inability to acknowledge adequately the social, cultural and ideological contexts within which human settlements are situated and which structure the day-to-day routine activities ... this model attempts to superimpose an abstract, atemporal Cartesian geometry onto a reality that is fundamentally reflexive, subjective and contingent (p. 189)

Meanwhile Gaffney (in Gaffney & van Leusen 1995) argues that GIS, as used by many of its is adherents is:

> environmentally and functionally deterministic and that such stances will ultimately be unproductive. (p. 372)

15.3 An emerging theory of place

This type of debate, however, is primarily negative in character. It merely decries the absence of theory or, at best, identifies redundant thinking within some research, both of which are quite different from actually theorising spatial analysis in archaeology. This requires both critical reflection on existing theoretical statements and a positive attempt to construct a suitable theoretical basis for the use of spatial technology.

15.3.1 Human ecodynamics

Verhagen *et al.* (1995) outline a theoretical framework for GIS studies. While accepting the social construction of space, they decry the tendency to separate space from time, offering a view of settlement dynamics as the inter-penetration of socio-historical (politics, defence, relations of production *etc.*) with biophysical (natural, geological climatic) domains. More specifically, they define a set of six 'fundamental domains which are regarded as representing a primary set of descriptors which may be seen to encompass the dynamics of societal reproduction' (p. 191). These are constituted as domains of 'human reproduction and maintenance activities', 'food production', 'material technology production', 'raw material and artefact transactions', 'political and administrative organisation' and 'ancestors'. Using these, they claim that it should be possible do address the need for a 'dynamic ecology of social space'(p. 190).

The strength of approaches which are founded in historical ecology or ecodynamics is that they seek to bypass the dichotomy between nature and culture which has long pervaded western thought, and which has been perpetuated by GIS studies which seek to explain cultural pattern through correlation with environmental variables. However, it can only be seen as extreme reductionism to define fundamental cultural building-blocks in this particular way, and if there really are socio-cultural fundamentals, then these would not intuitively be the first candidates. Interesting though they are, this is really a list of topics for investigation and not fundamental objects — there is more than a slight suspicion that the GIS/CAD concept of 'fundamental mappable objects' has simply been translated into 'fundamental socio-cultural objects'. What is presented is therefore a thinly disguised 'cultural' ecosystem which neglects the reductionist problems of equating cultural systems to ecological systems. The suggested domains are not distinct, and are not amenable to study separately: 'food production' (the only of the fundamentals actually analysed, and this in a wholly synchronic manner) is just as socially constrained as 'political and administrative organisation'.

15.3.2 Cognitive archaeology

Zubrow (1994) has attempted to make use of GIS in the context of a cognitive approach to archaeology. 'Cognitive archaeology' (see various papers in Gardin & Peebles 1992, and other papers in Renfrew & Zubrow 1994) sets out to bypass the apparent impasse between the processual and post-processual schools of archaeological theory through a focus on theories of knowledge representation and cognition. Although the methods of cognitive archaeology remain philosophically rooted in positivist epistemology, the subject matter (cosmology, ideology, belief, symbolism *etc.*) has until recently been primarily the domain of social the-

orists. Zubrow (1994, p. 109) espouses the aims of cognitive archaeology, but the claim that 'the entire processual/post-processual argument is largely irrelevant to understanding prehistoric cognition' seems to deny the contribution which social archaeology has made.

There is considerable merit in a focus on how human beings represent knowledge but, although this is an undoubtedly interesting area of research, the statement that 'how humans encode information transcends culture and time' (Zubrow 1994, p. 109) is deeply anti-historical, and undermines the line of argument. When Zubrow (1994, p. 109) claims that 'what archaeologists must do is decode the information in order to understand what knowledge is represented' he ignores a large part of the post-processual critique of positivism: that archaeological research is not simply a process of moving from 'statics' to 'dynamics' through the search for generalising rules of translation.

15.3.3 Evolutionary approaches

Closely related to cognitive approaches, other theoretical approaches to GIS-based settlement studies have drawn heavily on evolutionary ecology and evolutionary psychology. Maschner (1996), for example, uses these to argue that optimal foraging theory remains a sound approach to the study of settlement patterns. He claims that it has only failed to explain settlement behaviour adequately because of flawed assumptions about basic human decision-making processes in societies which are intermediate between bands and states. He further argues that the:

> '... discrepancy in the performance of optimal foraging theory is that the psychological adaptations for cost-effective foraging that evolved in and work so well for small, kin-based, mobile groups do not work so well in multi-kin-based sedentary societies' (Maschner 1996, p. 175)

The complex human psyche, he argues, assumed modern form as an adaptation to the Pleistocene landscape and, in the neolithic, began changing the social landscape far faster than evolution could 'track', leaving no basis for the assumption that human behaviour is in any way adaptive in a modern context. For these reasons, Maschner advocates that archaeologists should continue to build predictive models based on assumptions of economic maximisation, but that they should not regard these as an end product. Instead, the 'deviation from the predicted model will inform on areas in which the prehistoric peoples were sacrificing economic efficiency for political and social ends' (p. 176).

