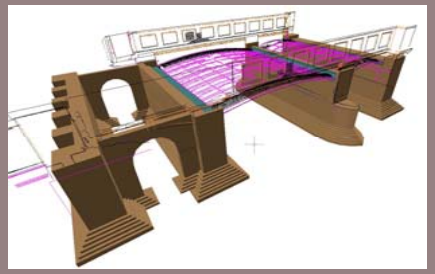


Metric Survey at English Heritage

David Andrews

Photogrammetric Unit
Imaging Graphics and Survey, Research Department,
English Heritage

IMAGING, GRAPHICS
AND SURVEY

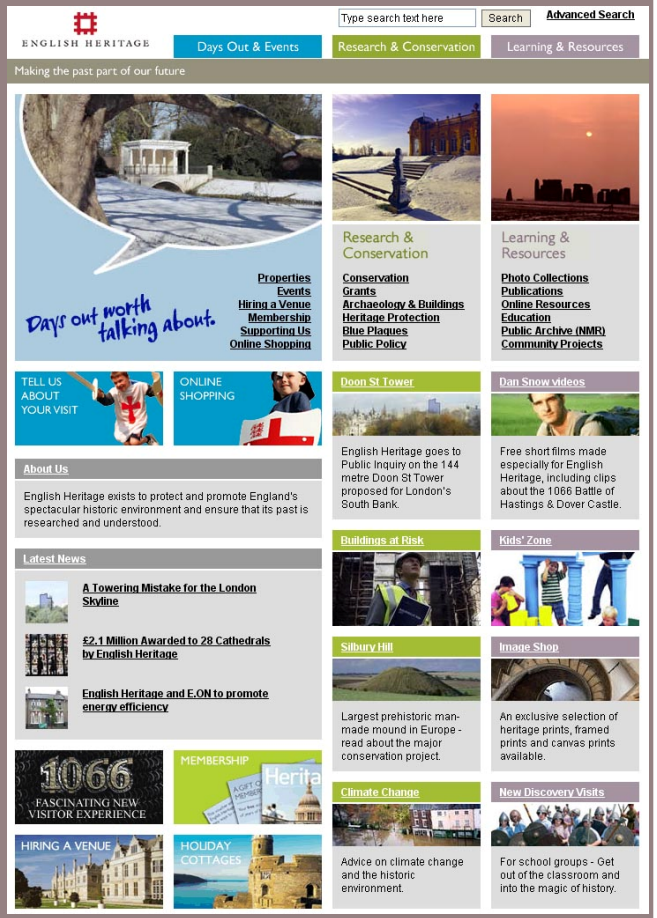
ENGLISH HERITAGE

Introduction

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

ENGLISH HERITAGE

What is English Heritage?



www.english-heritage.org.uk

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

What is English Heritage?

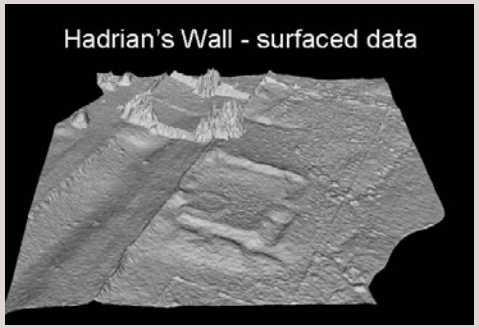
Duties:

- 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

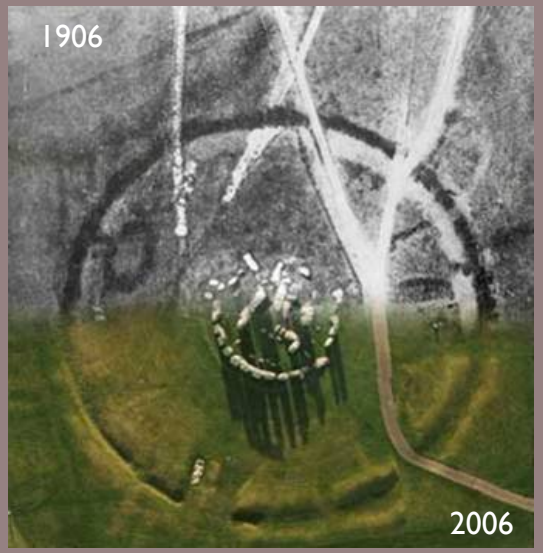
- The most important monument built by the Romans in Britain
- Built in AD 122 over a six year period by order of the Emperor Hadrian to '*separate the Romans from the Barbarians*' in the north.
- The 80 Roman mile long wall (117km), some 5 metres high, stretches from Wallsend near Newcastle in the east 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

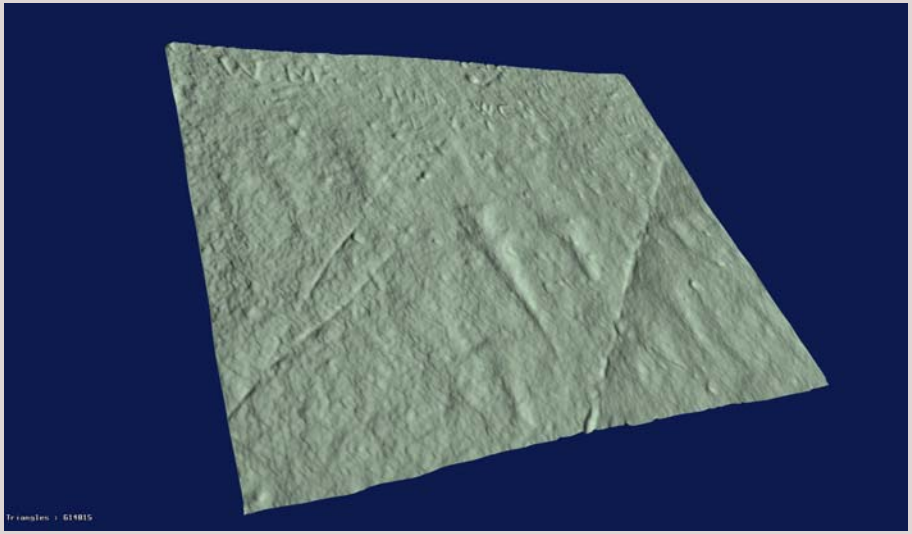


English Heritage in the West

Stonehenge

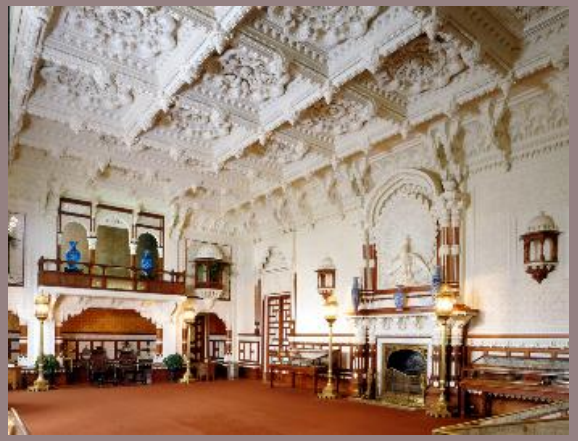
- One of the wonders of the world erected between circa 3000BC and 1600BC
- The stone circle, including its famous carvings, is surrounded by more than 300 burial mounds and major prehistoric monuments
- UNESCO World Heritage Site since 1986





