‘It’s all Fun and Games to You, Isn’t It?’: The Assimilation of New Technologies Introduced by Archaeology’s ‘New Generation’

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Improvements and adaptations in technology have been aiding archaeologists since the birth of the modern profession. But never has the pace of development been as fast and as far-reaching in its application as it is today. As a result, the onus to understand this technology and to apply it to archaeology is now not only on established professionals and academics, but on the ‘New Generation’ of archaeologists.[1] There is an understandable reluctance to use new technology and, with much of this technology coming from the world of video games or from hobbies, the amateur archaeologist has often assumed responsibility for assimilating new technologies. Amateur archaeologists are not, however, typically critical in their use of the technology. It can be frustrating to see such technology being used unproductively, even by trained archaeologists. Such archaeologists tend to trivialise the discipline through the inefficient use of technologies designed for fun and games. To quote the British phrase, which expresses exasperation that serious thought has not been given to a subject: ‘It’s all fun and games to you, isn’t it?’

Archaeologists today should work to ensure that the profession remains vibrant and modern. Many outside the discipline still perceive archaeology as antiquated and reluctant to incorporate new technologies into their work. Much of the new technology that will be discussed in this paper is created for the home entertainment industry but, as will be shown, this technology has the potential to be useful outside purely domestic and social spheres. These new technologies offer innovative ways to make archaeology more accessible and efficient, by offering new methods for teaching as well as for surveying large areas accurately and precisely, and with greater ease. This paper will demonstrate some of the ways in which the New Generation is looking to assimilate new technologies into its work. It will critique the use of these new technologies in relation to older applications of technology, and it will examine the viability of technologies not yet being used in the discipline of archaeology.

Problems Facing Archaeology

There are some major difficulties within archaeology as an academic discipline at the present time. One major obstacle concerns automation and innovation. Gary Lock elucidated the distinction between automation and innovation ten years ago, and this

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[1] The Institute for Archaeologists has defined ‘New Generation archaeologists’ as students and early career professionals, normally under the age of thirty. Discussion at New Generation Special Interest Group AGM (Glasgow, 9-11 April 2014).

distinction remains vitally important to the advancement of the discipline.[2] Automation is the computerisation of methods and techniques that are already in use, and innovation is the use or invention of new ideas, methods and equipment. This can be seen in the use of iPhone 'apps', which apply archaeology both as games and as a supplement to the explanation offered by a museum stand. Initially this seems to represent an effective innovation that enables the museum exhibit to be taken beyond the museum, and to thereby bring the excavation to the individual. Nevertheless, so many of these apps have been created that it often seems as though they are being automated; while this is not a bad thing in itself, the automation arguably stifles the creativity of archaeologists trying to introduce new technologies to the discipline. This can be demonstrated with the Romans app for the Corinium museum. Its subtitle states 'Discover and Explore Roman Cirencester from your iPad for only £2.50', and the app can be viewed from anywhere. While it may appear innovative to bring the museum into domestic spheres, it is possible to question the extent to which such features are simply automating tasks that are already being carried out by the museum, thus trivialising the research that has been completed for the museum. The distinction between automation and innovation can, therefore, seem blurred. While automation is not necessarily negative for the discipline, and does allow for the dissemination of information to the public, innovation (and the assimilation of new technologies) is what carries the discipline forward.

The use of a Geographic Information System (GIS) in an excavation is a more pragmatic example. A GIS is primarily a system that uses layers stored in a database, and which specialises in spatial coordinates, with a global positioning system. The database element is being exploited to store archaeological information beyond spatial coordinates. For example, information is stored about archaeological sites, from archaeological contexts to site drawings. But now that another new technology is being used for so many sites, it no longer seems like an innovation (although the use of this technology is more common in European countries excluding the United Kingdom). Therefore, care must be taken in defining an innovation over an automation in relation to a technological advancement. While it may seem as though an automation is helping to educate a wider audience, there is a risk of stagnation with the technology as new models and operating systems become endlessly recycled.

