

RESEARCH NEWS



Developing the use of satellite systems for Research Department surveys - story on page 3

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In this issue of Research News we focus on the development of methodologies and also on some of the new discoveries and interpretations that recent work in Research Department has generated.

The development of new methodologies and the updating of others, particularly in the light of technological advances in some of the hardware and software essential to our work, allow us to sharpen the tools employed in our research activities. The first three articles look at the wide-ranging impact of new techniques. In the area of Global Navigation Satellite Systems (GNSS) greater coverage and new equipment has allowed surveyors to position themselves and their surveys in the field far more effectively, leading to savings of time in later data transfer and analysis work. Developments in laser scanning and photogrammetry were shared with our sister organisation, Historic Scotland, through the Measured Survey Summer School which was held in St Andrews. New applications of low-cost photogrammetry, particularly in the field of recording prehistoric rock art, have been successfully implemented.

The emphasis within Research Department upon outreach, co-operation and the sharing of practical experience is once again demonstrated, by the Summer School held with Historic Scotland, the training week held in the Mendip Hills, and, further afield, the discussions which have taken place with the Heritage Conservation Directorate in Canada.

The well known medieval village site of Wharram Percy in North Yorkshire has been intensively studied and excavated over half a century. Research Department specialists have been involved in aspects of the work, and the recent publication of the final report on the church and cemetery allows Simon Mays to summarise the implications of the scientific study of all aspects of the human remains from the site.

Reassessment of monuments and landscapes will often prompt revisions in our understanding of sites and locations. Nowhere is this more startlingly seen than at Dowdeswell Camp in Gloucestershire, where a review of the evidence has shown that a monument scheduled as an Iron Age or Romano British camp was in fact a post-medieval park. Much of this re-interpretation rested on the study of documentary evidence, and it was the combination of documentary and dendrochronological sources which has allowed a rich and detailed picture of the structural and tenorial history of Treludick House in Cornwall to emerge.

Christopher Scull
Research Director
Research and Standards Group

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Developing the use of satellite systems for Research Dept surveys



From the mid 1990s, Global Navigation Satellite Systems have developed to a point where they are the most commonly used tools used by the Archaeological Survey and Investigation team. Team members examine their applications.

Use of Global Navigation Satellite Systems (GNSS), which in practical terms has meant the US Global Positioning System (GPS), has been one of the surveying techniques available to archaeological surveyors in Research Department and its organisational predecessors since the mid 1990s. It has proved so successful that for landscape surveying and ground modelling it has become the most commonly used technique by far for the archaeological investigation team, as well as being used to locate geophysical surveys and on excavations carried out by the archaeological projects team.

For all but coarse navigation standards, use of GPS requires the availability of a source of differential correction to improve survey accuracy. A means of locating surveys on the Ordnance Survey National Grid is also a requirement for consistency with all surveys carried out for English Heritage. The methods of achieving acceptable standards of accuracy and precision have changed over the years, but they have steadily improved in terms of the accuracy routinely achieved and, for the surveyor, in the ease of achieving it. The good news is that this technology is set to continue to develop as more navigation satellites belonging to the United States, to Russia and to the European Union are launched, leading to stronger more readily available signals, which translates into the ability to operate more efficiently and in a wider range of terrain. At the same time, new ways of using the satellite data have been made commercially available. These developments avoid much of the complex computer processing previously needed, allow recording on the National Grid in ‘real

time’ and provide us with the ability to take portions of our GIS record into the field for editing and updating.

Both in our role as professional surveyors, keen to do our work in the most efficient and reliable way and in our role of horizon scanning and standard setting for the sector, Research Department teams are making use of this developing technology.

Bernard Thomason

The Trimble R8 equipment, in use by Abby Hunt from AS&I at Scordale lead mine, Cumbria

Trevor Pearson, © English Heritage



Abby Hunt using the hand-held GPS unit at Beningborough, North Yorkshire



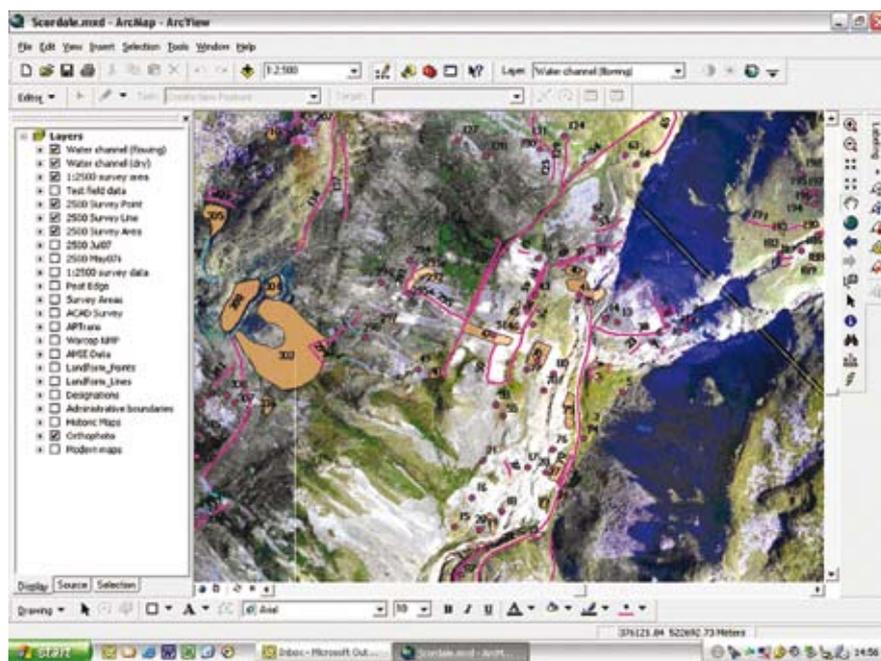
Chris Dunn, © English Heritage

National Grid using positional information direct from the network of GPS reference stations maintained by the Ordnance Survey. The team now also has several mapping grade hand-held GPS receivers which though slightly less accurate than the more expensive survey grade equipment nevertheless have proved very useful for surveys at 1:2500 scale or above.

The field team has found that the new survey grade GPS equipment works in situations where previously satellite reception was problematic such as in deep valleys or close to buildings. This is because of the increased number of satellites available through access to both the American GPS system and the Russian GLONASS system. The equipment will also be able to receive satellite data from the European system (Galileo) when this is fully operational extending its capabilities still further. Another major advantage of this equipment is that it can receive positional information from the Ordnance Survey network of GPS stations in 'real time' via a modem. Combining data from this source with the satellite data means that every point surveyed in the field is instantly adjusted to its correct location on the Ordnance Survey National Grid, a transformation previously achieved only after processing of the survey data back in the office.

In the last twelve months, the Archaeological Survey and Investigation team has brought their satellite positioning equipment up to date in order to benefit from technical developments to the system. The new equipment works with both the American and Russian satellite systems while at the same time transforming surveys onto the

Screen shot of the Scordale GIS



Abby Hunt, © English Heritage

The hand-held GPS consists of a small satellite receiver with an integral screen that can be set up to display digital maps covering the area targeted for survey. It is used in combination with a radio receiver called a beacon, which is typically worn on a belt. The beacon receives positional information broadcast by the coastguard which when combined with satellite data means the hand-held GPS can instantly locate its position on the Ordnance Survey National Grid to an accuracy of about 0.5m.

The hand-held GPS is now routinely used for surveys at 1:2500 scale and has proved particularly useful in upland landscapes such as Dartmoor and the North Pennines. Its portability combined with the facility to display background maps means the field investigator can cover the ground methodically and map any features encountered to an acceptable degree of accuracy. In addition, by loading an historic Ordnance Survey map on to the GPS, the field investigator can use the system to

locate features that were last mapped in the middle of the 19th century. On several field surveys the hand-held GPS has also been set up for data entry. At Scordale in the North Pennines some 500 features relating mainly to 19th-century lead mining have been surveyed and the details of each entered into a database held on the GPS. The survey and associated data base is then downloaded in the office into the Scordale project GIS.

Trevor Pearson

Since the early 1980s the Metric Survey team and its predecessor groupings, have both carried out and procured numerous topographic and architectural surveys for many English Heritage sites spread across the country. Archived in the Historic Plans Room, part of the National Monuments Record Centre in Swindon, these surveys have over the years utilised both modern and traditional technologies, including hand survey, REDM, photogrammetry and more recently laser scanning based systems. However rather than being nationally referenced, these surveys have tended to be related to a local co-ordinate system where only height values were typically tied into the Ordnance Survey's National Grid. Although sufficient for previous 'site specific' recording, conservation and works applications, the introduction of a corporate GIS and with it an increasing need for more spatially referenced datasets, has led the team to recently investigate modern methods of observing and transforming surveys to the National Grid.

The Ordnance Survey has recently established its own network of around 100 permanent GPS reference stations, linked in real time to a server hub at their Southampton headquarters. Data collected by all the stations is relayed in real-time to the hub, where it is transmitted for use by partner applications. This 'virtual' network was made commercially available throughout Britain and Ireland in late 2005, with the launch of systems such as Trimble's VRS (Virtual Reference System) and Leica Geosystems SmartNet.