All of these things are interesting, and insights from evolutionary psychology might well be useful in the understanding of spatial patterning. However, the methodology which Maschner advocates (and applies in his example) is the generation of a statistical model which simply relates settlement location to environmental variables. However good the resulting model is statistically — in this case the logistic result accounts for 75% of the variation in the site location variable (Maschner & Stein 1995) — this cannot form the basis of a coherent explanation of these site locations because it fails to account for the fact that the sites form an historical sequence. It also fails to address the connections between the sites, treating each as if it were an independent statistical observation, when in fact the choice of settlement location was made with knowledge of the existing social landscape.

It is not that this approach is invalid or incorrect. Interesting observations are made about the choice of settlement location, in terms of defensibility or proximity of resources. The problem with this, and other statistical generalising approaches is that they are extremely reductionist and anti-historical. The desire to provide general explanations which are applicable cross-culturally, is not tempered with a corresponding need to interpret the specific historical sequence being studied. If we accept Maschner's argument that modern human behaviour is in no way adaptive, then his suggested strategy of building statistical models on the assumption that it is, so that we might see how badly they fit seems particularly anomalous. At the same time, his observation that non-sedentary societies fit optimal foraging models is far from universal, and even if it is generally true, it is not an excuse for condemning non-sedentary archaeology to wholly functionalist interpretations: mobile groups, too, have complex socially constructed views of their landscape which require explanation.

15.4 Spatial technology and an archaeology of place

If present attempts to provide a grounding for spatial theories are insufficient, because they tend to be reductionist and anti-historical, and the deterministic assertions of van Leusen (in Gaffney & van Leusen 1995) are also rejected, then some alternative framework is needed.

Zubrow (1990) comments on three areas of GIS application to archaeology: the idea of landscape (which adds a historical and contextual dimension to space), the deconstruction of archaeological categories, and the implications of the choice between vector or raster representation. Worthwhile observations are made on each of these three themes although they are not drawn into a coherent theoretical perspective. The themes, however, must remain central to attempts to construct a meaningful basis of theory for spatial archaeology, and might be combined with the view of Gaffney, who suggests that the alternative to a empirical and deterministic use of GIS is:

> ... the application of a more contextual approach to analysis. This will involve a fuller and more thoughtful use of the available archaeological data. There will be less emphasis on pattern recognition and physical measurement as goals in their own right, and more concern with interpretation of the historical processes which result in such patterns. (Gaffney & van Leusen 1995, p. 378)

This provides something of a 'mission statement' for theory building: few would disagree with the sentiment that the use of spatial analyses and technologies should aspire to more than empiricism and pattern recognition. The remainder of this paper is builds on these sources to try and generate a theoretical agenda for archaeological research using spatial technologies. As a start, this might have four goals:

- Development of an adequate concept of landscape which might (for reasons which will become apparent) be better termed the study of places.
- An elaboration on the idea that spatial technologies might play a central role in the deconstruction of archaeological categories such as the site.
- The analysis of spatial scale, and the special significance of this for the understanding of the relationship between agency and process.
- The means through which spatial technology can analyse time, that is can be analytically historical in nature.

15.4.1 Landscape and perception: defining places

Following Crumley & Marquardt (1990), Zubrow (1990) makes a distinction between landscape studies and regional studies seeing this as one way in which time can be adequately theorised with GIS because 'past landscapes influence present landscapes and the landscapes of the prehistoric past will impact the landscapes of the future' (p. 68). Landscape is rather a nebulous concept, but if Zubrow means that regions are defined irrespective of their archaeological context while landscapes depend on their historical, cultural and interpretative context for their definition then there are echoes here of Hodder's (1987) call for a contextual approach.

