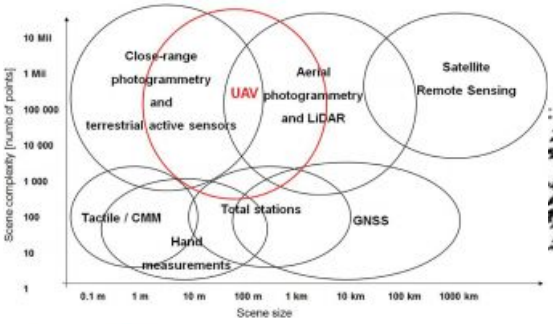
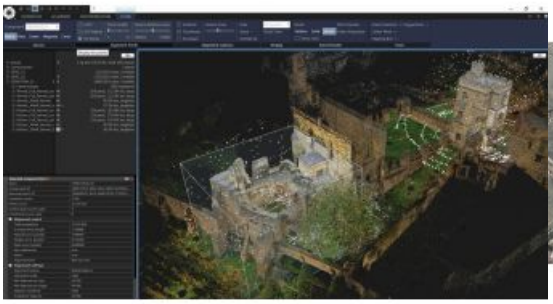
UK is a Leader in Heritage Mapping





The mapping of historical cultural features, which we will call heritage mapping, is mainly based on photogrammetric methods. Mapping for this purpose has been going on for many years using a great variety of techniques. There are also many applications from conservation and archaeology to museums and public understanding.

Early Developments

The use of photogrammetry for recording buildings was introduced during the late 19th century by the German civil engineer and architect Albrecht Meydenbauer, and techniques and applications have been developing and extending ever since. In the United Kingdom, the Royal Commission on the Historical Monuments of England (RCHME) was a government advisory body responsible for documenting buildings and monuments of archaeological, architectural and historical importance in England. It was established in 1908 (shortly after the parallel commissions for Scotland and Wales) and was merged with English Heritage in 1999. In 2015, English Heritage was split to form Historic England, the public body that looks after England's historic environment, with English Heritage continuing as a charity managing and curating the National Heritage collection. Much of the work of RCHME was in creating inventories of historic buildings, but in 1965 the Air Photographs Unit was formed and carried out extensive identification and recording of archaeological features over large areas such as Bodmin Moor and The Cheviots using photography from light aircraft.

At University College London, starting in the 1960s, E. H. Thompson calculated the geometry of the dome of Castle Howard based on archive photographs (Thompson, 1962), and Keith Atkinson and his co-workers in the Department of Photogrammetry and Surveying mapped a large variety of buildings and objects using close-range photogrammetry. These ranged from the White Tower at the Tower of London and the ancient city of Petra, to carvings such as a dagger engraved onto one of the sarsen stones of Stonehenge (Atkinson,1968). UCL also recorded the excavation of the Brigg boat. At this time, the Photogrammetric Unit at the University of York was established, funded by the Directorate of Ancient Monuments and Historic Buildings (Dallas, 1983). This unit was mapping a wide variety of historic buildings, both indoors and outside. At the time, both the Directorate of Ancient Monuments and Historic Buildings and the Property Services Agency were commissioning substantial numbers of photogrammetric and rectified photography surveys from commercial survey companies. Photarc Surveys, founded in 1974, was created specifically to carry out architectural surveys.

Ordnance Survey had an archaeological division from 1947-1983, but still records archaeological features.

Mapping cultural heritage has been on-going to the present day but recent developments in photogrammetric techniques has had a profound effect on the way in which this mapping has been carried out.

New Techniques

Digital imaging has made architectural photogrammetry far more flexible because measurements are no longer subject to the constraints imposed by the optical and mechanical limitations of the instruments. The development of drones, or UAVs, and laser scanning, has had a significant impact on mapping cultural heritage. Figure 1 shows the large overlap between close-range photogrammetry and UAVs and the ability to obtain images at close range above a site and the manoeuvrability of the

platform speaks for itself as a flexible and rapid means to cover an area. Modern heritage mapping generally involves the recording of a lot of detail, requiring many points, thus falling into the top half of the graph in figure 1.

Similarly, laser scanning enables very rapid and detailed surveys and specifically very small items on the site. The mobility of scanning systems, such as Leica's Pegasus Backpack, 3DLM's Robin and GeoSLAM's Revo and Horizon are particularly useful. Historic England used two Revo systems within many of their survey projects to provide overview context mapping as well as within underground tunnel and cave recording projects where their speed and flexibility of data capture prove very beneficial.

