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The good, the bad, and the downright misleading: archaeological adoption of computer visualization

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3.1 Introduction

Over the past decade, archaeologists have been quick to adopt the techniques of computer visualization, often with eye-catching effect (Reilly 1988, 1992). The images produced by these techniques serve to enable archaeologists and public alike to visualize past monuments, landscapes and excavations, truly bringing the past to life. Over the years, delegates to CAA conferences have been awed by the latest piece of solid modelling, or reduced to avaricious jealousy by the price tag on the computer producing it.

We suggest, however, that there are dangers, both in the techniques themselves and in the way they have been utilised within archaeology; dangers that to a large degree have gone unrecorded by practitioners and the greater archaeological community alike.

3.2 Visualization

'Visualization' as used here refers to the computerised exploration of data which have been converted into displayable geometric objects. However, it is more than the application of image processing, solid modelling, or GIS techniques. Visualization is an interactive process whereby large and potentially complex data sets may be displayed on the computer screen and explored to reveal new insights. It is also a methodology, a way of looking at and approaching the problems of imparting data to an audience. As such, computer-based visualization has tremendous research potential within a discipline such as archaeology:

- archaeology is a very visual subject. Its data frequently comprise images – of artefacts or sites; aerial photographs, geophysical survey plots, satellite images, or excavation plans
- archaeological data sets can be very large, with a single survey or excavation producing thousands of records
- archaeological data can be extremely complex, with uncharted relationships between a number of variables

However, to date the catalyst for visualization in archaeology has not been the search for improved techniques for discovering new knowledge but rather for improved ways for presenting existing knowledge to the public.

3.3 Visualization in Archaeology

The general perception of computer visualization in archaeology is of impressive but expensive computer reconstructions of some of the major buildings of antiquity. Indeed, in Britain, visualization projects originated in the 1980s, starting with Bowyer and Woodwark's reconstruction of the Temple Precinct from Roman Bath (Smith 1985; Woodwark 1991), and that of the Roman legionary bath house at Caerleon in Wales (Woodwark 1991).

These pioneering projects inspired a succession of visualization applications elsewhere in the UK, including the Saxon Minster at Winchester (Burridge *et al.* 1989), the Cistercian foundation at Furness abbey in Lancashire (Wood & Chapman 1992), the Roman palace at Fishbourne (Cornforth & Davidson 1989), or Kirkstall abbey (Dew *et al.* 1990).

Due to the success of the earlier temple project, Bath City Council commissioned a second model, resulting in a short video of the civic bath complex (Lavender *et al.* 1990). The resulting video provided a walk through the civic bath complex and consisted of hundreds of images, each of which took many minutes to compute on powerful workstations. As with other models, the final video was impressive, but it was impossible to deviate from the route laid down by the programmers and even the single images were far from interactive, due to the time required for computation.

Elsewhere in Europe there were other experiments with visualization technology including the Stabian baths in Pompeii (Moscati 1989), the medieval church of St Giovanni in Sardinia (Soprintendenza Archeologia Per le Provincie di Sassari e Nuoro 1989), the Athenian Acropolis (Eiteljorg 1988), or the pyramids at Giza in Egypt (Labrousse & Cornon 1991).

With all of these models, the *raison-d'etre* was to make a reconstruction of the site accessible to the general public. They are generally of buildings which have been excavated or recorded, but where poor survival makes it difficult to visualize the appearance of the original structure without artificial aids of this type. For example, the Civic baths complex in Bath is one of most visited tourist attractions in the UK with around one million visitors each year. The surviving remains, although impressive, are only a faint echo of the original imposing structure, and are overshadowed by later structures.

An important factor is that most of these computer-based projects are concerned with Classical or Romanesque architecture. In most cases the architectural principles are well understood. The building foundations had been excavated and the above ground appearance was known, or at least calculable, from surviving buildings. Therefore in each of these cases the archaeologists had already formed a fairly clear view of what the building looked like before they considered developing the computerised model. Thus there was little extra to be learnt by constructing the model. This is not to say that the visualization failed to provide any new insights, but merely that it was not the primary aim of the project.