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

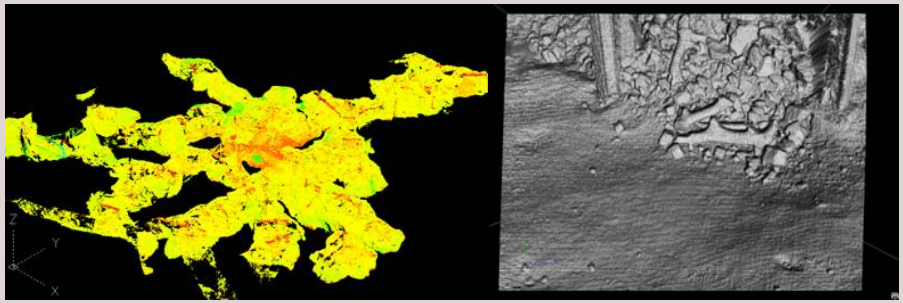
English Heritage in the East

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

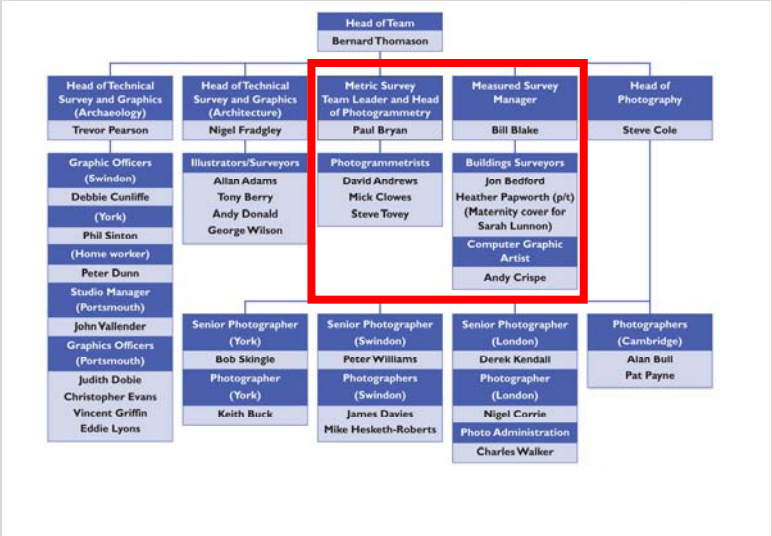
English Heritage Structure

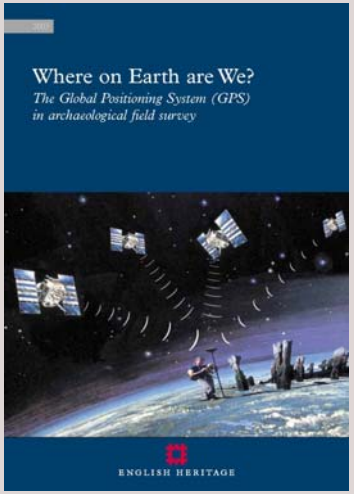
DIRECTOR OF RESEARCH & STANDARDS
Edward Impey

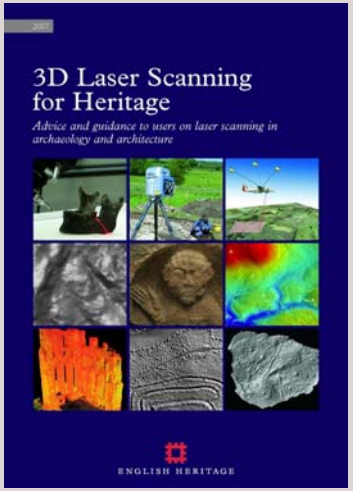
Chief Executive

Simon Thurley

- STRATEGY
- ARCHAEOLOGICAL ADVISOR
- RESEARCH DEPARTMENT
  Chris Scull
  - IMAGING, GRAPHICS & SURVEY (IGS)
    - Photogrammetric Unit
- PROPERTIES PRESENTATION
- NATIONAL MONUMENTS RECORD
- CONSERVATION DEPARTMENT







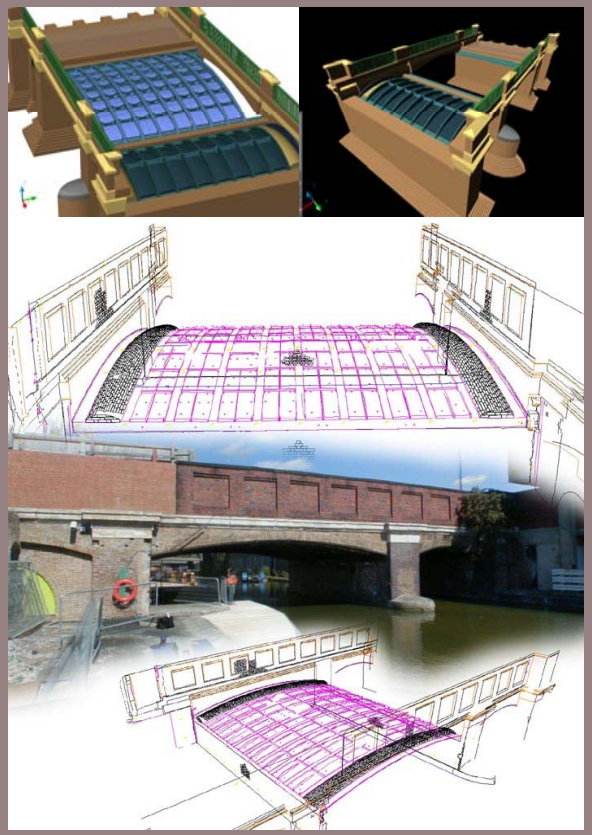
IMAGING, GRAPHICS AND SURVEY

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

ENGLISH HERITAGE

Why do we survey?