By upgrading their existing total station theodolites through the addition of a fully integrated GPS Antenna, RTK communication device and a SmartNet

Bernard Thomason, © English Heritage



licence, the team are now able to rapidly determine the three dimensional position of their surveys to centimetre accuracy in real-time anywhere in the country where a mobile phone signal may be received. As well as providing obvious resourcing benefits in terms of the equipment and site staff needed this means that all future surveys will be rapidly geo-referenced 'in the field' to OS National Grid and will allow the future importation of such data directly into the corporate GIS systems.

Paul Bryan

Jon Bedford, © English Heritage



Testing the SmartNet virtual network on St. Mary's, Isles of Scilly, prior to purchase

David Andrews, Metric Survey team, receiving training on the integrated equipment

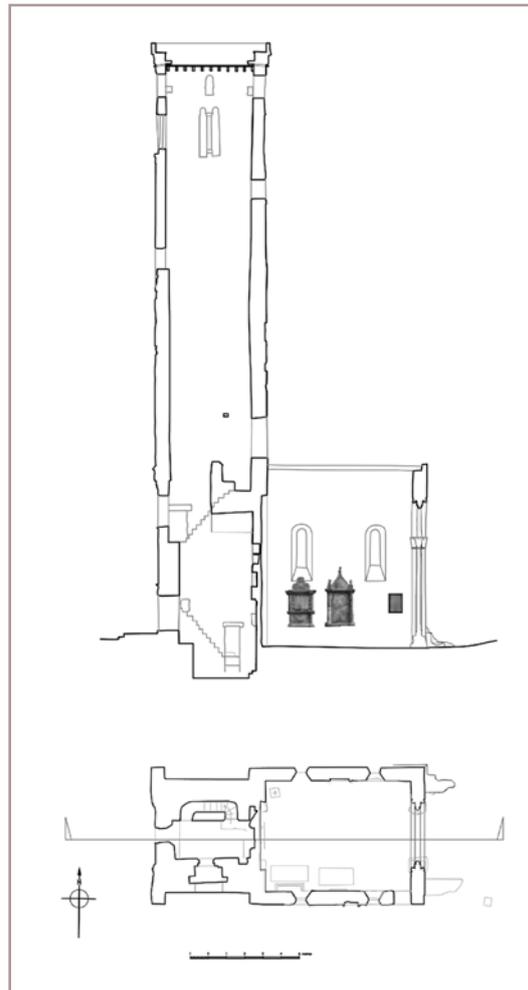
DEVELOPING METHODOLOGIES

Metric Survey and Historic Scotland: reinforcing skills and links

In an example of co-operation with the sister organisation of English Heritage north of the Border, the Measured Survey Summer School was delivered to Historic Scotland.

Following an exchange of meetings on procurement issues in metric survey, Historic Scotland requested that the Measured Survey Summer School package be delivered in Scotland as a cost effective means to refresh survey skills. Based on the principle of reversing travel and accommodation costs the training impact would be greater, as more delegates could attend.

The course was adapted by focussing on specific issues facing the Historic Scotland team. The base survey of sites has made use of procured survey for some time in Scotland but it was agreed that the technique application and framework aspects of the process would benefit from sharing the English Heritage experience particularly in the development of specifications for laser scanning and digital photogrammetry.



© English Heritage

Improving the understanding of the balance between information sources and selection skills was a priority for Historic Scotland. The information needs of heritage asset management require a variety of methods of capture, and sharing experience in this area proved to be valuable for both English Heritage surveyors and our Historic Scotland counterparts. The continuity of experience in Scotland with on site masons was a reminder of past practice in English Heritage and emphasised the close relationship between drawing skills and building crafts.

On 5th to 8th June 2007 the Metric Survey team delivered a bespoke three day training course, hosted by Historic Scotland, consisting of some 25 contact hours practical and six hours classroom contact for each practitioner delegate. The course was held at the Cathedral site at St Andrews, Fife at which a number of conservation documentation issues were addressed. The venue included excellent teaching space in the recently converted Prior's House cellar. Fifteen delegates, principally from the Conservation and Maintenance Branch, attended. They received hardware and software training in the areas of plan and section preparation, the preparation of condition records, and data capture for 3D surface modelling. A good basis for partnership was the fact

Completed 1:50 scale plan and section of St Rules Tower, St Andrews Cathedral, St Andrews, Fife prepared by Historic Scotland course delegates using measured drawing, EDM and rectified photography. The drawing is a CAD product developed from metric 3D wire-frame



Completed rectified montages of 2 elevations of the monastic complex at St Andrews Cathedral: this is a typical condition record that can be used for work schedules. Similar, higher precision, condition records were achieved using stereo imagery and ortho-photographic methods

that the two organisations shared much in common, and the appreciation of learning from the applied experience of practitioners. The lesson plans from the Wrest Park Summer School needed revision to accommodate the high skill level of the delegates and focus on ‘tips and tricks’ emerged as the most wanted information: everything from getting the best out of photogrammetry to working with EDM in tight spots was covered.

Historic Scotland shared their experience in the use of close range scanning on carved stone work and this was supplemented by a field demonstration by Mason Land Surveys on the use of terrestrial scanning at the Hamilton façade of St Andrews Castle. Live data from the site was used in both cases to demonstrate the utility of the captured data, an important factor as it was decided to use a results driven (rather than theoretical) model for as much as possible of the course.

The participants consisted of a mixture of technicians from both repair and design working in conservation using a variety of established skill and tool-sets. Sustaining experience, continuity of expert knowledge, enthusiasm for historic fabric and the familiar constraints of funding and forward planning for survey were shared concerns between English Heritage and Historic Scotland surveyors. This made the course an occasion to reaffirm core professional values of precision, draughtsmanship, and respect for heritage value and craft skills.

The key questions Historic Scotland wanted answered were:

- *How to manage procurement of survey more effectively*

- *How to improve CAD and EDM skills for drawings preparation*
- *How to make the right choice of technique to document stone replacement/repair programmes*
- *Keeping up-to-date on techniques and making equipment and software choices*

Feedback from the attendees was positive and showed the strength of the Metric Survey Team as a training resource.

Outstanding issues were the ruggedness of field computing kit and the integration methods for bringing combinations of photographic drawn and EDM/CAD data together. As ever time did not allow more than an overview of techniques but the team was able to solve some longstanding technical problems. As well as confirming the excellence of practice on both sides of the Tweed the short course provided a boost to the confidence of newer attendees in using equipment like EDM and rectified photography.

Future work in developing the relationship between Metric Survey and Historic Scotland will be the inclusion of Historic Scotland in the framework agreement for the supply of metric survey and adapting the specification for metric survey to meet local needs in Scotland. Further collaboration in documentation tool development, particularly in accessible digital photogrammetry are anticipated.

Bill Blake



Recording by pixels

Lower-cost digital photogrammetry becomes a practical reality.

Photography, in its many forms, has always played an important role within recording. Whether it be a single photograph taken simply to record the context of a feature within a historic landscape or a series of detailed, overlapping images of the feature itself to record its three dimensional form, the power of the photograph to rapidly record information is well established. This is ably demonstrated by the millions of photographs now archived within the National Monuments Record Centre (NMRC) in Swindon and the thousands of survey related drawings and images relating to many of EH's own sites held within its Historic Plans Room. Although the majority

of the collection is in traditional analogue form, such as the original photographic negatives on either glass plates or film or hard copy drawings on drafting film or paper, an increasing amount of photographic recording is now being collected, processed and archived in a 'pixelised', digital form.

PIXELS AND DIGITAL PHOTOGRAPHY

Taken from the abbreviation for *Picture Element*, a pixel is a single point in a graphic image. Although commonly viewed as being square in shape, pixels can take various

One digital image from a stereo-pair of the carvings on stone 53 at Stonehenge



forms including dots, lines or a simple set of numerical values. With care, the pixels in an image can be reproduced at any size without the appearance of the visible dots or squares showing through. This feature is commonly referred to as 'resolution' and even though is not the only factor to consider when taking a digital photograph, does provide an indication of the amount of detail that may be captured by the camera's imaging sensor. Although digital cameras have been available for over 20 years, it is during the last decade in particular that has seen a dramatic rise in the general availability of such devices. Coupled with the exponential development of larger imaging sensors that can capture more and more pixels within each exposure, this has led to the general availability of smaller and cheaper digital cameras with sufficient resolution for recording purposes. In turn this has opened up new areas of application for specialist surveying techniques such as photogrammetry.

