Visual interpretation, survey and graphics: adding value to archaeology

HANNAH KENNEDY PCIfA, HISTORIC ENGLAND

Grime's Graves during the Mesolithic (Artist's reconstruction by Judith Dobie – an interpretation drawn from data captured by archaeologists, archaeobotanists, archaeozoologists, surveyors and archaeogeologists © Historic England)

Technology is wonderful. Its development makes our lives simpler in all sorts of ways. In the archaeological sector there is no doubt that advancing technologies and their applications have enabled us to reveal far more about our hidden past than the pioneers of the field like Kathleen Kenyon or Gertrude Bell would ever have conceived. We are collecting more data, processing more data, turning it into meaningful, valuable, information that breathes further life into dusty pot sherds and microscopic remains. And once we have discovered their secrets, technology allows us to present that knowledge creatively, and share it more widely and collaboratively.

The impact of technology in the specialisms of graphics and survey has been as noticeable as anywhere. Our enormous drawing tables, noisy plotters that take up half the room, plane tables and trusty 'dumpy' level are mostly gone. In their place are computers on every desk – dual screens obscuring the earnest faces of the illustrator and surveyor. Global Navigation Satellite Systems and digital total stations have replaced kilometres of measuring tape. Every output is never more than a few simple steps away from the printed (or digital) page.

Undoubtedly, advancing technology has added value to the visual interpretation of archaeology. Look at a 30-year-old archaeological publication in contrast to one printed recently. Affordable colour printing and digital publication allow us to show information much more efficiently and clearly through photos and coloured maps and plans, even allowing the viewer to interact and further interrogate the information interactively. Geospatial Information Systems (GIS) allow the illustrator and surveyor to start to build visual interpretation from the data processing stage. The viewer is now able to examine 3D surfaces and objects from their own computer screens. The information we can now share was beyond the reach of the remote scholar even ten years ago.

An example of a (reasonably) recent method and technology providing us new information is Multi-light or Reflectance Transformation Imaging (RTI). This method, developed in 2001 by Malzbender and Gelb, uses images captured under multiple specific lighting conditions to record surface details that may not be visible to the naked eye and examine them using virtual lighting. This method was further adapted to suit cultural heritage organisations, using a lower-tech approach at Cultural Heritage Imaging, and has successfully been used to record

A rock carving at Roughting Linn, Northumbria shown using standard photography (a) and digitally lit using multi-light imaging (b) (© Sarah Duffy after Historic England, 2018) objects from the microscopic to surfaces with an area of up 2m and has even been used under water. The results have contributed to a better understanding of artefacts and sites, including identifying microscopic worked antler from Star Carr and recording ancient rock art in Armenia. Furthermore, recording using RTI allows further remote interrogation of the surfaces captured (Historic England 2018).

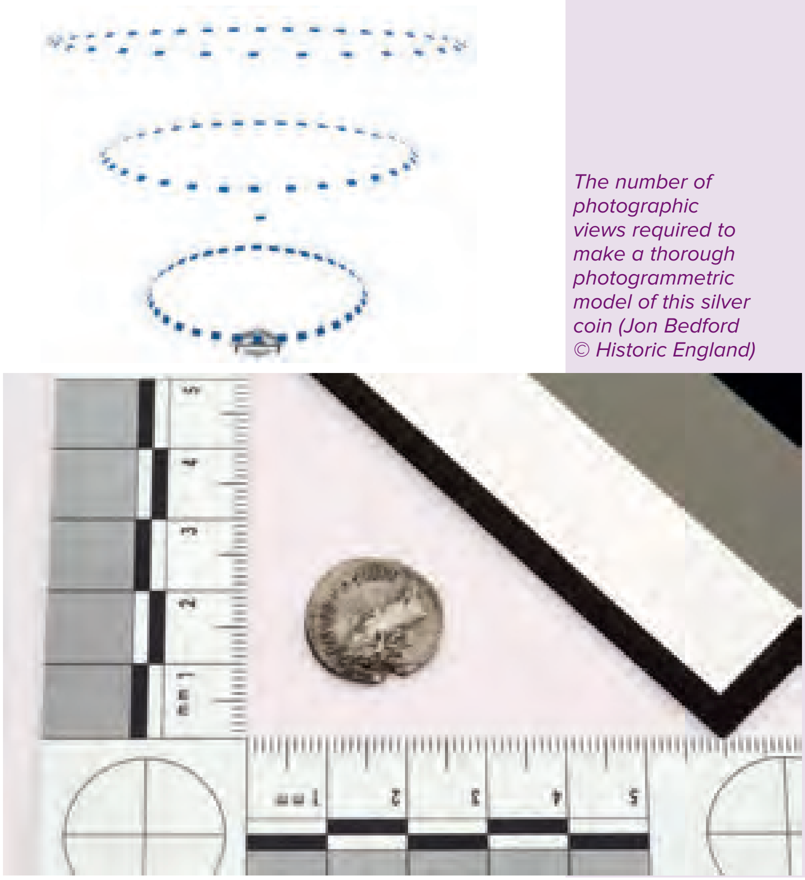
Other advancements in technology focus not on capturing new data, but rather capturing data more efficiently. Automation allows us to both record more and interrogate the data further, creating more information. For example, total stations record exactly the same data as plane tables, using the same basic methodology, trigonometry – still going strong after all these millennia – but in a process which takes minutes, not days.

The use of aerial survey is not a new development, 'taking off' at the start of the 20th century (Bewley 2003, 16). It created a new perspective, giving rise to new interpretation and inspiring a new style of reconstruction art (Dobie 2019), but the availability and flexibility of drones (Small Unmanned Aerial Vehicles – SUAVs) has renewed the value of this unique perspective.

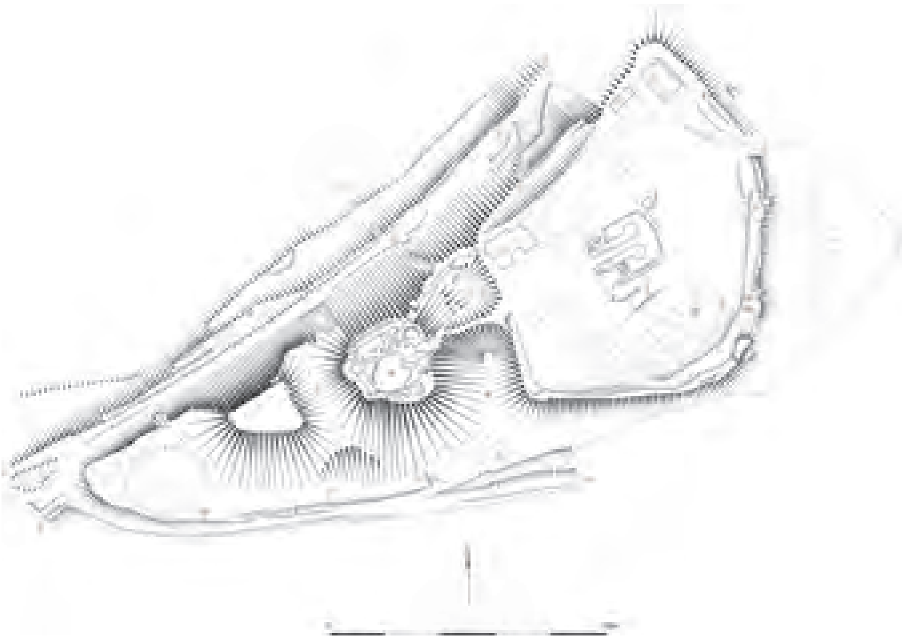
Even photogrammetry, or Structure from Motion (SfM), a technique now widely used to record all sorts of things, has been around for a couple of centuries (Bewley 2003, 16); it is the availability of high definition photography and enormous processing power in the office environment that have allowed this surge of 3D information, and the development of lightweight viewing platforms that allow us to share our findings.