There have also been significant developments in software such as the free web-based approach of Photosynth, which makes use of a large number of images taken from a variety of cameras to create a point cloud and digital model. Figure 2 shows a point cloud of the Colosseum in Rome created from the crowd-sourced images shown by the triangles. A particularly striking example of using crowd-sourced images is the digital reconstruction of the Bamiyan Buddhas which were destroyed by the Taliban and a digital model created from mainly tourist images (Gruen et al, 2004).

The fusion of photogrammetry and laser scanning within 'reality capture' software products is shown in Bentley ContextCapture and Capturing Reality's Reality Capture. These are particularly beneficial when integrating drone acquired imagery with terrestrial laser scanning data as seen in figure 3 of the Historic England survey at Lincoln Medieval Bishop's Palace.

Following a typical photogrammetric workflow digital surface or terrain models (DTM/DSM), contours, textured 3D models and vector information can be produced, even on large areas.

The ability of laser scanning to create very high-resolution point clouds of small objects has led to an increased interest in mapping artifacts and creating virtual museums.

Satellite imagery has also been used for heritage mapping. A recent example of this is monitoring the Palmyra in Syria, following the destruction of the site by the so-called IS. See figure 4.

Also of interest is the UNESCO atlas 'From Space to Place: an Image Atlas of World Heritage Sites on the 'In Danger' List' (2011, UNESCO, Paris, ISBN 978-92-3-104227-0, 84 pages).

As an indication of the scope of heritage mapping, Historic England has published a number of guides to assist the recording of monuments:

- Metric Survey Specifications for Cultural Heritage
- 3D Laser Scanning
- Photogrammetric Applications for Cultural Heritage
- Using Airborne Lidar in Archaeological Survey
- The Presentation of Historic Building Survey in CAD
- BIM for Heritage: Developing a Historic Building Information Model
- Traversing the Past: Landscape Survey
- Where on Earth Are We: GPS in Archaeological Field Survey
- Graphical and Plane Table Survey of Archaeological Earthworks

Heritage Mapping in the UK

Historic England is a major player in heritage mapping in the UK. Paul Bryan is the Geospatial Imaging Manager at the Building Conservation & Geospatial Survey Team, Technical Conservation, Policy & Evidence Group based in York. In Scotland, there is Historic Environment Scotland (HES) which has developed a BIM strategy for managing the Scottish monuments. In Wales, the Royal Commission on the Ancient and Historical Monuments of Wales manages historic buildings and monuments.

Other agencies such as The New Forest National Park Authority have programmes for mapping cultural features within their areas.

There are also companies which specialize in heritage mapping, for example Spectrum Heritage based in Edinburgh, who undertake some very impressive heritage surveys on heritage objects and buildings using a range of geospatial techniques and technologies.

BIM is of great interest in heritage mapping. In the UK, there is a Special Interest Group called BIM4Heritage and as seen above, Historic England has a publication, 'BIM for Heritage: Developing a Historic Building Information Model' which will shortly be joined by 'BIM for Heritage: Developing the Asset Information Model' due out in May 2019. The BIM4Heritage group acts as a forum for the exchange of knowledge in the field but also to: 'Develop consistency of messaging, support and standards of BIM implementation within the Historic Built Environment. Provide opportunities for communicating best practice, and debating issues concerning the adoption of BIM in both private and public sectors, and with increasingly advanced applications of BIM.' (www.bim4heritage.org).

International View

There are numerous international organizations concerned with mapping heritage sites. The International Council on Monuments and Sites (ICOMOS) has recommended the use of photogrammetry for the recording of historic buildings and monuments since 1961. The International Committee for Documentation of Cultural Heritage (CIPA), one of the international committees of

ICOMOS, has promoted the development of photogrammetry within monument conservation services.

ISPRS has working groups which concern themselves with heritage mapping, particularly Commission II and historically Commission V. CIPA is also a committee of ISPRS. ICA has the Commission of Cartographic Heritage into the Digital and FIG, which also promotes work in this area.

Summary

New technology and software have made a great difference to the well-established procedures for mapping cultural features and together with a rising interest in the preservation and recording of our heritage has reinvigorated this sector of geomatics. This trend has been accentuated by new techniques such as virtual reality for the display and presentation of features and artefacts.

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