Bishop’s Rd Bridge, Paddington

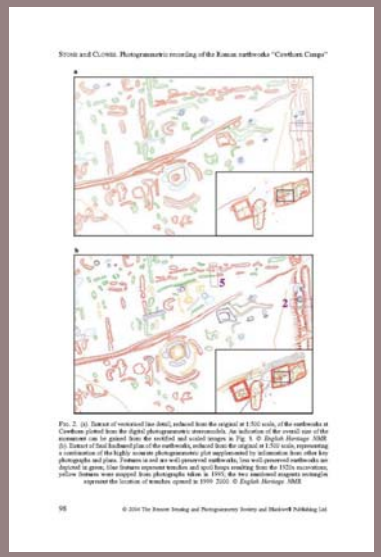
Photogrammetric line drawings provide accurate record of former canal bridge at Paddington Station, built to a design by famous engineer Isambard Kingdom Brunel in 1838

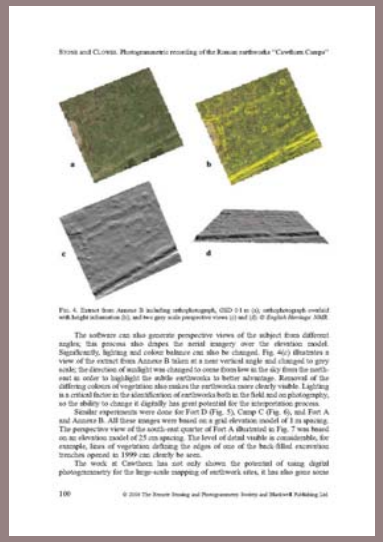
To assist with understanding a monument or landscape through

- Architectural Recording

ENGLISH HERITAGE

Why do we survey?





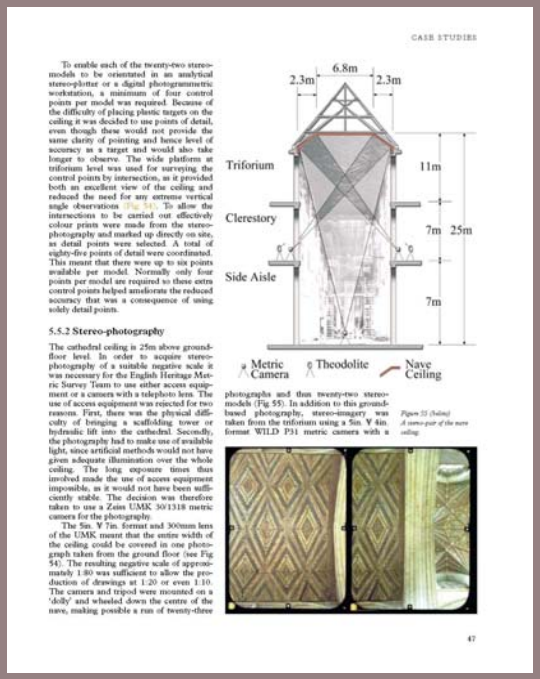
Cawthorn Roman Camps, North Yorkshire, Northern England

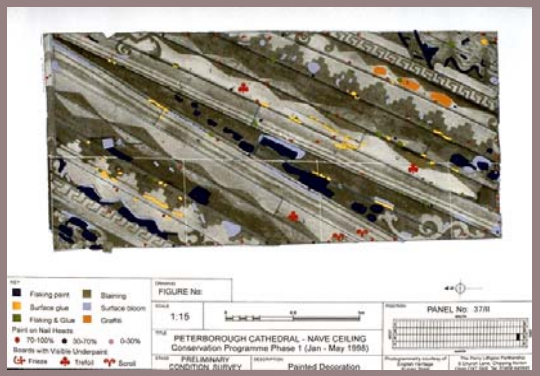
To assist with understanding a monument or landscape through

- Architectural Recording
- Archaeological Recording

ENGLISH HERITAGE

Why do we survey?





Peterborough Cathedral, Cambridgeshire

Prior to an Intervention

- Architectural Recording
- Archaeological Recording
- Condition survey reports

ENGLISH HERITAGE

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

ENGLISH HERITAGE

Why do we survey?

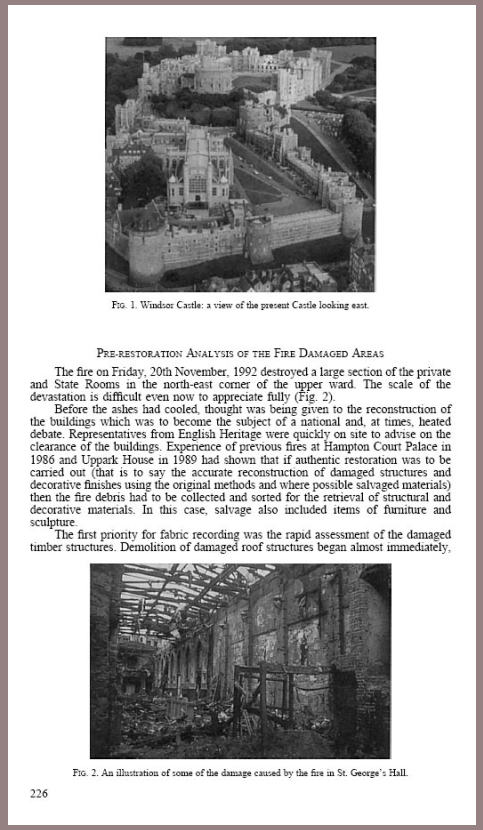


Fig. 1. Windsor Castle: a view of the present Castle looking east.

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.

226

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

ENGLISH HERITAGE

Metric survey techniques used by EH

Direct (non image based):

Selection at the point of capture

Hand Survey/Drawing

Theodolite/REDM Survey

GPS (Global Positioning System)

Indirect (image based):

