

Metric Survey at English Heritage

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Imaging Graphics and Survey, Research Department,
English Heritage

Introduction

- Introduction to the work of English Heritage
- Why do we survey?
- Metric survey techniques used by English Heritage
- Procurement
- Summary



What is English Heritage?

Non-departmental public body created by the National Heritage Act 1983

The Government's lead advisor on the historic environment

Principal aims:

- to secure the conservation of England's historic sites, monuments, buildings and areas
- to promote access to, and enjoyment of, this shared heritage
- to raise understanding and awareness of the heritage and thereby increase commitment to its protection

The screenshot shows the English Heritage website homepage. At the top, there is a search bar with the text 'Type search text here' and a 'Search' button. Below the search bar are navigation tabs for 'Days Out & Events', 'Research & Conservation', and 'Learning & Resources'. The main content area is divided into several sections:

- Properties, Events, Hiring a Venue, Membership, Supporting Us, Online Shopping:** A large section with a background image of a historic building and a speech bubble that says 'Days out worth talking about.'
- Research & Conservation:** A section with a background image of a person walking on a path, listing 'Conservation Grants', 'Archaeology & Buildings', 'Heritage Protection', 'Blue Plaques', and 'Public Policy'.
- Learning & Resources:** A section with a background image of a sunset over a landscape, listing 'Photo Collections', 'Publications', 'Online Resources', 'Education', 'Public Archive (NMR)', and 'Community Projects'.
- Doon St Tower:** A section with a background image of a tower, stating 'English Heritage goes to Public Inquiry on the 144 metre Doon St Tower proposed for London's South Bank.'
- Dan Snow videos:** A section with a background image of a woman, stating 'Free short films made especially for English Heritage, including clips about the 1066 Battle of Hastings & Dover Castle.'
- Buildings at Risk:** A section with a background image of a person working on a building, listing 'A Towering Mistake for the London Skyline' and '£2.1 Million Awarded to 28 Cathedrals by English Heritage'.
- Kids' Zone:** A section with a background image of children playing, listing 'English Heritage and E.ON to promote energy efficiency'.
- Silbury Hill:** A section with a background image of a hill, stating 'Largest prehistoric man-made mound in Europe - read about the major conservation project.'
- Image Shop:** A section with a background image of a stone archway, stating 'An exclusive selection of heritage prints, framed prints and canvas prints available.'
- Climate Change:** A section with a background image of a building, stating 'Advice on climate change and the historic environment.'
- New Discovery Visits:** A section with a background image of a group of people, stating 'For school groups - Get out of the classroom and into the magic of history.'

At the bottom of the page, there are several promotional banners for '1066 Fascinating New Visitor Experience', 'Hiring a Venue', 'Holiday Cottages', and 'Membership'.

www.english-heritage.org.uk

What is English Heritage?



Duties:

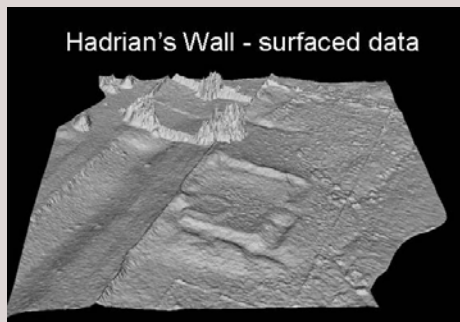
- A legal planning function for around:
 - 15,400 ancient monuments
 - 450,000 listed buildings
 - 9,000 conservation areas across England
- Provision of grants for conservation work throughout England
- Advisor to the Heritage Lottery Fund (HLF) on the distribution of lottery grants to the heritage sector
- Manages estate of around 410 historic properties spread over 9 regions including.....

English Heritage in the North



Hadrian's Wall

- The most important monument built by the Romans in Britain
- Built in AD 122 over a six year period by order of the Emperor Hadrian to '*separate the Romans from the Barbarians*' in the north.
- The 80 Roman mile long wall (117km), some 5 metres high, stretches from Wallsend near Newcastle in the east to Bowness in the west
- By the early 400's, the empire had declined, Britain was abandoned by the Romans and the wall became derelict

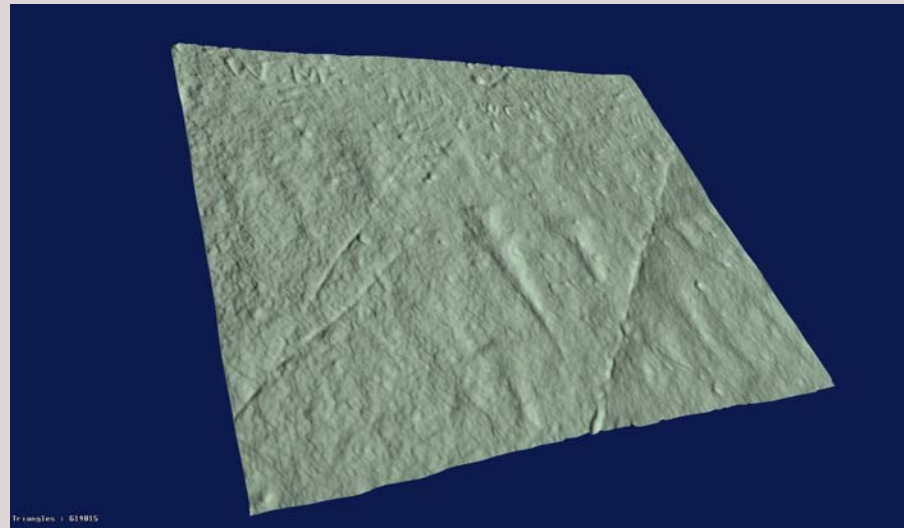
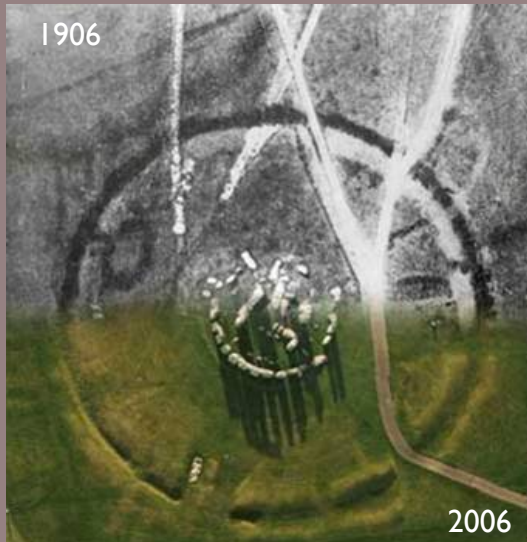


English Heritage in the West



Stonehenge

- One of the wonders of the world erected between circa 3000BC and 1600BC
- The stone circle, including its famous carvings, is surrounded by more than 300 burial mounds and major prehistoric monuments
- UNESCO World Heritage Site since 1986



Recording carvings using low-cost photogrammetry



English Heritage in the South



Osborne House, Isle of Wight

- The house and surrounding grounds were purchased by Queen Victoria in 1845 – her '*Palace by the Sea*'
- The interiors are full of grand architectural design and decoration that serve as a reminder of the royal family's links to the crowned heads of Europe and previous reign of the British Empire