An additional concern surrounds the identification, preservation and dissemination of the archaeological record. In particular, with climate change, the likelihood of natural events not only exposing archaeological sites but also destroying them is increasing. Conventional methods of recording sites are becoming too time-consuming and expensive. There were a vast number of sites exposed in the course of January and February 2014 in Britain alone that are presumed to have gone unrecorded, as there are no reports on the recording of these sites before their destruction.[3] There are not enough archaeologists to identify, record and protect these sites. With the current methods of assessing archaeological features, it can take several days to record just one site. Furthermore, a number of county-level archaeologists have to deal with huge amounts of archaeology in difficult or varying terrain, so already rely on specialist equipment to reach some sites. The database of archaeological sites is constantly growing in the United Kingdom, thanks in part to recent legislation which means that construction projects have

[2] Gary Lock, *Using Computers in Archaeology: Towards Virtual Pasts* (London: Routledge, 2003).

[3] For example, skeletons were uncovered at Borth by storms, and it is thought that these had not been discovered previously. See Hywel Trewyn, 'Bronze Age Walkway in Borth Uncovered by Storms,' *Daily Post*, 20 January 2014, accessed 18 July 2014, http://www.dailypost.co.uk.uk/news/north-wales-news/bronze-age-walkway-borth-uncovered-6528481.

to mitigate (and pay) for archaeological discoveries. Climate change poses a great threat, particularly to coastal sites, as these are most at risk of erosion from natural processes. No legislation can bring an artefact back from destruction. With this in mind, can archaeology assimilate new technologies in order to identify, record and preserve these sites?

The final issue to be raised in this article is the rise of the Internet and of communities created by the Internet. Archaeology has not yet embraced the potential of the Internet, which is now used by a third of the world's population. Seventy-three percent of the British population access the Internet daily.[4] Many archaeologists do not blog about their work, thereby denying a wider audience access to valuable information about their discoveries, many of which are interesting and relevant to the public. This is a less prominent problem within academic circles, where blogging is encouraged. The commercial sector is also slowly taking up blogging as a means of advertising. Social media is changing the way that archaeologists are teaching, and it is also changing the way that wider academia is being taught; the Internet has helped to ensure that education has gradually widened to the general public. Today the Internet provides a place where anyone can learn almost anything, and do almost anything to the benefit (or otherwise) of his or her community. Social media now operates on a new, much larger scale than ever before, affecting people from all walks of life and offering a viable alternative for all ages and abilities as a result of its relative cheapness and accessibility. Though Internet technologies (which are free or affordable, particularly in relation to photogrammetry) are now commonly used by graphic designers, they are simply not known within archaeology, due to the lack of training available.[5] There are so many ways in which the Internet can help archaeologists, but the understanding and creation of new technologies is left to computer scientists. Consequently, such work only reaches archaeologists in a diluted form. How is the new generation attempting to combat the above-mentioned problems?

Solution 1: Xbox Kinect and the 'Excavation in a Box'

One potential solution that tackles the educational aspect involves a novel use of the Xbox Kinect. The Xbox Kinect is a motion-capture device that is a complementary hardware to the Microsoft Xbox 360 (and later versions, such as the Xbox One) gaming console, and costs around £130 (as of 20 June 2014).[6] Jasmine Noble-Shelley was inspired to integrate the Xbox Kinect into the 'excavation in a box' activity (a sandpit to teach children how archaeologists excavate sites) used by the Hampshire and Wight Maritime Archaeological Trust.[7] The 'excavation in a box' was augmented using a projector and an Xbox Kinect in tandem to capture the movements of participants, the movement of sand, and to project an image of the site, which helps with stratigraphic interpretation (the analysis of layers of soil) and visualisation of a site. This creates an 'augmented reality' which other participants can see on a separate screen.