Used where there is a need for mass metric data capture

Rectified Photography

Photogrammetry

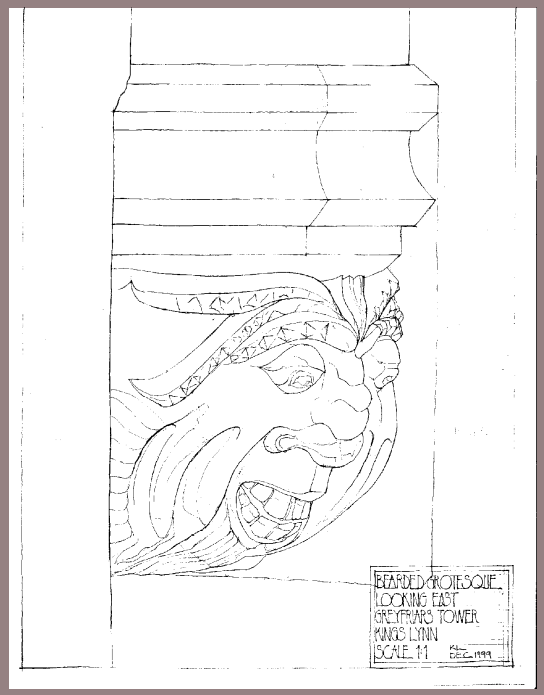
Laser Scanning

ENGLISH HERITAGE

Direct survey techniques

ENGLISH HERITAGE

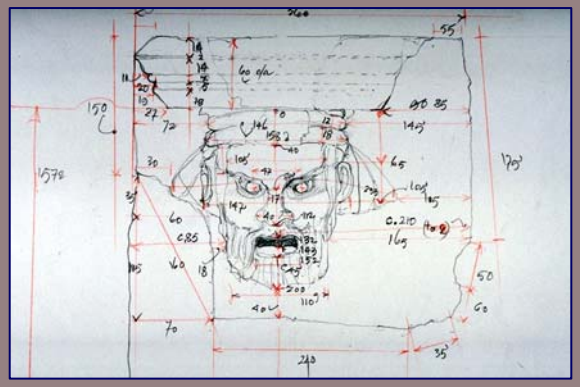
Hand survey/Measured drawing



Drawing techniques:

1. Direct plotting

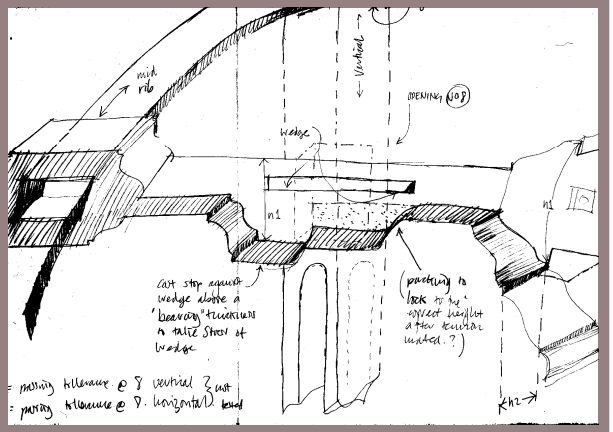
Hand survey/Measured drawing



Drawing techniques:

1. Direct plotting
2. Measured drawing

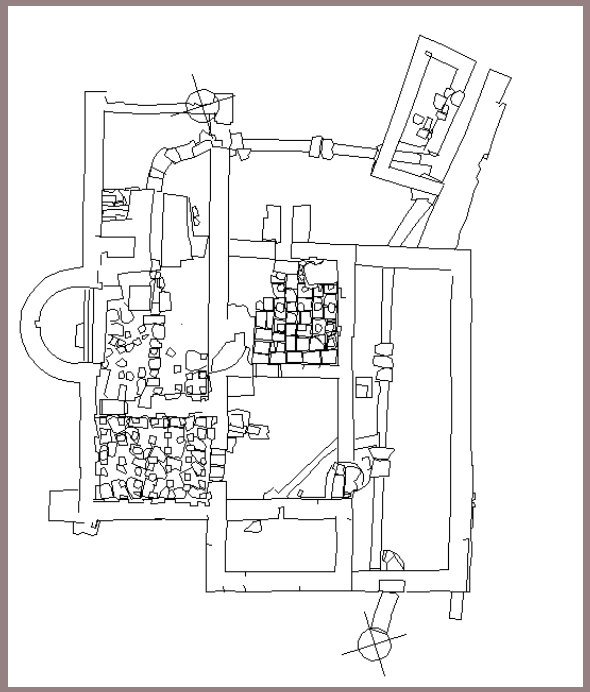
Hand survey/Measured drawing



Drawing techniques:

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

Theodolite/REDM 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

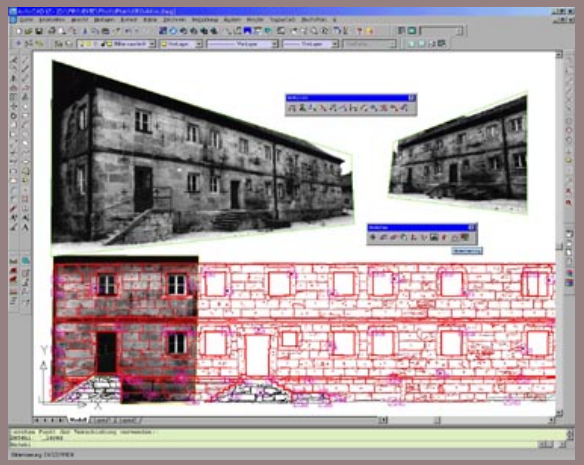
Leica TCRA1203 equipped with Smartstation GPS

- 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

ENGLISH HERITAGE

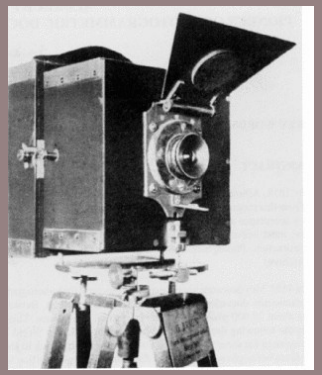
Rectified Photography



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

ENGLISH HERITAGE

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

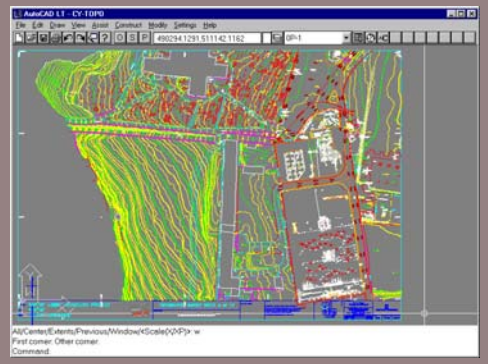
Chatterley Whitfield Colliery, Staffordshire