Thomas (1993), however, has argued that 'landscape is not a universal concept, applied in the same way by all people at all times, and thus cannot represent a definitive way of apprehending the world'(p. 20), rather that it is a component of a particular 'way of seeing'. Drawing on Cosgrove (1984) he describes landscape art, in the sense of realist landscape art, as a means of freezing a three-dimensional world on a two dimensional canvas and consequently locating the viewer outside the picture and outside of history. This, he argues, is a 'representation of place which alienates land, such that it can be appropriated by gaze' and that therefore the concept of landscape, 'land appropriated by the disengaged look' (p. 22), can be seen to have developed within a particular historical context. Landscape, and later Cartesian philosophy, are seen as part of the development of social relations which allowed land to become isolated from traditional patterns of heredity and meaning and, finally, commodified as part of an emergent capitalism.

There is a clear parallel between the appropriation of place through the representational choice of perspective painting, and the appropriation of archaeological landscape through the analytical use of GIS. The conventional representation of landscape in a GIS is the same as that of the Cartesian map. As for the observer in landscape art, this situates the viewer outside of the landscape. More, while the viewpoint of landscape art is a choice from any number of possible but quite human perspectives, the vertical, Cartesian viewpoint of maps and GIS is above and equidistant from every place within the landscape, geometrically impossible, providing the viewer with a godlike perspective and completing the decontextualisation of the analyst.

The use of non-Cartesian viewpoints to present archaeological places (a practice often disparaged as the generation of 'pretty pictures') should therefore be encouraged. Technologies such as GIS and reconstruction modelling may allow archaeological places to be experienced by virtual presence, from something closer to a human viewpoint. This allows the analyst to be re-situated within something similar in experience to real places, and allows the landscape to be viewed as a series of places, from the perspective of the individual.

The disparaging of such techniques as animated walk-through and photorealistic rendering is misguided, and based on an irrational avoidance of aesthetics and personal experience. Archaeological places are, at least in part, concerned with both personal experience and aesthetic quality so that attempts through the use of technology to generate representations in which the viewer has a human viewpoint are essential. This also constitutes part of the difference between the analysis of places and that of space. Studies which situate themselves within a particular contemporary historical and theoretical context should also be encouraged. This is because computer representations are not only the product of a particular way of seeing in the past, but also of the particular way of seeing which is archaeology. This involves a reflexive approach to the use of technology: studies of how technology is adopted within the discipline (*e.g.*, Harris & Lock 1990, 1995) should be supplemented by, for example, studies of how computer-based analyses and representations relate to what Bradley has termed the 'craft traditions' of archaeological practice.

15.4.2 Representation: deconstruction of categories

Both Zubrow (1990) and Verhagen *et al.* (1995) have advocated the use of technology to deconstruct traditional archaeological categories, such as sites and regions, by either exploiting the technology to represent all archaeological material as points, or by defining entirely new categories. This, perhaps, reflects a more widespread dissatisfaction with site-based archaeology as expressed in Foley's call for an 'off-site archaeology' (Foley 1981). The site, however, is far from the only archaeological category which warrants close examination, and any profound theory of places should also offer an analysis of the distinction between settlements and ceremonial places by exploring whether such a distinction can be sustained as universal, or whether it arises because of a preoccupation in the present with the separation of the domestic sphere (with implications of simple, culture-less subsistence activities and female associations) from the ritual (which is complex, powerful, symbolic and frequently male).

An adequate theory of place will continue to deconstruct traditional archaeological spatial and temporal categories. This will involve the dissolution of the boundaries of analytical categories and the development of forms of analysis which experiment with new classes and categories. In practice, this will lead to methodological efforts both within the research framework, and in the context of resource management. In research, for example, Foley's offsite archaeology approach may be explored using spatial technology's unique ability to extract meaning from combinations of spatial variables. Settlement studies may be replaced with a more holistic analysis of archaeological materials achieved through alternative representations and varying categorisations of archaeological remains.

In this context, Zubrow (1990, p. 70) has already noted the theoretical implications of the choice between vector and raster GIS systems: for raster representation 'The critical concept for theory is that for raster systems, meaning is independent of boundaries' while within a vector system the meaning is almost invariably attributed to nodes and boundaries. This representational choice has been exploited by, for example, Wheatley (1996) which argues, using the ideas of *e.g.,* Schofield (1988), that a non site-based archaeology should move away from use of 'type fossils' and aim to extract as much as possible from the majority of the recovered data, rather than the minority. The explicit choice of a raster based analysis over vector forces the researcher to reject the idea of distinct bounded sites and discourages the use of single type-fossils within the analysis. In a management context, the adoption and use of spatial technology may lead to a reconsideration of the main object of archaeological management. The 'site' of Sites and Monuments Records is a bounded area of archaeological value which is deemed to exist within a matrix of no value; spatial technology makes this artifice unnecessary, allowing resource management the choice of adopting a conceptual model of the archaeological resource which is spatially continuous and which recognises that all places are archaeologically important (Wheatley 1995).

