Archeologia e Calcolatori
20, 2009, 27-35

FROM ANARCHY TO GOOD PRACTICE: THE EVOLUTION OF STANDARDS IN ARCHAEOLOGICAL COMPUTING

1. Introduction

Standards are essential to archaeological computing. From the earliest days of punched cards the discipline turned to computers and quantitative methods to help identify patterning in the archaeological record, and to systematise its data. Without standards there could be no patterning. However, there has also been some tension concerning the adoption of standards, with a feeling that standards can stifle creativity and evolution. Caught halfway between the Sciences and the Humanities, most archaeologists were reluctant to adopt standardised systems. This led to what has been described as the "not-invented-here" syndrome, by which each researcher thought their own problem was unique and deserved a unique solution. However, archaeologists also recognised that the tendency to reinvent the wheel and an overall lack of vocabulary control were combining to create an archaeological Tower of Babel.

Unfortunately, this rarely led to action. Early standards were imposed as much by the computing industry as by practitioners. Gradually, and with pressure from the worlds of libraries, museums and heritage management, archaeologists have adopted documentation standards – Dublin Core, CIDOC CRM, and MIDAS XML. However, these are still permissive standards – they lead to Guides to Good Practice, or Best Practice, but not Required Practice. This paper assesses the importance of standards initiatives and asks where we go from here. Do modern advances in natural language processing and data mining mean that databases and structured and controlled text have been superseded, or will we only reap the rewards of information technology if we learn how to describe our data in standard ways? Does the prospect of an interoperable Semantic Web render standards redundant, or does it depend upon standards if it is to function effectively?

2. What do we mean by standards?

In the English language the word standard can mean «something to which others are expected to conform», but it can also mean «the degree of excellence required for a particular purpose» – something can be of low or high standard. This association may not just be coincidental. Something that *conforms* to a standard may also be assumed to *be* of *high* standard – having been done with care and attention to detail.

Before we go further we should therefore be careful to define what we mean by standards. There are three broad types that have relevance in archaeology:

1. Technical standards: hardware and software.
2. Content standards: data recording systems.
3. Metadata standards: data documentation.

2.1 *Technical standards*

During the infancy of archaeological computing there was much concern with hardware and software standards. In the early days of technology there were many competing and incompatible computer systems, and many competing software applications. This also led to a fear that archaeologists operating in isolation were wasting energy by continually re-inventing the wheel, but that it was also leading to a situation where their data could never be integrated and shared. Whether we like it or not, the market dominance of Microsoft has to a large extent solved this problem. Most archaeologists are now familiar with some form of Windows-based operating system, and most of us use a PC or an Apple computer which can emulate a PC.

Whereas early surveys of archaeological computer usage (Richards 1986; Booth, Grant, Richards 1989) revealed an astonishing array of different applications programs, the market has also led to the dominance of particular software venders. The Microsoft Office suite dominates the spreadsheet, word-processor and database market. In more specialist areas there are also world-leading suppliers – AutoDesk for CAD, ESRI for GIS and so on. Even if one chooses to use another product the dominance of particular products ensures that any manufacturer will provide export facilities in standard file formats, such as DXF, or an ESRI shapefile. None of this came about because archaeologists were able to choose and agree on the best solution – standards were forced upon us – and the rest of the world – by the free market.

2.2 *Content standards*

Archaeologists have also been concerned with data recording standards. The development of computerised database systems has gone hand-in-hand with the standardisation of manual recording systems. The question of whether we should all record our excavations in the same way, with the same boxes, and the same codes, has occupied a great deal of attention. On the one hand this links to the idea of quality control and those minimum recording standards that should apply if one is destroying a site by excavation. There is also the issue of comparability of data and the question that unless data are recorded using the same parameters then it will never be possible to compare them. On the other hand there is the view that there is no such thing as an objective

archaeological record – one records or observes those factors that are strictly relevant to the research question under examination. In one form this view is similar to that which argues that every project is unique and that something "not invented here" will not be useful. However, there is also an argument that this diversity is a strength, and that the discipline will stagnate if we are all forced to use the same recording systems (Richards 1985).