Building recording and conditions surveys provided by rectified photography montages

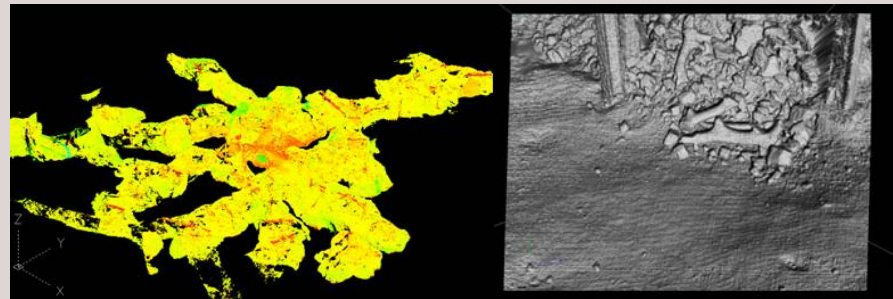


English Heritage in the East



Grimes Graves

- A large Neolithic flint mine complex considered to be the earliest major industrial site in Europe
- Dug by Neolithic miners over 4000 years ago, between 3000 BC and 1900 BC
- About 400 shafts spread across the 40 hectare site, many remaining as shallow hollows but some can still be descended to see the Neolithic remains



Recording the underground shafts and tunnels using 3D laser scanning



English Heritage Structure

DIRECTOR OF RESEARCH & STANDARDS
Edward Impey

Chief Executive
Simon Thurley

STRATEGY

ARCHAEOLOGICAL
ADVISOR

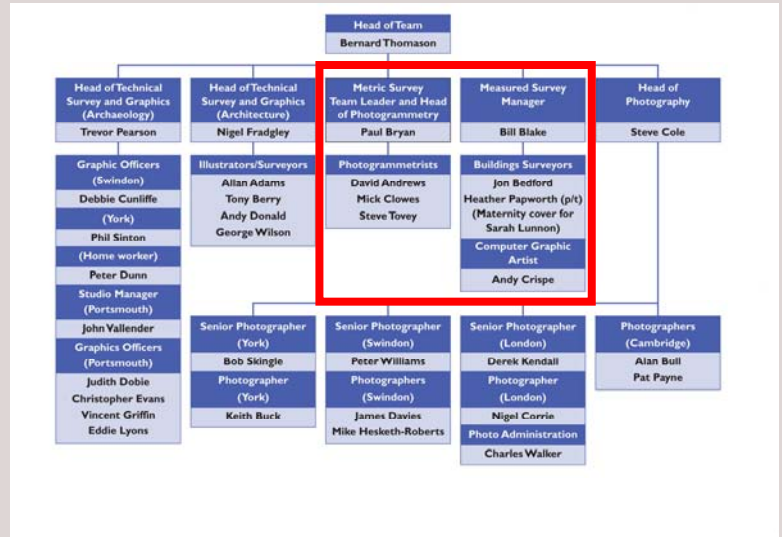
RESEARCH DEPARTMENT
Chris Scull

PROPERTIES
PRESENTATION

NATIONAL
MONUMENTS RECORD

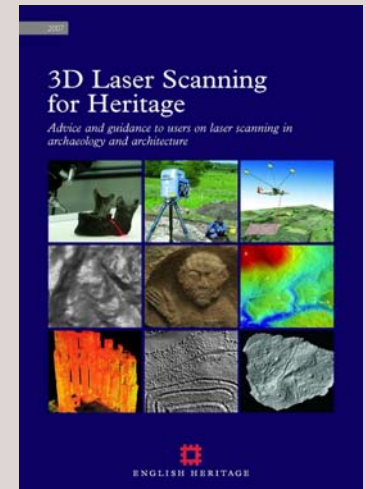
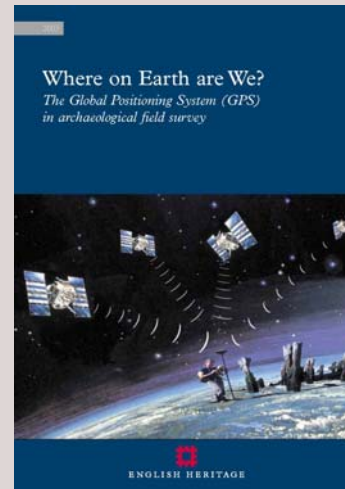
CONSERVATION
DEPARTMENT

IMAGING, GRAPHICS
AND SURVEY



IMAGING, GRAPHICS &
SURVEY (IGS)

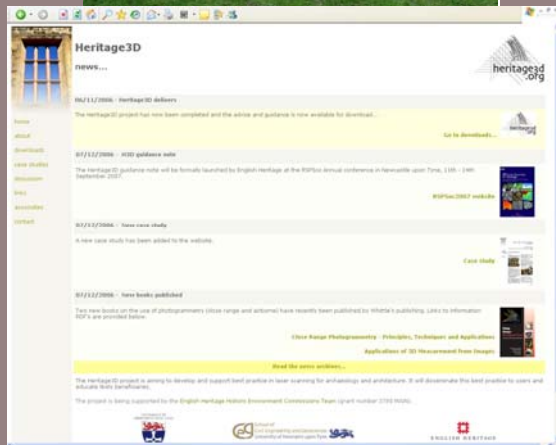
Photogrammetric
Unit



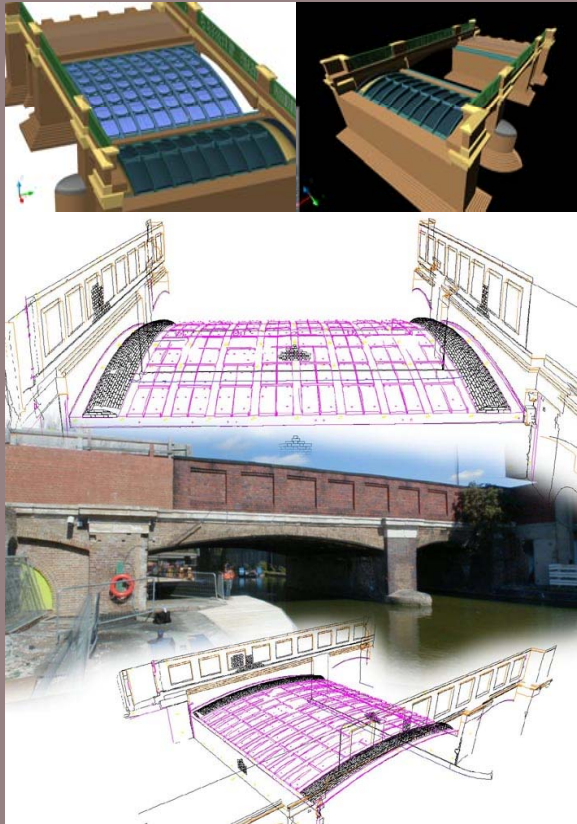
What does the Photogrammetric Unit do?



- Practical and advisory services in metric survey to English Heritage
- Develop and promote national standards for metric survey of the historic environment
- Procure metric survey from commercial sector
- Carry out training programmes, presentations, generate publications
- Conduct targeted and co-ordinated research into new methods of survey e.g. laser scanning



Why do we survey?