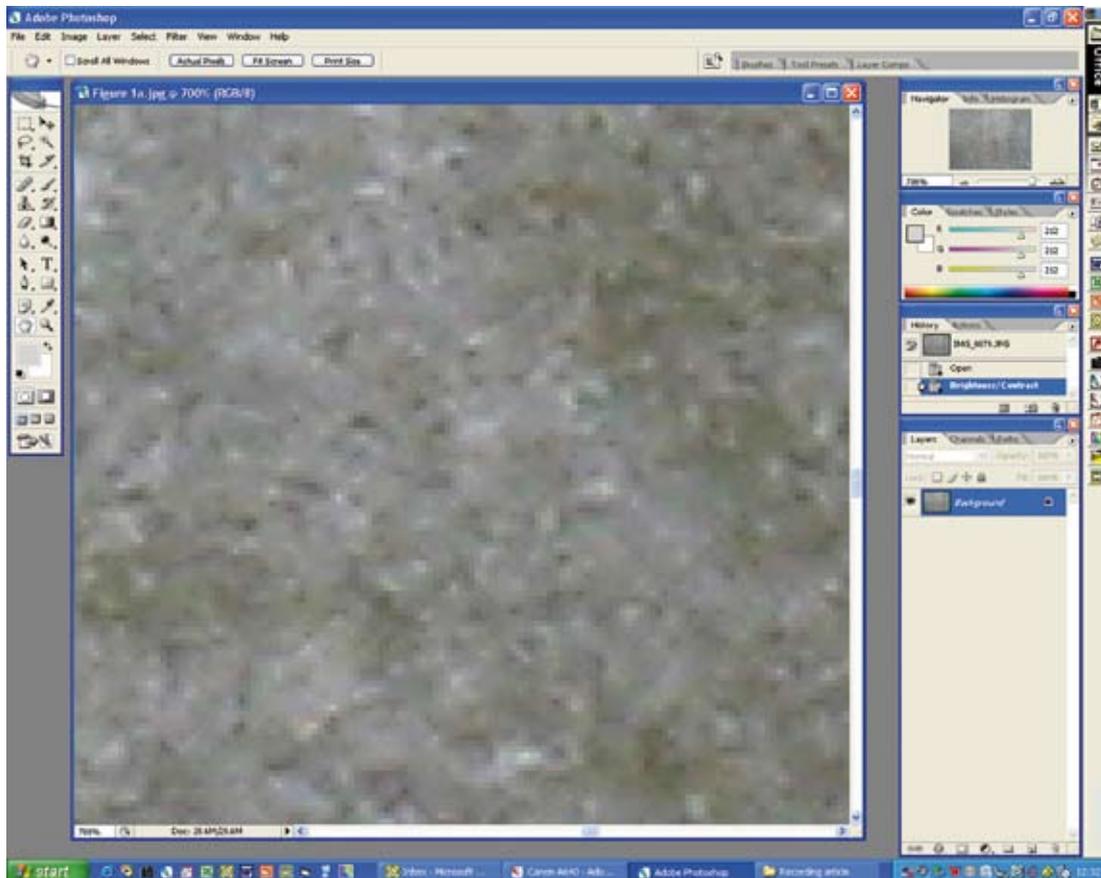
PHOTOGRAMMETRY

Photogrammetry is defined as '*the science and technology of obtaining reliable and accurate measurements from images*'. Typically relying upon the capture of stereo-photographs or

stereo-pairs of the subject in question, it is not a new technique having been first applied within a heritage context back in 1858 by the Prussian architect Albrecht Meydenbauer for documenting the historic buildings of Berlin. Although capable of capturing three dimensional recording data at a wide variety of scales and accuracies, it has typically relied upon the combination of expensive, specialist equipment and highly trained personnel to convert the primary stereo-photographs into other useable forms, such as a line drawing or orthorectified (scaled) photograph. The availability and widespread use of low-cost (sub £300), consumer-grade digital cameras now makes stereo photography data acquisition both a viable and exciting alternative. Also, although somewhat new to photogrammetry, this opens up potential application by non-specialists, including the voluntary sector, to both acquire and even process their own 3D recording data sets.

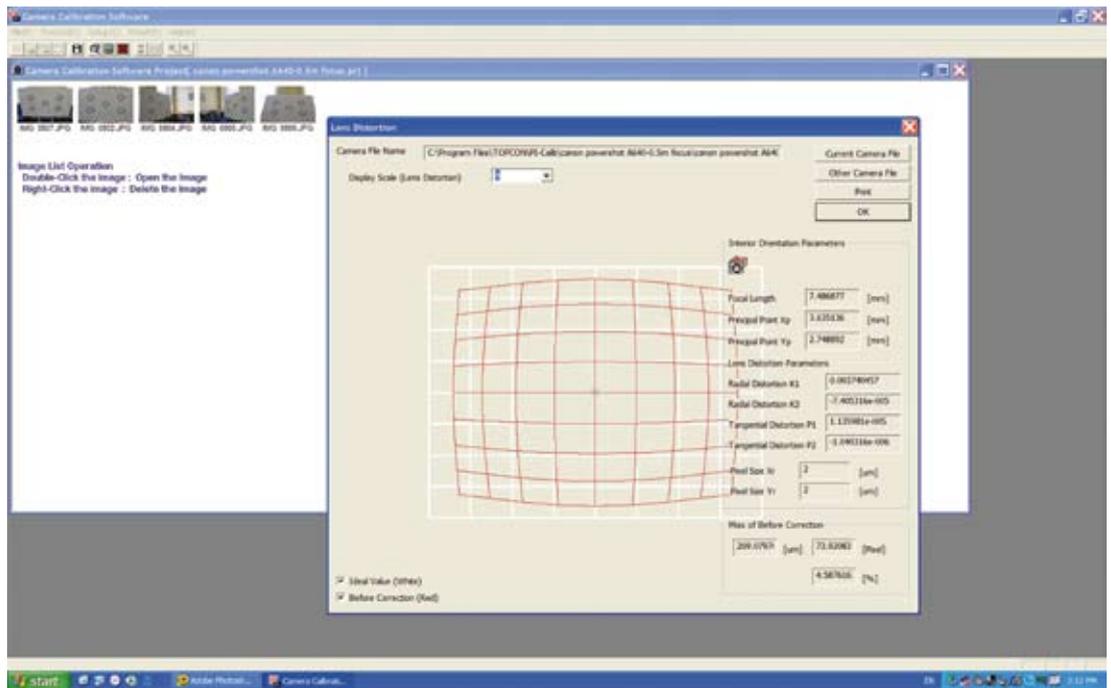
CAMERA CALIBRATION

Existing research has already suggested 5MPixels to be an appropriate, entry-point for 'low-cost' recording by photogrammetry capable of achieving millimetric accuracies over a range of 1-2m. However in order to



The same image magnified - highlighting the individual pixels making up the original digital image

Camera calibration images and report for Canon A640 digital camera. Generated using Topcon's PI-Calib' software



Andy Donald, © English Heritage

achieve such accuracy, it is prudent to first carry out a calibration of the chosen camera so as to provide the following geometric parameters:

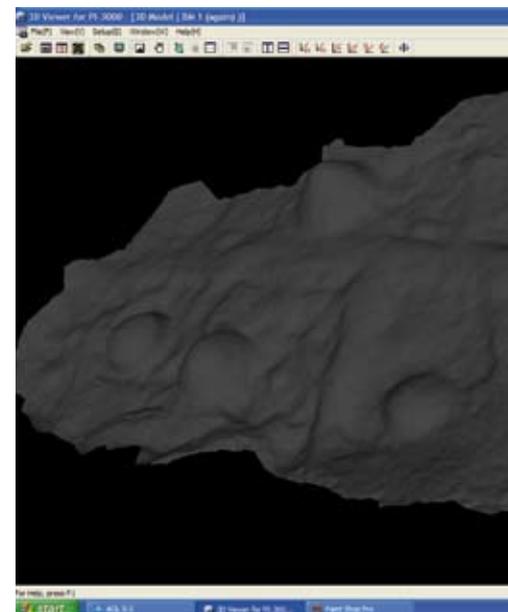
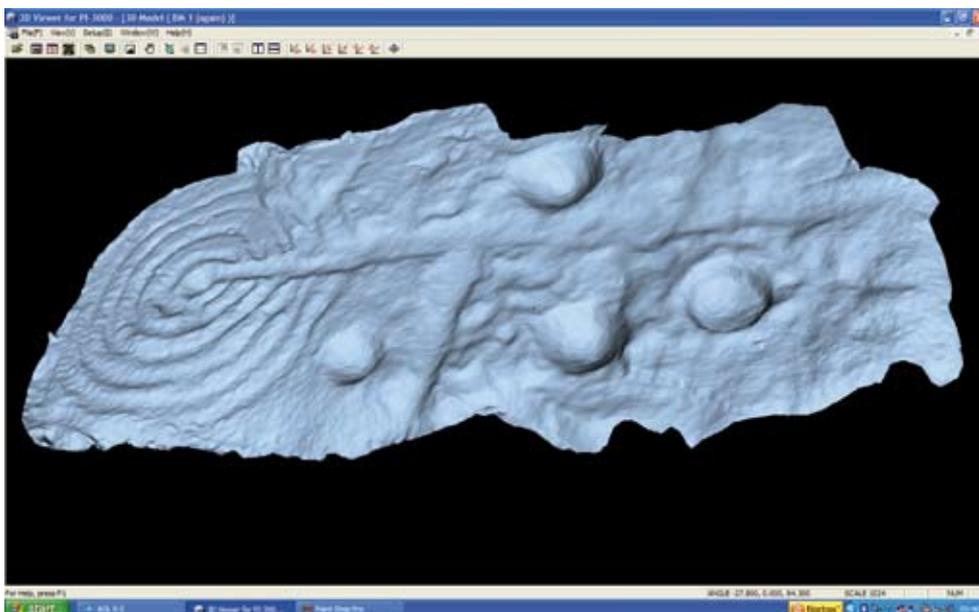
- the precise focal length of the lens at exposure
- the lens distortion, both in radial and tangential directions
- the central 'principal point' of the image sensor (CCD or CMOS)
- the exact dimensions of the individual pixels making up the sensor

This collection of parameters is commonly referred to as 'Camera Calibration' and,

once generated, is used within most photogrammetry software to increase the accuracy of any subsequently processed datasets. Even though this has traditionally been performed in university laboratories, using multiple imagery of a precisely observed test-wall, it can now be performed directly by the user using one of the calibration routines that are now being inserted into some 'lower-cost' photogrammetric software.

