On the Theory and Practice of Archaeological Computing

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CHAPTER 1

Computers and Archaeological Culture Change

Jeremy Huggett

Archaeological Attitudes to Computers

The use of Information Technology is widespread throughout the archaeology of the 1990s to the extent that it is barely considered worthy of comment (unless someone is not using a computer). Undergraduate students of archaeology are increasingly computer-literate and expect to use IT in their work. The public face of archaeology represented through television programmes is often one of scientists labouring with instruments and data loggers producing plots and reconstructions with impressive sleight of hand. There is virtually no corner of archaeology that has not been touched in some way by IT. The management and protection of archaeological sites, the initial prospection and discovery of sites, the excavation, processing, analysis and interpretation of sites, and the theoretical frameworks within which all these activities take place have all been affected to some extent by the use of IT. The all-pervasive nature of IT is underlined by the fact that it is about more than just computers – Information Technology includes any technological device for transmitting, communicating, storing, transforming, and presenting information. However, computers are becoming ubiquitous within IT, and the recent history and present-day reality of IT is one of the convergence of the electronics, telecommunications and computing industries. Whether it is digital telephones, digital cameras, scanners, 2-D and 3-D digitisers, digital callipers, electronic distance meters, data loggers, or any of a whole host of other forms of increasingly ‘smart’ instrumentation, the computer is integral and fundamental.

For something that is so increasingly important to archaeology, it is curious that there has been so little discussion about why computers are used, in what contexts, and with what effect. This is probably to a large extent due to a not unreasonable supposition that since IT is playing an increasingly large role in everyday life, it would be more surprising if archaeologists were not making use of them. According to this argument the motivations behind computer usage in archaeology are self-evident. However, it also implicitly reveals a sense of powerlessness – it is as if we have no alternative but to adopt the new technology. What discussions there are about the use of computers in archaeology almost exclusively concentrate on computer-based techniques and their application in a wide range of areas and projects. Books on computers in archaeology are sometimes manuals or synthetic descrip-
tions (rare examples include Richards and Ryan 1985, Ross, Moffett and Henderson 1991) or are more commonly edited collections of papers describing applications and techniques (for example, Mathew 1984, Cooper and Richards 1985, Reilly and Rahltz 1992, Lock and Stangic 1995). With the significant exception of contributions in Cooper and Richards (1985), computers, and the techniques and technologies surrounding them, are essentially taken for granted. Their benefits are invariably good, their negative effects (if they exist at all) are inevitably minor.

This focus on the tools and techniques in the archaeological texts represents the adoption of a technocratic approach, one which progresses little beyond looking at whether or not the techniques and technologies applied worked in the situation concerned, and whether the results were interesting from an archaeological perspective. In the process, assessments of the state of computer applications in archaeology tend to be shallow descriptive affairs, falling far short of equivalent assessments of, say, the introduction of new metalworking technology to some past society. Beyond the immediate realms of archaeology, approaches to the introduction and use of new technologies are infinitely richer and more complex in areas such as the history of science, sociology, philosophy, ethics, and business studies. The kinds of questions asked are more wide-ranging than those characterised above and yet have resonance in an archaeological context. For instance, who initiates, develops and applies the technology? What opportunities and barriers exist to access the technology? To what end and with what consequences is the technology applied? (after Webster 1995, 76). Such questions go far beyond those concerned primarily with the application of a tool and techniques and start to raise a series of political, social, and economic issues which archaeologists should feel comfortable with and yet which, strangely, have not been used to address the role of IT in archaeology. Ross, for example, asks

"Do computers change how archaeologists work? And, if so, what do these new practices look like, in what areas have results been demonstrated, and how was that work done?" (1997, 162)

yet the answers are not forthcoming in an otherwise straightforward review of techniques and methodology. Similar reviews focus exclusively on application areas and discuss the various typologies of computer methodologies (for example, Scollar 1999, Kamermans and Fennema 1996, Moffett 1991). The emphasis is again placed on the development of tools, techniques, and methodologies, yet this is only a limited aspect of computer use.

Part of the problem may be that there are several attitudes to IT, often apparently contradictory and mutually exclusive. On one hand, there is the idea of the computer as no more than a tool, likened to an archaeological trowel or wheelbarrow, and yet unlike the latter, the computer is privileged with its own international annual conferences. The computer is seen as an instrument of revolution and change, but can also be a means of conservatism and control. The computer is neutral, but is also value-laden. It facilitates communication, yet can result in greater isolation. Which is right? Can it be all of these and more? In many respects, it is this very difficulty in tying down what the role of computers actually might be that causes the often ambiguous attitudes towards them. Much depends on experience and perception, and since analyses of computers in archaeology rarely progress beyond methodologies and application areas, it is hardly surprising that though the range of attitudes to

computers can be so endless as to encompass everyone who has ever worked on a computer, the result is in all probability is a chaos, and perhaps a world of misunderstanding.