The models were developed on equipment that was at the time state of the art, and using software that was only available in a limited number of corporate research centres. In most cases they were the result of sponsorship by a large commercial organisation, such as IBM, Fiat, or BNFL who had quite cynically targeted archaeology as a discipline in which they could gain public relations points in an area which was politically safe, and at relatively little cost to them. They were each aware that archaeology attracts media attention and arouses large-scale sympathetic public interest, while those working within the profession would welcome collaboration due to lack of resources.

Each project was a result of collaboration between computer scientists and archaeologists, rather than being archaeologically controlled. In most cases the visualization software itself was not accessible to the archaeologists and therefore the computer scientists were interposed between them and their data. The archaeologists did not have direct control of the modelling themselves.

These high-tech reconstruction models are the direct successors of the water-colour drawings of Alan Sorrell which still grace many site guide books. The increasing use of computer-based reconstructions has not been developing in isolation, and may be seen as a result of several, related, factors:

- the recent and massive growth of the heritage industry, and the explosion in museums and heritage centres, opening it has been estimated in the UK, at the rate of one per day (Hewison 1987). Besides being under growing pressure to find new ways of attracting the public, museums and heritage bodies also have the raw materials necessary.
- as a result, there is money available for model development within the 'Heritage Industry'.
- although initially expensive, computer modelling is now relatively cheap, and when compared with the cost of employing a draughtsman for several months to prepare a single drawing, the development of a reusable computer model may be the cheaper option.
- the increased expectations of a public used to a diet of high quality multimedia-media presentations, from school learning software upwards.

However, these models carry a degree of authority which Sorrell's drawings never had. No clouds or wisps of smoke hide those areas where interpretation was difficult; the question marks and qualifications of the excavation report are reduced to the clinical fixed measurements of the architectural plan. Furthermore, computer models carry more authority than paper images; people expect computers to be right, and the past is therefore presented as a known – and knowable – reality. We do not know of any examples where alternative reconstructions have actually been published and clearly there is a major danger here. Large audiences are being exposed to visualizations in circumstances where the pictures or animations are divorced from the academic discussion (both technical and theoretical) associated with their development. Most archaeologists are keen to emphasise that there are many possible views of the past, and that we rarely know anything for certain, but these computer models are constrained by the short-term attention span the heritage industry assumes museum visitors to possess, and the small time-slices devoted to any one model amongst the plethora of images and displays bombarding the visitor. In presenting a very visual and solid model of the past there is a danger that techniques of visualization will be used to present a single politically correct view of the past, and will deny the public the right to think for themselves.

This is not a problem that is unique to archaeology. Under the heading of 'Lies, damned lies and slick graphics' *New Scientist* (Kiernan 1994) warned that computer graphics could be tricking the public – and even the scientists who use them – into believing that speculations or forecasts were in reality proven fact. Speakers at the Conference of the American Association for the Advancement of Science recently noted that in an image-hungry world, a computer forecast of patterns of air pollution was more effective in influencing policy makers and politicians than dry tables of numbers and charts. Worryingly, there is little, if any, quality control for computer graphics and they are not subject to the same intense peer review as scientific papers.

Part of the fault also lies with the visualization tools themselves. Rarely are they capable of displaying uncertainty or fuzzy data. One needs to be able to display levels of probability that a wall stood where it is shown, and the level of confidence in a computer generated terrain model.

An application area where these, and other, considerations are especially pressing at present is the field of GIS, variously described as 'the greatest thing since the map' and 'just another bandwagon'.

In archaeology, as elsewhere, the advent of powerful GIS (Allen *et al.* 1990) has enabled a revolution in the ways in which spatial data are visualized and explored. Allied to this visualization revolution has been the lowering of barriers between archaeologists and their data; no longer do we need a computer scientist to write our software, a geographer to analyse our distributions, or a cartographer to draw our maps. Now we do it ourselves.

This has enabled many archaeologists to explore their data in ways that were impossible or prohibitively expensive before, but it has also allowed the possibility of far lower standards for work of this nature.