APPLICATIONS

The basic concept of low-cost photogrammetry makes it particularly suitable for routine recording tasks on both a large and small scale.



Within English Heritage current examples include rock-art and artefact recording. An article on the application of low-cost photogrammetry within the 'Rock Art Recording Pilot Project in Northumberland and County Durham' appeared in a previous Research News (2). Although the project is now set to complete in March 2008, the volunteer groups have continued to acquire their own stereo-photography on a large-scale and of a wide variety of carved stones and panels, alongside the other documentation data required by the project. In addition a number of volunteers have gone on to be trained in the use of PI-3000, a lower-cost photogrammetry software package developed by Topcon (Japan), to enable them to process their own recording datasets. As two of the volunteers, Richard Stroud and Joe Gibson explain:

“In addition to 3D viewing and movement of carved rock panels, which in itself brings a greater reality than standard photography, the ability to remove distracting surface textures to better distinguish and assess artificiality and design components within markings is very useful. Previously undetected motif and design relationships have been revealed. Cup depth and shape can be better analysed and measured accurately on screen for comparison purposes. Digital Elevation Model's (DEM) of a reversed surface model can further clarify motif patterns and relationships. Essentially the photogrammetric process allows detailed desk based research on an accurate surface model without intrusion, removal or

otherwise endangering easily damaged and irreparable panels. However, photogrammetry should not be used in isolation as an interpretive tool for rock art, and should be used in conjunction with field visits.”

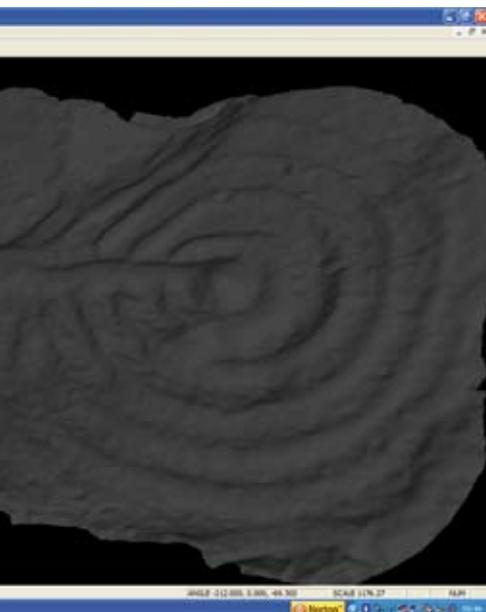
Another developing area of application is artefact recording where stereo-photography, taken with a calibrated, consumer-level digital camera from a range of up to 2m, can be acquired in conjunction with a simple set of scale-bars. Although dependant upon a number of factors including the resolution of the digital camera; the quality and angular coverage of the lens; the range over which photography is carried out and the surface texture of the object, this can still be used to provide not just a detailed, metric, photographic record of the object but form the basis for:

- *analytical interpretation of the detailing, both visually and graphically*
- *monitoring data, to enable an analysis of change over time*
- *presentation, in the form of a three dimensional model in both textured and untextured form.*

More costly techniques, such as laser-scanning, may provide potentially higher resolutions and accuracies of 3D data. However the work to date has already demonstrated that a fast, cost-effective solution to large-scale recording can indeed be provided by a low-cost photogrammetric approach through an appropriate integration of technology and expertise.

Paul Bryan

3D Digital Elevation Model (DEM) of rock art panel from Barningham Moor, Northumberland provided in untextured, reversed and textured forms. Generated by Joe Gibson using Topcon's PI-3000 'Image Surveying Station' photogrammetry software



The burials from the deserted village of Wharram Percy

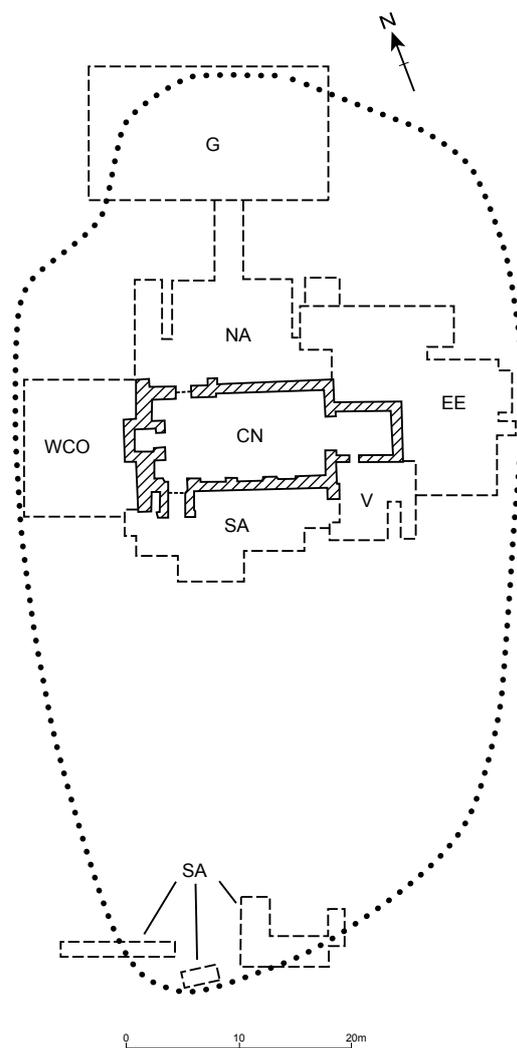
The long-running excavation at Wharram Percy resulted in the recovery of a large quantity of human skeletal remains. The recent publication of this work allows reflection on the conclusions drawn.

Wharram Percy is a deserted village in the Yorkshire Wolds. Between 1950 and 1990 it was subject to one of the longest running excavations in British archaeology. An important component of the field work centred on the church and churchyard.

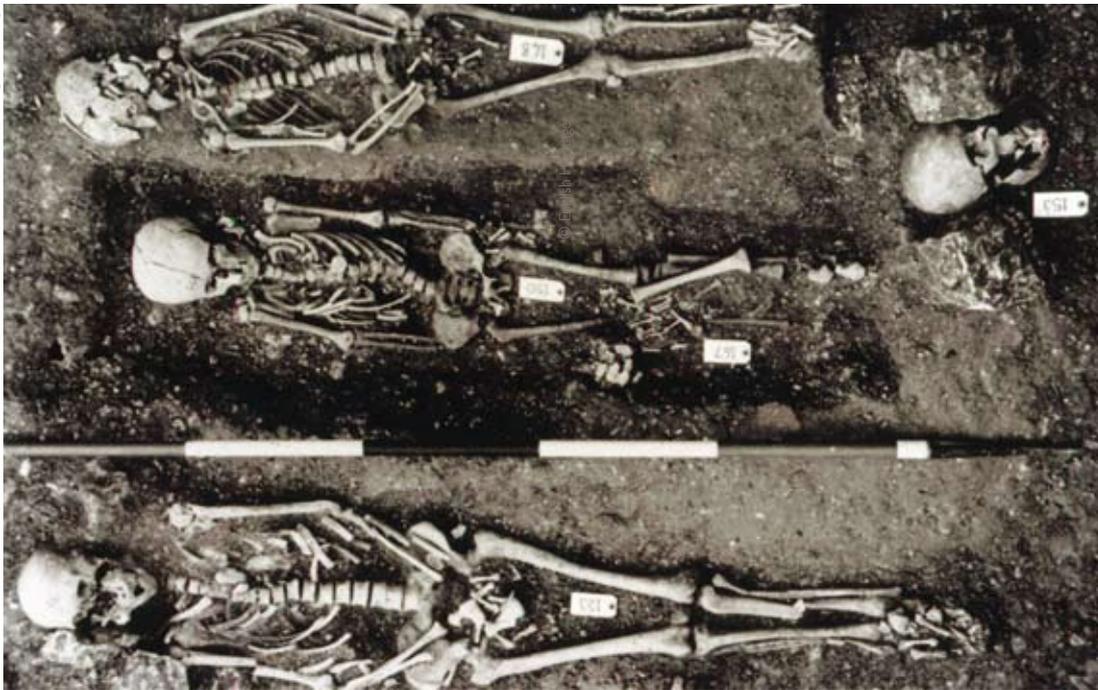
The aim here was not only to elucidate the chronological development of the church but also to obtain a large series of skeletal remains in order to shed light on life and death in this rural, peasant community. In June 2007, the volume covering the churchyard and the burials was published, so it is appropriate now to reflect upon what we have learnt from the scientific study of the human remains.