However, the reasons are often not a single and hence not results are ach not so much reasons for using technology as more seem relatively biological data has per se, for instance, tools and their fundamental question of this, it is an apparent point made by the unspoken and.

The reason so often referred to about archaeologists is that computer use is widely used be circumstances, itself. However, the concern of archeology computing and that discussions is thought to be considered relevant as such. Dinn 1995, Hid

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computers can run the full gamut of emotions, more often than not reports about their application are positive, enthusiastic, even evangelical. No one likes to admit to failure. Yet everyone who has worked with computers knows that behind the formal, measured prose there was in all likelihood many hours of confusion, puzzlement, despair, anger, frustration, chaos, and perhaps disaster before the ultimate (inevitable) triumph of logic and order.

However, the real motivations behind the application of computers to archaeological situations are often difficult to find. It often seems as if the reasons for their use are self-evident and hence not worthy of mention, let alone discussion. The fact that a computer is used and results are achieved is justification in itself, and needs no further comment. The question is not so much should a computer be used, but how should it be used. The typical practical reasons for using computers – they help in data handling and data processing, for example – disguise more fundamental and implicit reasons which by their very universal nature may seem relatively insignificant within an archaeological context. Issues of efficient archaeological data handling naturally seem more important than the larger question of efficiency per se, for instance. Important questions are perceived to relate to the availability of software tools and their appropriateness or otherwise for the archaeological task, not to the underlying fundamental questions about the technology itself. While archaeology is hardly unique in this, it is an approach which leads to a lack of appreciation of the limitations of computers (a point made by Moffett 1989, 13, for instance), and, more importantly, by disguising the true, unspoken and implicit reasons and justifications for using computers, potentially leads to a misunderstanding and mis-application of computer technology. The application-driven approach may also lie behind the general lack of more sceptical examinations of computer applications, yet when questions such as ‘should we use computers?’ are asked, they are all too often perceived as unimportant and their answers self-evident. They are not.

The reason such questions are important is because of the very ubiquity of the technology referred to above. It is increasingly part of, embedded in, and allied with much of what archaeologists do and the tools with which archaeology is done, and at the same time, it is widely used beyond archaeology as a defining factor in the new ‘information age’. In such circumstances, we need to look beyond the techniques used to the effects of the technology itself. However, one problem is that such questions may not be seen to be the appropriate concern of archaeologists. This makes for an interesting parallel between archaeological computing and archaeological management – for example, Carman et al (1995, 9) suggest that discussions of management in the archaeological literature are limited, partly because it is thought to be about issues such as productivity and cost-effectiveness which are not considered relevant to archaeology. Yet the fact that the application of computers within archaeological organisations may have far-reaching implications (for example, Cooper and Dinn 1995, Hinge 1996) suggests that they should not be ignored in this way.

The New Technological Paradigm

Talk of a new age – a post-industrial or informational society – which, it is argued, will bring about major culture change in terms of values, attitudes, beliefs and methodologies, is predicated on a new technological paradigm based on information technology. According to Forester there are two reasons for this: first, it creates a new ‘best practice’ or set of ground
rules, rapidly becoming the new 'common sense' and secondly, it calls for dramatic changes in organisational structures (1989, 1). Attewell and Rule comment that

"It is taken as self-evident that organisations computerise in order to pursue long-standing goals of efficiency and cost effectiveness. Rationalisation or the relentless effort to adopt the most efficient means to established ends, is seen as the hallmark of modern organisations. Computerisation is considered as the most eminently rational of present-day technological trends" (1994, 286).

Discussion of such ground rules and changes in organisational structures predicated on this new paradigm are extremely rare within the archaeological context (although see Cooper 1985, for instance).

A major characteristic of this supposedly rational trend is the speed with which it changes – the ground rules are effectively set in quicksand. It is commonly felt that technology is running ahead of society and that there is a constant need to catch up, seen in the almost instant obsolescence of IT equipment purchased today. Kalman and Grillo talk of the 'Order of Magnitude Effect', which suggests that for each ten-fold increase in speed our perception of what is going on changes dramatically –

"we can barely manage to learn the new technologies before they change, and as a result, we often pay scant attention to the consequences of their use" (Kalman and Grillo 1993, 25).

This has resonance with the way in which manufacturers use planned obsolescence to provide the illusion of progress. Only rarely is this rush to the future questioned, rarely is it pointed out that a 20% increase in processor speed does not result in a 20% increase in work completed, or that the feature-rich, power-hungry software of today is more often than not used to perform identical tasks to the leaner packages of five or even ten years ago.

