FROM ABSTRACT DATA MAPPING TO 3D PHOTOREALISM: UNDERSTANDING EMERGING INTERSECTIONS IN VISUALISATION PRACTICES AND TECHNIQUES

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HUMANITIES, E-SCIENCE AND VISUALIZATION

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As a term, e-science has been in existence for at least ten years. In the past, it has referred to the storage, management and highly controlled dissemination of very large systems of data, services or other resources generated in the 'hard' sciences across computational networks[1]. Formalized by massive government investment in a 'core programme', this brought a range of discipline-specific visualization challenges. One of the best-known e-science pilot projects, eDiaMoND (the Diagnostic Mammography National Database Project)[2], is itself fundamentally concerned with access to very large collections mammographic images, with the aim of integrating access to those images and thus improving the NHS's capacity for treating breast cancer at a national scale. Another high-profile e-science pilot project, DAME (Distributed Aircraft Maintenance Environment)[3] relies to a great extent on pattern matching across terascale datasets to identify potential problems with passenger aircraft engines. In both cases, as in many others besides, the need for real-time access to accurate and highly detailed visualisations of the data involved is self-evident.

What then of the visualization challenges entailed by the adoption of e-science tools, methods and technologies in the arts and humanities? The stated potential for e-science in these disciplines is '[t]he development and deployment of a networked infrastructure and culture through which resources - be they processing power, data, expertise, or person power - can be shared in a secure environment, in which new forms of collaboration can emerge, and new and advanced methodologies explored'[4]. Conceptually, this aligns closely with the 'grid vision' articulated elsewhere in the e-science agenda. However, the inception of the AHRC-JISC-EPSRC Arts and Humanities e-Science Initiative in 2005[5] raises a new set of visualization research questions. In 2006-7 six workshops and three small scale demonstrators were funded, and in 2007, seven pilot research projects won funding from the Initiative[6]. Whilst not pretending to give a complete description of the visualization issues arising from these, this paper highlights some important aspects that have emerged in the first two years of the humanities e-science agenda. For reasons of space, visualization in the visual and performing arts is not discussed, although this is not for a moment to underplay the critical role the arts are currently playing, and will surely continue to play in the future[7].

1 http://www.nesc.ac.uk/nesc/define.html (last accessed 23/8/2007)
2 http://www.ediamond.ox.ac.uk (last accessed 22/8/2007)
3 http://www.cs.york.ac.uk/dame (last accessed 23/8/2007)
4 This is the definition adopted by the 2006 AHDS e-Science Scoping Survey: http://www.ahds.ac.uk/e-science/e-science-scoping-study.htm (last accessed 23/8/2007)
5 http://www.ahrc.ac.uk/e-science (last accessed 20/8/2007)
6 http://www.ahessc.ac.uk/projects (last acccessed 28/8/2007)
7 See http://www.ahessc.ac.uk/eva (last accessed 23/8/07), and also relevant projects supra n. 4.

