The Royal Academy of Engineering

Inquiry to Examine Science and Heritage

Response from the Royal Academy of Engineering to the House of Lords Committee on Science and Heritage

February 2006

Conservation science

1) *How is conservation science, in the UK and internationally, coordinated between museums, universities and other organisations?*

1.1 The extent to which there is formal coordination of efforts in conservation science is unclear. However, it was felt that, since conservation specialists operate within a range of organisations and individuals in private practice, and given the specialist nature of the work, good links exist. Key co-ordinating bodies include: the Archives Council, which has a number of on-going initiatives to co-ordinate communications and knowledge; the Society of Museum Archaeologists is a key group, setting standards and providing a forum for discussions; and English Heritage whose science advisors provide expertise to the wider industry. English Heritage also has a degree of liaison with Historic Scotland and Cadw (the Welsh heritage organisation), and the Building Limes Forum (The Building Limes Forum is a charitable organisation with members in the UK and overseas. It encourages expertise and understanding in the use of building limes). Coordination is further assisted by a number of organisations at different levels both nationally and internationally – e.g. ICOMOS (International Council on Monuments and Sites) and ICOMOS-UK and The European Construction Platform which has Cultural Heritage as one of its six focus areas.

1.2 The Arts and Humanities Research Council (AHRC), Economic and Social Research Council (ESRC), Engineering and Physical Science Research Council (EPSRC), and Natural Environment Research Council (NERC), working with English Heritage, have identified a need to build working relationships across discipline barriers in the historic environment research community. They are holding a facilitated workshop in Birmingham on March 29th 2006, with the aim of forming up to five 'research clusters' in cross-cutting themes. These will be funded for one year to build inter-disciplinary research communities.

1.3 On a smaller scale, and a more informal basis, the various clubs and specialist repairers of historic vehicles have excellent IT-based networking of information on restoration and maintenance, which contribute greatly to the promotion of best practice. This is a good example of how IT can be used to enable coordination of research and experience in conservation.

1.4 Italy provides an interesting international comparison to the situation in the UK. In Italy conservation is a big business which involves universities, state authorities, private offices and contractors. The high level of coordination is for several likely reasons. Between 1960 and 2000 there was little new building work going on, and as a result many architects (and engineers) were trained in restoration, and consequently there are also very good specialised research facilities. Ancient buildings (medieval or pre-medieval) are very much part of the Italian urban environment, which is not the case in the UK. These structures need a large amount of restoration, especially since Italy is in many parts an active seismic area, meaning that restoration and maintenance is also a health and safety issue.

1.5 In Italy research is funded by the state and the EU. There is a similar arrangement in Germany on a smaller scale – research is done by the Universities, funded by state, church and EU.

2) *Is conservation research adequately funded, and is it directed at the right areas? Does the UK possess the capacity and skill base to maintain its cultural heritage for future generations?*

2.1 Conservation research in engineering departments at UK universities is mostly concerned with process life cycles, preserving the longevity of materials during and following manufacture and endeavouring to recycle materials for further use. Funding for research is usually through the Research Councils.

2.2 In terms of other funding, it would appear that Government conservation funding is being pruned, e.g. English Heritage's current grant has been 'frozen', so that with inflation it has effectively been cut. The replacement for the PiI (Partners in Industry) scheme, with larger sums to be applied for but to be matched by greater industry contributions and with more complex project arrangements, has probably not assisted here.

2.3 In answer to the second part of the question, there is a recognised shortage of conservation specialists in the UK. Finding the skilled and specialist conservation staff is difficult, as there are often only one or two individuals with the specific technical skill required. For example, in undertaking the Channel Tunnel Rail Link (CTRL) heritage works (a £15m archaeological project associated with the construction of Channel Tunnel Rail Link) it was discovered that there were no county council or museum based conservationists in Kent. Expertise had to be sought remotely, from either the Museum of London Specialist Service or the Lincolnshire Conservation Laboratories.

2.4 There is concern, in terms of buildings and records, for the significant stock held in local authority ownership. Local authorities hold a large number of buildings on the BAR (Buildings at Risk) register, and often lack both the resource and the skills to cover their upkeep. This becomes a particular issue where the building no longer suits the needs of the local authority in terms of size, location or use. In terms of conserving records, Edinburgh City Council has recently come under attack for not properly maintaining and preserving its archives.