Altogether 687 burials were excavated, but this probably represent less than one tenth of all those that were made in the churchyard. An extensive radiocarbon dating programme shows that burial had commenced by about the mid tenth century, before the erection of the first stone church. It also showed that the burial ground was set out to its full extent at an early date rather than growing outward from the centre. Wharram Percy itself was deserted by the sixteenth century, but the churchyard continued to be used for burial by other settlements in the parish up to the mid nineteenth century. However, the great majority of the excavated burials come from the eleventh to fourteenth centuries.

There was no evidence for family groupings in the churchyard but there was a tendency for individuals under about 18 months of age to be buried close to the north wall of the church. The north sides of churchyards were traditionally used for burials of the unbaptised. However this is unlikely to be the explanation here as baptism in Mediaeval times was carried out in the first seven days of life, or sooner if the child was thought to be in danger of death. Presumably some other life transition occurred at about this



Plan of churchyard showing the outline of the standing church (hatched); the excavated areas (dashed lines with letter codes for the different areas) and the likely limits of burial (dotted line)



Some skeletons from the churchyard under excavation

point which was given recognition in burial placement.

About 15% of individuals died before their first birthday. If this is a guide to infant mortality levels then it is a fairly modest rate by historical standards. Study of the infant bones for signs of anaemia suggested that, in the newborn, iron stores were probably adequate, which in turn means that low birth weight and prematurity may not have been regular problems. Nitrogen stable isotope analysis indicated that breastfeeding continued for about 18 months from birth. If we are correct in inferring a fairly modest rate of infant mortality in this group, it may

be, given the well-known beneficial effects of breast-milk (in terms of building the child's immune system and saving it from having to consume potentially contaminated food or water), that the extended breast-feeding practiced at Wharram Percy played some part in this.

Growth in children seemed to match that seen in modern subjects up to the age of one year (the benefits of breastfeeding again), but after this their growth quickly starts to fall behind modern children. This suggests (not surprisingly) that nutrition was poorer and disease worse in Mediaeval times than today, but the difference was very marked – a 10



Wharram Percy today, viewed from the south-east

Healed compression fractures of two vertebrae from an elderly woman. These are typical fractures of osteoporosis. Her femur neck bone density was four standard deviations below the young adult mean, providing clear evidence that she suffered from the disease



© English Heritage

year old from Wharram Percy was 8” shorter than his modern counterpart or, to put it another way, a 14 year old from Wharram Percy was only about the same height as a modern 10 year old. The Wharram Percy people were shorter by about 3.5” as adults than people are today. The likely reason why this height difference was less than in childhood, is that people in the past grew for longer than we do today.

Approximately 40% of the adults were aged over 50 years at death, suggesting that even in this low status community, life expectancy for adults was reasonable. Some diseases of old age were evident. Women suffered from osteoporosis at least as badly as modern women. This is despite the fact that risk factors commonly held to exacerbate the disease, such as cigarette smoking or sedentary lifestyle, were absent at Wharram Percy. Osteoarthritis was also frequent, perhaps due to the strenuous lifestyle of the average peasant. Cancer was rare (there being only one example, a case of prostate cancer) but this probably just reflects the likelihood that they died of other things first.

Study of the skulls showed that, unlike material from Anglo-Scandinavian York, the crania at Wharram Percy show little affinity with Mediaeval Norse crania. This

may suggest that the any Scandinavian contribution to the population at Wharram Percy was minor compared with that in earlier Mediaeval York.

Males outnumbered females in the population as a whole by about 3 to 2. A possible explanation for this is female-led migration from countryside to town. There is documentary evidence for this sort of pattern of migration in the Mediaeval period, and it is thought to be a result of labour imbalances consequent on the mid fourteenth century outbreak of the Black Death; there was an increased demand for female labour in urban centres, mainly in domestic service but also in craft industries such as weaving. However, the sex imbalance applies for all phases at Wharram Percy suggesting that, if a female led migration to urban centres is the correct explanation, then this phenomenon was underway well before the Black Death outbreak.

The bones also serve to remind us that Wharram Percy in the Mediaeval period had important trading links with other settlements. For example, the stable isotope work shows that sea-foods were a small but significant source of protein for the Wharram Percy people. However these links may



Vertebrae from a spine of an adult female. The bone destruction has resulted in forward angulation of the spine of about 90 degrees. The bone lesions are typical of tuberculosis, a diagnosis confirmed by DNA analysis

also have introduced less welcome things. DNA analysis of cases of tuberculosis from the site showed that it was acquired not from infected animal products but from other people with the disease. The human type tuberculosis is a population density dependent disease, and it may be that regular contact with large urban centres helped maintain the disease even in sparsely populated parts of the Mediaeval countryside like Wharram Percy.

Despite the evidence for regular contacts between village and town, there were signs of differences in lifestyle and health. Analysis of the structure of some arm bones from Wharram Percy and York suggested that gendered division of labour was less at Wharram Percy than in York, and there was greater female participation in physically demanding tasks in the countryside than in the town.

Comparison with York showed that skeletal signs of infectious diseases as a whole were more frequent in the town than at Wharram Percy. This is consistent with a greater pathogen load in the urban environment due both to crowded living conditions and contamination of water supplies. More of the York group probably suffered from infectious disease for more of the time than

the Wharram Percy population. In addition, there was a tendency for more of the York lesions to be healed, whereas a greater proportion of the Wharram Percy cases were active at time of death. This suggests that the conditions which caused these lesions more often led to death at Wharram Percy, whereas at York there may have been greater resistance to disease so that a greater proportion of individuals tended to recover. This too is consistent with the idea of a greater pathogen load in the urban environment; long-term exposure from birth to a pathogen-rich environment might be expected to lead to greater resistance to infectious disease.

The Wharram Percy collection continues to be used for research. Current research projects, mainly in collaboration with other institutions, encompass studies of back injuries, kidney disease, evidence for violent injury, knee and hip arthritis, and further work on growth in the children and on osteoporosis in the elderly, as well as an array of methodological studies.

Simon Mays

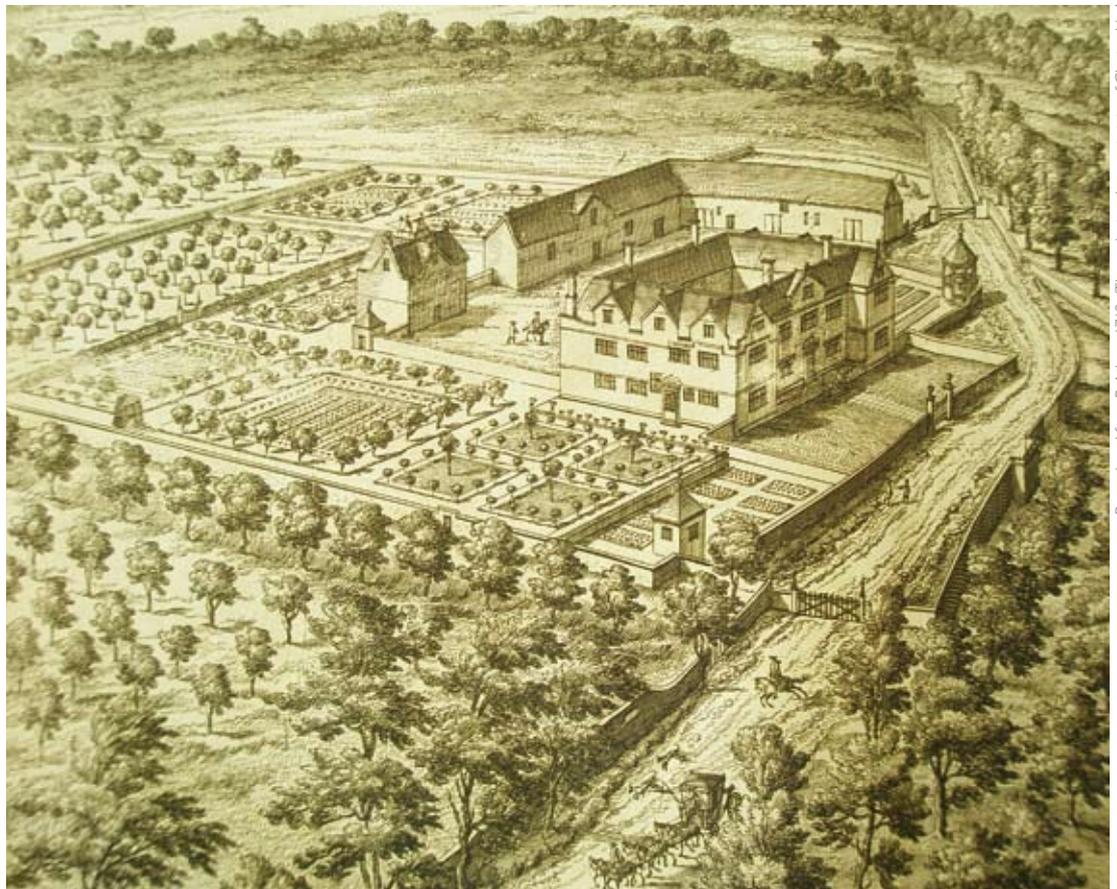
NEW DISCOVERIES AND INTERPRETATIONS

Dowdeswell, Gloucestershire: reassessing the scheduled Romano- British camp

Examination of the earthworks of a scheduled ancient monument, together with the use of documentary evidence radically revises understanding of the monument.