Until recently, much of the discussion about reconstruction modelling within archaeological computing has been concerned with the relative merits of solid geometry over surface models, a discussion carried out exclusively in terms of the technical merits of each method. Such discussions are important but not sufficient, ignoring the interesting choice to be made at a theoretical level between representing spaces and places as groups of interfaces (surfaces) or as groups of spaces (solids) — a choice which is related to that of landscape representation as edges (vector) or land parcels (raster). It should be possible, using reconstruction models, to devise alternative ways of representing buildings and monuments: the decision to represent a place as either a solid or surface model is more significant than relative technological superiority, it forces the analyst to break down classes such as 'building', 'tomb' or 'church' into components which may be analysed alternatively as blocks of space or as thresholds between spaces.

The deconstruction of categories is not itself sufficient to constitute an adequate theory of place: such a theory must also attempt to define alternatives to those categories which are found lacking. If this is not the case, then there is a real danger that theories concerning space and place will be divided into, on the one hand, those which uncritically accept the existing units of analysis as given and, on the other, those which reject the existing ones without offering any alternatives. In this respect the work of Boaz & Uleberg (1995) on the Iron Age landscape of eastern Norway is noteworthy because, while rejecting traditional units of analysis such as territories (defined by cost surface analysis) it suggests as an alternative the construction of landscape rooms, implemented in this case through the calculation of viewshed maps. It remains to be seen whether such a concept will prove genuinely productive, but this certainly represents the kind of analysis which must be attempted.

15.4.3 Scale: agency and process

One of the failures of spatial technological analyses to date has been to begin analyses from the abstract, large scale viewpoint of the physical geographer. This is not to say that the task of identifying general cultural pattern at a large scale is not valid, merely that this should not be the starting point for the analysis. Spatial technologies such as GIS allow a human scale of study to be the fundamental unit from which methods are built. Visibility analyses, for example, invoke an individual human as the viewer, and then relate this to the wider scale (temporal and spatial) effects

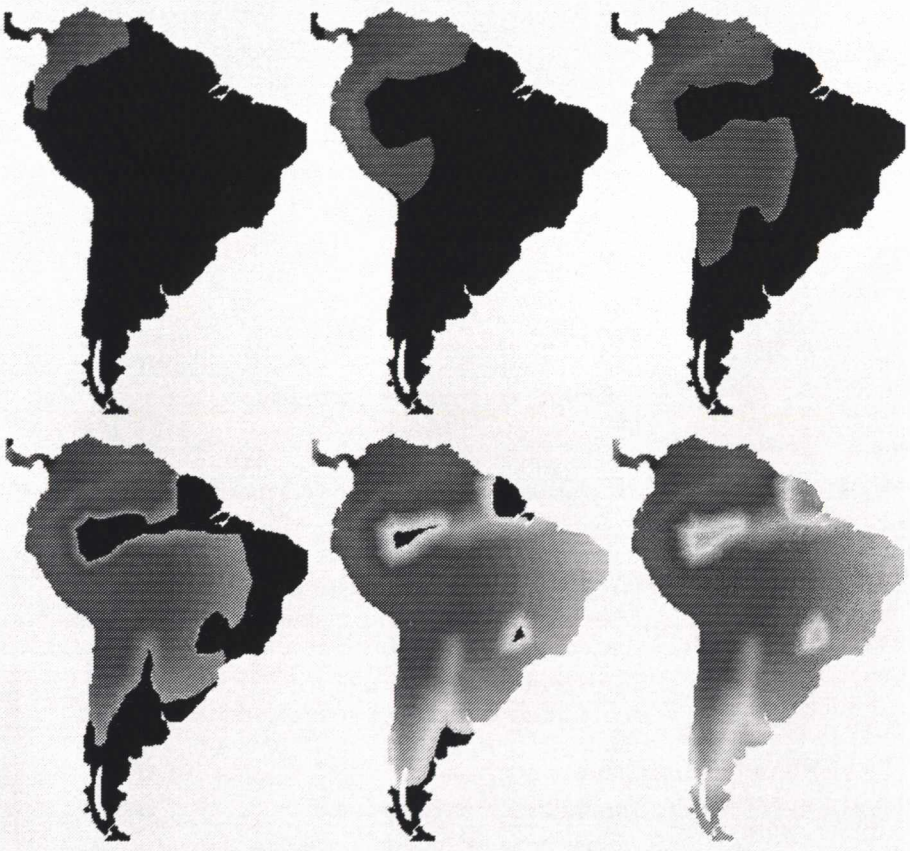

Figure 15.1: The colonisation of South America.

of their actions. What is needed is a bridge between the large scale processes which are often detectable in the archaeological record, and the human-scale activity which we know is responsible for these patterns. Shennan has made a similar point regarding the use of cellular automata and stochastic simulation models of cultural trait transmission:

> Archaeologists have always been unhappy with "individuals" ... Any approach which emphasises their centrality is therefore immediately unattractive unless the type of individual presupposed is a self-interest maximiser of a very simple kind ... it is increasingly clear that they are far from simple and that a 'rationality' approach does not straightforwardly provide us with reasons (or answers)' (Shennan 1991, p. 199).