Bishop's Rd Bridge, Paddington

Photogrammetric line drawings provide accurate record of former canal bridge at Paddington Station, built to a design by famous engineer Isambard Kingdom Brunel in 1838

To assist with understanding a monument or landscape through

- Architectural Recording



Why do we survey?

Brace and Clifton. Photogrammetric recording of the Roman earthworks "Cawthorn Camp"

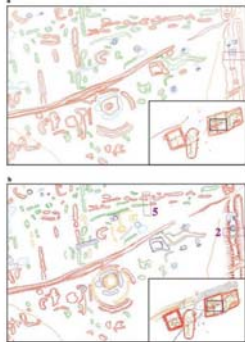


Fig. 2. (a) Series of recorded the field, selected from the original at 1:500 scale, of the earthworks at Cawthorn plotted from the digital photogrammetric reconstruction. An indication of the overall size of the monument can be gained from the north-south and east-west scales in Fig. 2. (b) Digital elevation model (DEM) derived from the digital photogrammetric reconstruction of the original at 1:500 scale, representing a combination of the highly accurate photogrammetric data supplemented by information from other line photographs and plans. Features such as the well preserved earthworks, but with associated features not beyond a guess, the lower features represent trends and soil types resulting from the 1970s excavations. Yellow features were acquired from photographs taken in 1999. © English Heritage. JMS.

© 2004 The British Institute of Photogrammetry Society and Blackwell Publishing Ltd

Brace and Clifton. Photogrammetric recording of the Roman earthworks "Cawthorn Camp"

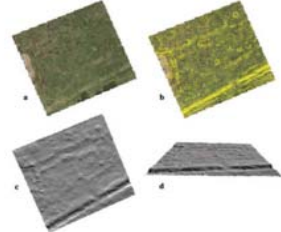


Fig. 4. Series from Access B including orthophotograph, OED 23 in (a), orthophotograph (aerial) with height information (b), and two grey scale perspective views (c) and (d). © English Heritage. JMS.

The software can also generate perspective views of the subject from different angles. The process also changes the aerial imagery over the elevation model. Separately, lighting and colour balance can also be changed. Fig. 4(c) illustrates a view of the exact from Access B but taken at a more vertical angle and changed to grey scale. The direction of sunlight was changed to come from low in the sky from the north-east in order to highlight the subtle variations in terrain advantage. Removal of all the differing colours of vegetation also makes the earthworks more clearly visible. Lighting is a critical factor in the identification of earthworks both in the field and in photography, so the ability to change it digitally has great potential for the interpretive process.

Further experiments were done for Fort B (Fig. 5), Camp C (Fig. 6), and Fort A and Access B. All these images were based on a grid derived from a 1 m spacing. The perspective view of the north-east quarter of Fort A illustrated in Fig. 7 was based on an elevation model of 25 cm spacing. The level of detail visible is considerable, for example, lines of vegetation defining the edges of one of the back-filled excavation trenches, opened in 1999 can clearly be seen.

The work at Cawthorn has not only shown the potential of using digital photogrammetry for the large-scale mapping of earthwork sites, it has also given some

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To assist with understanding a monument or landscape through

- Architectural Recording
- Archaeological Recording



Why do we survey?

Prior to an Intervention

- Architectural Recording
- Archaeological Recording
- Condition survey reports

CASE STUDIES

To enable each of the twenty-two stereo-models to be constructed in an analytical stereo-plotter or a digital photogrammetric workstation, a minimum of four control points per model was required. Because of the difficulty of placing plastic targets on the ceiling it was decided to use points of detail, even though these would not provide the same clarity of pointing and hence level of accuracy as a target and would also take longer to observe. The wide platform at triforium level was used for surveying the control points by intersection, as it provided both an excellent view of the ceiling and reduced the need for any extreme vertical angle observations.

To allow the intersections to be carried out effectively colour prints were made from the stereo-photography and marked up directly on site, as detail points were selected. A total of eighty-five points of detail were coordinated. This meant that there were up to six points available per model. Normally only four points per model are required to these extra control points helped ameliorate the reduced accuracy that was a consequence of using solely detail points.

5.5.2 Stereo-photography

The cathedral ceiling is 25m above ground-floor level. In order to acquire stereo-photography of a suitable negative scale it was necessary for the English Heritage Metric Survey Team to use either access equipment or a camera with a telephoto lens. The use of access equipment was rejected for two reasons. First, there was the physical difficulty of bringing a scaffolding tower or hydraulic lift into the cathedral. Secondly, the photography had to make use of available light, since artificial methods would not have given adequate illumination over the whole ceiling. The long exposure times thus involved made the use of access equipment impossible, as it would not have been sufficiently stable. The decision was therefore taken to use a Zeiss IUMK 30/138 metric camera for the photography.

The 5m x 7m format and 300mm lens of the IUMK meant that the entire width of the ceiling could be covered in one photograph taken from the ground floor (see Fig. 54). The resulting negative scale of approximately 1:80 was sufficient to allow the production of drawings at 1:20 or even 1:10. The camera and tripod were mounted on a 'skid' and wheeled down the centre of the nave, making possible a run of twenty-three

photographs and thus twenty-two stereo-models (Fig. 55). In addition to this ground-based photography, stereo-imagery was taken from the triforium using a 5m x 4in. format WILD P31 metric camera with a

Figure 55 (detail) A corner part of the nave ceiling



Peterborough Cathedral,
Cambridgeshire



Why do we survey?



Whitby Abbey, North Yorkshire

The new C21st 'state of the art' EH visitor centre

Basis for planning proposals

- Architectural Recording
- Archaeological Recording
- Condition survey reports
- Detailed design work



Why do we survey?



FIG. 1. Windsor Castle: a view of the present Castle looking east.

PRE-RESTORATION ANALYSIS OF THE FIRE DAMAGED AREAS

The fire on Friday, 20th November, 1992 destroyed a large section of the private and State Rooms in the north-east corner of the upper ward. The scale of the devastation is difficult even now to appreciate fully (Fig. 2).

Before the ashes had cooled, thought was being given to the reconstruction of the buildings which was to become the subject of a national and, at times, heated debate. Representatives from English Heritage were quickly on site to advise on the clearance of the buildings. Experience of previous fires at Hampton Court Palace in 1986 and Uppark House in 1989 had shown that if authentic restoration was to be carried out (that is to say the accurate reconstruction of damaged structures and decorative finishes using the original methods and where possible salvaged materials) then the fire debris had to be collected and sorted for the retrieval of structural and decorative materials. In this case, salvage also included items of furniture and sculpture.

The first priority for fabric recording was the rapid assessment of the damaged timber structures. Demolition of damaged roof structures began almost immediately.



FIG. 2. An illustration of some of the damage caused by the fire in St. George's Hall.

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Windsor Castle

New & archived photography, both from the Royal Household's own collection and the National Monuments Record (NMR), used within post-fire restoration – as featured in Photogrammetric Record article October 1995

Providing an Archive

- Architectural Recording
- Archaeological Recording
- Condition survey reports
- Detailed design work
- Archival and ante-disaster purposes



ENGLISH HERITAGE

Why do we survey?