Despite these advances, the constant is that through all of these technologies, for the mass of data to be of any value, there must be a skilled recorder and primary interpreter of the data. All of the data in the world is worthless without interpretation. Just as the archaeologist interprets the different colours of earth in a trench and presents it as written and drawn record, so too do the illustrator and surveyor interpret and present the crude data captured by mechanical eyes. It takes skill and knowledge to direct these machines to capture data that is fit for purpose, whether using a total station, a laser scanner or a camera, just as it takes skill and knowledge to understand where to dig an intervention to reveal maximum information. There is an appropriate adage to explain this – Garbage In, Garbage Out (GIGO). Although it is easier than ever to operate these machines, without an understanding of how accurate data is required to provide us with meaningful information, the data is less valuable, and at worst, completely worthless. The hidden danger in the era of easy technology is that the unsuspecting can be fooled into accepting a product that looks good, but is not fit for purpose.

Furthermore, with so much information already out there, it may be less clear why methodical, in-depth archaeological work is needed. A clear example of why data needs to be intentionally and methodically captured can be seen in the efforts to salvage information from the tragic event of the destruction of Palmyra, where tourist photos were collated into photogrammetric models of the city, with some visually decent results. The issue, however, is that while there was a huge wealth of hundreds of thousands of photographs of Palmyra, they do not represent good data. For example, they tend to be largely from the exact same few locations. The Arch of Triumph has been recreated digitally, as have a few other notable treasures – the interior of the circus, the Lion of Al-lāt. However, a number of structures only exist in the background of these high-profile attractions. Even the most popular attractions suffer from limited views – very few people take photos of the back of a statue, even fewer the top of the head, and SfM requires multiple views to carefully map the surface of an object and avoid occlusions (data voids), meaning the models can only be approximations at best. Anywhere you see a melted, waxy-looking texture on a model it is due to inadequate data for that particular area. A surveyor carrying out a photogrammetric survey of an object understands at the point of recording where to expect occlusions and will make every effort to accurately record the entire object, not just the bit that people like to look at.



The number of photographic views required to make a thorough photogrammetric model of this silver coin (Jon Bedford © Historic England)



An interpretive, digitised hachure plan of earthworks at Clifford Castle, Herefordshire (Digitised by Amy Wright from hand drawn plans by Mark Bowden, © Historic England)

The importance of the role of the interpreter is only underlined as we discover new ways to record and collect data. However, the role of the surveyor and the illustrator is not only that of interpreter; we also serve as translators. The art of illustration is not in recreating what is in front of you: illustration is about giving understanding to the viewer – taking data and presenting it in such a way that the information contained is more readily understood. As technology advances, we must adapt and augment our visual language to incorporate this new information. In some cases this means discovering new ways to present, as with RTIs or photogrammetric models – discovering and inventing ways to illustrate 3D or even 4D datasets for a 2D medium. In many instances the most useful and accessible output of a 3D dataset may still be a hachured drawing – an analytic and interpretive output, and one that can still really only be drawn by hand, even if digitally.

Similarly, the skill of object illustration is not something that can be replaced by high-definition photography or SfM. The act of illustration is in itself interpretive, with the illustrator seeking to interpret and demonstrate the composition, material, treatment and use of an object to the viewer with just a few drawn faces. The finds illustrator uses conventions and style refined over a century to effortlessly impart knowledge about an object. Photography and SfM models can supplement this information, but the illustration remains the best method to share the interpretation of the specialist and illustrator.

In conclusion, technology *is* wonderful. It provides us the opportunity to gather new information; it expedites the capture and processing of data; and it can provide us access to places that were previously difficult to reach. New techniques allow us to see archaeology through fresh eyes. We can record more data than previously thought possible and leave a record of value for future archaeologists to do even more with. However, the data is only of value if it is strategically, skilfully and accurately acquired. Accidentally captured data may provide the basis of some later interpretation, such as at Palmyra, but will never provide the value of a designed archaeological survey and will rarely be a sufficient record. Therefore, the true value of this wealth of opportunity lies with those who plan for it, record and interpret it. The information would be forever out of reach but for the skills and knowledge of those responsible for acquiring the data, interpreting the information and presenting the knowledge. The archaeologist, the scientist, the surveyor and the illustrator are the basis for the creation of new knowledge; they add value to the profession and subsequently to society and business.

References and further reading:

Bewley, R H, 2003 Aerial Archaeology. The First Century, in *Aerial Photography and Archaeology 2003. A Century of Information.* Ghent: University of Ghent. Accessed on 20 April 2020 [online] at: https://books.google.co.uk/books?id=UhRTRszpnd4C&printsec=frontcover#v=onepage&q&f=false

Dobie J, 2019. *Illustrating the Past. Artists' Interpretations of Ancient Places.* 1st ed. Swindon: Historic England

Dobie, J and Evans, C, 2010 *Archaeology and Illustrators: A History of the Ancient Monuments Drawing Office.* Historic England Research Report 33/2010. Accessed on 18 April 2020 at https://research.historicengland.org.uk/Report.aspx?i=14874&ru=%2fResults.aspx%3fp%3d1%26n%3d10%26t%3ddrawing%2520office%26ns%3d1

Historic England, 2017 *Photogrammetric Applications for Cultural Heritage. Guidance for Good Practice.* Swindon: Historic England. Accessed on 20 April 2020 at https://historicengland.org.uk/images-books/publications/photogrammetric-applications-for-cultural-heritage/

Historic England, 2018. *Multi-light Imaging. Highlight-Reflectance Transformation Imaging (H-RTI) for Cultural Heritage.* Swindon: Historic England. Accessed on 20 April 2020 at https://historicengland.org.uk/images-books/publications/multi-light-imaging-heritage-applications/

Hannah Kennedy is the Graphics and Photography Studio Manager at Historic England, where she leads a talented, multi-disciplinary team of illustrators and photographers. She is also Chair of the Graphic Archaeology Group of CIfA. She previously worked for many years at Oxford Archaeology, initially as an archaeologist but for the most part as an archaeological illustrator.

New visualisations, same data

GARY JONES and KEN WELSH ACIfA, OXFORD ARCHAEOLOGY

The OA WebMap interface on desktop and mobile

Data are at the core of what we do as archaeologists, so facilitating the effective interrogation, interpretation and understanding of those data is vital. As part of a new digital strategy, Oxford Archaeology (OA) has overhauled core internal workflow systems by developing a series of digital modules designed to enhance the value of its large range of field data.

In this article we discuss some of the motivations and aims of this undertaking, before looking at what we have currently achieved and how it is already benefiting our staff and clients.

MOTIVATION FOR CHANGE

We wanted to create a system that would give our site teams access to a range of spatial, contextual and other data to assist with archaeological interpretation and decision-making. This system needed to be deployable to projects of all sizes, not just large flagship excavations. Furthermore, the data needed to be made available on a timescale that could really make a difference to the way we dig our sites – in other words, while the excavation is still under way.

A secondary motivation for change was to update our ageing context database. Updating a primary database is a daunting task: the system must be suitable for the breadth of sites, varying in type, archaeological complexity, and work duration. In an industry where a single project can produce data over a span of years or even decades, it is no surprise to find conflicting data structures and bespoke databases.

Our existing systems had grown and changed over the years with the result that, while everything worked, the interaction between systems was frustratingly limited. Site survey particularly had limited connections to the other systems, and links between spatial data and site records were created as part of the post-excavation process. This approach is time consuming, prone to error, and limits the ability of site survey teams to contribute to analysis.

With the opportunity to update our core data systems, we wanted to ask: could we get the data to do more?