Elements of this new rationality can be seen clearly in the blandishments of the computer and software manufacturers: Apple's emphasis on paradigm shift and revolution in their Ridley Scott directed '1984'-style advertisement for the Macintosh is a classic example. More recently, IBM's use of nuns, monks and anthropologists to advertise a range of laptop computers emphasises the use of the machine to bring everyone together and improve their lives immeasurably. Microsoft's advertisements seek to seduce us with images of access to a new world of limitless information through the use of their software. Whether it is hardware or software, the manufacturers promise it will change us for the better. The nature of that change has implications for archaeological users as much as anyone else.

Technological Determinism

Explaining Change

Clearly there is a general expectation that computers will bring change – whether it is improvements in the speed with which a task is accomplished, or the accomplishment of new tasks altogether. This emphasis on technological change as the cause of social change is a

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common form of determinism. Technology comes to identify an entire social world (Webster 1995, 10); for example, the Palaeolithic, Mesolithic, Neolithic, the Bronze and Iron Ages, all have their origins in the identification of technological change. This change is always perceived in one way or another as progress along an evolutionary social or economic trajectory, following a sequence of predictable development (for example, Heilbroner 1967).

Typical attitudes to new technology polarise into two categories: optimistic (pro-technology, liberal, progressive, positive) and pessimistic (anti-technology, reactionary, luddite, negative), for example, Rowe and Thompson (1996, 20–26). Nor are such attitudes new, or restricted to computers and information technology. An identical dichotomy in relation to technology existed at the time of the Enlightenment (Marx 1997, 13), when the new sciences were seen as a means of political liberation and social transformation while the counter-Enlightenment rejected the mechanistic ideas of Newton, Descartes, and others for the romanticism of Rousseau and Carlyle, for instance. Of course, characterising attitudes to technology in terms of pro- and anti-technology is clearly too simplistic, but the search for the middle-ground is not as straightforward as it might at first seem. Some would argue that technology is neither good nor bad, but neutral or benign. Here technology is seen as not worthy of particular notice because the effects on social or economic change are relatively small and well-understood (for example, Mesthene 1997, 66–7). Alternatively, Fiorman argues for the “tragic view” of technology, which recognises paradox and ambiguity but allies itself with those who “aware of the dangers and without foolish illusions about what can be accomplished, still want to move on, actively seeking to realise our constantly changing visions of a more satisfactory society” (Florman 1997). A variation on this theme is Kranzberg’s First Law: “technology is neither good nor bad, nor is it neutral” (Kranzberg 1989, 30) which above all emphasises the unpredictability of technology. However, in many respects this so-called middle ground is populated by people of one or other persuasion—for instance, Mesthene (1997) clearly opts for a pro-technology stance, and Florman (1997) adopts what is still essentially a pro-technology standpoint. Rowe and Thompson (1996, 23) prefer to see attitudes to technology as ranging across a continuum, recognising that most commentators are both optimistic and pessimistic at different times and in relation to different aspects. They also identify a relationship between the level of analysis and the attitudes adopted: as the level of analysis reduces from the global to the particular, the level of optimism tends to rise and greater emphasis is placed on choice (Rowe and Thompson 1996, 25).

Essentially it seems to be very difficult to break out of a pro-technology, progress-driven mould, even whilst trying to adopt a more neutral, objective perspective towards computers and computing. To a considerable extent, this is due to the prevalence and largely tacit acceptance of a market-driven approach, in which efficiency, control, speed and cost-effectiveness are the primary considerations that have shaped attitudes towards computerisation. As Kling and Iacono argue, this means that most studies of computerisation ignore the ways in which people develop beliefs about what computing technologies are good for and how they should organise and use them (1990, 214). In particular, they claim that computerisation is socially charged through the activities of committed advocates and what they term ‘computerisation movements’ (Kling and Iacono 1990, 215; Iacono and Kling 1996, 88–90), more so than the adoption of other forms of office technology. These computerisation movements
"communicate key ideological beliefs about the links between computerisation and a preferred social order which help legitimise computerisation for many potential adopters. These ideologies also set adopters' expectations about what they should use computing for and how they should organise access to it" (Kling and Lazonko 1990, 215).

If this is indeed the case, then it is reasonable to draw two conclusions. First, if the adoption of computers is socially charged, then it becomes all the more important to understand the social and economic forces involved in order to fully appreciate the role and impact of the technology concerned and hence move beyond a technocratic approach. Secondly, if their argument is accepted it follows that we should expect the motivations and effects of the adoption and utilisation of computing technology to be disguised behind a welter of claims and counter-claims predicated upon the ideologies both of these computerisation movements (which may be archaeological, or imported from the wider world) and the producers of the hardware and software employed. It is necessary to see through and beyond these in order to examine the role and use of computers in archaeology.