Greatstone Listening Devices,
West Sussex, Southern England

Taken from 3-D virtual model for site
created by photogrammetry and laser
scanning

To assist site interpretation and presentation

- Architectural Recording
- Archaeological Recording
- Prior to an Intervention
- To assist detailed design work
- Archival and ante-disaster purposes
- Presentational images and 3-D models



Metric survey techniques used by EH

Direct (non image based):
Selection at the point of capture



Indirect (image based):

*Used where there is a need for
mass metric data capture*



Hand Survey/Drawing

Theodolite/REDM Survey

GPS (Global Positioning System)

Rectified Photography

Photogrammetry

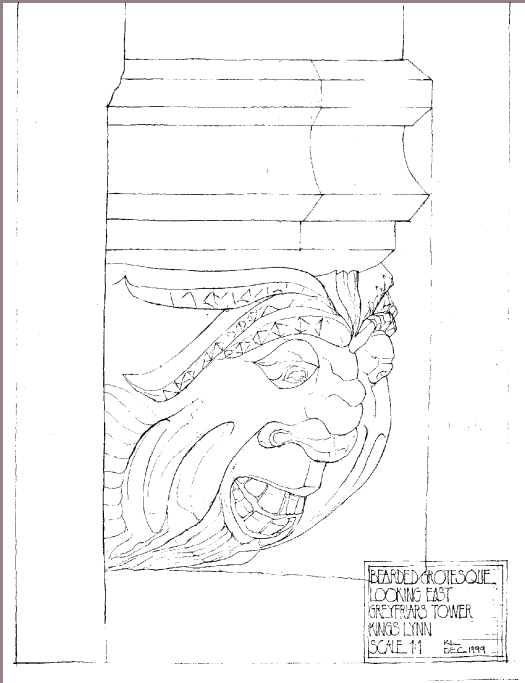
Laser Scanning



Direct survey techniques



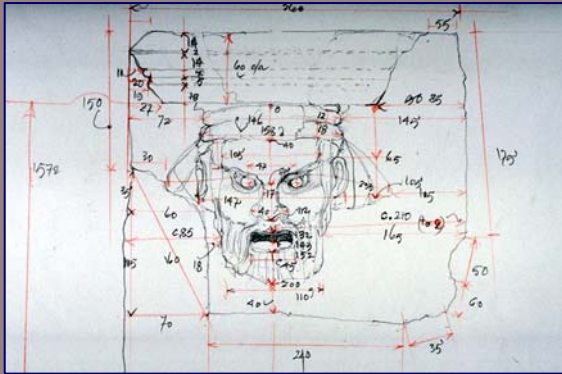
Hand survey/Measured drawing



Drawing techniques:

1. Direct plotting

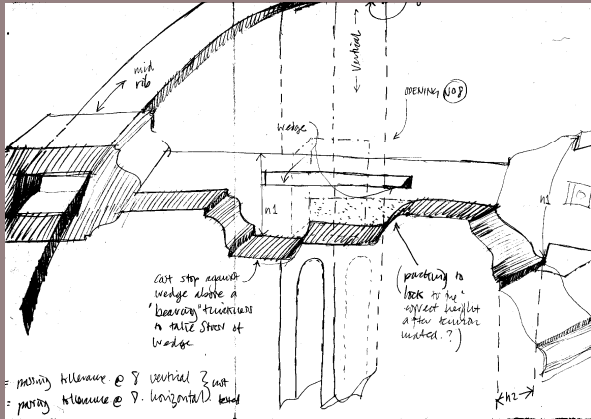
Hand survey/Measured drawing



Drawing techniques:

1. Direct plotting
2. Measured drawing

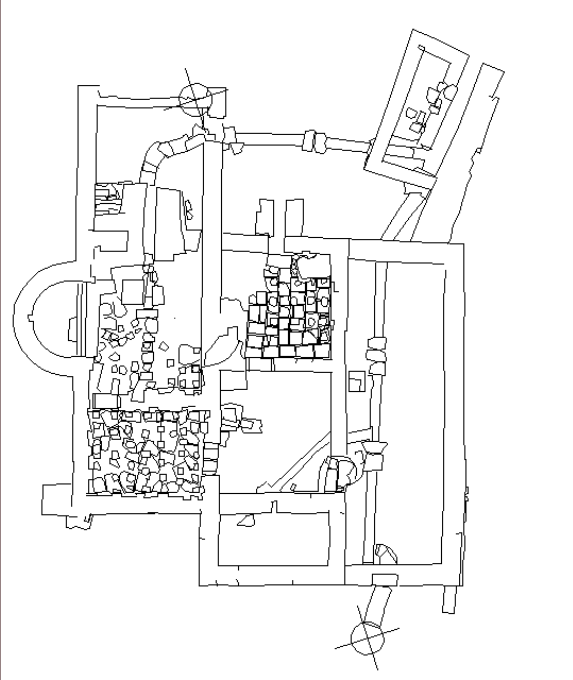
Hand survey/Measured drawing



Drawing techniques:

1. Direct plotting
2. Measured drawing
3. Sketch Diagrams

Theodolite/EDM Survey



EDM techniques:

1. Post process
2. Real-time CAD
3. DTM generation

EDM products:

1. Control data
2. 3-D CAD wire-frames
3. Digital Elevation Model (DEM)

GPS Survey



- Principal survey tool for landscape surveying as carried out by Archaeological Survey & Investigation team

GPS Survey



- Principal survey tool for landscape surveying as carried out by Archaeological Survey & Investigation team
- Hand-held GPS now routinely used for archaeological landscape surveys at 1:2500 scale - has proved particularly useful in upland landscapes such as Dartmoor and the North Pennines

GPS Survey



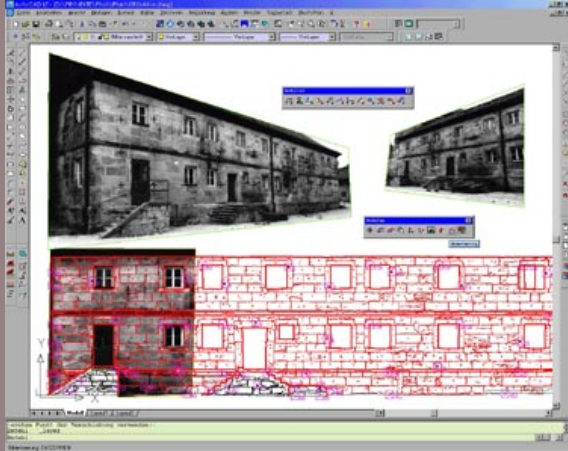
Leica TCRA1203
equipped with
Smartstation GPS

- Principal survey tool for landscape surveying as carried out by Archaeological Survey & Investigation team
- Hand-held GPS now routinely used for surveys at 1:2500 scale and has proved particularly useful in upland landscapes such as Dartmoor and the North Pennines
- Geo-referencing of
 - Building survey
 - Topographic survey
 - Geophysical survey
- Photo-control for aerial photogrammetric surveys