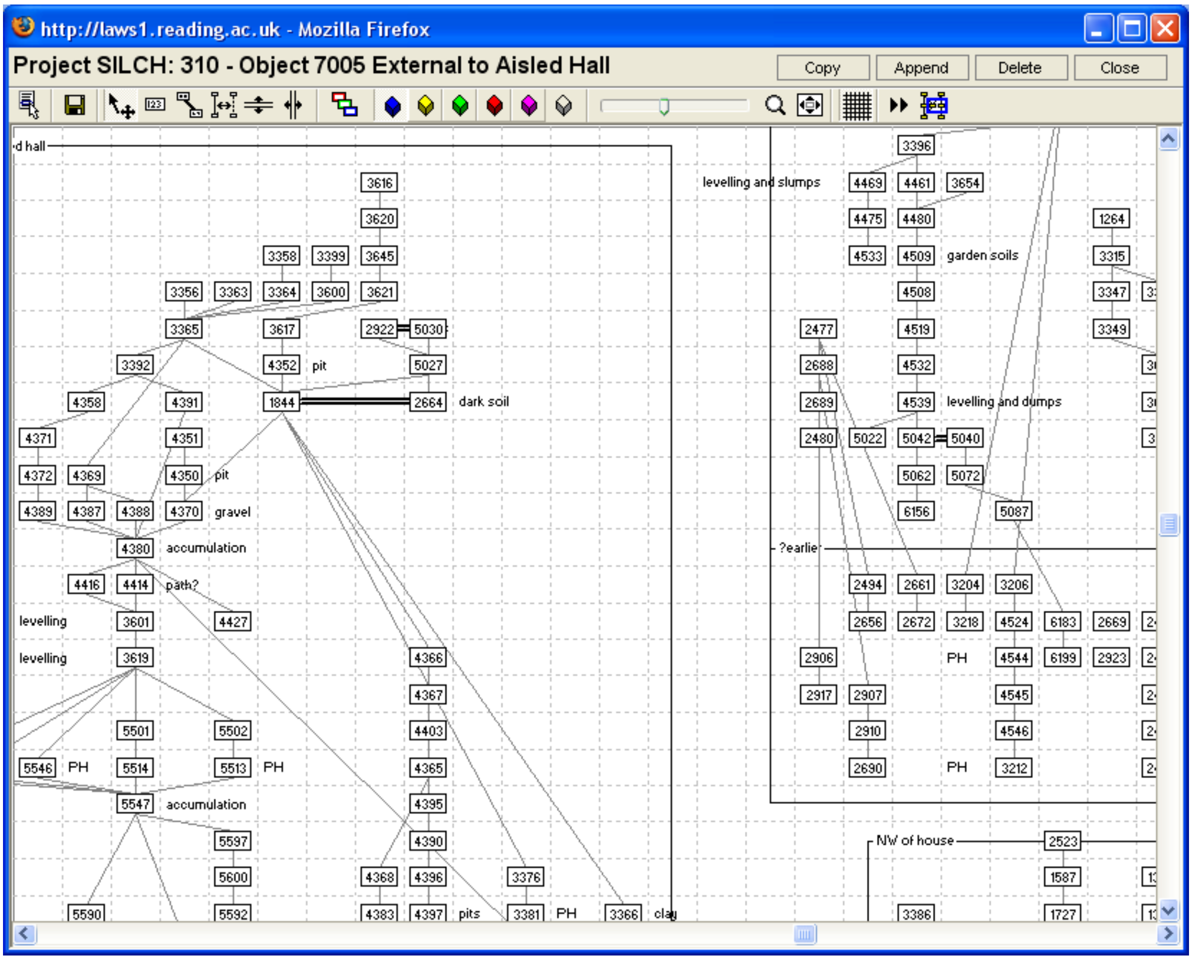

Fig 1. Harris Matrix of the Silchester excavation (screen grab courtesy of Prof. M. Fulford)

Humanists have long used visualization techniques to represent data structures. An excellent abstract example of this, the 'Harris Matrix', comes from archaeology (Fig 1). This is an established schematic system used by archaeologists to represent archaeological contexts in stratigraphic sequence. Although precise implementation of the system is likely to vary from excavation to excavation, a context is usually defined as a set of archaeological features or artefacts which can be confidently said to have been deposited conterminously. Recognizing a context, whatever exact system is in use, is a highly skilled process requiring extensive training and experience. Once identified and recorded, individual contexts are assigned numbers. A Harris Matrix is made up of a sequence of such numbers, arranged and linked according to *termini ante quos* and *termini post quos.* Although the Harris Matrix long predates the digital age, its simplicity and familiarity with most practitioners engaged in archaeological fieldwork has led to its easy adoption in digital contexts. The 'Virtual Environment for Research in Archaeology' project (VERA)[8], a JISC-funded Virtual Research Environment centered on the large scale Roman town excavation of Calleva Atrebatum (Silchester) in Hampshire, illustrates this. Part of the functionality of this VRE allows experts in various areas relevant to the excavation – numismatists, ceramic specialists, paleoethobotanists and so on – access to the so-called 'Integrated Archaeological Database' (IADB). The IADB stores all the data