He goes on to advocate the use of game theory to provide a more sophisticated 'individual' on which to base simulations, arguing that:

> ... if culture history is worth reviving, processualism is in need of revision. As a basis for explanatory mechanisms, its essentially ecological rationality is as weak in its own way as the migrations and diffusions of culture historians. (Shennan 1991, p. 208).

It may be that, at larger spatial scales, different processes can be discerned than those in operation at smaller scales. Figure 15.1, for example, shows a simulation of the earliest colonisation of South America, based on assumptions regarding the relationship between average rate of advance and environment Glass *et al.* (1999, 1997). Clearly such methods are only interesting or meaningful at this kind of immense temporal and spatial scale: at smaller scales the level of generalisation would become meaningless. This is not, however, as van Leusen Gaffney & van Leusen (in 1995) has suggested an excuse to turn to crude environmental determinism at particular scales. Instead, this is an opportunity to explore the relationship between agency and the larger scale patterns which are often the unintended consequences of multiple actions. Some specific aims in this area might include the development of models to explain cultural diffusion as something other than an abstract mathematical system, or the use of simulation studies which again incorporate some concept of individual perspective.

Theories of places should therefore lead to analytical methods which start at the scale of the individual, and then relate this scale of analysis (the individual viewshed or the individual pathway, for example) to the patterns which become apparent at larger scales of analysis. These larger scale patterns, however, do not have meaning when they are divorced from the individuals who generated them. Far from representing a problem, however, it is possible that this may offer the greatest opportunity for the use of spatial analyses in archaeological research. The special relationship

between agency, process and scale makes spatial technologies the most promising forum currently available for the exploration of these issues.

15.4.4 Diachronicity and synchronicity: the relationship of places to time

An emphasis on scale is equally important temporally as it is spatially, because the effects of individual actions accumulate through time. Each action which leaves a trace (and some of which which do not) influences all subsequent actions in the same place. In many ways this means that studies of spaces must always recognise time implicitly, to the same extent that it is explicitly involved in simulation and diffusion models. Theories of place should therefore work to develop methods to understand the particular historical sequences of change which result in archaeological remains both when undertaking synchronic analyses of related places, and explicitly, when analysing or modelling change to spatial patterns through time.

This might be achieved explicitly, through the use of simulations and models which represent the changes to places through time, such as models of diffusion or cultural trait transmission. These, however, do not remove the need for the implicit recognition of time in analyses which, superficially, may seem to be synchronous. For example, in the analysis of intervisibility (*e.g.*, Wheatley 1995), there is an implicit recognition that the construction of monuments at one time will influence those built later — here the diachronicity is implicit because there is no necessary sequence to individual monuments, yet the analysis assumes the influence of existing monuments on the choice of new location.

15.5 Conclusions

This paper has argued that there is a growing need for a coherent body of theory within archaeology to underpin the application of technologies which represent and manipulate space, including GIS and reconstruction modelling. It has argued that recent attempts to establish such a body of theory, deriving, for example, from cultural ecology, cognitive archaeology or evolutionary perspectives are promising but reductionist, anti-historical and overly generalising in nature.

An alternative view, which derives from a contextual and critical approach to theory, has been presented. This is that such a body of theory must derive from an archaeological perspective, rather than from a technological one because it is archaeological questions which need to be addressed, and from a historical and reflexive approach to archaeological analysis. It should both be derived from, and contribute to a wider archaeological theory of place.

The central concerns of such theory, in respect of spatial technologies, should be:

1. the re-contexualisation of the researcher and the recognition that the representation of space as abstract and Cartesian is not a passive act;
2. the deconstruction of archaeological spatial and temporal categories such as 'site' and 'settlement' and the development of analyses based on alternatives;
3. the analysis of scale,particularly with respect to the way in which scale impacts on the relationship between agency and process;
4. the development of diachronous, historical forms of spatial analysis.

Throughout, it has been emphasised that this draws extensively on existing work, with the primary aim of synthesising and developing the existing body of theory.

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