Indirect survey techniques



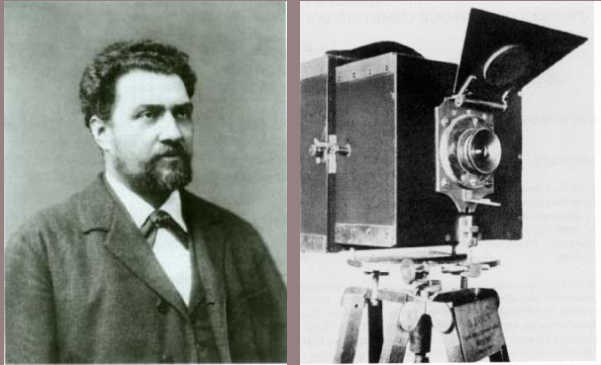
Rectified Photography



- Photography taken parallel to object, together with some form of scale measurement
- Digital imagery processed using dedicated rectification package such as PhoToPlan from Kubit



Photogrammetry



- Technique developed over **160 years** ago by Frenchman, Aimé Laussedat
- Used for constructing topographic map of Paris
- Term 'photogrammetry' first used in 1858 by Prussian architect Albrecht Meydenbauer
- Used it to generate surveys of historical monuments, churches and buildings throughout Berlin

Photogrammetry – how is it used by English Heritage?

- Overview for Conservation Plans



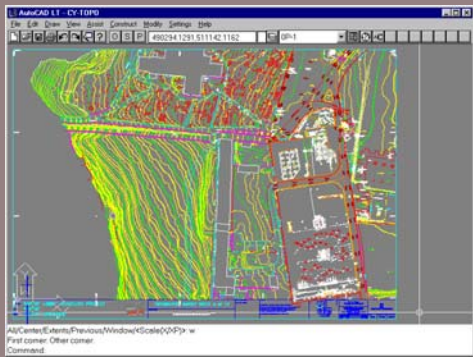
Chatterley Whitfield Colliery,
Staffordshire

Digital orthophotograph used
as base map for
Conservation Planning
process

*'At its simplest, a
conservation plan is a
document which explains
why a site is significant
and how that significance
will be retained in any
future use, alteration,
development or repair' –
Kate Clark, 2000*



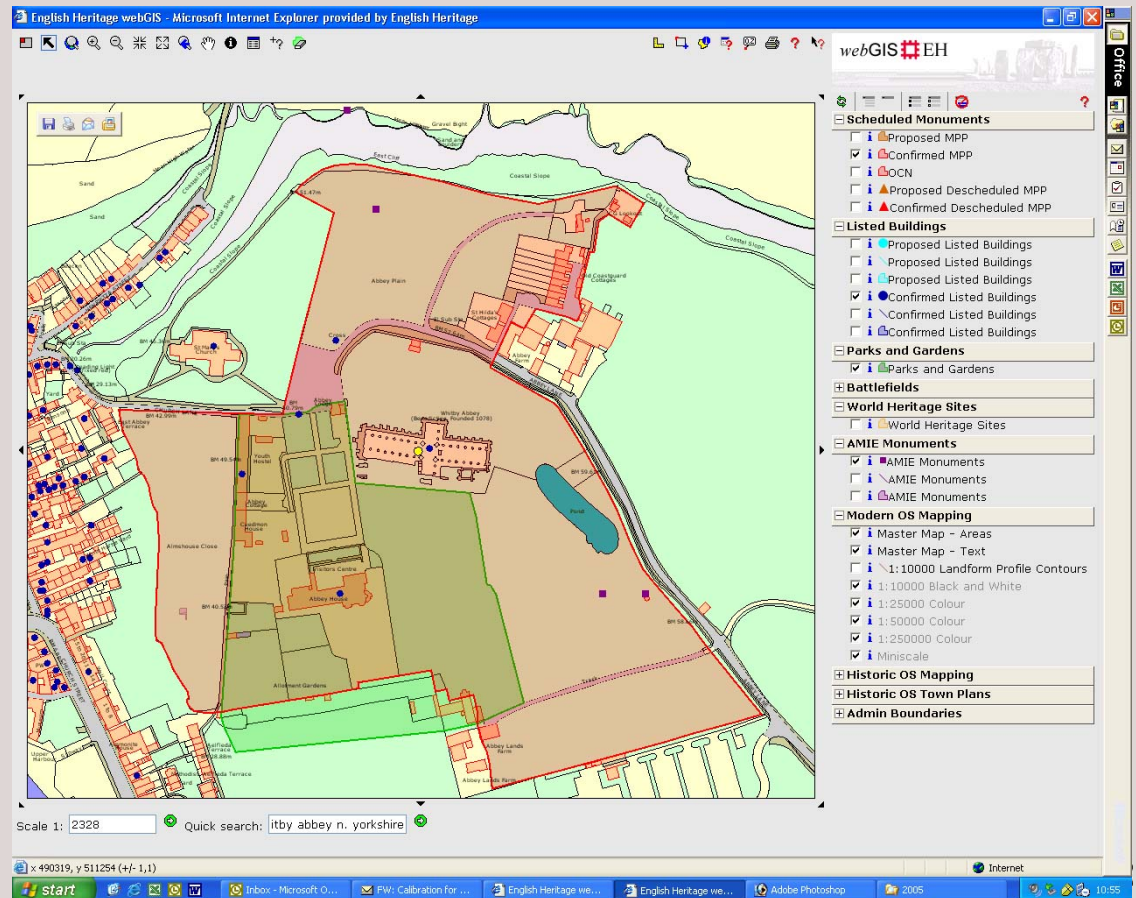
Photogrammetry – how is it used by English Heritage?



Whitby Abbey, North Yorkshire

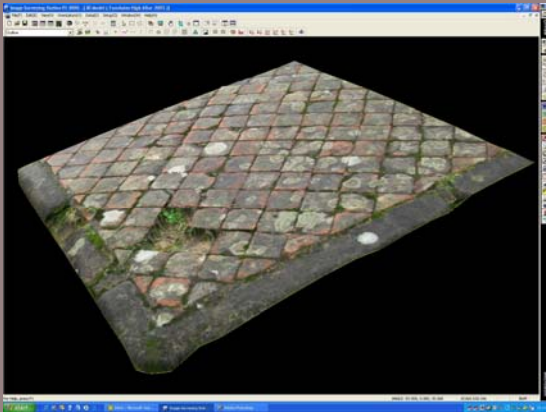
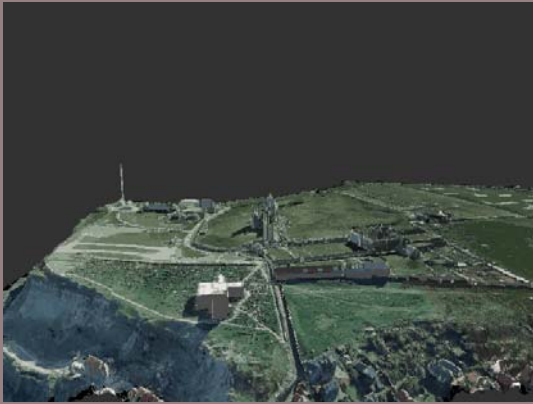
Photogrammetrically derived topographic survey and digital orthophotograph used to enhance base webGIS mapping for site