The Archaeological Survey and Investigation team were invited to examine the Scheduled earthwork remains of a Romano-British camp at Upper Dowdeswell. During the process of reviewing the current boundaries of the Scheduled area, Heritage Protection Advisor Sandy Gerrard highlighted inconsistencies in the layout of the site and requested a more detailed review.

The Romano-British camp at Upper Dowdeswell was originally thought to be one of three Iron Age or Romano-British enclosure camps in Dowdeswell; a second Scheduled example survives at ‘The Castles’ to the west, while a third example to the north at Lower Dowdeswell was discredited as an ancient monument by RCHME Investigators in the 1970s. The earthwork site



Reproduced from R. Atkyus, 1712. 'The ancient and present state of Gloucestershire'

Upper Dowdeswell Manor House with one of the earthwork banks evident behind the taller row of trees



The east bank of the 'enclosure'



Far left: Terraced slope on the east side of the Scheduled area

Left: 'The Castles' hillfort to the west of Upper Dowdeswell

at Upper Dowdeswell consisted of two banks running roughly north to south. It had been presumed that the banks would have been joined at each end by sections of earthworks creating a large rectangular enclosure of around 4 hectares, although no physical evidence of the latter earthworks survived.

Following an initial reconnaissance of the site and an analysis of aerial photographs at the NMRC the nature of the site was still not clear. Although there was enough evidence to consider the site's interpretation as a Romano-British camp as incorrect, a viable alternative was proving elusive.

However, it was at this stage during background documentary research on Dowdeswell that a reference was followed up to Atkyn's *The Ancient and Present State of Gloucestershire* which was published in 1712, a copy of which is usefully housed in the NMR library. Within this volume a print of Upper Dowdeswell depicted the manor house (which survives as a Grade II Listed

Building) with extensive gardens and wooded parkland to the south, the latter divided by earth banks on the very same line as those of the supposed Romano-British camp. Examination of the 1838 tithe map confirmed that this was in fact parkland, with the relevant fields recorded as Upper Park, Lower Park and Park Piece.

So what had been a Scheduled Romano-British camp at the start of this survey ended it as part of a post-medieval parkland landscape, possibly dating to the early 17th century when the resident Abingdon family were linked to the Prince of Wales. While post medieval parkland is no less interesting than a Romano-British camp, this rediscovery of the true nature of the site will require a reassessment of its importance and the relevance of protection entailed by its current Scheduling.

Michael Fradley

NEW DISCOVERIES AND INTERPRETATIONS

Treludick House, Cornwall

Dendrochronology helps unravel the history of a 17th-century Cornish House.

Treludick, 13km west of Launceston, Cornwall, consists of a substantial 17th-century house, listed grade II*, set within a group of historic farm buildings. It has a three-roomed, through-passage core, entered through a two-storey porch, and a large service range to the south. Two-storey wings have been added to the north-west corner of the house and several single-storeyed outshuts to the west, with the current plan apparently complete by the time of the 1839 tithe map. The principal elevation of the house is built of coursed rubble with some granite dressings, whilst the rest of the house is walled in cob above a substantial ground-floor of rubble. Although the original mullioned windows have mostly been replaced, the interior retains much of the 17th-century fabric, including a ribbed plaster ceiling in the parlour, moulded and stopped doorcases in the hall and in the chambers above the parlour, a screen between the through-passage and the hall, and several granite fireplaces.

Documents show that a John Harry and 'Alice his wife' were living at Treludick by 1515. On the

death of Richard Harrys in 1584, Treludick was inherited by his son John, who sold the estate in 1593–94 to a group of local yeomen, including a John Baron of Badharlick (died 1624) and George Sleeman, of Egloskerry (died 1617). How much of the 16th-century house remains *in situ* is uncertain. Richard Harrys may have been the owner commemorated as 'RH', carved on the mullioned window now located in the south wall. Treludick was occupied by John Baron's nephew (John Baron II, 1581–1654) and his wife Joan, daughter of George Sleeman by 1608; their son John Baron (1611–64; referred to as John Baron III) inherited the rest of the estate when his maternal grandfather died in 1617. When John Baron III married Mary Bennett in 1637, a document records their intention to build a new house at Treludick, a phase of construction apparently reflected in an inscribed door lintel ('IBMB 1641'), now found in the 19th-century stable block. In 1673, when her son Christopher married, Mary is recorded as occupying a parlour, a dairy, and the chambers above them; it is possible that these were the additions built in 1637–41, but which rooms these were, and whether they survive, is unknown.

Right:
East elevation of
Treludick House

Facing page top:
Treludick House (887) on the
Egloskerry tithe map of 1839

Facing page bottom:
Plan of building



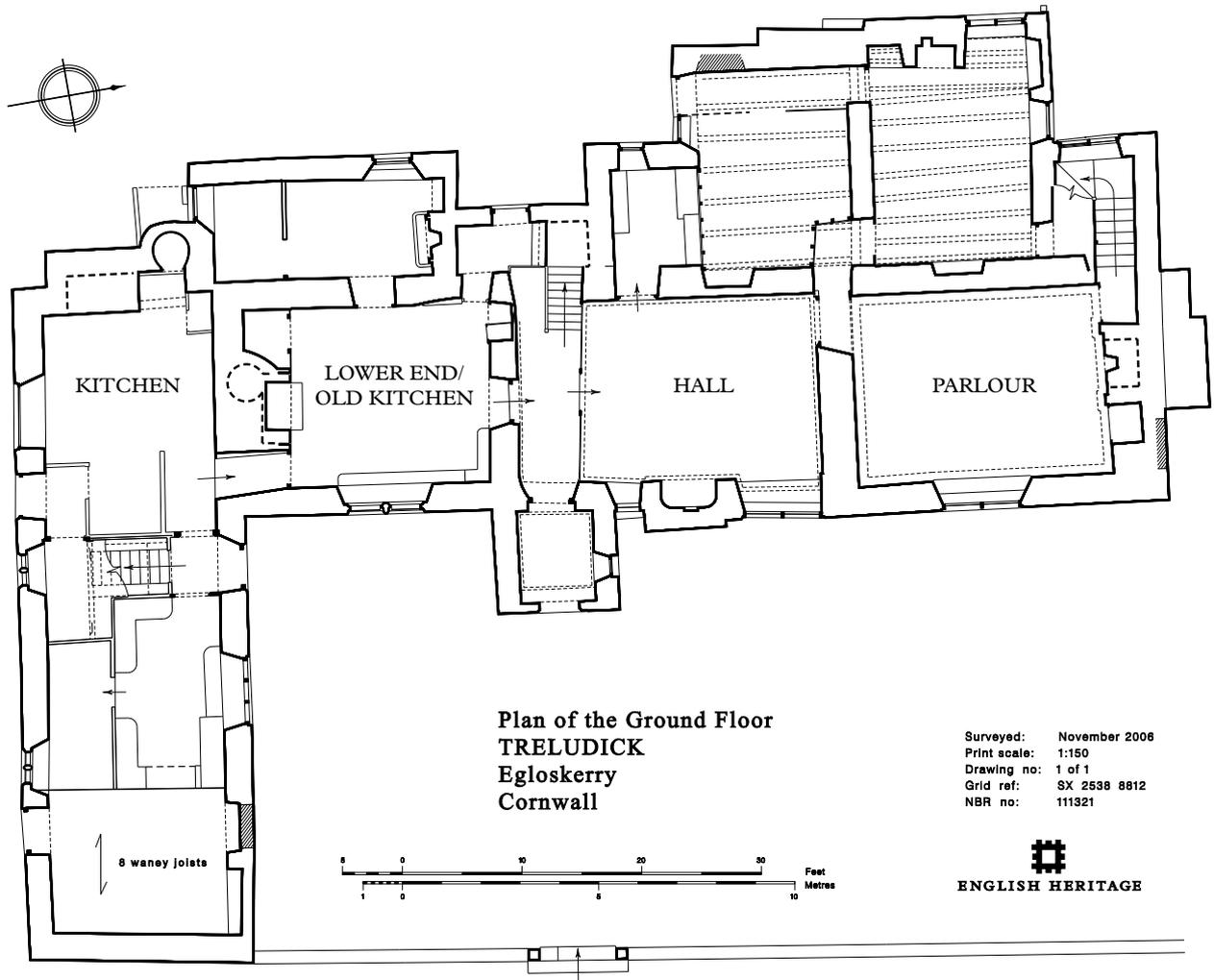
Interpretation of the building fabric is complicated by two factors: the stylistic and structural evidence suggests that several phases of construction probably occurred in swift succession, and rebuilding has removed or obscured much of the earlier evidence. There is apparently no *in-situ* medieval fabric, but a few fragments have survived, including a large smoke-blackened timber reused in the construction of the south range.