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[4] This is according to the report 'Internet Access – Households and Individuals, 2013,' Office for National Statistics, accessed 18 July 2014, http://www.ons.gov.uk/ons/dcp171778_322713.pdf.

[5] Photogrammetry is defined as 'the use of photography in surveying and mapping to ascertain measurements between objects.' *Oxford Dictionaries Online*, accessed 18 July 2014, http://www.oxforddictionaries.com/definition/english/photogrammetry?q=photogrammetry. See also Alistair Galt, '3D modelling for Archaeologists,' Archaeological Computing Research Group, University of Southampton, accessed 18 July 2014, http://www.archserve.blogspot.co.uk.

[6] 'Kinect for Xbox 360,' Microsoft, accessed 18 July 2014, http://www.microsoftstore.com/store/msuk/en_GB/pdp/productID.281045300?srccode=cii_18615224&cpncode=35-2287096892&WT.mc_id=PLA_UK_GooglePLA.

[7] Jasmine Noble-Shelley, 'The Kinect: Potential and Application Within Archaeological Education and Outreach' (Undergraduate diss., University of Southampton, 2013).

The software for the Xbox Kinect can also be modified, and Noble-Shelley used a modified version developed by Oliver Kreylos (from the University of California Davis). This modified version was used to explain geological and hydrological principles by using sand as a 'tapestry' for modelling water. The innovation comes in taking this technology and making it into an archaeological game that allows people who otherwise cannot be involved (such as children, or those with a disability) to participate in an excavation. It allows for people to become immersed in the excavation, and it also makes the excavation easier to explain to large groups of children, as the monitor can be made larger than the excavation itself. The Kinect also stands up well against older 'virtual reality' excavations, which primarily featured on websites. These should not, however, be considered true virtual digs as there is no interactivity, they are not as engaging, and they are often included on very impractical, complicated websites, such as the Grand Pré excavations in Canada.[8]

Other uses of the Kinect in archaeology, such as the Roskilde 'Experience Cylinder' charting the 2007 voyage of a Viking ship from Denmark to Ireland, have not focused on the teaching of excavations, but on other aspects of archaeology, such as experimental archaeology, which gives the viewer a more 'real' experience of being in the past. The augmented reality 'excavation in a box' is very limited in its educational value; at present there is no use beyond the activity itself, except in videos. There is, however, scope to develop it so that a consumer could use their Kinect at home to excavate a virtual site, without the need for the sandbox.

Solution 2: Arch Aerial's 3D Printed Drones and Photogrammetric Software

The problem of preserving the archaeological record may be combated through the use of drones. Drones, or Unmanned Aerial Vehicles (UAVs) are often associated with amateur enthusiasts who fly small machines around an open area as a way of passing time with friends or as part of a club. Archaeologists have been employing drones for a number of years, but due to the high cost of top-grade drones there has been an understandable reluctance to purchase a piece of equipment with limited applications to archaeology.[9] There is also a barrier in training archaeologists to use drones effectively, and to use photogrammetric software. Currently, cheaper models are marketed to hobbyists. There is minimal scientific or commercial value, with lower-quality cameras, and little or no guidance on extracting photographs into modelling software.

However, Arch Aerial is combining innovations from multiple fields in order to ensure that more people can afford commercial-grade drones without the high costs. Based in Texas, Arch Aerial designs drones which allow archaeologists to take aerial photographs. The company is currently working on installing LIDAR (Laser Imaging, Detection and Ranging) into these drones, allowing for a precise set of data that can be used for creating digital terrain models, which can be used for several purposes.[10]

The idea for 3D-printed drones came from an Italian excavation at which the expensive use of helium balloons meant that there were only a few aerial photos produced

[8] 'Grand-Pré National Historic Site,' Société Promotion Grand-Pré, accessed 18 July 2014, http://www.grand-pre.com/en/.
[9] Dennis Nilsson, 'The Usage of Unmanned Aerial Vehicles and Their Prospects in Archaeology' (Master's Thesis, Lund University, 2010).
[10] Ryan Baker, email to author, 17 January 2014.