2.5 The skills base is therefore a cause for concern, at professional and at craftsman levels. The CITB (Construction Industry Training Board) has done some work on this issue.[1] The results of a research project carried out by Arup and DeMontfort University assessed the skills-base in relation to the maintenance of heritage buildings, and found worrying shortfalls.[2]

2.6 A "capacity and skill base to maintain [our] cultural heritage for future generations" requires informed and adequately-funded practitioners – English Heritage staff, local authority conservation officers, architects, engineers, craftsmen, and so on. This demands adequate educational and training provision. In this respect, it is regrettable that the excellent English Heritage training centre at Fort Brockhurst near Gosport was closed down after a fairly short life. Its closure indicated a worrying attitude among those responsible for its closure towards this important aspect of conservation – training by those who know, so that others can learn. These are not necessarily 'high-tech' skills, e.g. slating, carving stonework, drystone walling, ironfounding, carpentry repairs, are all essential but generally traditional skills.

[1] Published in *Employers' Skill Needs Survey: Autumn 2002*. CITB, London, and *CITB Skills Forecast Report: February 2002*. CITB, London.
[2] The report can be found at: http://www.maintainourheritage.co.uk/pdf/module6intro.pdf

3) *How does the UK compare with other countries in the application of cutting-edge science and technology to monitor the condition of our cultural heritage, and to assist in its conservation?*

3.1 The impression is that insufficient funds are allocated to the application of science and technology to conservation monitoring, and that we are certainly not ahead of the game internationally. English Heritage has a number of on-going initiatives to quantify and assess key aspect of the heritage resource – for example the Monuments Protection Programme – but questions are usually asked reactively once damage has occurred, for example to Silbury Hill.[3]

3.2 Despite this, there have been notable advances in the UK in this area. For example, a recent technological advance has been the introduction of laser scanning for the in-situ surveying of buildings and other cultural objects, saving time and money. It is particularly advantageous for recording work where access is difficult and/or dangerous. It produces a database from which plans, elevations, measurements, moving images, and other information can be presented. This is one area where modern technology is greatly superior to traditional practice.

3.3 Some interesting work is being done on the mechanisms of stone decay, and in the use/development of new materials and their application in conservation – an area that needs to be nurtured. As with much research, it is important that what has been done is properly documented and available – a CRISP (Construction Research and Innovation Strategy Panel) project a few years ago identified this as a real problem within the construction industry – and perhaps elsewhere also.

3.4 There are a lot of monitoring techniques and devices available. However, it is more important to understand what is needed than to use 'high tech' methods for their own sake. A great deal of condition monitoring and conservation does not require "cutting-edge science and technology". What it does require is *regular care*, i.e. ensuring that buildings are inspected regularly and subject to planned routine expert maintenance. Unfortunately, inspections and maintenance are easy casualties for deferment when annual budgets have to be slimmed.

3.5 Another welcome advance is the state-of-the-art, purpose-built archive store at English Heritage's Headquarters at Swindon. This houses the National Monuments Record, and is a good example of the application of climate control for the long-term preservation of irreplaceable records. However, it is likely that many other archive stores are not so well-served.

3.6 Science and engineering in the UK have played, and continue to play a major part in the conservation of rare books. Cradles have been developed in which fragile books and manuscripts can be held safely and imaged at high throughput because both focus and magnification are permanently fixed. Curvature effects at the spine are corrected by software, and image quality as well as information in marginalia are thus retrieved. This has made it possible to digitise large collections in months, rather than the years it would have taken without the innovations. There is therefore much scope for applying new technology to improving the accessibility and preservation of books, manuscripts, illuminations and pictures held in museums, libraries and galleries.

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[3] In 2000, a large hole appeared in Silbury Hill after an excavation shaft, created by investigations of the site in the 18th Century, collapsed. After this collapse, English Heritage undertook an in-depth investigation to assess the Hill's stability, and produced plans for restoring the hill and monitoring its condition in the future.