The extent to which cultural change is driven by new technology is open to question, however. For example, some would argue that there is no such thing as technological determinism: "Technology does not determine society: it embodies it. But neither does society determine technological innovation: it uses it." (Castells 1996, note 2). Clearly other factors – political, social and economic – have a role to play in the explanation of change. For example, Hughes (1994) talks of 'technological momentum', a concept which falls somewhere between technological determinism and social constructivism while borrowing elements of both. However, 'non-technological' political, social and economic processes resulting in technological developments can equally be seen as a form of technological determinism (for example, Freeman 1987, 6). It is all too easy to intuitively conform to the popular experience of largely powerless consumers pulled along by the producers of Information Technology.

On the face of it, technologically deterministic explanations begin to look inevitable and unavoidable, but this need not be the case. While the demand-pull and technology-push forms of determinism in particular seem depressingly all-embracing, they make relatively little allowance for the political, social and economic dimensions – as Webster argues, technological determinism subordinates these dimensions to technology, whereas technology is in fact an integral part of them. For example, the motor car is more than a technological means of travel: it contains assumptions about family size, the value of personal ownership, the importance of status, attitudes to the environment, the role of public versus private transport, and so on (Webster 1995, 10). This leaves it open to examine the priorities and values expressed through the technology without necessarily employing arguments predicated on the technology itself, loosening the apparent stranglehold of technological determinism. However this can be taken too far: to treat technology as an independent variable by attempting to deconstruct these dimensions and extracting technology as a residual, non-social, neutral entity would itself lead to a form of technological determinism (Grint and Woolgar 1997, 14). It is not simply a question of recognising that the non-technical variables are important in understanding change, but equally, that technology is not a black box on which these other variables act. Indeed, as Scranton suggests, the study of technology consists of political and social factors.

However, where there are circular fashions of technological theory or a particular intervention, there are also analogous: the extent of which are it is possible to see through such realities.

A Neutral Model

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First, if the impact and influence of the use of technology does not have a determinism in society, then it is the role of society in order to question, technological determinism and other factors change. For which falls the borrowing of processes from the producers of a relatively-new technology and values dedicated to determinism. variable by variable, non-variable (Grint and Goodwin, 2013).

Computers and archaeological culture change (1994, 149), where social, economic, political and technological factors play on a localised rather than global basis. However, the expectation of change associated with information technology remains, and where there is such an expectation, technology and technological change are used in a circular fashion to predict change, describe change, and explain change, whether in archaeology or in society as a whole.

A Neutral or Value-Laden Technology?

Technological determinism can also be seen to appear on a smaller scale, in the form of the computer tools we use and their application to archaeological situations. To what extent are archaeological applications determined by the tools available, or the archaeological questions asked defined in terms of the tools applied? For example, most archaeological users of GIS seem to have research interests related to large-scale survey and landscape analyses rather than smaller scale within site analyses (Biswell et al. 1995, 269). Is this coincidence, or is it related to the origins of the tools, or something else altogether? To what extent are perceptions of the data requirements for GIS behind their lack of use for intrasite studies (Huggett, forthcoming)? In much the same way, archaeological data are structured in relational databases, which enforce a particular view of the information contained within the tables.

There is a perception that computers are a malleable technology which fit into an environment rather than changing it (for example, Johnson 1994, 132). Chameleon-like, the computer takes on the role devised for it without changing the nature of that role. Malleable they may be, but the idea that they do not change the tasks they undertake is counter-intuitive, as is demonstrated by Hinge’s analysis of the changing nature of work at the Museum of London (Hinge 1996), for example. Archaeologists are accustomed to accept that the data we work with are theory-laden (Reilly 1985) but often appear less concerned that the computers used to work with those data may themselves be value-laden. These values may well determine and shape certain applications – perhaps built into the software itself. The very nature of computers might favour certain values: for example, they could be seen as skewing analysis towards the quantitative – “if you can’t measure it, it does not exist” (quoted in Johnson 1994, 161). Similarly, there is a certain inevitability about the types of applications that are generated by Geographical Information Systems. Wheatley (1996, 75) has observed that GIS-based archaeologies tend to focus on environments rich in economic or settlement evidence and avoid situations where it is scarce because of the ease with which GIS manipulate such data. In such circumstances, it is as well to remember Kranzberg’s First Law: “technology is neither good nor bad, nor is it neutral” (Kranzberg 1989, 30). The tools may be content-free, in the sense that they can be applied within a whole host of different archaeological contexts, but they are not value-free.

Technological Utopianism

If many of the explanations of change are driven by the technology, many of the descriptions of change and predictions for future change are characterised by technological utopianism
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(Kling 1996, Iacono and Kling 1996). Kling sees this as a style of writing that tends to be buoyant, expansive, breathless, enthusiastic, and polemical. It accentuates the positive and minimises conflict, emphasises benefits and trivialises concerns, and, as Kling argues, it side-steps difficult questions while creating a sense of excitement about the new (1996, 48). Inevitably this triggers anti-utopian responses, “tragedies that serve as counterpoints to the technological utopians’ inspiring romances” (Kling 1996, 51). In combination with computerisation movements, this becomes a highly potent force for legitimising the adoption of the new technologies.