In practice we have witnessed the development of a number of standard data recording systems, but not a single system that everyone uses. Large organisations have tended to promote particular ways of doing things. For a long time in England variants of the English Heritage CEU Delilah site recording system competed with the DUA single context system (Jefferies 1977; *DUA* 1980). Through time these systems have tended to come closer together (see, for example, Roskams 2001). Whilst preserving some unique features they have defined a lowest common denominator of recording fields across which comparison is possible. Occasionally new projects and new ways of doing things have led to the appearance of new systems – as in the site recording system developed by Framework Archaeology employed at Heathrow (Beck 2000). The internationalisation of archaeology has also led to overseas innovations being adopted, such as the adoption of the Swedish Monuments Board Intrasis recording system in other countries, including the UK[1].

Similarly, we have seen a smaller number of monument inventory systems emerge from the wide range of individual sites and monuments records systems (see, for example, papers in Rahtz, Richards 1989; Robinson 2000). Once again though, this has largely been the result of commercial dominance (for example by the Exegesis HBSMR system in England)[2], rather than fitness for purpose, and a discipline as small as archaeology cannot support many rival systems at a commercial level.

Some level of standardisation is essential to the discipline. Archaeology is about the search for patterning – the repeated and consistent re-occurrence of a range of attributes may define a type of pottery or a form of burial for example. It is how Childe defined a culture as regularly reoccurring and associated variables (Childe 1929, v-vi). Without standards there can be no patterning. Unless we use the same terms to describe an artefact there can be no artefact types, no typologies, and no classification – an activity which is fundamental to the discipline. As soon as archaeologists used the first punched card machine they imposed standards. The pottery sherds recorded could only be meaningfully compared if there was agreement on the attributes to be measured and on standardised ware descriptions (Richards, Ryan 1985).

[1] http://www.intrasis.com/.

[2] http://www.esdm.co.uk/HBSMR.asp.

However, the fashion in the 1970s and 1980s for the development of universal archaeological databases (Chenhall 1971; Arroyo-Bishop 1989) has now given way to a greater realism, and an appreciation that centralised standardised systems will never be adopted in a world where there are diverse practitioners, and geographical, historical and political drivers behind diversity. There is now greater emphasis on distributed data systems, and upon interoperability, supported by the development of documentation standards (e.g. Kilbride 2004).

2.3 *Metadata standards*

During the 1980s and 1990s the emphasis on standardised recording systems was replaced by greater concern with documentation standards. The rise of the Internet has highlighted that one does not have to use the same computer or even the same application to communicate with other computers and other applications. Networks of computers can talk to one another and share information, and a user can access a range of data sets without leaving their web browser. There has been a realisation that it is not really important which machine or programme is used, but that proper documentation of the archaeological content is much more important to allow computers to talk to one another.

Metadata standards have emerged as the key standards which allow data sets to be interoperable, and make their discovery over the Internet possible. Many of these new standards have emerged from the library world and are international in scope. The Dublin Core element set is an ISO standard with scope for archaeological extensions[3]. Similarly the CIDOC-CRM is a cross-discipline high level ISO standard which seeks to define types of data elements, and the relationship between them[4]. If datasets are ever meaningfully to be integrated and compared it provides an essential mapping. It provides the infrastructure for an archaeological Semantic Web.

Metadata standards are generally flexible and permissive. They are standards about data, they do not determine the data itself (Wise, Miller 1997). Thus the ADS Guides to Good Practice series does not dictate *how* one should record something; rather it says that *if* you are going to record something this is what you should record about it if anyone else is going to be able to find and reuse your data[5].

[3] http://dublincore.org/.

[4] http://cidoc.ics.forth.gr/.

[5] http://ads.ahds.ac.uk/project/goodguides/g2gp.html.