- Overview for Conservation Plans
- Base mapping for GIS

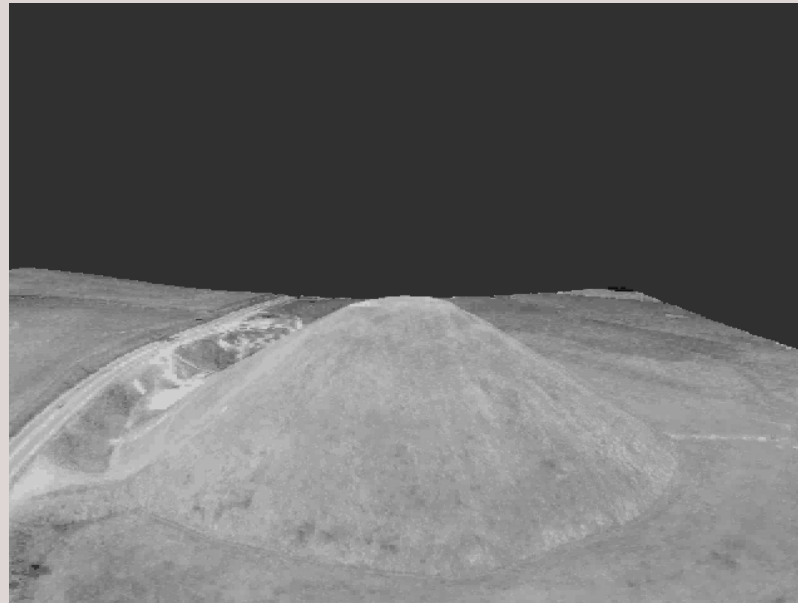


Photogrammetry – how is it used by English Heritage?

- Overview for Conservation Plans
- Base mapping for GIS
- Perspective views and flyrounds



Fountains Abbey High
Altar, North Yorkshire



Silbury Hill, Wiltshire



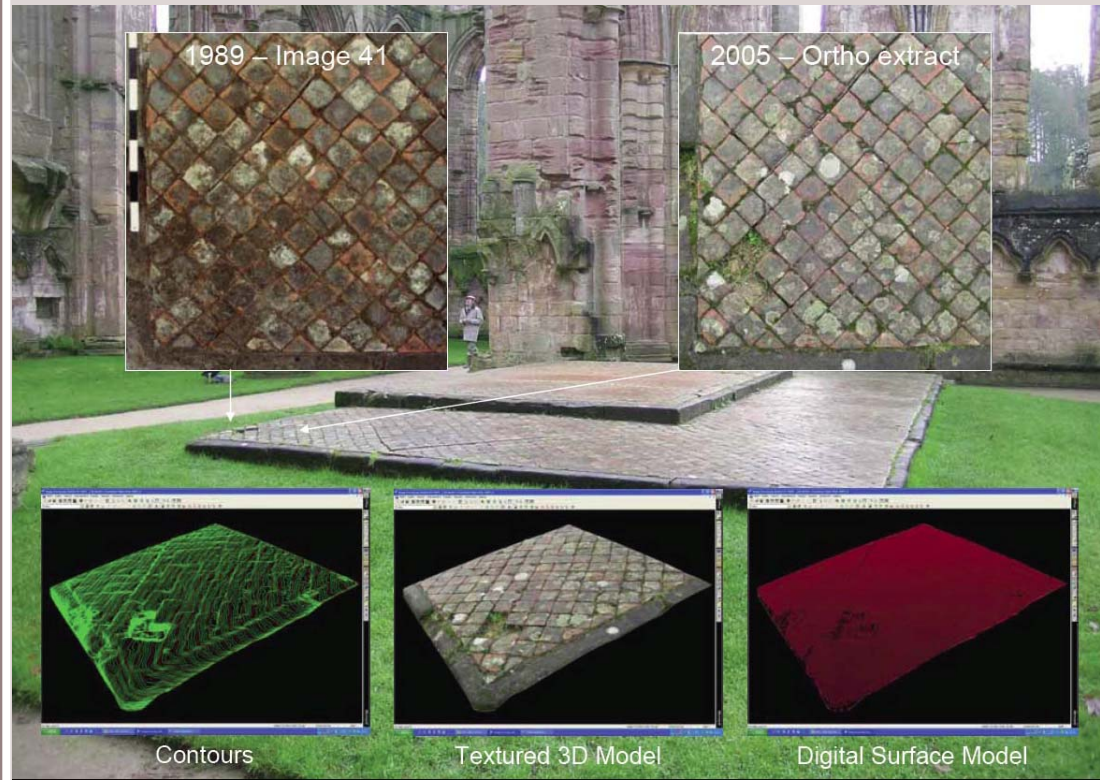
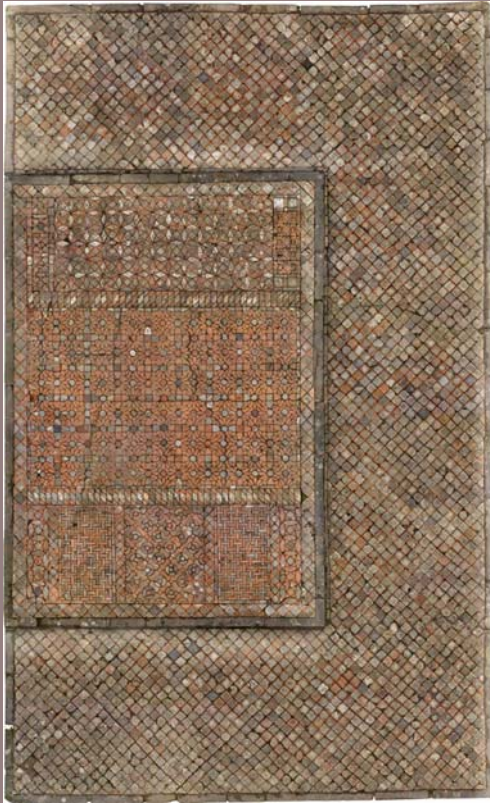
Photogrammetry – how is it used by English Heritage?



- Overview for Conservation Plans
- Base mapping for GIS
- Perspective views and flyrounds
- Building Recording



Photogrammetry – how is it used by English Heritage?



Fountains Abbey - High Altar
Digital photogrammetry used to provide accurate spatial record of 18th century tiled floor for both decay monitoring and conservation repair works

- Monitoring



ENGLISH HERITAGE

Photogrammetry – how is it used by English Heritage?

Lopen Roman
Mosaics, Somerset

Following
excavation in 2001,
Digital
Photogrammetry
used to provide **the**
record of this
remarkable find,
dating back to
360AD.

