Geo-ICT and the role of location in Science, part 2: Archaeology

'Archaeology is the determination of human behaviour from the location of cultural objects'

In this second article in our series on the value of GIS for different sciences we turn our focus to Archaeology. In this discipline, GIS is being used much more widely and intensely than among historians (see: our first article). However, the integration of GIS is by no means complete. The databases have been filled in by eager archaeologists, but these are not always suitable for GIS-analyses. Also, the financial resources needed for innovative research methods (such as GIS) are lacking. This is a missed opportunity for both for parties – archaeologists and GIS-designers. On the one hand, GIS certainly has potential for archaeological research. On the other hand, archaeologists could be of great value when it comes to 3- and 4D-visualisations.

Archaeology is a discipline that is, in many ways, particularly suitable for the use of GIS. Unlike historians, who almost naturally tend to focus on temporal dimensions, archaeologists have a natural interest in both time and location/place. The first studies in 'spatial' archaeology already appeared during the 1970s. As Hans Kamermans, Senior Lecturer in Archaeology at the University of Leyden, has strikingly pointed out: "Archaeology is the determination of human behaviour, from the location of cultural objects." Moreover, archaeologists have started to digitalise their data much earlier than historians. The use of computers and computer-based analyses is therefore much more imbedded in their research methods. Also, the introduction of GIS, during the mid 1980s, fitted in well with the dominant quantitative methodology at the time – also known as the 'New Archaeology'. Methodological objections, as the ones we encountered with historians, are therefore not to be expected in this field.
To what extent have these positive circumstances indeed been translated in intensive use of GIS among archaeologists? The annual proceedings of *Computer Applications and Quantitative Methods in Archaeology* (CAA), a scientific society, may give us a good indication. The first European paper dedicated to the application of GIS in archaeology was presented at a CAA-conference in 1988. With the exception of 1989, when no such paper appeared, the number of articles increased to five per year thereafter. According to Hans Kamermans, who has been a secretary of the CAA for 12 years, the real break-through came in 1995. In that year, 15 papers were presented in which the use of GIS for collecting, visualising and analysing of archaeological data was the main focus. Moreover, from 1995 onwards these papers were now collected under a separate heading: 'spatial analyses' or simply 'GIS'. During the same period, several hundreds of articles and tens of edited volumes were published on GIS in Archaeology. Also, at least one journal was founded that deals exclusively with this topic. All these developments signify a growing interest in GIS among archaeologists.
When we compare the developments in archaeology to our growth model (see: 'In search of an explanatory model' – on our website) we see that the different phases that have been identified by us are more or less in line with reality. Let's take the development in the Netherlands as an example. According to Kamermans it were the publications of a small number of American 'champions' during the late 1980s, who used GIS to predict the location of archaeological sites, who raised an interest among archaeologists in this country. This resulted in 1988 in a paper by the Leyden archaeologist Milco Wansleeben at the CAA-conference that we mentioned earlier. Two years later the American Ken Kvamme came to Leyden to inform his Dutch