3. Standards in action

However, to undertake meaningful cross-searching of disparate data sets two other things are essential. Firstly, one needs agreed technical standards-communications protocols, such as Z39.50 (Miller 1999)[6] or OAI-PMH[7]. Secondly, one still needs some level of agreement about content standards and vocabulary control. The painstaking work of the Data Standards Unit at English Heritage and of the Forum for Information Standards in Heritage (FISH)[8] group in developing agreed thesauri of Monument Types and Period terms now starts to bear rewards when one integrates monument inventories for different regions in applications such as ADS ArchSearch[9] or the English Heritage Gateway[10]. For artefact types the Museum Documentation Association artefact thesaurus[11] or Getty Art and Architecture thesaurus[12] have similar importance. Archaeology is generally more advanced than other humanities disciplines in its adherence to standards (Richards, Hardman 2008). Generally, historians do not comply with content and metadata standards. If standards are a measure of how scientific a discipline is, then Archaeology is definitely further towards the scientific end of the spectrum, with greater emphasis on the importance of testing and re-use of other people's data. However, even within the discipline there is considerable variation in standards compliance. It is easier to integrate several animal bones databases, or a number of monument inventories, than it is to integrate the databases of a number of pottery or lithic specialists for instance. This has implications for identifying the low-hanging fruit for a number of cyber-infrastructure or eScience projects now under consideration (Kintigh 2006; Snow *et al.* 2006).

But to achieve interoperability at a European level much more standards work is required (Hansen 1992; Kilbride 2004). The variability in European languages, and archaeological concepts, creates special problems (Oberländer-Târnoveanu 2005). The ADS ARENA[13] project dodged the language issue by mapping local classifications to the English Heritage thesaurus (Kenny, Kilbride, Richards 2003; Kenny, Richards 2005). The Council of Europe has developed a Bronze Age thesaurus with mapping between a limited number of European languages (Barber *et al.* 1995; *Council*

[6] http://www.loc.gov/z3950/agency/.
[7] http://www.openarchives.org/OAI/openarchivesprotocol.html.
[8] http://www.fish-forum.info/.
[9] http://archaeologydataservice.ac.uk/.
[10] http://www.heritagegateway.org/.
[11] http://www.mda.org.uk/archobj/archcon.htm.
[12] http://www.getty.edu/research/conducting_research/vocabularies/aat/index.html.
[13] http://ads.ahds.ac.uk/arena/.

of Europe 1999). To undertake a comprehensive thesaurus project would require many decades of investment.

4. Do we still need standards?

But is all this standards investment really worth it? In the 2000s most archaeologists will turn to Google to cross-search Internet resources. As everyone knows, Google indexes unstructured free-text data and returns the most relevant hits. Does it matter that no standards may have been applied in the classification used, as hopefully all occurrences will be returned? Or will they?

In 2007 the Archaeology Data Service embarked on the Archaeotools project[14], with funding under the AHRC-EPSRC-JISC eScience programme, and in collaboration with the Natural Language processing group of the Department of Computer Science at the University of Sheffield (Jeffrey *et al*. 2009 and forthcoming). The project aims to replace the "type-and-hope" search engine philosophy with a more reliable "point-and-click" approach, allowing users to browse large datasets.

In the first phase of the project over one million Dublin Core metadata records for archaeological sites and monuments have been indexed according to pre-defined ontologies. The resulting faceted classification interface classifies the sites according to three primary facets – what, when, and where – each based on mapping the record to a standardised thesaurus. The degree of concordance of the records to the thesauri provides an interesting index of how far each resource included within the one million record database has complied with standardised thesauri.

In the second phase of the Archaeotools project techniques of natural language processing have been employed to search for "what", "when", and "where" terms included in the thesauri within 1000 grey literature reports, and integrate the index within the faceted classification browser, providing access to the unstructured grey literature alongside the more structured Dublin Core metadata database records. In the UK, as elsewhere in Europe, gaining access to grey literature reports of developer-funded archaeological fieldwork is extremely difficult. At the Archaeology Data Service we are creating an online library of grey literature[15]. However, cataloguing and indexing this library by hand would be a major task. In Norway the Museums Documentation Project used an extensive labour force over many years to manually mark-up the key index terms within historical archaeological archives in XML (Holmen *et al*.

[14] http://ads.ahds.ac.uk/project/archaeotools/.

[15] http://ads.ahds.ac.uk/catalogue/library/greylit/index.cfm.

2004). It is not feasible to extend such a labour-intensive manual approach on a large scale. However, if the process can be automated then the dream of an archaeological Semantic Web becomes a reality (Richards 2006). Once again, standards are critical to achieving a high success rate in automatically extracting index terms from the grey literature reports, as the more the reports adhere to standardised vocabulary the higher the success rate.