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

ENGLISH HERITAGE

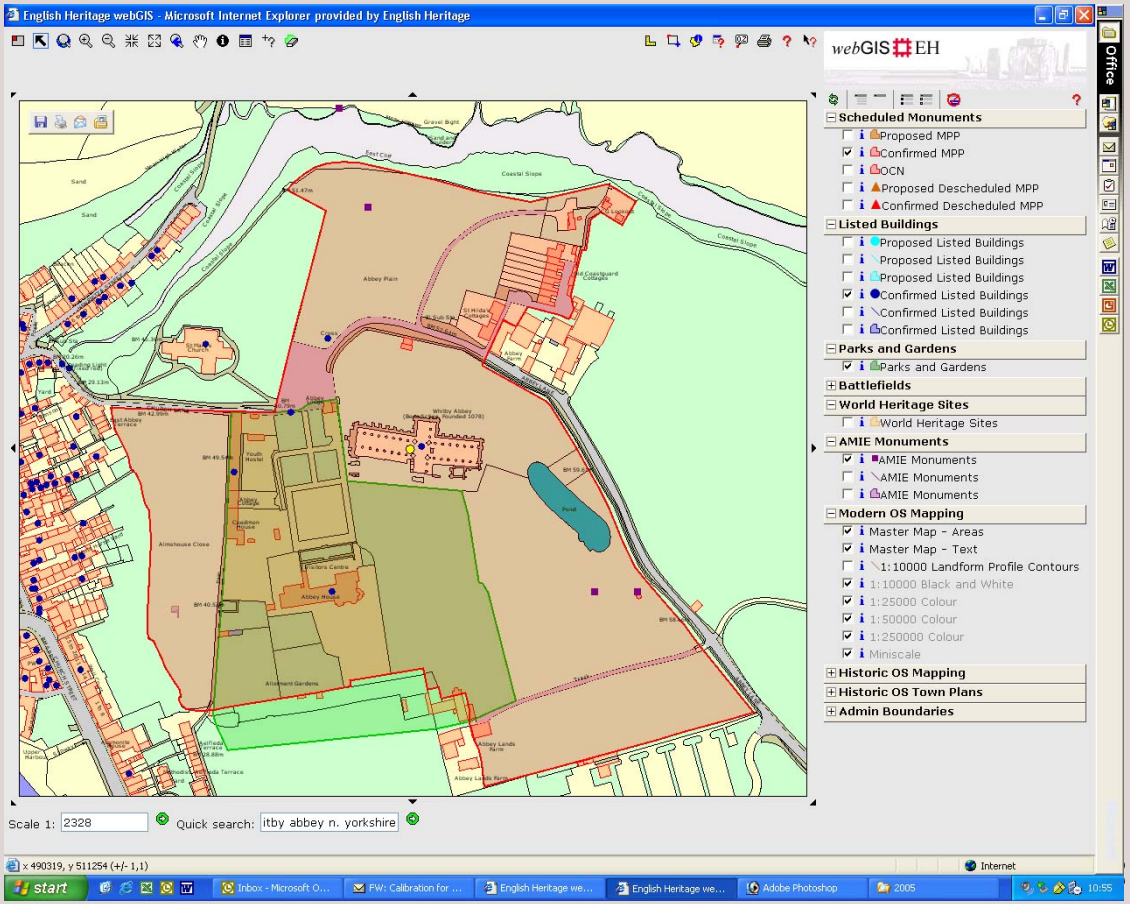
Photogrammetry – how is it used by English Heritage?



Whitby Abbey, North Yorkshire

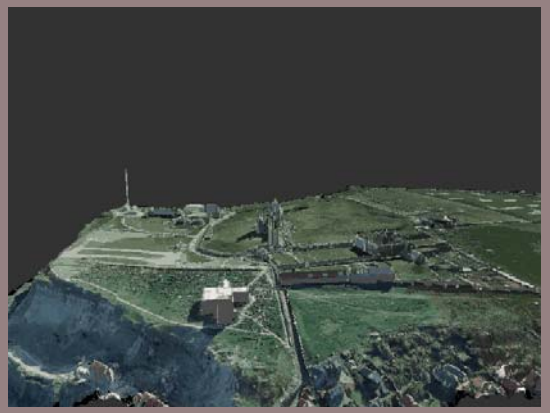
Photogrammetrically derived topographic survey and digital orthophotograph used to enhance base webGIS mapping for site

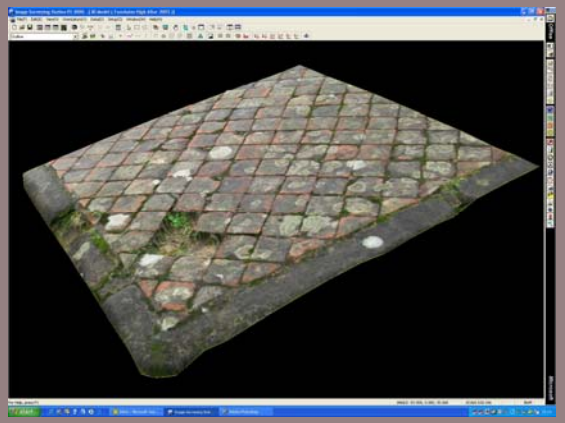
- Overview for Conservation Plans
- Base mapping for GIS



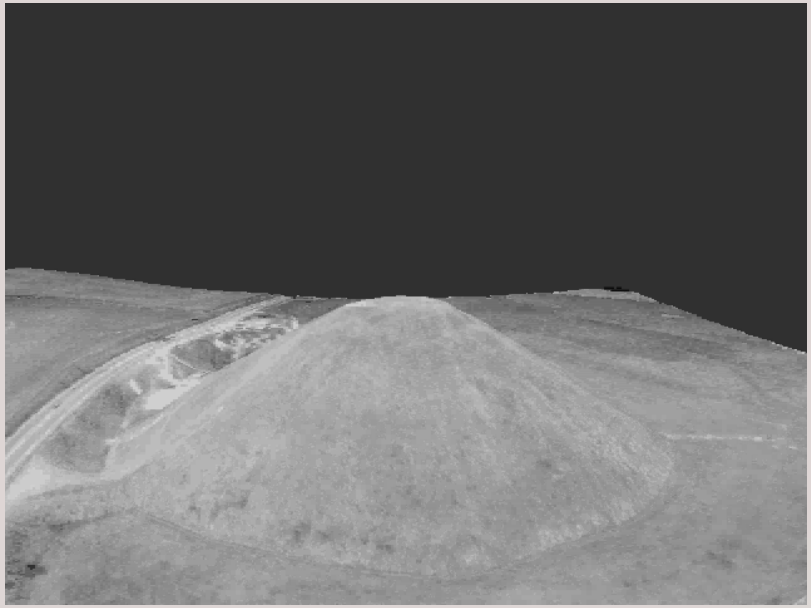
Photogrammetry – how is it used by English Heritage?