The development aim was to make our data work for us. The fundamental field data being collected might remain the same, yet we needed to increase their accessibility and provide meaningful feedback to staff while they were active in the field and the sites open. The idea would be for the data to help inform the fieldwork strategy rather than being simply a product of it. It was important that the systems should be easy for our staff to use and should not erect technological and skills barriers.

To this end we designed two tightly integrated digital modules which work well independently, but are far more powerful together: OA WebMap, which focuses on survey data, information retrieval and the end user, and the OA Digital Recording System, which captures a range of contextual data within a modern database design.

Undertaking a photogrammetry survey that will eventually be part of the site WebMap

OA WEBMAP

The OA WebMap module was envisaged as a means of providing a modern yet familiar interface to the spatial and contextual data collected within our fieldwork projects. A web-based approach was chosen to reduce the need for specialist software.

In the field our survey methodology was adapted to a more attribute-driven approach, allowing more consistency in data capture and quality control. The underlying data schemas are more tightly defined as the data moves from GPS to GIS to WebMap. This means that survey data sent back from the field can be uploaded into the WebMap database as soon as it is processed and checked, often before the surveyor is back in the office.

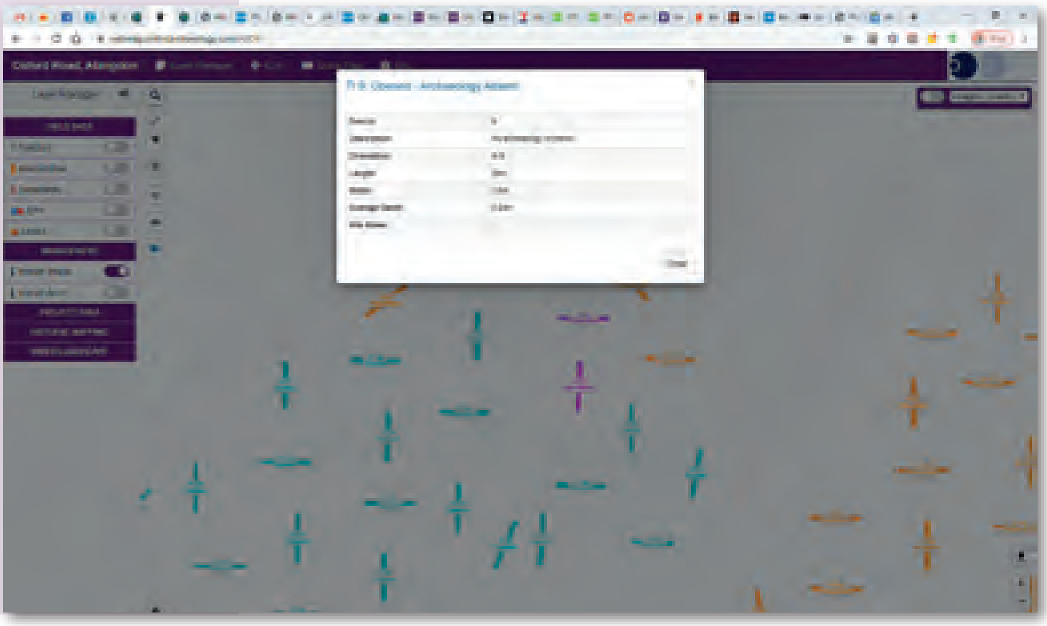
Once a site is uploaded into the OA WebMap system, the benefits to a user are many. Current site survey and related information can be easily viewed on any internet-enabled device by any member of staff. Site information is presented as categories of styled layers which can be turned on and off as desired to allow the user to visualise just the data they need.

The WebMap interface also allows for a more intuitive way to view site data, putting sites into wider landscape contexts and, with future development, will allow easy comparisons with other sites. The user can overlay the data onto aerial photographs, LiDAR, data relating to designated sites, and other publicly available datasets. We can even overlay features onto site-specific datasets such as geophysical survey results and orthomosaics generated through drone and photogrammetry techniques.

Further value is gleaned through giving access to clients and members of other teams. This allows clients, consultants and curators to keep up to date and obtain a much clearer understanding of the site than can be achieved through conventional means.

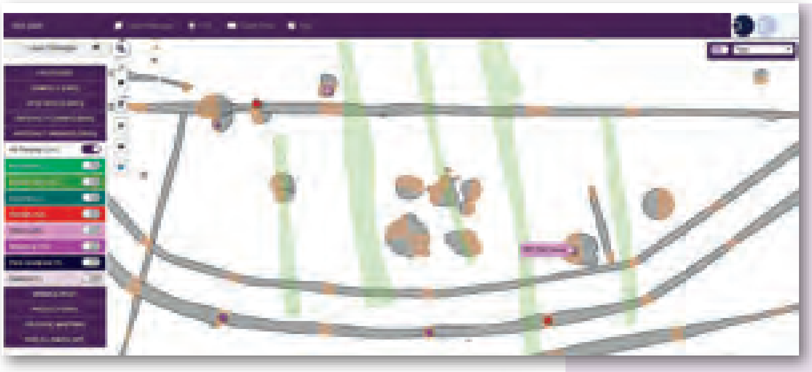
WebMap's true benefit, however, is how it provides visual access to site context information gathered using the accompanying Digital Recording module.

Trenches visualised by status, and example of information pop-up



THE OA DIGITAL RECORDING SYSTEM

The OA Digital Recording System (OA DRS) module was conceived to gather the core context data and to allow a number of useful tasks to be completed. It allows site index data to be entered into a web-based database, directly from site, using an interface optimised for tablets, mobiles or Chromebooks. It can be used off-line, with the data syncing once connections are re-established. Data such as trench descriptions, environmental sample data



Top left: Example of feature context pop-up showing information retrieved from the OA DRS

Top right: Example of the sample pop-up, showing both sample and related feature information

Example of spot dates displayed by weight, and mouse roll-over tooltip

and pottery and context spot dates can all be entered rapidly by an authorised user on any web-enabled device.

The database validates entries and provides common filters and export functions, allowing staff to access their data from any device.

THE FULL SYSTEM: OA WEBMAP AND OA DRS

The true benefit of the system is that contextual information is automatically linked in real time to spatial data collected by our survey department; this can then be interrogated via OA WebMap. When a site has data entered into both modules it opens up new avenues of interrogation and new data management options.

Within WebMap each trench can be clicked to view the current trench data, which will reflect the final trench table used in any report. The presence and absence of archaeology and the current field status of the trench (opened, recorded, backfilled) can be displayed using distinct colours to aid site management.

Context information becomes accessible through WebMap by simply clicking on a feature. Any associated record will be retrieved and shown in a pop-up. This information can also be used to search the map for a feature using the context number, group number or feature category.

The system will automatically match registered environmental samples and artefact spot date entries to features. Using the context relationships, it will auto-generate a point at the centre of the corresponding feature, providing real-time point distributions.

The environmental sample points are automatically coloured based on the sample type, and detailed sample information can be viewed with a click. Individual sample types can be displayed.

Spot dates offer more display options, allowing the records to be displayed and coloured by period, or sized dynamically based on their count/weight values as entered into the OA DRS.

CONCLUSIONS

The creation of a new system allowed us to evaluate what core data was needed in order to provide a more dynamic field methodology. The new systems provide a higher level of data validation and integrity during the fieldwork phase, removing some of the delays usually seen in projects. Survey becomes an integrated part of a wider system that pushes data to the forefront. The platform also provides the basis for future refinement and expansion, allowing a much greater range of information to be made accessible through OA WebMap.

While these developments may not be ground-breaking in terms of technological advancement, they do represent an internal paradigm shift within the company, adding extra value to any project for both our own staff and for external parties.