A cartographer does far more than draw maps. He has been trained for many years in the science of cartography, and has an awareness of how different elements of map composition go together to make up the whole. In any map he prepares, all of this knowledge and experience is brought to bear, adding to the overall quality of the map, and the accuracy of the information conveyed (Tufte 1990).

By allowing untrained archaeologists loose with a GIS, they have the tools at hand to produce maps superficially of the same, if not greater, quality to that produced by the cartographer, but without the background expertise. Given such a plethora of tools, it becomes all too easy to generate pretty but meaningless or even misleading maps.

Even allowing for the problems of map composition and design, the most able map creator faces many difficulties in representing multidimensional archaeological data within the constraints of the two dimensional display medium. As archaeologists, we face very different visualization problems to those encountered by other social scientists as our maps do not merely record the distribution of occurrences through space, but also attempt to represent their temporal distribution (Castleford 1992).

Complications begin to arise when data or analysis move beyond the first two and into the less conceptually concrete 3rd and 4th dimensions. Whilst we can perceive these dimensions (up as opposed to down, early rather than late), representing them within GIS in such a way that they may be visualized and manipulated is proving a great challenge. Several ingenious solutions have been found to the problem, but they tend to rely upon the use of snapshots, or slices through the dimension under study (Castleford 1992; Kvamme 1992). This approach enables basic visualization, but dissociates data from their fundamental inter-relationships. We become resigned to viewing only part of the whole, and begin to forget that our maps are only components of a totality in which past influences present, and low elevations interact with higher ones.

In order to truly explore our data, it is necessary to investigate the means by which true multi-dimensionality may be built into our visualization systems. For detailed research, interactive links between data, images and user are also vital, and more important than the aesthetics of the image itself.

As mentioned earlier, a major aspect of any archaeological visualization is to create representations of archaeological data that may be seen and understood by other archaeologists and the general public. With this in mind it is important that we recognise the limitations of current techniques and find ways to represent the failings in both our data and the display methodology.

A terrain model, for example, might be displayed which is based upon thousands of accurately surveyed points. Another model could also be displayed which is based upon only several hundred. Without recourse to ground truthing, or to the data themselves, it becomes very difficult to realise which is the more accurate. As disseminators of information to a data-naive public, we must find techniques for displaying areas of fudged data within our models, and attempt to educate people in the skills of visual data analysis: an awareness of scale, an understanding of the fact that lines on maps often represent fuzzy boundaries, and a perception of the limitations inherent in our data.

3.4 Conclusion

In conclusion, we believe that computer graphics should carry a health warning. The motive for employing graphical modelling and imaging systems in the entertainment and advertising industries is the creation of pictures that elicit certain kinds of responses from the viewer, such as awe and wonder. Their role is to manipulate the audience.

One can see examples of this in archaeology. Paul Reilly (forthcoming) described a German project to rebuild the great baroque Frauenkirche of Dresden, which was destroyed by the firestorms that ravaged the city in the aftermath of the allied bombing raids of 1945. The church had become a symbol of national unity and the project had a high public profile. As part of the campaign to raise funds for the restoration, an award-winning computer-generated tour of the Frauenkirche, restored to its former glory, had been made to show potential sponsors. The animation was accompanied by the music of Johan Sebastian Bach playing on the Frauenkirche's organ.

To quote Paul Reilly

> 'the image of archaeology that is being projected is one that is dynamic, hi-tech and, unashamedly, commercial' (Reilly forthcoming).

As a way of influencing large numbers of people, computer visualization is a potentially powerful tool. On the one hand it can give large numbers of people access to the past, but on the other hand it gives tremendous power to the custodians of the heritage. There are big differences between research, education, entertainment and propaganda, but it is not always easy to draw sharp lines between them. Those who watched the frightening televised virtual world of Oliver Stone's *Wild Palms* (BBC 2) will have witnessed a nightmare vision at one end of this continuum. As the past becomes increasingly commercialised and the graphics become increasingly sophisticated this is a problem which we believe is likely to grow in importance into the next century.

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