Utopian analyses of information technology are perhaps less obvious in archaeological writing, but early papers introducing new computer movements such as artificial intelligence or GIS are sometimes utopian in character and result in correspondingly anti-utopian reactions (characteristic of some contributions to Cooper and Richards (1985), for example). Indeed, utopianism was recognised as a characteristic of the language of archaeological computing by Pryor (1986, 50) who distinguished between rosy optimism and reality in an early discussion of why archaeologists used computers. In fact, it seems more likely that archaeological writing about computers can be characterised not so much as utopian or anti-utopian, but as a form of ‘social realism’ (Kling 1996, 56), in which the emphasis is placed on empirical data about actual applications rather than deterministic logics. This reinforces the argument put forward above: that the emphasis of archaeological writing about computers is exclusively application-oriented and hence its assessments of computer usage are essentially flawed. Furthermore, the proposition that archaeologists write utopian analyses of computer use should not be rejected immediately – writing is socially charged, and Kling argues that utopian views of the world are an inevitable result of the need to justify positions, salaries, budgets, grants and the like. Whether or not archaeological writing about computers can be characterised as utopian, anti-utopian, or as social realism, the fact remains that archaeologists are not divorced from the wider world. Knowledge, opinions, and decisions will be based on the reports of business analysts, journalists, industry gurus, and the proponents of computer movements as well as on the experience of experts in the archaeological world.

Some Case Studies

To re-phrase Attewell and Rule (1994, 286), we can see that computerisation is an eminently rational trend in present-day archaeology, yet this very rationality is based, for good or ill, on essentially utopian and often deterministic views of the technology. Hence, when we investigate some of the justifications that might be put forward for computerisation, these are by their very nature optimistic in that they focus on perceived benefits. This applies whether they be productivity-related (efficiency, cost-effectiveness, etc.), or to solve specific issues (data handling, archiving, access, for example), or simply talk of the advantages to be gained from a specific application (development of bespoke software, the use of a particular tool or technology, for instance).

The Productivity

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The Productivity Paradox

Most arguments for the adoption of computers and various software solutions rely in one way or another on the idea that the use of computers increases efficiency and productivity and hence (usually more peripheral) aspects such as job satisfaction. Can these assumptions be justified? One of the problems in approaching this within an archaeological context is that the motivations behind the adoption of the technology and its subsequent effects are rarely questioned. Some issues are more or less openly addressed (the augmentation of tasks leading to new opportunities, and benefits associated with information handling and creation, for instance), whereas others remain largely unspoken (efficiency, cost-effectiveness, and quality of work, for example). Why these latter justifications remain largely moot is unclear, but it seems likely to be associated with the sense of powerlessness amongst archaeologists and others in the face of the IT onslaught noted previously, and hence a reluctance to address the absence of proof (or at least, supporting empirical evidence) for the supposed benefits paradoxed by the various computerisation movements.

Actual data relating to productivity, where they exist, are rarely more than anecdotal. For example, the system developed for the Maxey excavation “led to substantial savings in time and effort, and its cost-effectiveness is assured” (Booth et al 1984, 87) and it was claimed that with computer data entry work that would have taken around three months took only days. A technological solution to digitising context plans led to a thirty to forty-fold increase in the number of plans an illustrator could process in a day (Templeton 1990). The automated artefact processing system developed by the All American Pipeline Project was claimed to be capable of measuring artefacts between 10 and 100 times faster than a human (Plog and Carlson 1989, 264).

Interestingly, there has been a good deal of concern outside archaeology that computers have not brought their much-vaulted claims to greater efficiency and productivity – hence the productivity paradox. For example, “we observe a downward trend of productivity growth starting roughly around the same time that the Information Technology Revolution took shape” (Castells 1996, 71). There are problems of measurement which affects the reliability of this picture, and much of the slowdown may be explained in part by the soaking up of productivity gains in manufacturing industry by the dramatic expansion of the service sector (for example, Castells 1996, 74; Landauer 1995, 73–77). One of the key issues to arise out of this debate is that introducing computers does not necessarily increase productivity, and that there are many social processes that reduce any potential gains (though these social processes may in themselves be desirable). For example, Attewell (1996) defines six such restricting social processes:

1. formalisation of communication (increase in typed communications at the expense of faster spoken communication);
2. quantity/quality trade-off (for example, improving the appearance of output rather than its substance);
3. expanding the volume of work (“computers may make information work easier to do, but they thereby increase the amount of such work to be done” (Attewell 1996, 232));
4. Managerial control (the growth of Management Information Systems data and increasing levels of managerial employment. Computers may also move tasks 'up' an organisational hierarchy, such as word processing);
5. Competition (information technology is used to increase the volume of business, but such expansion does not necessarily involve increased productivity as long as the growth is at competitors’ expense);
6. Demands for information (improvements in information availability lead to demands for more information placing greater burdens of information-work on organisations, the costs of which may not be passed on).