Adding value to marine geophysics with visual interpretation

ALISON JAMES MCIfA and MARK JAMES MCIfA, MSDS MARINE

This article explores ways in which archaeologists can add value to their marine geophysical surveys by ensuring surveys are adapted to enable new ways of visual interpretation. It builds on the experiences of MSDS Marine, which is well known for its marine geophysics capability.

The world of maritime archaeology is by its very nature under water, out of sight and perhaps out of mind for the majority of the population. For this reason, MSDS Marine has been working with its geophysical data to find new methods for visual interpretation and public presentation.

Primarily, remote sensing within marine archaeology consists of four sensors: Sidescan Sonar (SSS), Multibeam Echo-Sounder (MBES), Magnetometer (MAG) and Sub-Bottom Profiler (SBP). The aim for all marine geophysical surveys is that during the collection, processing and interpretation stages the data and accuracy are of the highest standard possible, that surveys are repeatable and that the outputs are suitable for archaeological assessment, analysis and presentation. Remote sensing surveys can be specified and undertaken for a number of reasons, including: prospection, either over a wide area or localised to a feature such as a wreck looking for anomalies such as debris; the establishment of an accurate position of a site; condition assessment and monitoring; and to support the creation of public engagement resources. This latter point is considered in greater detail in the next article. Each sensor collects and presents data in different ways, so not every sensor is suitable for every job. Contractors should work with their clients during the planning phase to establish the most appropriate sensor (or combination of sensors) for the task.

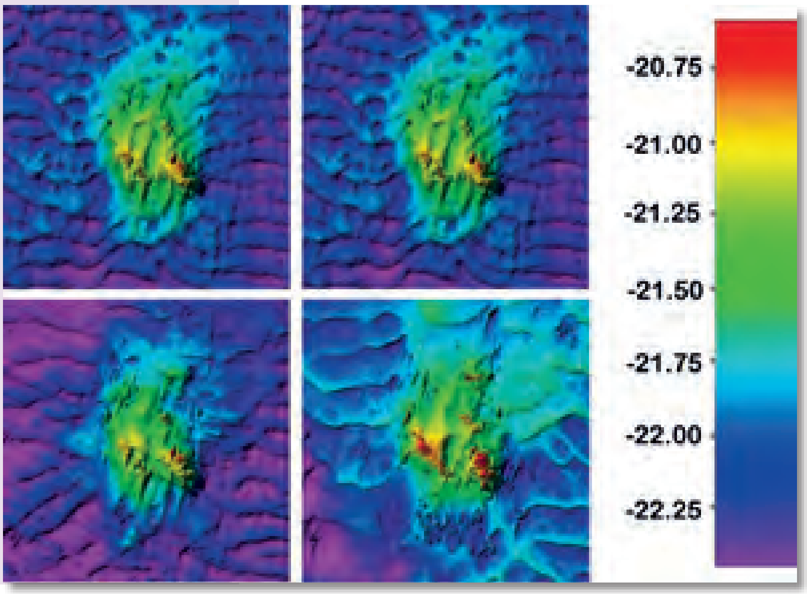


Figure 1: Top left clockwise, 2015–2018 multibeam bathymetry of the Rooswijk protected wreck site clearly showing the rapidly shifting, mobile sands

In this article we focus on multibeam bathymetry over other geophysical techniques. Its use as a tool to identify wrecks and their extent on the seabed is well established. It offers a highly engaging image that can be readily understood by many people in a way that other geophysical techniques such as sub-bottom profiling and sidescan sonar survey can't. The following two case studies look at ways it can be used outside of the normal hydrographic survey.

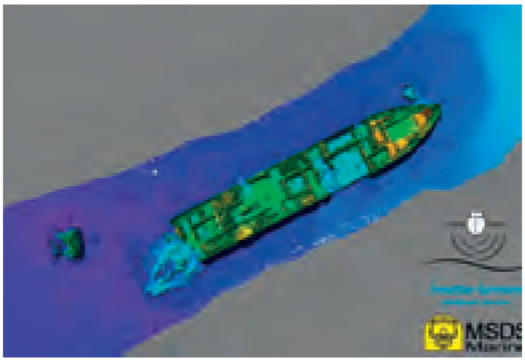
CASE STUDY: MULTIBEAM AS A TOOL FOR COMPARATIVE ANALYSIS

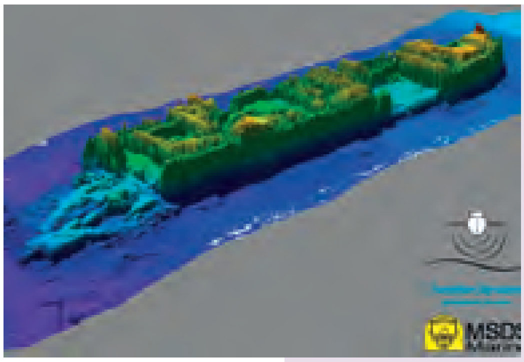
MSDS Marine has undertaken repeat geophysical and hydrographic survey over the site of the *Rooswijk* during 2015 (multibeam), 2016 (multibeam, sidescan, magnetometer and sub-bottom), 2017 (multibeam) and 2018 (multibeam). The works were undertaken in advance of, during, and after the fieldwork phase of the *#Rooswijk1740* project running between 2016 and 2018.

The Goodwin Sands, where the *Rooswijk* lies, is a highly dynamic environment with rapidly shifting mobile sands. In order to monitor the sand levels over and around the main site of the *Rooswijk,* a high resolution multibeam survey was planned that would be repeatable with equipment, methods, datums, and processing so that the excavation could be planned when the sand overburden was lowest, future sand movements predicted, and the level of environmental risk to the site monitored. The surveys also allowed the project team to prioritise the areas to be excavated and the data provided base maps to be used as an underlay for the diver acoustic tracking. The data in Figure 1 is presented to the same datum and colour scale and clearly shows the changes to the site over the four-year period.

CASE STUDY: MULTIBEAM PROCESSING FOR A PUBLIC AUDIENCE

The standard approach to processing multibeam data is to average the data points out into a uniform grid, typically ranging from 30cm to 50cm dependent on the specification of the survey and the data density. This grid of data points is then used to create a three-dimensional surface that is coloured by depth. The images in





Figures 2 and 3: The James Eagan Layne, multibeam bathymetry presented in the traditional way

Figure 4: Point cloud model of the James Eagan Layne aimed at a public audience

Figures 2 and 3 show a typical presentation of a wreck, in this instance the *James Eagan Layne,* the data of which was collected by Swathe Services and processed by MSDS Marine.

To visualise shipwrecks in a more accurate and arguably more understandable form, the methods of processing and visualisation need to be adjusted. From an accuracy and interpretation point of view the greatest concerns are the gridding of data and the application of a surface. These issues can be overcome by working solely with the point cloud data. Each line of data is corrected for height and position and then cleaned to remove erroneous points and suspect data. Data cleaning is generally undertaken in a number of programs as each has strengths and weaknesses dependent on the data collected. The lines of data are then combined to create the final point cloud for the site. Further processing work is then undertaken to present the data in a clear and visually impressive model – Figure 4.

As can be seen in Figure 4 the difference between a point cloud and a surface model is marked. The final visualisation aspect of the processing further increases the coherence and aids interpretation, both for archaeologists and the general public viewing the model. The resulting model can be presented in a number of formats including images, fly-through video, interactive models and in a web-based viewer.

CONCLUSIONS

Marine geophysical survey techniques offer a wealth of possibilities for archaeologists. Identifying the final uses of the survey allows the right approach to data collection to be selected. The technology available is evolving rapidly and the ways in which data can be collected are changing too. The development of Unmanned Survey Vessels (USVs), Figure 5, means that it is now possible to mobilise quickly and more cost effectively in some environments.