Currently reburied,
to protect the fragile
tesserae from
further damage,
whilst final decision
is reached as to its
long-term future



- Presentation



Laser Scanning

Three categories of scanner:

Close range

Triangulation & Structured light



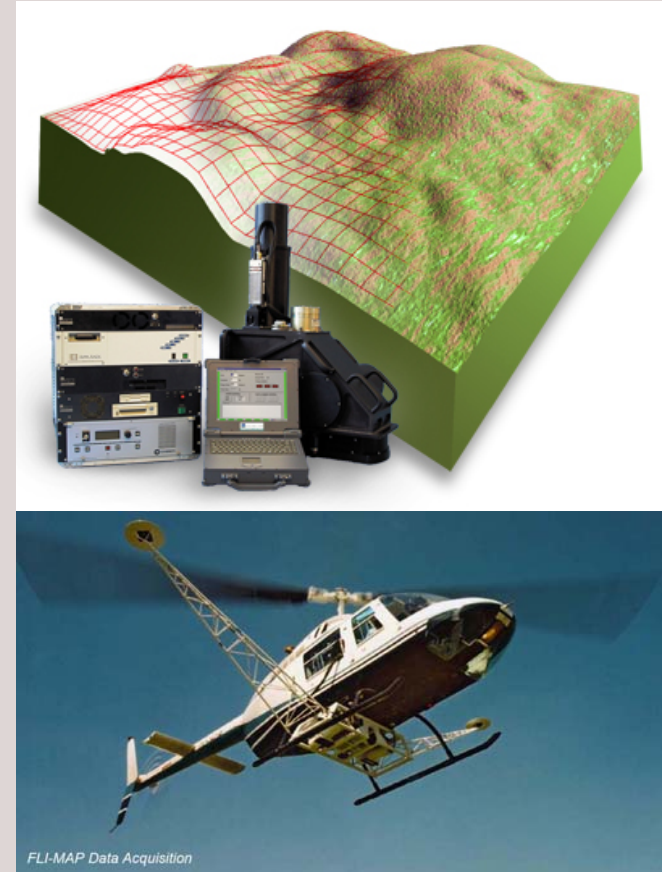
Terrestrial

Time of flight & phase based

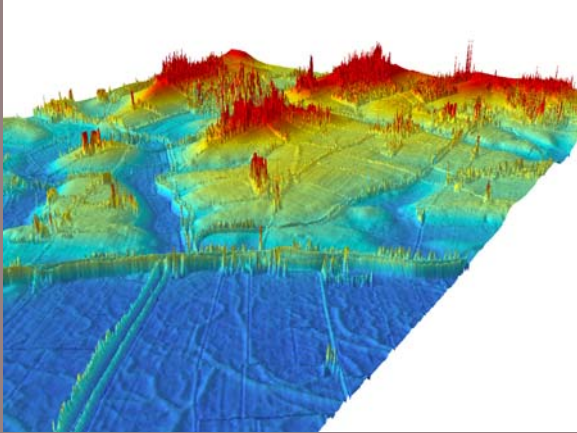


Airborne

LiDAR



Laser Scanning – how is it used by English Heritage?

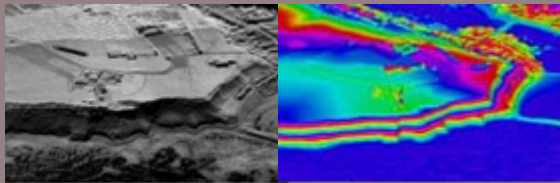
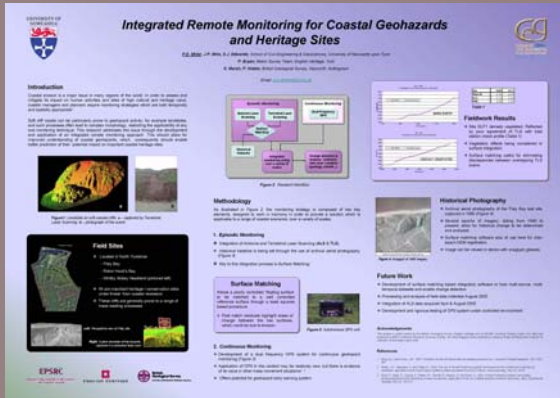


Witham Valley, Lincolnshire

LiDAR data used to assist mapping of the historic landscape. Provided comparison with data recorded from traditional, aerial survey methodology

- Landscape mapping and interpretation

Laser Scanning – how is it used by English Heritage?



Whitby Abbey, North Yorkshire

Assessing the threat of coastal recession using an integrated remote monitoring approach combining aerial and terrestrial laser scanning and traditional photographic/photogrammetric imagery

- Landscape mapping and interpretation
- Coastal survey and monitoring

Laser Scanning – how is it used by English Heritage?

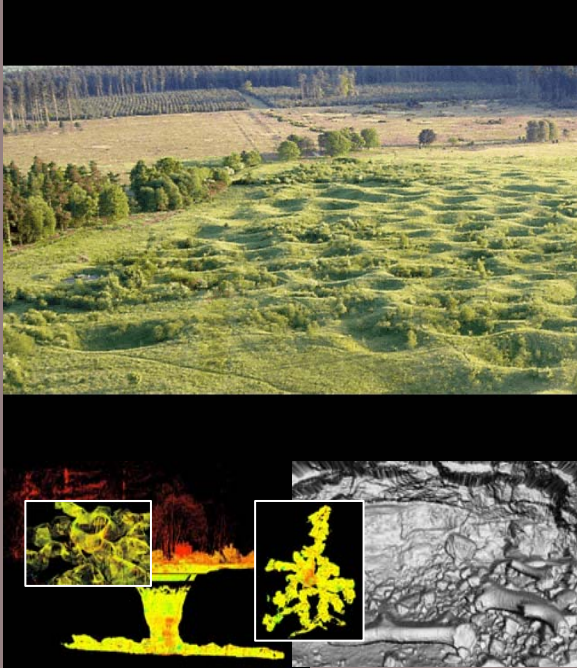


Greatstone Listening Devices,
West Sussex

Laser scanning used in combination with photogrammetry to provide baseline record for monitoring both the effectiveness of modern repairs and the structure's condition over time

- Landscape mapping and interpretation
- Coastal survey and monitoring
- Building and structures recording

Laser Scanning – how is it used by English Heritage?



Grimes Graves, Norfolk

- Landscape mapping and interpretation
- Coastal survey and monitoring
- Building and Structure Recording
- Archaeological Recording

Both terrestrial and close-range laser scanning used to provide accurate spatial record of the archaeological remains within Greenwell's Pit. Also provided spatial information on the structural supports within the tunnels

Laser Scanning – how is it used by English Heritage?



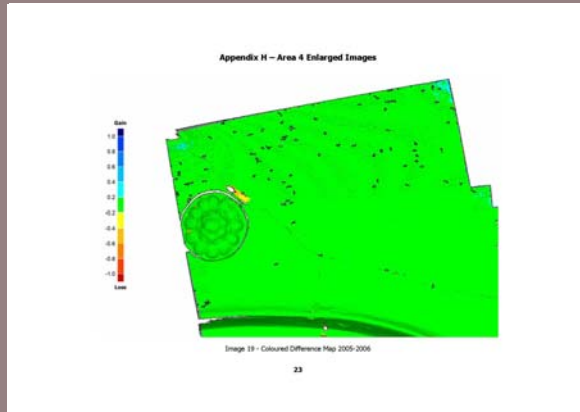
Annunciation Panel,
Fountains Abbey, N. Yorkshire

World Heritage Site

Close-range laser scanning used to provide detailed, sub-mm accurate three dimensional record of this architectural panel. Data to be used by curatorial staff to assist both on-going research, into designs of similar panels from other sites, and decay monitoring

- Landscape mapping and interpretation
- Coastal survey and monitoring
- Building & Structure Recording
- Archaeological Recording
- Artefact Recording

Laser Scanning – how is it used by English Heritage?