5. Conclusion

In summary, there are three types of standards. At the bottom, and least influenced by the Heritage sector, are technical standards. These include file formats, communication and computer standards. In the middle are content standards. This is the area within which the Heritage sector can exercise innovation, and must do so to stop stagnation. Finally there are the metadata standards that support resource discovery and integration. As Steve Stead said at an AHRC ICT Methods Network workshop held in October 2007:

«The pragmatic result of any work on Standards should be that our data is consistent, our process documented and our documentation explicit. If we achieve that then our work will survive as the profession as a whole will be able to reuse its results. If we fail in any part of this then our data is damned and can be safely deleted at the end of the project as it is no use to man nor beast» (Stead 2007).

In conclusion, archaeological computing standards have evolved enormously in the last 40 years. Far from making them redundant, the Internet Age and the development of sophisticated search algorithms give data documentation standards fresh importance. At first sight one might assume that the power of search engines such as Google means that structured data and the use of pre-defined terms have become superfluous. On the contrary, and as anyone who has discovered hundreds of false hits when undertaking a free text search of the Internet will know, the Semantic Web can only function if the meaning and relationship of data items is mapped to pre-defined standardised ontologies that carry international agreement.

Julian D. Richards
Department of Archaeology
University of York

REFERENCES

Arroyo-Bishop D. 1989, *The ArchéoDATA Project*, in Rahtz, Richards 1989, 69-86.

Austin A., Richards J.D., Pinto F., Ryan N. 2002, *Joined up writing: an Internet portal for research into the historic environment*, in G. Burenhult (ed.), *Archaeological Informatics: Pushing the Envelope CAA2001*, BAR International Series 1016, Oxford, Archaeopress, 243-251.

Barber M., Regteren Altena J.F. van, Brandt R. 1995, *European Bronze Age Monuments: A Multilingual Glossary of Archaeological Terminology. A Pilot Project Covering Denmark, France, the Netherlands, and the United Kingdom*, Amersfoort.

Beck A. 2000, *Intellectual excavation and dynamic Information Management Systems*, in G. Lock, K. Brown (eds.), *On the Theory and Practice of Archaeological Computing*, Oxford, Oxbow Books, 73-88.

Booth B.K.W., Grant S.A.V., Richards J.D. (eds.) 1989, *Computer Usage in British Archaeology: Second Edition 1989*, Birmingham, IFA Occasional Paper 3, Institute of Field Archaeologists.

Chenhall R.G. 1971, *The archaeological data bank: a progress report*, «Computers and the Humanities», 5, 3, 159-169.

Childe V.G. 1929, *The Danube in Prehistory*, Oxford, Clarendon.

Council of Europe 1999, *European Bronze Age Monuments - Glossary*, Strasbourg.

DUA 1980, *Department of Urban Archaeology, Site Manual: Part 1, the Written Record*, London, Museum of London.

Hansen H.J. 1992, *European archaeological databases: problems and prospects*, in J. Andresen, T. Madsen, I. Scollar (eds.), *Computing the Past. Computer Applications and Quantitative Methods in Archaeology*, Aarhus, Aarhus University Press, 229-237.

Holmen J., Ore C.-E., Eide O. 2004, *Documenting two histories at once: digging into archaeology*, in Magistrat der Stadt Wien - Referat Kulturelles Erbe - Stadtarchäologie Wien (eds.), *Enter the Past: The E-way into the Four Dimensions of Cultural Heritage*, BAR International Series 1227, Oxford, Archaeopress, 221-224.

Jefferies J. 1977, *Excavation Recording: Techniques in Use by the Central Excavation Unit*, London, Department of Environment.

Jeffrey S., Richards J.D., Ciravegna F., Waller S.J., Chapman S., Zhang Z. 2009, *Digging up Data: The Archaeotools Project, Faceted Classification and Natural Language Processing in an Archaeological Context*, Philosophical Transactions of the Royal Society A, 367, 2507-2519.