8 http://www.vera.rdg.ac.uk/ (last accessed 23/8/2007)

from the excavation, and therefore forms the focal point of the post excavation processing activity, to which researchers from these areas contribute in a variety of ways. The Harris Matrix is used within the VRE as an interface with the IADB – photos of artefacts can be associated with context records, as can statistical data, plans, digitized section drawings etc. Within the VRE, the context records are hyperlinked back to the relevant records in the IADB. This therefore incorporates search functionality for the data within the visualization, rather than simply *representing* the data[9]. This, arguably, is a key possibility of Collaborative Work Environments and VREs for the humanities: the transformation of traditional and well-understood analogue modes of visualizing data from being simple representations to being interactive elements within the research process.

Extensive use is made across the arts and humanities of geospatial data (this was itself the subject of a separate Methods Network workshop in July 2007)[10]. Geographical Information Systems (GIS) has been in use for almost five decades, and the fields of history and archaeology in particular have extensively developed the potential for integrating geographical visualizations, (including 'traditional' 2D maps, plans and other spatial representations), into their practice. GIS applications are based on the representation of geographical features as points, lines and polygons. These can be used to visualize the data at various scales, or deployed with algorithms and software applications that carry out quantitative analyses, such as viewshed analysis, which calculates which parts of a landscape will be visible from a certain point. This application has, for example, proved important in studies on the processes that lead to the selection of sites of ritual importance in ancient societies[11]. Although a very significant level of increased functionality has been evident for some time as a result of this[12], it is only relatively recently that digital visualization has achieved the complexity here as it has elsewhere. An example of this that was extensively discussed at the July workshop is Agent Based Modelling (ABM). Agents – software units that respond in certain ways when subjected to certain parameters – are represented diagrammatically within a representation of an actual landscape. For example, a human population represented by such agents can be given instructions such as 'do not settle near water', or 'forage only where vegetation types X and Y occur' and so on. Such models cannot *reconstruct* or even *represent* the past in the way that conventional GIS-style visualization has, but they *simulate* human behaviour, at any scale, and in accordance with available input data about prevailing economic or environmental conditions (in the example given here these data could be comprised of hydrological evidence for ancient water coverage, and palynological evidence of vegetation types X and Y for the same period)[13]. However, such modelling is meaningless without effective visualization of the outputs. At a general level, this gives us a further example of the humanities moving beyond conventional

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9 Lynch, C 2007: "The shape of the scientific article in the developing cyberinfrastructure," *CTWatch Quarterly*, Volume 3, Number 3, August 2007. http://www.ctwatch.org/quarterly/articles/2007/08/the-shape-of-the-scientific-article-in-the-developing-cyberinfrastructure

10 http://www.nesc.ac.uk/esi/events/772 (last accessed 23/8/2007)

11 Winterbottom, S. J. and D. Long: "From abstract digital models to rich virtual environments: landscape contexts in Kilmartin Glen, Scotland". *Journal of Archaeological Science* Volume 33, Issue 10 (October 2006): 1356-1367

12 For the most comprehensive recent review, see Wheatley, D. and M. Gillings 2002: *Spatial technology and archaeology: archaeological applications of GIS.* London: Taylor and Francis.

13 See Dr. Mark Lake's presentation at Methods Network workshop on geospatial computing (23 and 24 July 2007, eSI, Edinburgh), "Agent based modelling: a question of scale": http://www.nesc.ac.uk/action/esi/download.cfm?index=3546

models of visual representation – in this case the conversion of real-world data into points, lines and polygons, for years the staple of GIS analyses – to a form of visualization which enables completely new ways of understanding the past.