The success of the virtual dive trail scheme led by Historic England has shown that there is a demand from the public to engage with marine archaeology. Marine geophysics is leading the way in adding value to archaeological survey in new and interesting ways.

Figure 5: Images showing the work of MSDS Marine and Swathe Services developing unmanned survey vessels, from conception to end product

Access to maritime archaeology for all: tools to visualise, understand and value significant heritage assets

JULIE SATCHELL MCIfA, BRANDON MASON and GARRY MOMBER MCIfA, MARITIME ARCHAEOLOGY TRUST

The wreck thought to be the Ocean exposed following winter storms and accessible at low spring tides off Hayling Island, Hampshire

Divers surfacing following photogrammetric recording of a 108m-long wreck site at 40m depth in a total of just 78 minutes over two dives

The previous article explored how maritime archaeology geophysical survey techniques are being used to collect more extensive and better data and visualise it to help us better understand historic environment assets underwater. These techniques are also helping archaeologists to overcome the fact that few people can physically visit these shipwrecks and submerged landscapes, so helping people to value them more. This article focuses on how maritime archaeologists are using these and other technologies to improve interpretation and access and develop diverse ways of presenting maritime and coastal sites, helping to overcome the perception that sites are remote, scarce and difficult to access. This is enabling maritime heritage to be fully explored, understood and enjoyed by all.

The Maritime Archaeology Trust (MAT) is one of the longest-running specialist maritime archaeological organisations in the UK, undertaking a wide range of work across the UK and internationally. The need to make sites accessible has driven the MAT's holistic approach, which embeds learning, involvement and enjoyment of heritage within its projects. An active education and outreach programme and running the Isle of Wight Shipwreck Centre and Maritime Museum provide opportunities for public engagement for all ages through a range of traditional visits and workshops, in addition to expanding online, digital and virtual access and learning.

In 2004 the MAT established a trading company – Maritime Archaeology Ltd (MA) – which undertakes development-led work, with all surplus generated going to support the charitable work of the MAT. This organisational set up allows MAT to pioneer innovative research and recording techniques in an area of the discipline that is rapidly changing due to the application of technology. Its development-led work benefits from this experience, where solutions ahead of marine construction are using the most up-to-date equipment and approaches as well as promoting opportunities for public engagement.

The use of technology is apparent in all aspects of archaeological practice; geophysical survey, data capture and analysis; artefact scanning and 3D printing, modelling and visualisation have all become familiar techniques. Within the marine and coastal environments, these advances are facilitating progressive levels of discovery, recording and dissemination. Many new wrecks have been located using acoustic seabed survey data gathered for a range of purposes including dredging and offshore development, such as aggregate extraction and wind farms. The use of diver-based and drone-based multi-image photogrammetry has been a particular game-changer in the speed and precision with which it is possible to capture details of sites and landscapes. The resulting datasets utilise a pipeline of software packages to create 3D models, renders and immersive digital environments.

The following case studies demonstrate how new technologies for recording and visualising archaeology that has previously been out of reach are enhancing value for clients while enabling public access and the enjoyment of heritage for all.

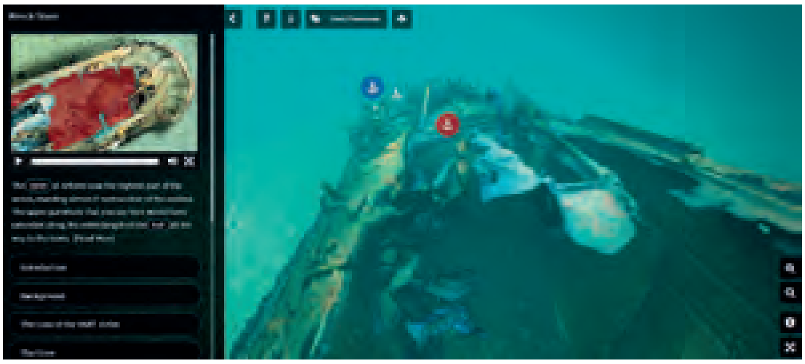
VISUALISATION FOR ACCESS, EDUCATION AND OUTREACH

Providing virtual access to underwater sites through 3D modelling and visualisations has rapidly brought marine cultural heritage to new audiences, as techniques in the previous article illustrate. The 3D visualisations produced can be supplemented with information, annotations, extrapolations, images and video to provide more detailed interpretation. The use of high resolution, true colour photogrammetry captured by archaeological divers who train their cameras on every detail creates virtual reality visualisations that transport the viewer to an animated wreck site environment that comes astonishingly close to the real-world experience of otherwise elusive underwater cultural heritage.

Techniques that the MAT has developed through research-focused projects are now increasingly being applied in commercial environments where maritime cultural heritage

Rapid 3D recording allows finds to be lifted, recorded, and redeposited ahead of wind farm development, offsetting impacts on the historic environment by obtaining detailed knowledge of a complete assemblage.

The John Mitchell, a steam drifter, sunk off Dorset, can be experienced as an annotated 3D model or in full virtual reality (https://www.maritimearchaeologytrust.org/hmd-john-mitchell-interactive-model)



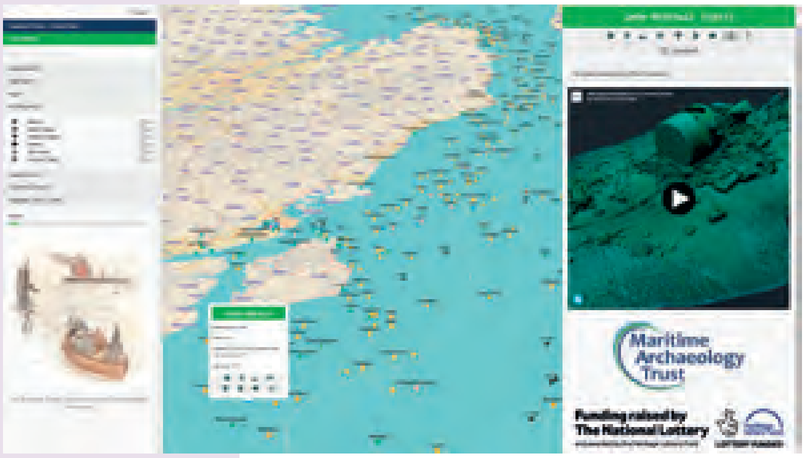
HMT Arfon, a recently designated protected wreck of a requisitioned trawler lost while on mine-sweeping duties, which has been developed into an online dive tour (https://www.cloudtour.tv/arfon)

At the Mesolithic occupation site of Bouldnor Cliff, 12m below the water off the Isle of Wight, a significant timber platform feature was recorded in situ using photogrammetry, prior to rescue recovery. The resulting 3D seabed model aided reconstruction in the laboratory.

is encountered. Beyond the extensive data and increased potential for engagement, these techniques have also helped to reduce time and cost to developers through more efficient data gathering. Better data then enables more informed curatorial decision-making and long-term management of submerged archaeological sites. When significant sites or features are encountered, outreach content can facilitate engagement with the public. For example, digital visualisations of historic assets are being used to engage clients, the public and schools as inspirational tools to aid learning and understanding.

The benefits of disseminating new knowledge about our past is recognised in planning policy and is increasingly realised as an integral part of the development process.

The Forgotten Wrecks of the First World War interactive map viewer



While the SS Gallia was initially imaged and surveyed as part of the planned Navitus Bay Offshore Wind Farm using sidescan sonar, MAT divers returned to the wreck in 2015 deploying multi-image photogrammetry in just two dives, from which a high-resolution digital terrain model (DTM) was developed.