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





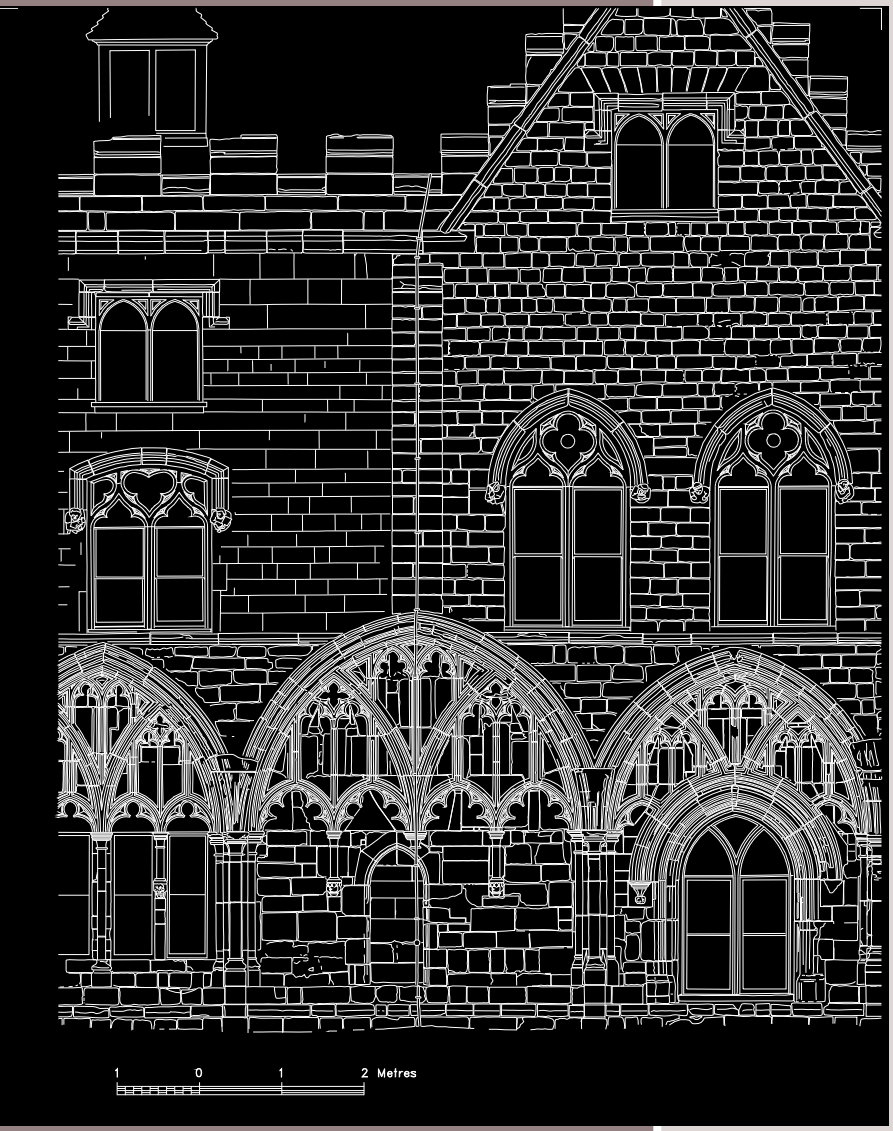
Fountains Abbey High Altar, North Yorkshire



Silbury Hill, Wiltshire

ENGLISH HERITAGE

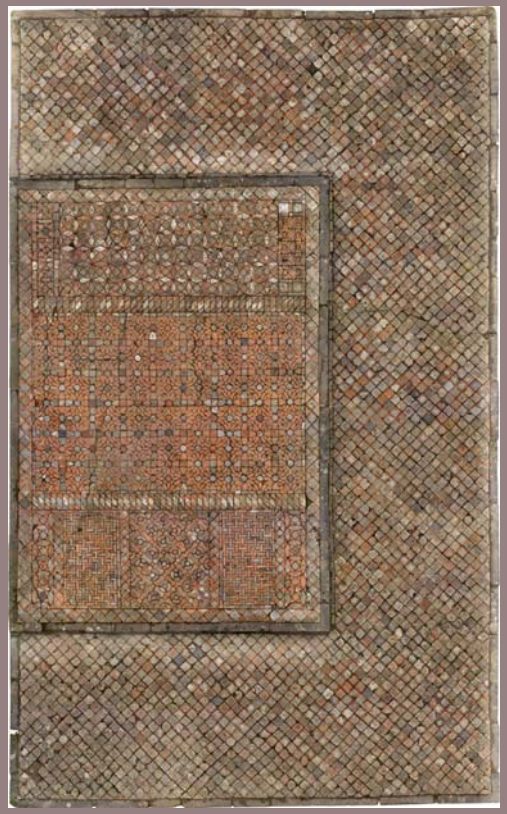
Photogrammetry – how is it used by English Heritage?

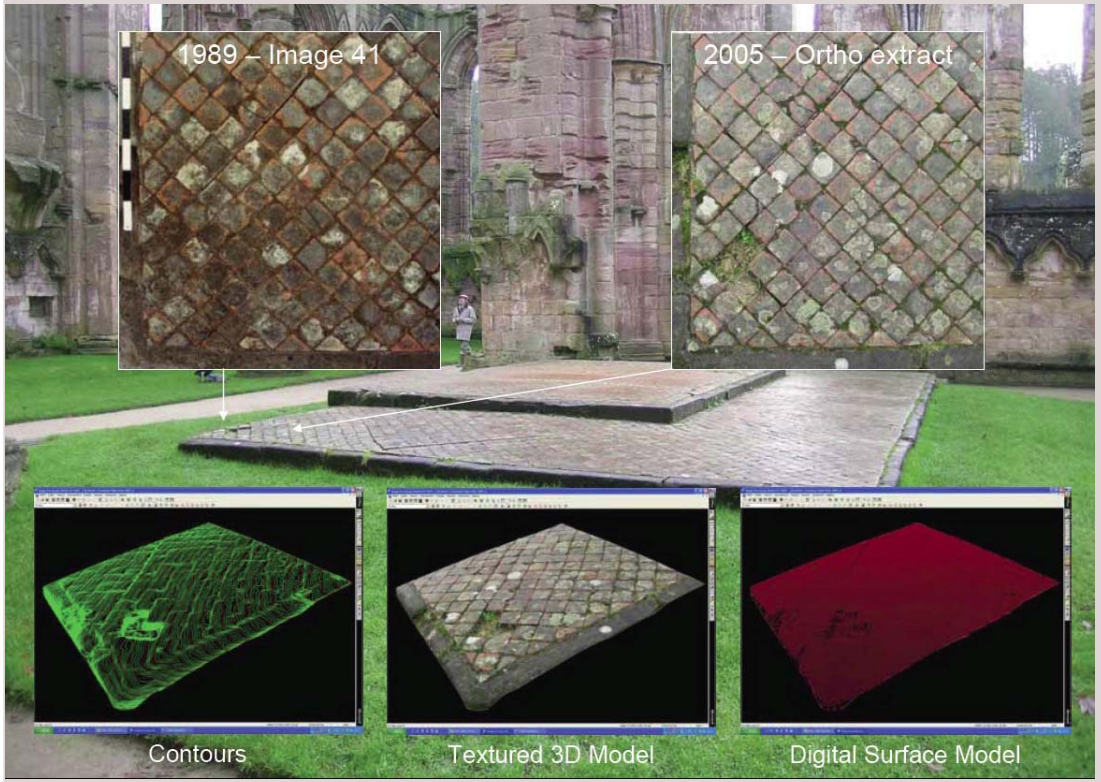


- Overview for Conservation Plans
- Base mapping for GIS
- Perspective views and flyrounds
- Building Recording