All of these features can be recognised in the modern archaeological world. Arguably, most of the developments in British archaeology in the face of competitive tendering and commercialisation could not have been accomplished without the use of Information Technology, but that does not mean that computers have increased productivity per archaeologist. The speed of artefact processing claimed by Plog and Carlson (1989) was not borne out in reality (Ackerly 1995), and given the level of investment and numbers of programmers required to maintain the system, it is doubtful whether it ever could have been as productive as was thought. The digitisation of context plans reproduced traditional on-site planning (Templeton 1990) and, in spite of the advantages in relation to the creation of structure and phase plans, it is doubtful that overall productivity was enhanced. In any event, even where productivity may be enhanced, it may be offset by increasing the overall workload. In areas such as CAD, the productivity gains are often negligible since much of the same tasks are undertaken as were carried out prior to computerisation, and any enhancement of productivity is probably offset by the increased number of draft drawings, and time spent altering the infinite range of properties, colours, line thickness, hatch patterns, fonts and the like. In much the same way, written texts are worked and reworked with word processors, increasing the quality of appearance of the report, but not increasing the overall quantity of completed reports.

The nature of work may also change as a result of these activities. Task-shifting is a common characteristic in business, and may ultimately lead to job replacement. In archaeology, examples of task-shifting are starting to appear though not (yet) any clear examples of job replacement. For instance, Hinge identifies it as a significant aspect of change brought about by the introduction of a relational database system at the Museum of London (1996, 16–17). De-grading of previously skilled work is another characteristic which also has its parallels in archaeology – for example, the computer system used by the All American Pipeline Project was tedious and boring to use for trained archaeologists who reacted by developing sophisticated means of sabotaging the system (Plog and Carlson 1989, 263). Similarly, McVicar and Stoddart reported that the availability of on-site computer-generated stratigraphic sequences caused problems with the site supervisors who found it difficult to keep full control over the excavation when faced with stratigraphic inconsistencies revealed by the computers (1986, 226). A similar interpretation could be placed on the emphasis on user-friendly database interfaces which offer terminology control and hence inadvertently de-skill the data entry role.

The conclusion, then, is not so much that computers do not improve productivity, because in some circumstances desirable, which gains.

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in some circumstances they might, but that more often than not they have side-effects, some desirable, which may not have been predicted and which impact upon potential efficiency gains.

**The Digital Data Mountain**

For a number of years now, computers have been seen as a means of coping with the expanding quantities of data, particularly generated by excavations (for example, McVicar 1986). However, the shift to digital data processing led inexorably to larger quantities of data being collected in the first place, leading to a still greater data mountain (Moffet 1989). For a time, some sought to deal with this by using computer-based data compression methods (for example, Powlesland 1985, Huggett 1988). However, with the increasing power and capacity of personal computers, such concerns seemed to vanish. At the time, the concern was over the quantities of paper-based data which could be conveniently reduced in physical size through computerisation, but today the concern is increasingly to do with the preservation of the growing quantities of electronic data (for example, Condon et al 1999). Archaeological data archive projects have been set up both in the USA (Eiteljorg 1997) and in the UK (Richards 1997) to try to deal with issues of preservation and access. These are important and valuable programmes, but if we stand back and take a longer view then they may be indicative of a more worrying trend than simply the need to preserve digital data.

Metadata, data about data, is a concept that is increasingly appearing in archaeological parlance (Miller 1996, Wise and Miller 1997). Used to define the way data was originally described, it also enables its re-location by providing a high-level catalogue for resource discovery. But the term is significant: metadata means more data. The quantity of ‘ordinary’ data has grown to the extent that we now need still more data in order to understand and use the data we already have. This puts archaeological data on an exponential growth path – only half jokingly, people already refer to ‘meta-metadata’. Archaeology thereby conforms to the First Law of Informational Entropy: information

> "... *multiplies in its raw form, and then goes through an interpretative process to create informational by-products, which in turn become more information, thus creating an exponential and ultimately infinite explosion of information*” (Pearce 1997, 280).