VISUALISATION FOR INTERPRETATION

An area where new approaches to archaeological interpretation using visualisations has been particularly beneficial is in understanding submerged and buried prehistoric landscapes and associated archaeological sites and features. An example is the 8,000-year-old site at Bouldnor Cliff off the Isle of Wight, now 12m below the water in the north-west Solent, which is of international significance for its sequence of submerged prehistoric landscapes.

3D modelling has enabled large-scale, area-based interpretation of submerged landscapes, such as the Langstone Harbour 3D visualisation. A 3D Google-Maps-style interactive viewer allows exploration of this important area, which was occupied from the Mesolithic onwards.

The wide-ranging analysis made possible with online viewers is advancing the interrogation of large marine data sets; this helps with considerations of significance that can feed into interpreting sites discovered during commercial activity. The *Forgotten Wrecks of the First World War* project considered over 1,100 wrecks off the south coast of England, representing over 10 per cent of world-wide losses; see https://forgottenwrecks.maritimearchaeologytrust.org. Interrogating this detailed baseline information reveals new perspectives on the war at sea, exposing patterns related to the numbers of vessels lost during each year of the war, the causes of loss, the types of vessel lost, the nationalities of ships, their ports of departure and planned destination, and what they were being used for at the time of sinking. This quantification and characterisation contribute to priorities within national and thematic research agendas and provide data to support judgements on the rarity and significance of individual sites, which helps future management and protection of the wider underwater cultural heritage (UCH) from the First World War period.

These results feed back into knowledge derived from commercial projects, with a key example from the *Forgotten Wrecks* project being the wreck currently identified as SS *Gallia* (1917), which is located off the south-west coast of the Isle of Wight. This work provides unparalleled resolution of this extensive site and a unique baseline for understanding change and sediment transport processes, which will inform any potential future development work in this area.

VISUALISATION FOR MANAGEMENT IN AN EVER-CHANGING ENVIRONMENT

The wealth of archaeology surviving in the intertidal and coastal zone is phenomenal. Traces of our past include wrecks, hulks, hards, jetties, docks, forts, breakwaters, defences, remains from saltmaking, brickmaking and shellfish industries, maritime training sites, prehistoric landscapes and structures once on land. The coast is a dynamic environment where storms and erosion threaten sites, which then become exposed, posing challenges for archaeological recording. This zone is also impacted or traversed for marine development and management projects such as port developments, coastal defences or renewables connecting offshore wind power to the national grid.

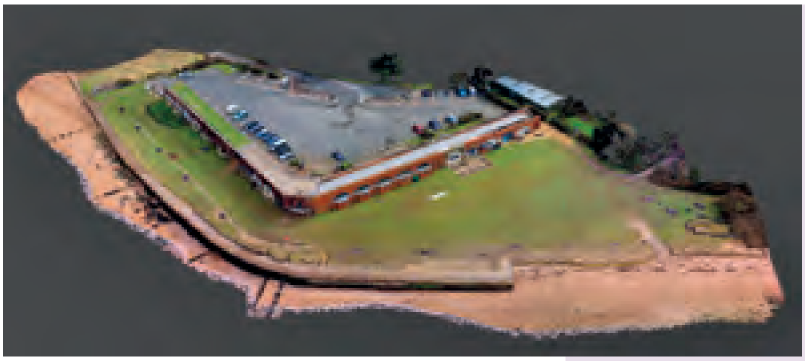
New technology means that available techniques for recording are changing almost as fast as the coastline. The use of drone surveys and aerial cameras for photogrammetry enable rapid recording of sites that the tide only uncovers for short periods, or that have recently been revealed due to shifting deposits. These survey 'snapshots' enable an understanding of site conditions and, when combined with further periodic survey, can show changes over time to aid interpretation and to provide an evidence-based approach to cultural resource management.

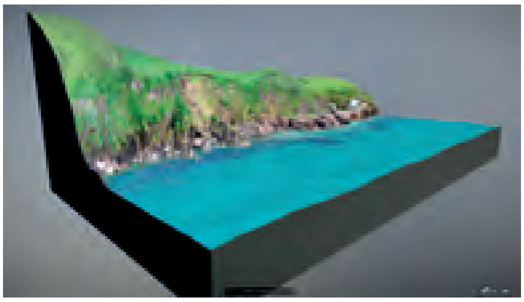
A variety of drones exists for a wide range of applications and environments, from confined-space mini-drones to fixed-wing platforms for coastal survey. These can be deployed to record intertidal features at low water on spring tides, monitor sedimentary changes, cliff erosion and other hard-to-reach sites including urban historic monuments, in research and commercial settings. In all these instances, drones are changing our perspective on the past, both literally and figuratively.

USING THE HERITAGE RESOURCE TO UNDERSTAND ONGOING CHANGE

The value of archaeology in understanding coastal change, within a climate change framework, is proving to be a very useful tool for coastal managers. Knowledge of the history of coastal change has become increasingly necessary when planning for future scenarios. Coastal managers face an ongoing battle to moderate impacts from the sea in the face of a changing climate and pressures from human use of the coastal zone. When decisions are required to determine levels of future risk, science-based evidence is necessary to support these decisions. The use of sites such as hulks, buildings and prehistoric peat deposits as indicators for coastal change reveals information on the scale and pace of erosion spanning from the past decade to thousands of millennia.

This work links with similar coastal management issues in other western European countries. The EU-funded Arch-Manche project (www.archmanche.maritimearchaeologytrust.org) worked with EU partners to use archaeological, historical and artistic evidence to inform on long-term coastal change, the results of which used a geo-portal for data interrogation and dissemination. A new EU, ERDF, Interreg VA project titled *Sustainable and Resilient Coastal Cities* (SARCC) is also under way; see https://www.interreg2seas.eu/en/SARCC. This initiative is incorporating historical data to inform threats to coastal cities, including underwater and intertidal information. Visualisation of these previously obscured areas has been key to engaging with decision-makers and stakeholders.





Top: Perspective view of drone-based condition survey of Fort Victoria, Isle of Wight, supplemented with DSLR multi-image photogrammetry

Middle: The lost village of Hallsands, Devon, a 19th-century fishing village destroyed by aggregate dredging in the early 20th century, is an example of a site recorded by our drone team in just 25 minutes using a drone deployed from a boat.

Bottom: Drone survey of the Isle of Wight coast where Military Road is under threat from erosion

CONCLUSION

The use of visualisations to analyse and present archaeological data to develop management approaches is being increasingly applied to the marine zone. These developments are likely to accelerate as we enter the UN Decade of Ocean Science for Sustainable Development (2021–2030); this brings together scientists, policy makers, managers and service users to develop a range of initiatives, one being a comprehensive digital atlas of the oceans. Through such mechanisms the value of the marine historic environment can be realised. There is now an opportunity for researchers and maritime developers to assess the resource collectively, maximising benefits by enhancing understanding of our past while aiding knowledge of the oceans. When all sectors work together, maritime heritage will gain wider recognition as a tool to increase our understanding of the seas and ourselves.