ENGLISH HERITAGE

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

ENGLISH HERITAGE

Laser Scanning

Three categories of scanner:

Close range

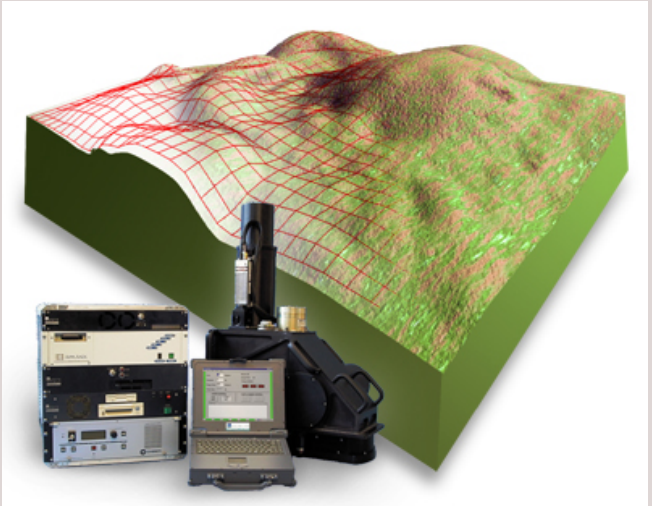
Triangulation & Structured light

Terrestrial

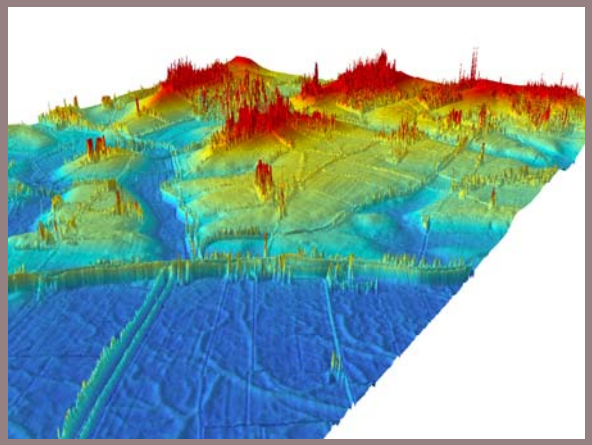
Time of flight & phase based

Airborne

LiDAR



Laser Scanning – how is it used by English Heritage?

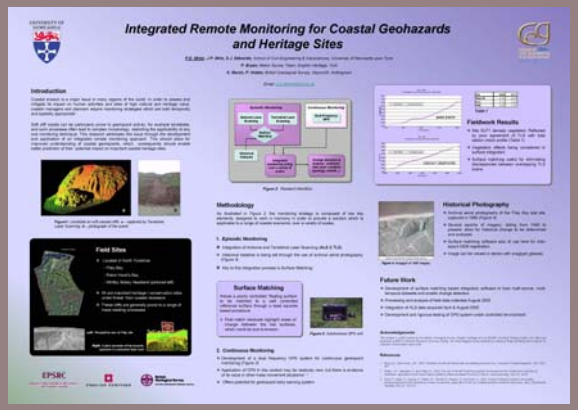


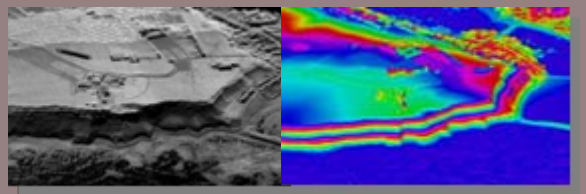
Witham Valley, Lincolnshire

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

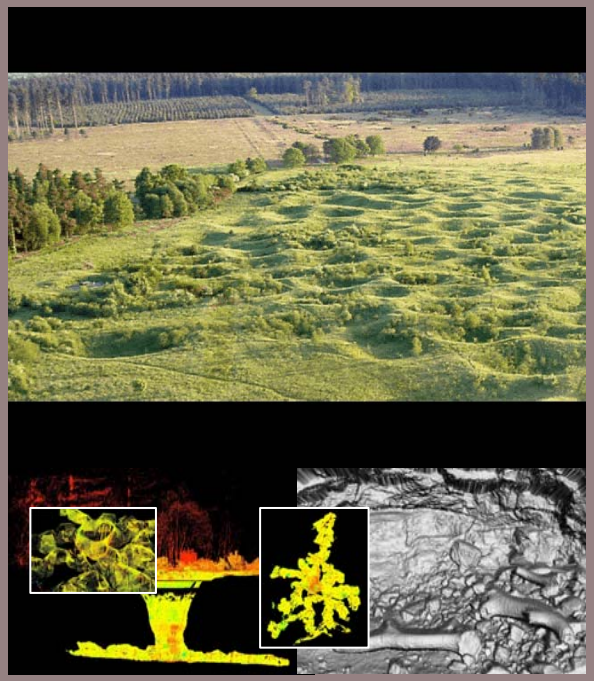
Laser Scanning – how is it used by English Heritage?

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

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

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

Laser Scanning – how is it used by English Heritage?

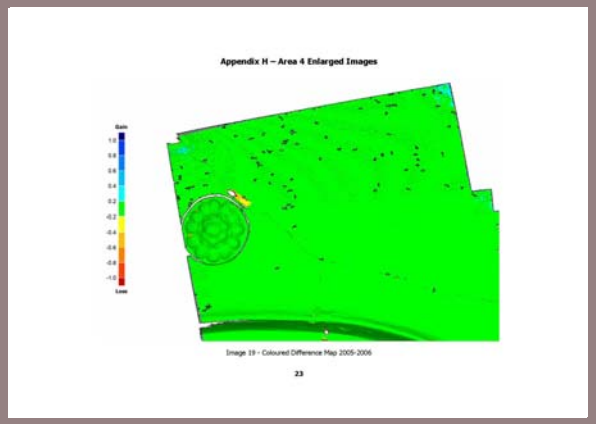
Annunciation Panel,
Fountains Abbey, N. Yorkshire