Archaeology has always been data-rich, now, with computer mediation, the data are more immediate, arrive faster and in greater quantities than ever before. Access to these vast datasets is usually perceived as a positive benefit, but how are we to handle it? By creating more data? As humans we only have a limited capacity to handle information. Pushing those limits with technological support results in a reduced ability to recall and process what we do know, leading to information stress, information anxiety, data smog, and paralysis by analysis (Shenk 1997, Dertouzos 1997, 295–8). The desirability of increased access to information and its associated emphasis on Internet delivery only serves to exacerbate this situation. In many respects the post-processing emphasis on multi-vocality of the archaeological record (for example, Hodder 1997, 1999) may indeed
be the only way to make sense of the data, albeit a conclusion arrived at from a practical rather than a theoretical perspective.

One thing we can be certain of, computer power will not restrict the exponential growth in information. Under Moore’s Law computer power has continued to double every eighteen months for the last forty years and shows every sign of continuing to do so for the foreseeable future. In comparison, it has been estimated that knowledge doubles only every seventeen years and has done so since the time of Newton (Hamming 1997, 73). The solutions offered by technologists such as Dertouzos and Hamming involve the application of still more new technology in order to reduce the complexity, to summarise and simplify, but is this an appropriate archaeological solution? Responding to the growth in information by relying on corresponding technological solutions simply emphasises the powerless of the individual.

Great Expectations or Great Misconceptions

If it is the case that the application of computers gives rise to often unexpected side effects, it is also the case that they engender hopes of great improvements, revolutionary developments, liberating tasks, and hence raise expectations to higher levels than perhaps any other technology. This is not an especially archaeological characteristic, and largely conforms to the (over) optimistic claims of manufacturers. Even though, it often seems as if archaeologists throw away their critical faculties when faced with the promise of the new technology – we critically study the material culture of the past, but fail to apply those same analyses to modern technology. This may take many forms, ranging from the many detailed ‘blue-sky’ discussions of proposed software which for whatever reason are never developed, through overly optimistic descriptions of systems and software in which often large amounts of time and money have been invested, to associations between archaeological desiderata and software solutions that may turn out to be wholly inappropriate or misconceived.

In many respects, this is similar to the state identified by Grint and Woolgar as ‘technological hegemony’ (1997, 130), where it is the need to be seen to use the technology which seems to become all-important. To what extent therefore is archaeology becoming a ‘technopoly’?

"Technopoly is a state of culture. It is a state of mind. It consists in the deification of technology, which means that the culture seeks its authorisation in technology, finds its satisfaction in technology, and takes its orders from technology" (Postman 1997, 25).

The technological solution is seen to be the rational one; to adopt a specifically non-technological approach can be seen as irrational and deliberately perverse. Hence though archaeologists and others

"... may believe they are acting rationally in adopting new technologies, their decisions actually reflect a pervasive mystique that what can be developed, must be developed." (Attewell and Rule 1994, 287).
Determinism therefore re-appears in the form of the computer-driven application which puts technological solutions before archaeological questions — a common criticism of the early stages of computer archaeology in which it was often felt that tools and techniques were in search of an application. This is one of the criticisms made of the use of computers in the All American Pipeline Project, a rare example in which the computer system developed for an archaeological project was openly discussed (Plog and Carlson 1989) and subsequently critiqued (Ackerly 1995). Allied to this technologically driven approach was the unthinking recording of data — Ackerly points to the 1350 gigabytes of data collected but comments that the usefulness of that data was never considered (1995, 600). This was a project that pushed the limits of technology yet which ultimately fell prey to the very technology which it depended upon. With the benefit of hindsight, Ackerly lists a catalogue of failures but includes specifically: the failure to anticipate the speed of technological evolution, the failure to appreciate the future necessity of constantly upgrading hardware simply to keep the data available, the failure to anticipate the need (and the expense) of the maintenance of custom software to the extent that the database can now no longer be retrieved (Ackerly 1995, 600–1). Nor does this even begin to deal with the technical problems associated with the recording and analysis of the data themselves. This very public airing of problems rings true across many projects – the same or similar problems are experienced albeit to differing degrees and some will have similarly resulted in ultimate failure, but in most cases the evidence for this is anecdotal. In a utopian environment, reports of failure are generally discouraged, or else causes other than those associated with the technology are sought (which usually means human failure).