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Visualising archaeological potential: a deposit-modelling case study from Beam Park Riverside, Dagenham

DANIEL YOUNG MCIfA and ROB BATCHELOR MCIfA OF QUATERNARY SCIENTIFIC (QUEST), ROBERT MASEFIELD MCIfA OF RPS GROUP, HELEN HAWKINS MCIfA OF PRE-CONSTRUCT ARCHAEOLOGY

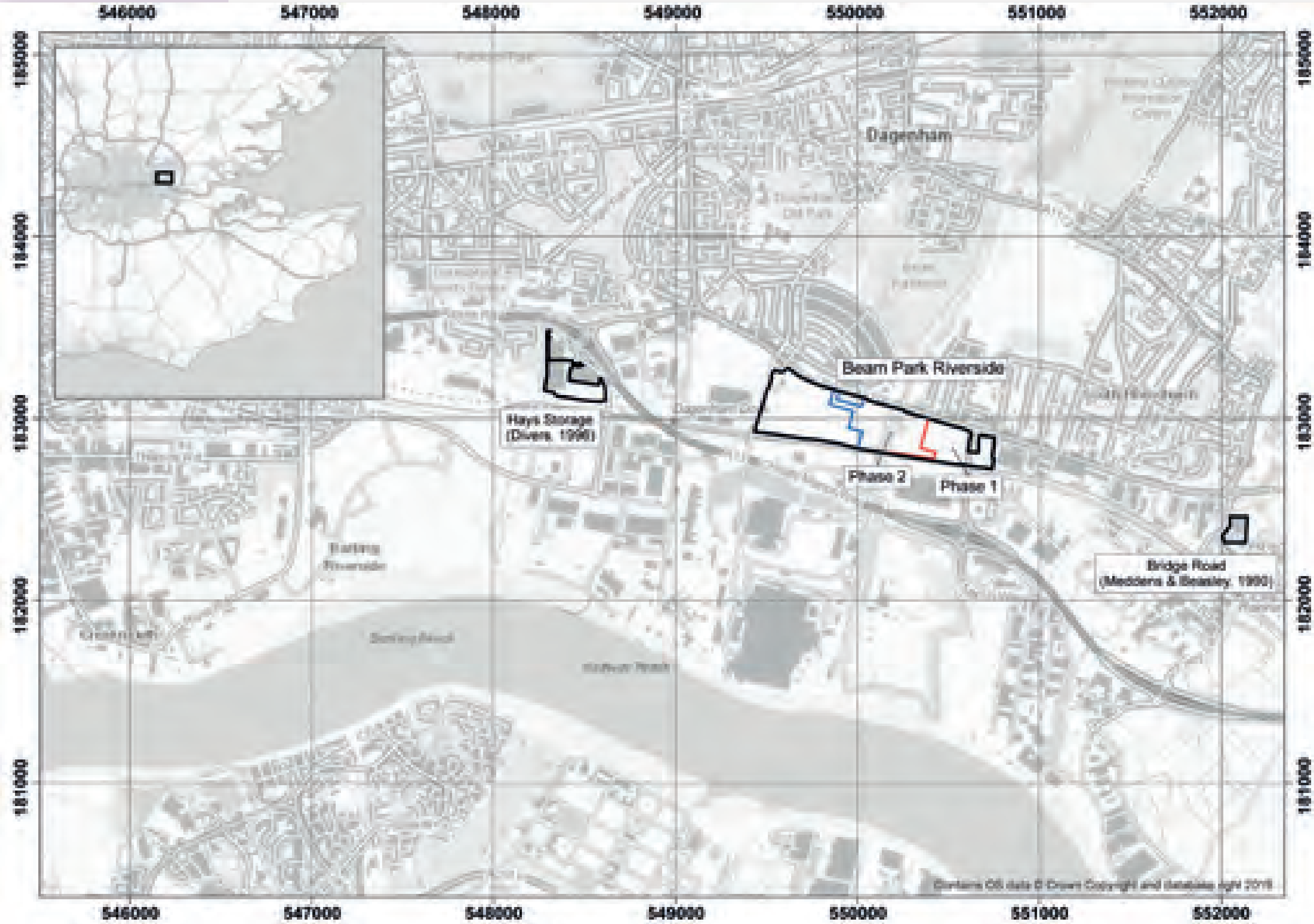

Figure 1: Location of Beam Park Riverside, showing the Phase 1 and 2 areas of investigation and sites of prehistoric archaeological finds at the floodplain edge

Geoarchaeological investigations at Beam Park Riverside, Dagenham (Figure 1), show how deposit modelling can be a useful tool for visualising and interpreting archaeological and palaeoenvironmental potential. Geoarchaeological deposit models are particularly useful where sediments have accumulated over a long period, and where archaeological deposits may be deeply buried. Such deposits are difficult to detect using geophysical survey and archaeological trial trenching. However, if sediment logs from engineering boreholes exist, or are commissioned, they can be used by a geoarchaeologist to determine the nature of the buried sediments, the type of environment in which they accumulated, their likely age, and their archaeological and palaeoenvironmental potential.

Used at the early stages of a development-led project, the models can cost-effectively guide the selection of appropriate archaeological evaluation and excavation strategies, and contribute to our understanding of the wider landscape context and any associated archaeological finds. The benefits of geoarchaeological deposit modelling are discussed further, with case studies and guidelines, by Historic England (2020).

Deposit models are valuable for identifying and visualising former land surfaces. Such land surfaces are significant, because they represent a type of environment, existing for a known period, which may provide evidence for human interaction with the environment in the form of archaeological finds and features. The potential of a buried land surface will usually be determined by the geoarchaeologist, working with an archaeological team with knowledge of previous archaeological finds in the wider area. A significant buried land surface for assessing archaeological potential in the Lower Thames Valley (and other lowland rivers) is the river terrace gravel, which underlies the historic floodplain and forms a 'staircase' of former gravel terraces on either side of the river. At Beam Park Riverside, Quaternary Scientific (QUEST), University of Reading was commissioned by RPS Group (on behalf of Countryside Properties) to undertake geoarchaeological deposit modelling in advance of development. The work formed part of a series of geoarchaeological and archaeological investigations, including an initial phase of desk-based geoarchaeological deposit modelling, archaeological evaluation (including geoarchaeological borehole survey) and excavation, each stage followed by an updated deposit model.

CASE STUDY: VISUALISING ARCHAEOLOGICAL POTENTIAL AT BEAM PARK RIVERSIDE

The Beam Park Riverside site covers an area of approximately 29 hectares, formerly occupied by the Ford car assembly factory. The existing geological maps, based on scattered archive borehole data, show that it lies at the interface between the historic River Thames floodplain and higher, drier ground to the north. The site has been levelled, so that the former floodplain and its relief is now buried below variable thicknesses of made ground. On the former floodplain, the British Geological Survey (BGS) shows that several metres of Holocene (the present interglacial period) floodplain deposits (alluvium) have accumulated, most likely of Mesolithic through to modern date. Underlying this alluvium are river terrace gravels, known as the Shepperton Gravel, deposited at the end of the last ice age around 10,000–15,000 years ago (during the Upper Palaeolithic) in a high energy, braided river environment. Rising above the level of the floodplain to the north the superficial geology is shown by the BGS as the Taplow Gravel, from a similar depositional environment to the Shepperton Gravel but much earlier (around 130,000–350,000 years ago). Combined, these gravel deposits form the template upon which other sediments have accumulated.

The existing geological maps therefore show that Beam Park Riverside sits at a location of high potential for prehistoric remains: the interface between the floodplain and higher, drier ground is an environment that would have been attractive to prehistoric human societies. Other prehistoric features have been identified in this type of environment nearby, including a possible Bronze Age trackway and causeway.