Other excellent case studies of reconstruction and representation in the archaeological domain exist. One is the North Sea Paleolandscape Project[14]. Run at the University of Birmingham's VISTA laboratory, the reconstructs the landscape to the north and east of Britain as it would have been before it was inundated by the present-day North Sea. Arguably this project is more in line with 'conventional' arts and humanities visualization, inasmuch as any such thing exists, in that it reconstructs a non-extant entity using a 'mash up' of visual and non-visual data. However, it raises important questions of visualization across massive scale. To make use of large scale datasets in this way, a key need for arts and humanities is visualization technology which resolves it in the way the Paleolandscape project has demonstrated.

Geospatial visualization for arts and humanities e-science has a further dimension, in its role in information storage and retrieval. In 2006, the AHRC funded a workshop at Queens University Belfast under the Arts and Humanities e-Science Initiative entitled *Geographical Information Systems e-Science: Developing a roadmap.* This sought to discover whether 'GIS technology might facilitate the location, retrieval and interrogation of e-resources made available through the Data Grid'[15]. This approach, exemplified by projects such as TimeMap[16] and the Vision of Britain[17] site (both represented at the workshop) which link descriptions of data objects (e.g. in metadata and library catalogues) using constant references in space and time, and search interfaces where the user retrieves information from multiple collections by pointing and clicking on maps. The workshop concluded that such 'what, when, where' methods of storing and managing data in grid and networked environments have a great deal of potential, although it was agreed that the 'when' and 'what' would be easier to deal with at a semantic level than the 'where', as georeferencing across multiple geodectic systems can be a complex business[18]. Nonetheless the potential benefits highlighted by the workshop are based around the use of imagery to manage e-resources in the humanities. It should be noted that this approach has been used to very great effect by AHDS Archaeology/Archaeology Data Service. The ArcSearch facility provides a 'point and click' map of the UK as an interface to its collections, linked to a faceted classification system. A search can thus be conducted spatially within a user-defined area of the map **and** semantically by keyword. As argued by Stuart Jeffrey at the Edinburgh workshop[19], this is a highly effective way of delivering very diverse resources. It is also a further example of a very powerful use of imagery in the humanities in an e-science context. Linking e-resources using geospatial map data makes little sense outside virtual or networked environments, and a stated aim of the arts and humanities e-science agenda is to add value to such e-resources by linking them together in novel ways.

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14 For a full case study see http://www.ahessc.ac.uk/gaffney2-case-study (last accessed 23/8/2007).

15 http://www.ahessc.ac.uk/files/active/0/GIS-report.pdf (last accessed 23/8/2007)

16 http://www.timemap.net (last accessed 19/8/2007)

17 http://www.visionofbritain.org.uk (last accessed 10/8/2007)

18 Hill, L. L. 2006: Georeferencing: The Geographic Associations of Information. Linda L. Hill Cambridge, MA/London: The MIT Press.

19 "Finding your way to the map: the challenges of delivering geospatial data to archaeologists": http://www.nesc.ac.uk/action/esi/download.cfm?index=3543 (last accessed 23/8/2007)

This short paper has reviewed some examples of how the use of visual techniques – even those that would be regarded as basic by experts working in the field of visualization – are driving significant elements of the humanities e-science agenda in its current early stages. This agenda, and its relationship with visualization, will surely become far more complex as the current pilot projects mature, and beyond their lifetimes. However, a common theme that has emerged thus far is that e-science is adding new meaning the *concept* of the image for the humanities. Previously in these disciplines, an image would generally be purely illustrative: as a research output it would be an attribute of accompanying text, and would be unlikely to mean a great deal to the reader without a legend, annotation, labelling etc. As we have seen here however, humanities e-science enables the image as a research tool in its own right, as a means of linking and accessing data. This could be the digitalization of long-familiar modes of representing data in VREs, interpolation where lacunae exist, or representing abstract or simulative concepts, such as scenarios derived from Agent Based Modelling exercised. It is argued here that humanities e-science is – or at least should be - acting as an agent driving the evolution of the concept of the image for these disciplines. Extensive future interdisciplinary collaboration between humanities e-science ‘early adopters’ and professionals in all branches of the existing field of visualization will be essential if the great possibilities inherent in this are to be realized.