Audley End, Cambridgeshire

Close-range laser scanning used to monitor cracks apparent in the ornate plaster ceiling, within Lord Braybrookes Reading Room. Laser scans repeated annually over three year period to provide quantitative assessment of perceived crack propagation

- Landscape mapping and interpretation
- Coastal survey and monitoring
- Building & Structure Recording
- Archaeological Recording
- Artefact Recording
- Monitoring

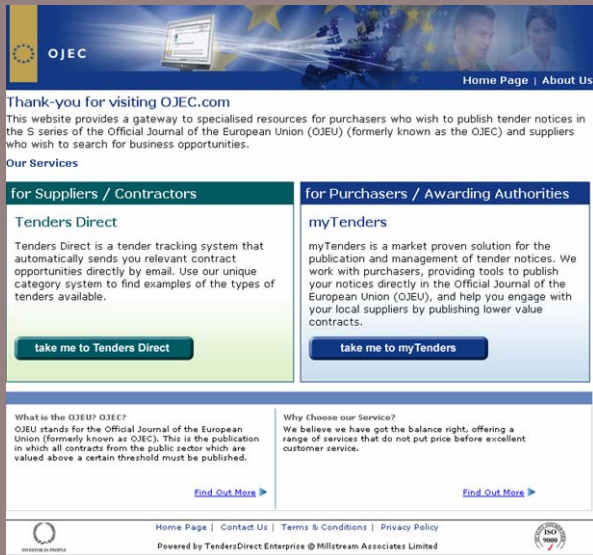
Procurement – Framework Agreement



- Use EU compliant framework agreement
- Pre-tendered rates
- Four different groups of survey
- Three to five contractors per group

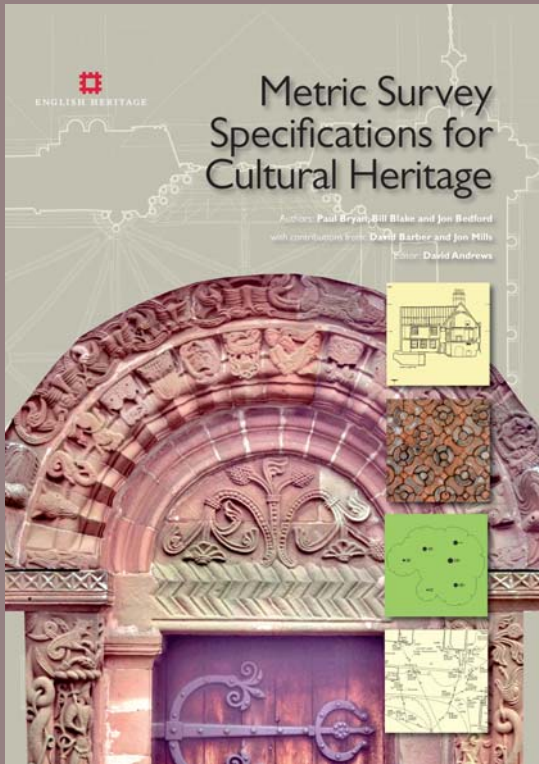
EU Compliant? – public procurement rules

- Services worth over approx. £100,000 p.a. must be tendered throughout the EU
- Advertised in European Journal (OJEU)
- Pre-qualification questionnaire



The screenshot shows the homepage of OJEC.com. At the top, there is a navigation bar with the OJEC logo and links for 'Home Page' and 'About Us'. Below this is a welcome message: 'Thank-you for visiting OJEC.com'. A paragraph explains that the website is a gateway to specialised resources for purchasers who wish to publish tender notices in the S series of the Official Journal of the European Union (OJEU) and suppliers who wish to search for business opportunities. The main content area is divided into two columns. The left column is titled 'for Suppliers / Contractors' and features 'Tenders Direct', a tender tracking system that automatically sends relevant contract opportunities by email. It includes a 'take me to Tenders Direct' button. The right column is titled 'for Purchasers / Awarding Authorities' and features 'myTenders', a market proven solution for the publication and management of tender notices. It includes a 'take me to myTenders' button. At the bottom, there are two sections: 'What is the OJEU? OJEC?' and 'Why Choose our Service?'. Both sections include brief descriptions and 'Find Out More' links. The footer contains the OJEU logo, navigation links, and copyright information: 'Powered by TendersDirect Enterprise © Millstream Associates Limited'.

Metric Survey Specifications for Cultural Heritage



- Specification for all types of survey in agreement except aerial photography
- Revision of ‘Metric Survey Specifications for English Heritage’
- Free download here

<http://www.english-heritage.org.uk/server/show/nav.1156>

Survey Groups



1. Image Based Survey
2. Aerial Photogrammetry
3. Topographic Survey
4. Measured Building Survey



Image Based Survey

- Photogrammetry
- Rectified Photography
- Orthophotographs

Group 2

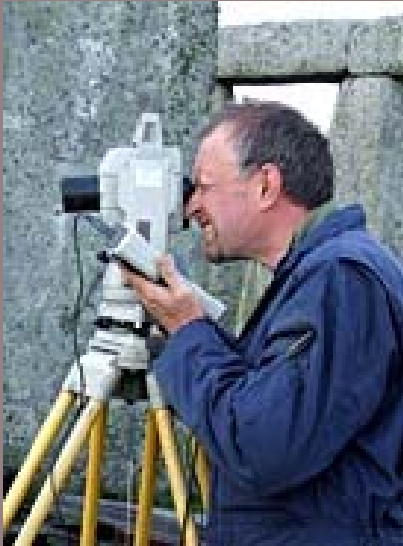


Vertical Aerial Photography and
Derived Digital Imagery
Client Specification Guidelines

RB
RICS BOOKS

Aerial Photogrammetry

- Vertical stereo-photography
- Topographic survey from aerial photography
- Orthophotographs



Topographic Survey

- 1:200 scale
- 1:100 scale
- Also day rates



Measured Building Survey

- Plans
- Sections
- Sectional Elevations
- Elevations

How Does It Work?



- Site visit and estimate price
- Write brief
- Choose most economical contractor if pricing straight forward
- Contractor makes site visit and quotes

How Does It Work?



- Otherwise initiate mini-tender amongst contractors in group
- Client commissions work
- We monitor progress and quality

Next Agreement



- Current agreement expires 31st March 2011
- Will advertise new agreement from October 2010
- Invitations to tender by about January 2011

Advantages?



- Easier for us to estimate
- Competition already occurred so don't necessarily have to tender each project
- Complying with EU regulations

Summary

- Number of different techniques
- Applied for various reasons
- Some work undertaken in-house
- Majority procured
- Ultimate aim is protection of heritage to enable access, understanding and enjoyment