from a whole season's work.[11] The results of the use of a drone at the Poggio Civitate site can be seen in Figure 1. The manufacturing technique is innovative because it uses a 3D printer in the design process. This allows the trial-and-error stage of creating the product to be completed exclusively in the office, which reduces costs without compromising on quality, and makes the product accessible to archaeological projects. Conventional drones in Britain are currently marketed to archaeological companies for between £15,000 and £35,000, which is equivalent to the salary of an entry-level archaeologist in the commercial world, or to that of an experienced project manager.[12] This represents a large proportion of a budget, perhaps meaning that companies are forced to sacrifice human labour for a drone. The drone cannot do more than take photographs, whereas an archaeologist is often trained with multiple specialist skills that may never be replaced by machines. Arch Aerial drones can be hired out for less than £1,000 for three months' use, making them much cheaper than those of rival companies, and more marketable to archaeological firms.[13]

Drones have multiple advantages over other techniques, including their versatility and reusability, and also their durability in many environments and climates. Drones are relatively small, and are built out of polymer (AVS plastic). They can be easily used on almost any site, as they can fly between twenty and three-hundred metres above ground to capture sites of any size within one picture. Additionally, they can cover several kilometres quickly; if archaeologists are trained and equipped with a drone, they can record the location and assess the importance of a site in a much shorter period of time compared with more conventional methods. This allows archaeologists to record many more sites without risking their lives, as drones are constantly being developed to work better and longer in hazardous weather and challenging natural conditions. If archaeologists could agree on a workable methodology for the use of drones for conservation purposes, this could revolutionise the way in which they approach the conservation of archaeology, while at the same time minimising expenditure. This could be a watershed moment for field archaeology, with drones coming to represent a viable alternative to the conventional methods for recording sites. The drone could become part of the archaeologist's toolkit, rather than just an expensive piece of equipment for the hobbyist or academician.

A further opportunity for archaeologists lies in is the growth of modelling software that relies on photogrammetry. This was first trialled in the 1980s, but was superseded by LIDAR. It is now experiencing a revival in the geodetics industry. Photographs from the drones can be downloaded and combined to create photogrammetric plans and models in about twenty minutes. They can therefore be used to help with the day-to-day interpretation of the site. Although these drones have only been used on a small number of archaeological sites, they have already significantly increased archaeologists' understanding of the sites they have visited. For example, archaeologists discovered a number of new sites by flying around the canopy of the Belize rainforest.[14] Today, it is possible to apply photogrammetry to a variety of situations within archaeology. Software like Agisoft can be used to create 3D models of a site, which can aid interpretation by creating a precise and holistic topography of sites that are not compatible with

[11] Ryan Baker, email to author, 17 January 2014.
[12] Greg Colley, 'Best Practice in the Use of UAV and Low-cost Software for Photogrammetric Surveys of Heritage Sites,' accessed 18 July 2014, http://www.suaveairphotos.co.uk/newsletters/Newsletter4/SuaveISPRS2011BestUseUAVandLowCostSoftware.pdf.
[13] Ryan Baker, email to author, 17 January 2014.
[14] Ryan Baker, email to author, 17 January 2014.

conventional methods (which involve drawing a section of a trench) or with the use of field surveying, which is often limited to a few hundred global positioning system points over a large area. It is also possible to use free software such as Sketchfab to publish these models for free.[15] Although Arch Aerial is automating the process of aerial photography, this is making it easier for the archaeologist to take repeatable, high-quality photographs of archaeological sites.