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

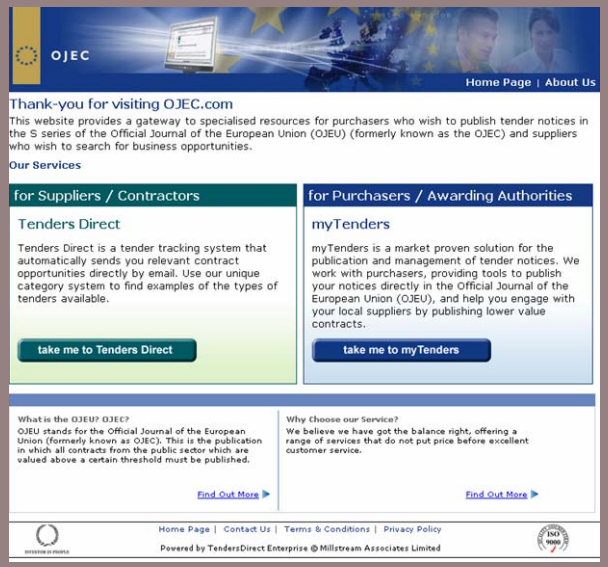
Close-range laser scanning used to monitor cracks apparent in the ornate plaster ceiling, within Lord Braybrookes Reading Room. Laser scans repeated annually over three year period to provide quantitative assessment of perceived crack propagation

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

Procurement – Framework Agreement

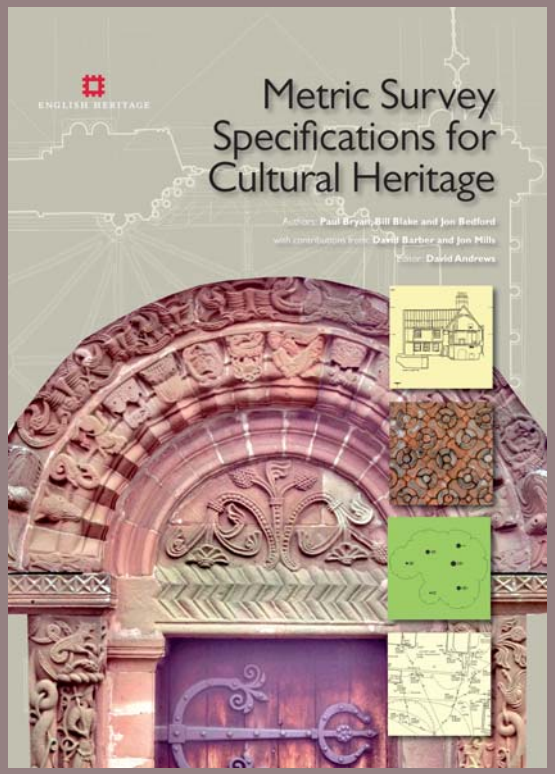
- Use EU compliant framework agreement
- Pre-tendered rates
- Four different groups of survey
- Three to five contractors per group

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

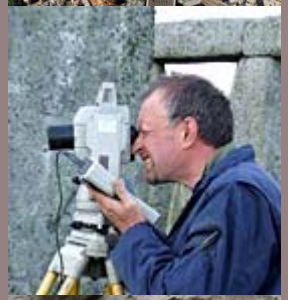
Metric Survey Specifications for Cultural Heritage



- 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



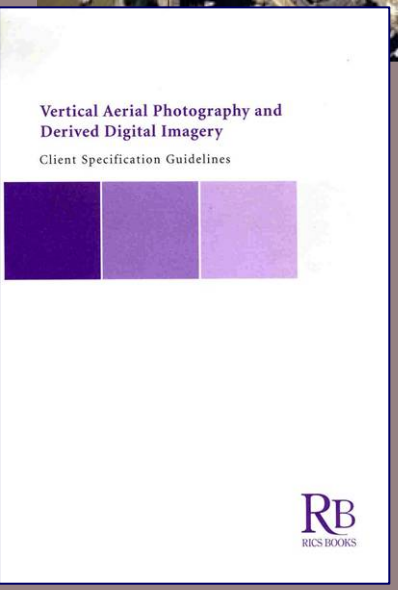
1. Image Based Survey
2. Aerial Photogrammetry
3. Topographic Survey
4. Measured Building Survey

Group 1

Image Based Survey

- Photogrammetry
- Rectified Photography
- Orthophotographs

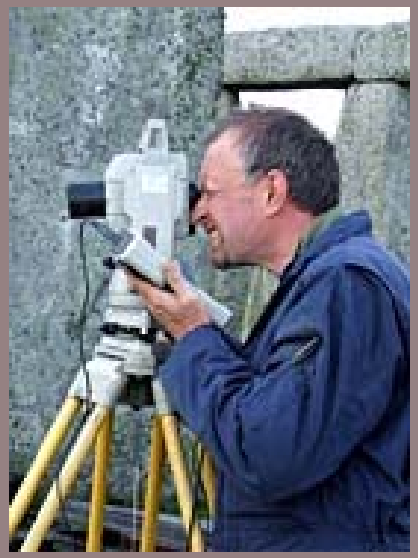
Group 2



Aerial Photogrammetry

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

Group 3



Topographic Survey

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

Group 4

Measured Building Survey

- Plans
- Sections
- Sectional Elevations
- Elevations

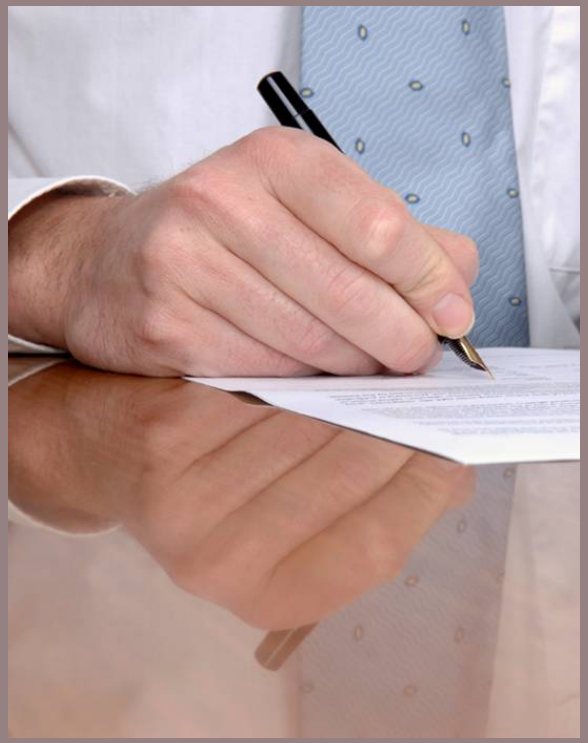
How Does It Work?

- 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