Courtesy of the Cornwall Record Office



The main range, containing the old kitchen, through-passage, hall and parlour, with chambers above, is probably the result of two main phases. The first is an earlier three-room plan consisting of the old kitchen and hall with a parlour of indeterminate size but in its current location; the second is a reconstruction of the parlour end of the house, adding the most northerly of the north-west extensions and a stair block in the corner between them. Decorative plasterwork in the parlour, with narrow ribs, widely spaced patterning and floral sprays, and the fragments of barrel-vaulting of the two

Nigel Fradgley, © English Heritage



The 'IBMB 1641' datestone, reset in the 19th-century stable block



Peter Williams, © English Heritage

chambers above suggest an early-17th century date for the high end of the house; a granite window surround in the old kitchen is of a similar period. The roof of the kitchen and the lower end of the hall is lower than that over the higher end of the hall and the parlour and corresponds to the lower profile in the cob cross-wall, which has been heightened when the present roof was built. This suggests that the old kitchen predates the rebuilding of the parlour.

Dendrochronology was used to try to tease apart the house's history. Most of the structural timbers are of oak, aside from the roof of the south range which is framed in elm. Oak timbers can usually be dated, if a sufficiently long and well-replicated site sequence is obtained through the analysis of a series of timbers from each phase or area under investigation. The far south-west of England, including Devon and Cornwall, is a particularly challenging area to work in, however, and has a success rate well below the national average. This is likely to be due to a combination of factors, including the varied environmental and topographical character and the relative isolation of the area from the main body of the reference data. It is, for instance, quite common for oak ring-width sequences from woodlands located only short distances apart to show very low similarities. The need for a strong local network of reference chronologies is clear.

Nevertheless, a well-replicated 115-year site sequence (incorporating 27 timbers from throughout the main range and one of the north-west extensions) was dated successfully. However, the oak timbers in the cob barn (which

has trusses similar to those in the main house) produced three short and poorly replicated site sequences which could not be matched against the main range sequence or reference data (or each other) and thus could not be dated. The elm timbers of the south range also proved to have diverse growth patterns: this did not permit relative or absolute dating of this extension.

All the dated timbers were apparently felled in the early 17th century, but only one of these, from the upper (later) roof over the hall, was complete to the bark edge. This timber was from a tree felled in 1630. Felling date ranges for all the other timbers with the heartwood/sapwood boundary (based on an estimate of the number of missing sapwood rings) include this date, but, given the structural evidence, it is unlikely that all were felled in the same year. The clustering of heartwood/sapwood boundary dates, however, indicates that very little time elapsed between building phases; a timber from the earlier hall roof was probably felled after 1623, and one from the old kitchen roof was probably felled after 1626. It is possible that the hall and parlour roofs were raised as late as c 1641, by John Baron III and Mary Bennett, but this would require the timber felled in 1630 to have been reused or stockpiled for at least a decade and the detailed analysis provides no evidence to support this possible interpretation. Although three of the four dated timbers with heartwood/sapwood boundary dates in the northernmost north-west extension could be a few years later than those of most of the timbers in the main range roofs, there are too few of these timbers to conclude that it is a later extension, and it is probably part of the campaign

to rebuild the parlour area. Unfortunately, the roof of the adjoining projection was inaccessible, but appears (due to a change in floor level) to be a later addition than its northerly neighbour.

Although dendrochronology could not rule out that John and Mary built the south range roof, an unusual set of carpenters' assembly marks on one of the elm trusses matched those found in an oak-framed roof at Trerithick House, 6km south of Treludick. This building was itself the subject of a dendrochronological investigation earlier this year, also by the Nottingham laboratory. Well-replicated site chronologies were obtained for the hall and west range roofs, but these did not match any reference chronologies, and thus could not be dated, until the creation of a well-replicated site chronology at Treludick, which matched the overlapping period in the 171-year hall roof sequence at Trerithick. This showed that the Trerithick hall roof was built in around 1673, significantly later than expected, and possibly at about the same time that the south range (of elm) at Treludick was built. The matching assembly marks, however, were in the still-undated west range at Trerithick. This roof is perhaps more likely to be later than the hall range at Trerithick, as the west range was renovated in the early 18th century, a period for which there are even fewer reference chronologies. If so, the south range at Treludick may also post-date John and Mary.

These studies have shown that there is still a great deal of potential for both tree-ring dating and the analysis of architectural detail in Cornwall. Although the south range at Treludick may never be dated precisely, the west range roof at Trerithick may well be, as the corpus of dated buildings in the area continues to grow, and it is also possible that the Treludick cob barn will eventually be dated. Ironically, many of the undated timbers in the barn were complete to the bark edge, potentially providing the dating precision that would have resolved the closely-spaced building sequence in the main range.

The dendrochronological investigation was commissioned by the Scientific Dating Team and undertaken by Robert Howard and Alison Arnold of the Nottingham Tree-Ring Dating Laboratory, with quality assurance by Cathy Tyers of the University of Sheffield. The West Territory Architectural Investigation team, based in Swindon, became involved when Francis Kelly, Historic Buildings Inspector, South-West Region, asked for a report on the history and evolution of the house and farm buildings, to inform advice on an application for listed building consent. The team consisted of Barry Jones, Lucy Jessop, Ursula Dugard-Craig, Peter Williams (photography) and Nigel Fradgley (measured survey and ground plan). Elaine Jamieson from the Archaeological Survey & Investigation team, Exeter, surveyed the grounds for traces of earthworks. Research on Treludick appears in two reports in the Research Department Report Series, by Jessop (RDRS 91/2007 forthcoming, discussing history, architecture and archaeology) and Arnold and Howard (RDRS 63/2007, dendrochronology); a report on the tree-ring dating at Trerithick (RDRS 94/2007) is currently in production.

John Meadows and Lucy Jessop

Nottingham Tree-Ring Dating Laboratory



Nottingham Tree-Ring Dating Laboratory



Nottingham Tree-Ring Dating Laboratory



Above top:
Trusses in the hall roof

Above:
The Cob barn north-east of
the house

Left:
Assembly mark in the south
range, Treludick

NOTES & NEWS

A round-up of activities and developments showing some of the scope and variety of projects that are ongoing in the Research Department.

INTEGRATED TRAINING IN LANDSCAPE ARCHAEOLOGY AND BUILDING SURVEY: THE MENDIP TRAINING WEEK 🍷

Integrating skills and approaches for historic environment research is one of the key principles of the Research Department's Mendip Hills AONB Project. As reported in *Research News 5*, several of the Department's teams, led by colleagues from Archaeological Survey and Investigation, Architectural Investigation and Aerial Survey and Investigation, are undertaking a multi-disciplinary project aimed at enhancing understanding of the area's historic environment. Training and community engagement are fundamental to the project aims, and are being coordinated through English Heritage, the AONB and the Mendip Heritage Group: the latter a collaboration between the numerous local history and archaeology societies that are active in the area.

Measuring medieval and early post-medieval building platforms at Ramspits for comparison with the dimensions of existing buildings at Westbury



© English Heritage

On 21- 25 May, English Heritage held a five-day training course exploring the techniques of landscape and buildings-based historic environment research – an approach reflecting the project aims of integrated survey and providing training and guidance. The course, led by Mark Bowden, Barry Jones, Elaine Jamieson, Dr Lucy Jessop, Krystyna Truscoe and Graham Brown, focused on three days of practical training in the field, supplemented by classroom-based teaching. It was held in the AONB Centre and at local sites and villages, and provided introductory papers on survey, investigation and interpretation techniques for historic buildings and landscape archaeology, an introduction to aerial survey, mapping and the interpretation of aerial photography. Practical training in earthwork survey techniques took place at Charterhouse, close to the AONB office, and buildings investigation and survey at Chancellors Farm, near Priddy: a farmstead managed by the Somerset Wildlife Trust. The integration of these techniques and their application to the assessment of wider landscape areas focused on the exploration of two of the Mendip Project's study parishes, Westbury-sub-Mendip and East Harptree. In the former, the group looked at earthwork evidence of multi-period farming at Ramspits, high on the edge of the Mendip scarp, before descending into the village to pursue related themes in the village buildings and landscape.

Take-up of the course's sixteen places was managed to make best use of the opportunity to disseminate ideas and skills and spread the benefit across a wide audience. The course, provided free of charge, was promoted through the Mendip Heritage Group, in conjunction with the AONB, and was attended by one or two nominated representative from each of the interested local groups. The nominated individuals attended the course and were responsible

for reporting back and passing on the skills and experience gained to fellow members of their society. The course was supported by Amanda Feather, Training Manager, who visited classroom and field sessions and coordinated feedback on the course. The trainees were enthusiastic and committed, as demonstrated in their attendance for the duration of the week. Further benefit has been derived from strengthening contacts between local groups and the English Heritage Project team, and this has provided a springboard for further cooperation on mutual goals.

Barry Jones

CONSERVATION IN THE DARTMOOR MILITARY TRAINING AREAS

In early 2007 a five-year project to record the historic environment of the Ministry of Defence's (MoD) five military training areas on Dartmoor National Park was brought to a successful conclusion. The MoD had long been conscious of the wealth and significance of the archaeological remains contained within its Dartmoor Training Areas but until 2000 had only the scheduled monument list and the county HER as sources of information. Monitoring the condition of the resource using this paper record was difficult as non-scheduled, though important, elements were often overlooked and those that were recorded lacked context.