However, very little theoretical work has been completed in relation to the use of drones on sites. David Clarke referred to a 'loss of innocence' in the 1970s, as he argued that archaeology needed to examine the use of science in archaeology in more detail.[16] As L. S. Premo notes, if archaeology wishes to develop from a largely descriptive activity (an 'innocent pursuit') to a more scientific endeavour (a profession that has grown up from its amateur roots), its practitioners would need to scrutinise 'the philosophical assumptions which underpin and constrain every aspect of archaeological reasoning, knowledge and concepts.'[17] Applying the same philosophy, the use of new technology needs to be rigorously examined. This lesson was repeated in archaeology in the 1990s with GIS. Archaeologists' correct application of GIS in archaeology was only achieved when statistics within GIS were critiqued, as GIS is a method that is computationally intensive. Today the problem is primarily a question of scale: should archaeologists be concerned just with photographing the site, or with placing the site into a pattern within a landscape? The act of zooming into an image can be interpreted as a top-down interpretation of a site (which focuses on a system as a whole, rather than on individuals and the ways in which systems interact), whilst the zooming out of an image could be construed as a bottom-up approach (discussing the individuals, or agents, and changing a system using the archaeologist's own initiative).

Aerial photography had traditionally been the domain of air survey specialists, and this means that the archaeologist's knowledge of aerial photography is somewhat lacking. This has led to a limited use of aerial photography; sometimes photography has been used for economic or ergonomic reasons rather than for genuine archaeological enquiry. This has also resulted in a lack of critique relating to the theory and method, although not necessarily in the sense of interpreting features within the landscape. Within aerial photography, vertical images will feature degrees of distortion, where the centre of the image is perpendicular to the camera while the corners of the image are distorted by forty-five degrees, which affects the distance measured from the point of the ground to the camera. This represents a 1.44 times increase in the length of the distance between the camera and the ground at the edge of the image.[18] This is another advantage of photogrammetry, as photogrammetry relies on overlapping photographs, which removes the distortion of an image if all photographs are taken from the same angle (if the surface is flat) or if the camera is perpendicular to the surface being photographed. Archaeologists would need to be trained in how to critique their images before they are used in photogrammetric models. This also represents an opportunity for community archaeology to train and inform communities about free software that they can use with their own drones, if they have any. While the results may differ, archaeologists are usually very

[15] Robert P. Barratt, 'The Use of Photogrammetric Models for Recording of Archaeological Features,' *The Post Hole Journal*, 33 (2013), accessed 18 July 2014, http://www.theposthole.org/read/article/237.
[16] David Clarke, 'Archaeology: The Loss of Innocence,' *Antiquity* 47:185 (1973): 6.
[17] L.S. Premo, 'Equifinality and Explanation: the Role of Agent-Based Modeling in Postpositivist Archaeology,' in *Simulating Change: Archaeology into the Twenty-First Century*, eds. Andre Costopoulos and Mark W. Lake (Salt Lake City: University of Utah Press, 2010), 28.
[18] David Wilson, *Air Photo Interpretation for Archaeologists* (Stroud: Tempus, 2000).

good at giving the general public a chance to 'have a go' with new technology, enabling the public to understand archaeology in a new way as a result.

Figure 1: Aerial photograph taken by a quadcopter drone by Arch Aerial for the Poggio Civitate project. The ability to zoom into an image is a literal example of a top-down approach.[19]

Solution 3: Minecraft as an Educational Tool

The use of the Internet in recent years has expanded greatly. Together with an expansion in technology, this has allowed for the development of innovative methods for practising and publicising archaeology. For example, Archaeosoup Productions uses a variety of social media to engage the public in archaeological issues. Only a small number of archaeologists have blogs and social media accounts, but those who do use blogs and social media often include mention of their work and others' research, as well as discussions of current issues which have been conducted with their peers. This does not just represent advertising, however: this is a one-to-one engagement with the public, the main audience of the archaeologist. The excavation or museum exhibit can therefore come to the individual without the expense or inconvenience of travel. Based on the popularity of social media alone, it seems clear that every archaeologist should be given basic training in social media in order that they are able to make contact with the public. Archaeologists are not doing enough to keep the public engaged with archaeology. Social media provides a simple and under-valued solution to this fundamental issue. The main purpose of archaeology itself is at stake; if archaeologists cannot inform the public of their

[19] The image is taken from Anthony Tuck, Kate Kreindler and Theresa Huntsman, 'Excavations at Poggio Civitate (Murlo) During the 2012-2013 Seasons: Domestic Architecture and Selected Finds From the Civitate A Property Zone,' *Etruscan Studies* 16:2 (2013).

work, then why does the profession exist? While other professions exploit this technology in many ways, archaeologists seem to struggle to keep up.