At Beam Park Riverside the surface of the river terrace gravel was modelled in two

Figure 2: Surface of the river terrace gravel (m OD) in the area of Beam Park Riverside, showing the location of the geotechnical, geoarchaeological and archaeological data used in the deposit model

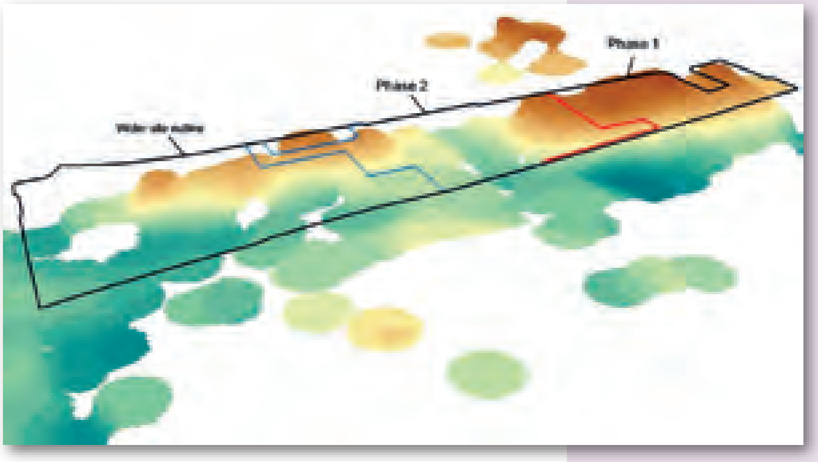

Figure 3: Surface of the river terrace gravel in the area of Beam Park Riverside (three-dimensional visualisation)

(Figure 2) and three dimensions (Figure 3), to visualise this former land surface, to define its archaeological potential, and to establish the depth and impact of the proposed development on these deposits. The most recent iteration of the model combines data from seven geoarchaeological boreholes, 500 engineering boreholes and more than 100 British Geological Survey (BGS) archive logs. The models were generated using RockWorks 17 geological utilities software, following the Historic England (2020) guidelines.

Important variations are apparent in the surface of the river terrace gravel at Beam Park Riverside. It can be considered the early Holocene land surface, and would have had a significant impact on the way Mesolithic, Neolithic and potentially Bronze Age human societies interacted with the floodplain environment. An interpretation of the prehistoric landscape zones represented by the model is

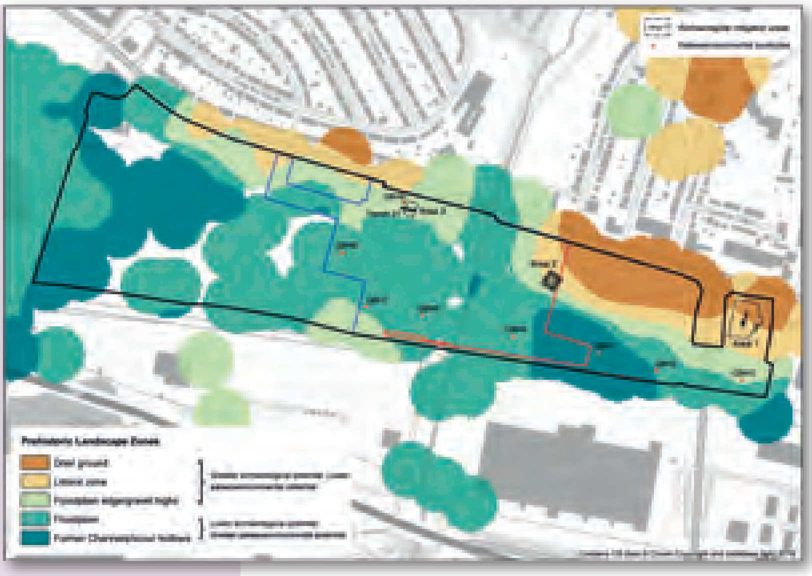

Figure 4: Visualisation of the prehistoric landscape zones (based on the modelled gravel surface), showing the location of archaeological mitigation Areas 1 to 3 excavated by PCA and the palaeoenvironmental boreholes investigation by QUEST

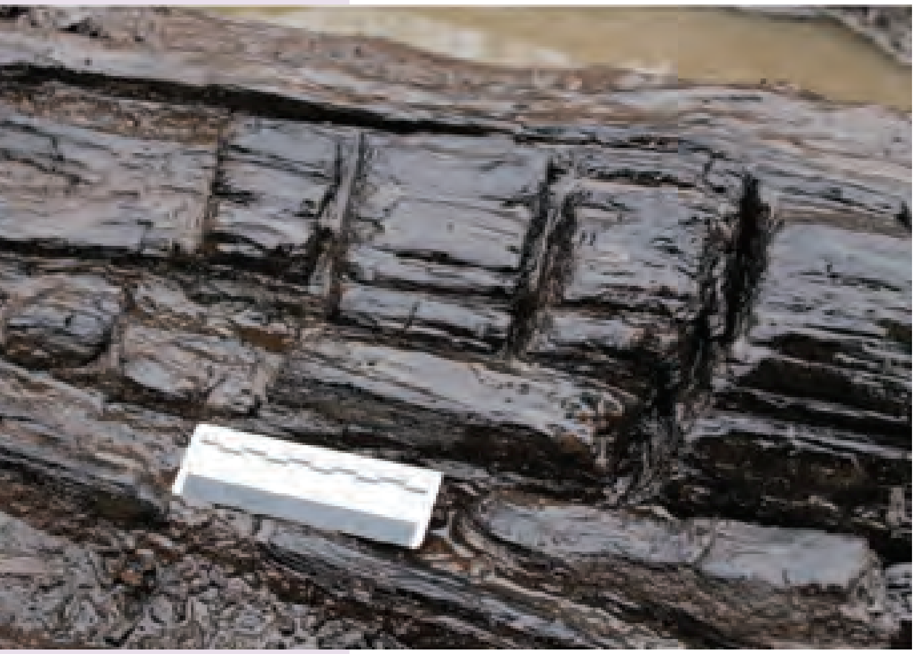

Figure 5: Notched yew timber (Photo: Pre-Construct Archaeology)

shown in Figure 4. The areas of higher gravel presented drier ground above the level of the floodplain during the prehistoric period, and are considered to have greater potential for preserving archaeological evidence associated with occupation or seasonal exploitation of the floodplain resource. The areas of lower gravel are likely to have been permanently or regularly flooded during much of the prehistoric period, and archaeological evidence (other than isolated finds) is less likely.

Some key elements of the prehistoric landscape can be identified in the deposit model; the valley of the River Beam, a now-culverted tributary of the Thames, can be made out towards the centre of the site, cutting through the Taplow Gravel terrace and joining the floodplain of the Thames within the modelled area. A possible former channel, since infilled with a thick sequence of alluvial sediments, flows broadly west to east across much of the site (see Figure 4).

Deposit modelling meant that archaeological investigation could be focused on areas of the site considered to be of greater archaeological interest. Archaeological trial trenching and subsequent excavations were undertaken in the north where the gravel was high, while geoarchaeological boreholes collected thick sequences of alluvium for palaeoenvironmental assessment from the south (see Figure 4). Archaeological investigations (Areas 1, 2 and 3 in Figure 4) found prehistoric pottery and worked flint in two linear features; a Bronze Age pit; a fragment of human tibia and the tibia of a large red deer, both of Bronze Age date; and a partially worked, late Neolithic, large yew timber with a series of narrow V-shaped grooves (Figure 5), likely to have been cut with a chisel driven by a mallet as a means of hollowing it out – to make a dugout boat, large trough, coffin or large drum – but abandoned in the early stages of working. Ongoing palaeoenvironmental investigations focused on the boreholes will shed further light on the sedimentary and vegetation history of this area of the Lower Thames Valley, integrating analysis of the biological remains and novel vegetation modelling techniques of the resultant pollen data.

CONCLUSIONS

The geoarchaeological deposit modelling technique used at Beam Park Riverside can be applied at any site where sediments have accumulated over a long period of time, and where archaeological remains may be deeply buried. Desk-based assessments can often be produced from existing engineering or geotechnical data at the early stages of development-led projects, to model the archaeological and palaeoenvironmental potential of a site, and the impact of a development on the buried deposits and their significance. This enables focused, cost-effective evaluation, involving minimally intrusive fieldwork (eg boreholes, test pits or geophysical survey). It is recommended that such models be constructed by a suitably qualified geoarchaeologist, following the guidelines provided by Historic England (2020).

Reference

Historic England (2020) *Deposit Modelling and Archaeology. Guidance for Mapping Buried Deposits*. Swindon. Historic England