Jeffrey S., Richards J.D., Ciravegna F., Waller S.J., Chapman S., Zhang Z. forthcoming, *When ontology and reality collide: the Archaeotools project, facetted classification and natural language processing in an archaeological context*, in *Proceedings of the CAA 2008 Conference*, Budapest, Archaeolingua.

Kenny J., Kilbride W.G., Richards J.D. 2003, *Enter the ARENA: preservation and access for Europe's archaeological archives*, in M. Doerr, A. Sarris (eds.), *CAA2002: The Digital Heritage of Archaeology. Computer Applications and Quantitative Methods in Archaeology 2002*, Heraklion, Crete, Archive of Monuments and Publications Hellenic Ministry of Culture, 349-353.

Kenny J., Richards J.D. 2005, *Pathways to a shared European information infrastructure for Cultural Heritage*, «Internet Archaeology», 18 (http://intarch.ac.uk/journal/issue18/kenny_index.html).

Kilbride W.G. 2004, *The Danube in prehistory in the digital age: towards a common information environment for European archaeology*, «Archeologia e Calcolatori», 15, 129-144.

Kintigh K.W. (ed.) 2006, *The promise and challenge of archaeological data integration*, «American Antiquity», 71, 567-578.

Miller A.P. 1999, *Z39.50 for All*, Ariadne 21 (http://www.ariadne.ac.uk/issue21/z3950/intro.html).

Oberländer-Târnoveanu I. 2005, *Multilingual access to Cultural Heritage resources*, «Internet Archaeology», 18 (http://intarch.ac.uk/journal/issue18/oberlander_index.html).

Rahtz S.P.Q., Richards J.D. (eds.) 1989, *Computer Applications and Quantitative Methods in Archaeology 1989*, BAR International Series 548, Oxford.

Richards J.D. 1985, *Standardising the record*, in M.A. Cooper, J.D. Richards (eds.), *Current Issues in Archaeological Computing*, BAR International Series 271, Oxford, 93-102.

Richards J.D. (ed.) 1986, *Computer Usage in British Archaeology*, Birmingham, IFA Occasional Paper 1, Institute of Field Archaeologists.

Richards J.D. 2006, *Archaeology, e-publication and the semantic web*, «Antiquity», 80, 970-979.

Richards J.D., Hardman C. 2008, *Stepping back from the trench edge: an archaeological perspective on the development of standards for recording and publication*, in M. Greengrass, L. Hughes (eds.), *The Virtual Representation of the Past*, Digital Research in the Arts & Humanities, Ashgate, 101-112.

Richards J.D., Ryan N.S. 1985, *Data Processing in Archaeology*, Cambridge, Cambridge University Press.

Robinson B. 2000, *English Sites and Monuments Records - Information, Communication and Technology*, in G. Lock, K. Brown (eds.), *On the Theory and Practice of Archaeological Computing*, Oxford, Oxbow Books, 89-106.

Roskams S. 2001, *Excavation*, Cambridge, Cambridge University Press.

Snow D.R., Gahegan M., Giles C.L., Hirth K.G., Milner G.R., Mitra P., Wang J.Z. 2006, *Cybertools and Archaeology*, «Science», 311 (5763), 958.

Stead S. 2007, *AHRC ICT Methods Network Workshop. Space and Time: Methods in Geospatial Computing for Mapping the Past*, Welsh E-Science Centre, Cardiff University, 10-11 October 2007 (http://www.methodsnetwork.ac.uk/redist/pdf/act24report.pdf).

Wise A., Miller A.P. 1997, *Why metadata matters in archaeology*, «Internet Archaeology», 2 (http://intarch.ac.uk/journal/issue2/wise_index.html).

ABSTRACT

This paper reviews the importance of standards in archaeological computing and traces their development, and the tensions surrounding their deployment. Three categories of standards are defined: technical, content and metadata standards. Standards are shown to be particularly important to current initiatives which seek to achieve interoperability between distributed electronic resources. If we are to achieve the potential advantages of a Semantic Web for heritage data over traditional search engine technologies, standards are essential. The paper introduces the Archaeotools project, which is seeking to create a faceted browse interface to archaeological resources. It concludes that data standards and ontologies are essential to the success of such projects.