colleagues on the ins and outs of 'predictive modelling'. It was not until 1995, however, that archaeologists here started to take a serious interest and that at conferences in the Netherlands and elsewhere in Europe GIS became a major topic.
The next step in our model, GIS-training for academic researchers, has been more or less missing in reality. The small number of Dutch scientific archaeologists who use GIS on a regular basis are all self-taught. However, GIS *has* gradually gained a place in university teaching programmes. In Leyden, all Bachelor students take a first-year-module on 'data-analysis and computer applications', in which GIS is introduced, and a third-year-course in 'GIS'. Due to limited resources, however, the latter is limited to a series of lectures, which means that students do become familiar with the theory, but do not receive the practical training needed for a successful application of GIS in their research.
It seems that the development slows down in the next phase of our model: the design and creation of large-scale databases. As early as the late 1970s, archaeologists have been digitalising their data. However, since these databases originate from a pre-GIS-era, the data have not been collected and digitalised with the possibilities of GIS in mind. As a result, the data from different types of research/research methods have never been integrated sufficiently. On top of this, the willingness among scientists to share their data has been limited – particularly if it were with foreign colleagues/ colleagues from abroad.
The so-called 'Treaty of Malta' (1992) obliges European archaeologists to record or register their findings following certain guidelines. In the Netherlands, this has resulted in the creation of a new data-system, ARCHIS II, managed by the *ROB* (the *National Service for Archaeological Heritage*), in which all well-known archaeological sites have been collected. However, the system is far from perfect. For example, the way in which the data have been selected and presented is not at all in line with the wishes or needs of scientific researchers. This is partly due to the fact that the system is above all aiming at the large group of non-academic, professional archaeologists that use the data for so-called 'Cultural Resource Management'. According to Professor Julian Richards, programme director of an MSc in Archaeological Information Systems at the University of York (UK) and co-editor of *Internet Archaeology* (an online journal), British archaeologists are faced with similar problems. The *Sites and Monument Records*, the British equivalent of *ARCHIS*, are being used for scientific research, but were however originally designed as planning tools. The Scottish *National Monuments Record* has become freely accessible online recently, and provides a map-based interface. For researchers, availability of suitable digital map bases is a significant constraint. The Digimap agreement has made the national Ordnance Survey maps available to academic institutions, but for a fee, and according to strict terms and conditions of use, resulting in limited accessibility.
Funded by the NWO (Dutch equivalent of *AHRC*) Kamermans and his colleagues from Groningen and Amsterdam have carried out a large research project on the usefulness of the predictive models, in which GIS plays such a crucial role. However, now that the time has come to optimise the models and to make them suitable for academic use (i.e. to reap the benefits) the funding is no more. In order to survive most archaeology departments have founded their own commercial departments – hoping to seal interesting sites. But then, delivering a project report is often the main goal, which means that there is simply no time (read: money) for developing a synthesis, trying out new instruments or testing an alternative methodology (GIS).
Thus, the most important obstacles on the way to a further integration of GIS are clear: the lack of accessible data and financial means for innovative research. But to what

extent should we see this as a wasted opportunity: in other words, what is the value for GIS and how could a further integration of GIS benefit the discipline? According to Richards the most important contribution/surplus value of GIS is the fact that it enables archaeologists to collect various types of data in one, single system. Both with surveys and excavations, different research methods are being used: e.g. aerial photography, systematic surveys, geomorphology and hydrology. But up until the introduction of GIS it was not possible to *integrate* the results of these different 'measurements'. GIS *is* often and routinely used for this by archaeologists – and much more widely than by their colleagues in the historical sciences. The same also applies to the *visualisation* of data in digital maps. However, for a third level on which GIS can be applied, that of *spatial analysis* is still only occasionally used. On the other hand, more traditional types of analyses such as visibility, shortest distance and cost-distance *have* become more popular again thanks to the introduction of GIS. This is very much related to a fourth level on which GIS, from the late 1980s is being applied: that of prediction. Based on spatial information of the environment, e.g. soil type, the presence of water, etc. models have been developed which can be used to predict the location of archaeological sites. For a long time, the inductive form of 'predictive modelling' was particularly popular in the US and in the Netherlands, but faced fierce criticism in Britain and other parts of Europe. According to Richards, British archaeologists generally see predictive modelling as unreliable, boring and old-fashioned – due to its strong resemblances with the quantitative analyses of the New Archaeology from the 1970s. Only if we move away from this 'physical determinism', taking into account also cognitive aspects (such as the way in which people have perceived their environment in different times), predictions could contribute to a better understanding of historical societies. Ironically, the archaeologists who try to come up with more deductive models, turn to traditional methods of analyses to do so – the same methods that they criticised themselves before.

Besides the integration of non-environmental factors in the predictive models, Richards and Kamermans expect archaeological GIS to develop significantly in two other areas. Firstly, an aspect that we already saw in our story about historical GIS: incorporating a temporal dimension. Surprisingly, it is mostly archaeologists, rather than historians, who are actually working on this process. A second area in which their expectations are high is that of truly 3D-visualisations. Archaeologists are not only interested in the x, y location of an object, but also in its depth (z) – because it reveals a lot about its date of origin. According to both Richards and Kamermans it is also in these three developments that we can find the contribution of archaeologists to the further improvement of GIS. If they indeed succeed in optimising their predictive models, incorporating a temporal dimension in GIS and in making truly 3D visualisations possible, then there instruments would also be of great interest to scientists in other disciplines.

Niels van Manen, Henk Scholten and Rob van de Velde
SPINlab, Vrije Universiteit, Amsterdam