With the introduction of electronic mapping and Geographic Information Systems (GIS), the opportunity was taken to completely re-evaluate all heritage assets within the training areas, scheduled and non-scheduled. The project was undertaken by the English Heritage Archaeological Survey and Investigation team (Exeter), funded jointly with the MoD Defence Estates. The aim was to undertake a new programme of reconnaissance, survey and mapping, the results of which would form the basis for present and future monitoring of the entire archaeological resource. The five Dartmoor Training Areas cover a total of 13,000 hectares, and include some of the most spectacular landscapes in the National Park, such as Tavy Cleave, High Willhays and parts of the Plym Valley. Three of the training areas are used for live firing.



Altogether within the five training areas 809 sites have been recorded, including single monuments such as small cairns, boundary stones and ruined buildings, but also complicated landscapes. These include prehistoric reave systems, settlements and ritual monuments, medieval and post-medieval settlements and fields, and industrial features from the medieval period onwards, particularly tinworks and mines. Many of these sites were previously unrecorded in either the National Monument Record (NMR) or the HER and of this total only 190 are scheduled.

The product of the survey is an updated or new field report for each site or area and all features have been mapped electronically at a scale of 1:2500. Every site has been photographed and a baseline condition survey compiled describing past interference and potential threats. All this information has been supplied to Defence Estates in GIS format.

Following on from the completion of the surveys by EH, a rolling programme of condition monitoring will take place every five years. This work will be undertaken by contractors and funded by Defence Estates. The first of these revisions for Willsworthy Training Area will be commencing in 2007.

Phil Newman

The Hingston Hill stone row and cairn circle. A scheduled monument in the Cramber Tor Training area on Dartmoor



© English Heritage

The Confederation Building, part of the Canadian parliamentary buildings complex in Ottawa, where the technical evaluations and demonstrations were undertaken

COOPERATIVE INITIATIVES FOR THE SHARING OF PROFESSIONAL AND TECHNICAL HERITAGE CONSERVATION EXPERTISE – METRIC SURVEY AND PUBLIC WORKS AND GOVERNMENT SERVICES, CANADA 🇨🇦

Jon Bedford of the Metric Survey Team visited the offices of the Heritage Conservation Directorate (HCD) of Public Works and Government Services, Canada (PWGSC), in May this year in order to compare project delivery methods and techniques for heritage recording with the objective of increasing productivity. HCD explained their approach for the delivery of recording projects, outlined their new National Historic Sites of Canada (NHSC) values-based baseline heritage recording project, and discussed their registered ISO9001:2000 Quality Management System for project delivery. English Heritage provided evaluation of and basic training in real time digital site recording techniques. The project selected for the technical evaluation was the Confederation Building, Ottawa, which forms part of the Canadian Parliamentary buildings complex. This building was chosen because results from this year's work could be compared to work produced during an earlier survey campaign undertaken by HCD in 2006 on a different section of the building. A porch at the rear of the building was chosen as a subject of suitable dimension and complexity for training in and evaluation of both the Tablet computer technology and its survey application and TheoLT, the site survey software, owned by English Heritage and currently employed by the Metric Survey Team. The software and hardware were demonstrated so that the appropriateness

of the system for this type of work could be evaluated by the HCD field survey team members. The field demonstrations took place over three days, between 28-30th May 2007. HCD field recorders from all over Canada were present for the demonstrations. The surveyors were divided into two groups of four persons for the training, with each group receiving 1 day's training with the system. This included an introductory session, followed by 'hands-on' experience for evaluation purposes. In each training session an outline plan and some elevational detail was surveyed by the teams. In addition to the main sessions, on Wednesday 30th May an open invitation was made to members of other teams in the HCD office to be able to see the system, and explanation was given and some 'hands-on' time given to those working in other, non-survey based disciplines. A lunchtime lecture presentation was also given to members of the other Ottawa office teams on 31st May, briefly outlining the role of the Metric Survey Team within English Heritage, giving examples of work undertaken by them, outlining their project delivery approach and presenting the results of the training exercise. A questionnaire was distributed to the surveyors, and feedback was very positive – the methods of surveying currently used by the Metric Survey Team were seen to offer considerable efficiency savings both on site and in the office, potentially significantly reducing project delivery times and with the additional advantage of being able to view and edit the survey data in real time. It is hoped that a return visit from a member of the HCD team can be made to English Heritage at some point in the future to exchange information and experience with survey and digital photogrammetry.

Jon Bedford

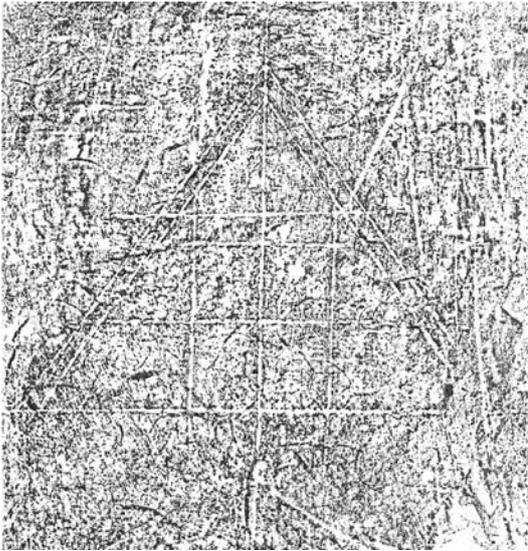


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Jon Bedford with surveyors from HCD outside the Confederation Building, Ottawa

EVIDENCE FOR A LAST MINUTE CHANGE TO THE ROOF DESIGN OF THE EAST RANGE, APETHORPE HALL 🇬🇧

Work on Apethorpe Hall (*Res News 5*) continues to reveal new aspects. Along with masons' marks and various other inscriptions a curious triangular shaped pattern was revealed when panelling was recently removed in the Long Gallery of the East Range (see enhanced tracing). Its significance was not at first obvious but



subsequent analysis of the roof structure above the Gallery has shown it to be the roof design that was first envisaged, started to be made and then altered during its construction in the early 1620s.

The inscription is believed to show a regular truss with rafters set at 55 degrees from the horizontal and with a 70 degree angle at the apex, the same angle of cut at the top end of principal rafters on the west side of the roof. These, however, are mismatched to the adjoining east principals which join them at an angle closer to 45 degrees (see photograph). The latter are a remarkable feature of this roof for the east side is constructed with 14 oak principals whose lower ends have a natural kink. Each timber had been carefully selected with an angle of deviation along its length of about 45 degrees. When set to the vertical the shorter end forms part of a low wall to the side of a walkway along the east side of the roof. The presence of such rare timbers is best explained by the owner's favoured relationship with King James I who ordered the construction of the East Range and who made timbers available from the Royal Forests.

The west principals show that a normal gabled roof was initially prepared but when the King's special timbers arrived the original design was abandoned. Reused timbers now acting as collars have been shown to be parts of the originally prepared east principals, cut up and reassigned when no longer needed. Trusses had been prepared with paired principal rafters attached by a single collar (set lower than the present ones), but with no tie beam. These early collars were then cut,



leaving their tenons *in situ*, and the principal timbers were either re-set or reused.

The presence of the design on the wall below the roof might also point to the floor area being used as a workshop before it was fitted out and before the ceiling beams and joists were set in place.

Richard Sheppard
Trent & Peak Archaeology
University of Nottingham

Left: Tracing of the Apethorpe roof design graffito

Right: Detail of roof timbering as built

RAVENGLASS ROMAN FORT, CUMBRIA ⁴¹

Local concerns that the Roman fort at Ravenglass on the Cumbrian coast, is under serious threat from coastal erosion have inspired a rapid desktop assessment using data from maps and aerial photographs.

The fort, which sits on a low estuarine cliff, has suffered from a number of damaging events including extensive tree planting and the building of the railway which cut through it in 1850. The findings of rescue excavations conducted in 1976 and 1977, compared with nineteenth and earlier twentieth-century accounts, confirmed that erosion of the cliff edge had destroyed the west and south western defences of the fort. Then in 1998 the RCHME assessed the rate of erosion since those excavations at 3.0m - 4.0m over the twenty year period.

An examination of historic Ordnance Survey mapping (1:2500 Cumberland 1899) and modern OS digital mapping (OS Mastermap



© English Heritage

2005) shows no apparent change to the cliff during a period in excess of a hundred years, implying minimal loss to the cliff edge. However, comparison of aerial photography taken in the period 1946-1995 confirms that localised erosion has occurred.

Selected photographs were rectified with specialist software and imported into a GIS environment (AutoDesk Map 2007) where the difference between the cliff edges as recorded on images from 1946 and 1995 could be measured. This equates to a loss of less than five metres over the fifty-year period. Even allowing for small inaccuracies in the rectifications (max $\pm 0.8\text{m}$) this figure would not approach that determined by the RCHME survey. Erosion tends to be episodic rather than constant and the indications are that most of the loss occurred in the period between the 1970s excavations and the 1995 photography with a period of relative stability in the thirty years between 1946 and 1976.

Melanie Partlett

The outline of the fort at Ravenglass superimposed on the aerial photograph

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