If determinism is apparent in the applications of computer technology in archaeological projects, so too is utopianism. This often takes the form of overly optimistic or unrealistic claims being made about the relationship between computers and archaeological ends. For example it is curious that, in a series of statements about excavation methodologies in which computers are used to derive the reflexivity required about archaeological assumptions, the same reflexivity is not applied to the technology being adopted (Hodder 1997, 1999). Hodder argues that excavation methodology needs to be relational (to understand context and inter-dependencies in the data), inter-active (enabling the data to be questioned from different perspectives) and multi-vocal (allowing different people to participate in the discourse) (Hodder 1997, 694) and underpinning each of these aspects is computer technology. There is a strong impression that since information technology is perceived to offer relational computer databases, inter-activity, and multi-vocality, it therefore provides a series of apparently natural technological solutions to the problems posed, but the implications or appropriateness of these technologies are never questioned. For example, there are the apparent contradictions between the degree of flexibility and change desired on the one hand, and the use of a more or less standard relational database which performs standard relational database tasks on the other. Hodder talks of the database retaining multiple hypotheses in parallel so that analysis and interpretation can proceed in different ways according to different definitions, but at the same time talks of the need for codification and ‘fixity’ of the data (Hodder 1999, 120–121). The solution offered – ‘to embed the database within other information which contextualises its own production’ – would seem to refer to a form of metadata held outwith the database which itself will be subject to contextualisation, simply
emphasising the inherent contradiction. Similarly, inter-activity and multi-vocality are realised through the use of hypermedia (Hodder 1999, 125) without addressing any of the problems associated with the use of the technology – for example, the deluge of information presented to readers, the ease with which readers become lost and disoriented, and the limitations of the hypertext model. To some extent, this is behind Hassan’s limited critique of the information technology used by Hodder (Hassan 1997). However, it is not just that hypertext and the Web constitute “an overload of unstructured information that eventually paralyses decision-making and interpretation” (Hassan 1997, 1024) – the technique itself does not do what is claimed for it. Structure and control over the text is still retained, albeit in a looser fashion than is traditionally the case, and the author still defines the kinds of pathways available to the reader (for example, Murray 1995, 139–40). The technology does not provide the support for the level of inter-activity and multi-vocality that Hodder seeks. Ultimately the danger is that this may become perceived as the failure of the technology, rather than a failure to properly specify the technology in the first place because of inflated expectations.

Technological determinism and utopianism are clearly characteristics of archaeological applications of information technology. As long as this remains the case, archaeologists will remain in thrall to the technology, and the technology will be blamed for shortcomings which may be archaeological rather than technological. It also has implications for the archaeological computing fraternity, caught up in any backlash.

**The Road Ahead**

The title of this concluding section deliberately recalls that of Bill Gates’ utopian view of the future of information technology (Gates 1996) as a reminder that it is all too easy to fall into adopting a relentlessly utopian or alarmingly anti-utopian perspective when looking to the future. The problem is the very universality of the computer, which makes it a difficult technology to tie down – a fact that became all the more apparent with the so-called Millennium Bug and its potential impact on all kinds of technologies that seem on the face of it to have little to do with computers. This very pervasiveness leads inexorably to talk of such machines having a revolutionary impact on the world around us. Technological determinism and utopianism colour analyses and inhibit efforts to examine the world as it really is rather than as it is perceived to be. Moreover, this determinism and utopianism encourages the presumption that the effects of computer use are self-evident and necessarily beneficial.

A key aspect is summarised by the corollary to Kranzberg’s First Law (defined above): “the same technology can have quite different results when introduced into a different cultural setting” (Kranzberg 1989, 30). This emphasises that just because computers or a software package is seen to have a particular effect in, say, business management or on a factory production line, it may have quite different, and unpredictable, effects in an archaeological context. Not only that, but the results may be quite different for different contexts within archaeology as well. It is the unpredictability of Information Technology that is at the same time its strength and its failing. It is important to remember, however, that information technologies of the past did not somehow have their function coded into them: their eventual use arose out of successive interpretations and negotiations, not determinations (Grint and Woolgar 1997, 21). There is every reason to think that the computers of today are no different in this respect.
Strange as it may seem, we are still in the early stages of computerisation. It is rare for any innovation in information handling to take less than twenty-five years to become established – for instance, the telephone was demonstrated in 1876 but was not used routinely until the 1910s; typewriting was introduced in 1871 but not used commonly in business until 1910; reproduction of documents was invented in 1780 but routine copying of documents was only undertaken in the 1860s (King 1996, 250). Equally, the recent past of information technologies emphasises their unpredictability: the radio was originally intended to replace the telephone, the telephone was envisioned as a means of piping music to people in remote locations, the original record players could also record and these recordings were predicted to replace the letter, the magnetic tape cassette was invented for dictation machines but used for music recordings, and the television was originally intended as a means of two-way visual communication (Cringely 1996, 45). This suggests that there is still plenty of opportunity to understand and shape the impact of computers within the archaeological community – the die is not yet cast. However, archaeologists need to take account of the problems associated with technological determinism and technological utopianism, as well as the host of political, economic and social issues surrounding the introduction and use of computers within archaeology. This requires an understanding of the technologies which goes beyond assessments and descriptions of the tools and techniques applied. While Hodder is surely right to claim that computers have the power to transform our lives, unless archaeologists take control of the technology, understand it and mould it, it will indeed retain its power “to homogenise, to limit debate and diversity, to create a true ‘end of history’” (Hodder 1998, 214).

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