The near future may well bring archaeologists a new medium which can be used to interact with the public: namely, Minecraft and the 'gamification' of social media.[20] The documentary 'Videogames Changed the World', fronted by Charlie Brooker, demonstrated that the future may lie in the gaming industry, and in particular with social media and games that can exploit this.[21] Minecraft is a cheap 'sandbox' game that allows the participant to create and destroy blocks as he or she wishes, and is often used to recreate objects from real life, including ancient and modern cities. Because of its community element, which means that several people can be on the same server (and in the same 'world'), real-life skills such as teamwork, communication and creativity can be developed in a safe environment.

Such qualities are particularly appealing for schools. Minecraft can be a powerful educational tool, and has already been useful for educating both children and adults from fields as diverse as architecture, history and physics. A version of Minecraft called MinecraftEDU, which is currently being used in the USA, parts of the Middle East and Europe, enables a school to complement its curriculum. Archaeology has not, however, been fully-developed as a subject within those school curriculums which use MinecraftEDU; only a few civilisations are currently explored, such as Mesopotamia and Ancient Egypt.[22] Minecraft has thousands of 'mods' which add additional content to the game, but as yet the closest impression of archaeology is a comic version of archaeological excavations. This is not to say that archaeology cannot be entertaining, but currently no archaeologists are developing Minecraft as a tool for education which highlights the realistic methods involved in excavation. Minecraft could be developed for future generations to enjoy archaeology, much like the Xbox Kinect is used as a game by children at the Hampshire and Isle of Wight Maritime Trust. It could also be used as a tool for educating the public more widely. Like the 'Excavation in a Box', this could be marketed for people who are unable to visit an archaeological site. Minecraft does, however, require a very different skills set from conventional archaeology, and some knowledge of how to manipulate the code within the game. But as the New Generation is growing up with Minecraft and with a knowledge of how to modify it, it may only be a matter of time before Minecraft is developed for archaeological purposes. For example, a mod may be developed that teaches how site-formation processes work, and how archaeologists interpret these processes from the evidence. This is not to say that it should replace conventional methods of displaying archaeology; it should be treated as a complementary resource.

Conclusion

Solutions to various archaeological problems can be found by assimilating, and adapting to, new technology. Many of these new technologies have been used as games or for hobbies, but they have applications outside of these original functions. Much of the technology discussed here is becoming increasingly affordable, thus allowing archaeology to adapt more easily, and to incorporate these technologies as part of a 'toolkit' of equipment. This paper has also demonstrated that archaeologists can innovate; while it is

[20] Kelly Ng, 'UNESCO uses Gamification to Teach Disaster Safety,' last modified 17 January 2014, http://www.futuregov.asia/articles/2014/jan/17/unesco-uses-gamification-teach-kidsdisaster-safet/.
[21] Dan Tucker, 'Videogames Changed the World' (London: Endemol UK, 30 November 2013).
[22] Eric Walker, email to author, 20 January 2014.

acceptable to automate processes, innovative uses of technology are not only eye-catching but can deliver unexpected results. There is also scope for archaeologists to create new methodologies based on some of this technology, which could potentially allow archaeologists to survey large areas without risking their lives (particularly in the case of affordable drones) or as a means of educating audiences in new ways. Most of the technology that can be used now or will be available in the near future is primarily focused on education and on the display of archaeology. In many cases, such technology needs to 'lose its innocence'; more theoretical critique is needed to ensure that these technologies are used in a manner which is beneficial to both archaeologists and to the wider public.

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