4) *Is there a satisfactory process to develop practical applications of conservation research for the market?*

4.1 The Academy Fellows consulted were not aware that any such process exists.

5) *Could better use be made of conservation science to improve public engagement with and understanding of science and technology, and the part they play in our cultural heritage?*

5.1 Demonstrations of the use of conservation science can encourage public engagement with both science and technology, and our cultural heritage generally. This is demonstrated by the popularity of historic research TV programmes, for example, *'Meet the Ancestors'*, which seeks to tell a complete story of an individual's ancestry. The science in this programme is presented in a digestible and accessible form. *'Time Team'*, the archaeological investigation programme, has also promoted the use of conservation science by using a wide range of specialists to interpret finds and opinion in a simple, accessible form. Another example is *'Restoration'*, which has encouraged TV audiences to become involved in campaigning for the restoration of historic buildings.

5.2 By showing the conservation methods used such TV programmes promote interest beyond just the artefact itself, to the science involved in restoring it. This could be encouraged further through exhibitions, and allowing sites to be accessible – with good interpretation both of the work that has been done and the significance of the building, site or record.

Use of information technology

6) *In what ways can IT contribute to enhancing public engagement with objects of cultural importance, without compromising their conservation?*

6.1 IT is being increasingly used at all levels of the archaeology and heritage profession to record and analyse features, objects and structures, and has become an indispensable tool. Digital technology enables still images, video and sound files to be viewed alongside textual information and, increasingly, offers the capability to explore sophisticated three dimensional models, visualise complex data and interact with multi-media environments. IT offers the facility to improve accessibility by making digital versions of many of our paintings, ceramic objects, rare books, manuscripts or ancient artefacts, which cannot be put on public display, for reasons of space, fragility or finance. The images can be viewed on the computer screen and fragile items do not then need to be handled. Additionally, the images can be preserved by electronic storage, even if the originals are lost or damaged.

6.2 Publishing such images on the internet creates a vast and easily available resource. For public understanding of and access to cultural objects, the internet represents a democratization in global cultural heritage, whereby all people with internet access can view, explore, share, study and/or engage with many different aspects of art, architecture and archaeology, without disturbing the original object itself. As an example of this use of the internet, English Heritage is, in its *Images of England* project, making a photograph of every listed building in England available through its website. Computer graphics and laser-scanning can provide static and moving 'walk-round' and 'fly-through' experiences of buildings and other structures, for example English Heritage has done this with the 1779 Iron Bridge over the River Severn, a key industrial monument.

6.3 The caveat is that the use of the internet should be seen as ancillary to an experience of the artefact or structure itself, not a substitute. Although technology can provide easy access to many, it cannot replace the ability to physically see and handle objects (except where this

is necessary for preservation reasons). Furthermore, there is the threat that the internet poses of allowing people to restrict their experience only to those things which they have a prior interest in. Visiting real sites and museums may allow people to engage with exhibits they would have never sought out themselves.

6.4 Aside from its power to create a vast repository of images, another extremely important role of the internet and other aspects of IT is in respect of the facilities they offer for the recording of, and providing access to, cultural information in the form of important data and archive material. Such information is, thanks to technological advances, now available in wider varieties and on a greater scale than ever before. On the CTRL heritage project, the services of ADS, the Archaeological Data Service, were utilised to take the vast amount of data generated by the project, process it into an appropriate form for web use and make this available via web based searches. The Nuclear Decommissioning Authority is currently undertaking a project to look at the development of a National Nuclear Archive to preserve documents, film, video and DVD evidence of the UK's nuclear energy programme. The project is looking into the feasibility of digitalising the current records, not only to preserve them, but to make them readily available to current and future generations.

6.5 However, a potential downside of the rapidity of technological innovation relates to the threat that technological obsolescence poses to the retrieval of records stored on electronic media. This highlights the need for important documentary records to be held on paper, irrespective of other means of storage. For example, anything stored on the earlier larger-diameter floppy discs is virtually inaccessible now, because the software and the hardware needed have generally been discarded. In contrast, acid-free paper of adequate quality should endure for centuries.

7) *Is there scope for improving the use that UK galleries, museums and others make of such technology?*

7.1 Many galleries have harnessed the advantages of IT, and the public have a high expectation of digital presentation both during visits and when choosing where to visit. However, the uses of IT in galleries, museums or sites can always be refined and developed. For example, in historical buildings, technology could be provided which visually recreates a 'missing' tower at a ruined or partly ruined castle, or a room within an old building. This needs to be done with skill, always being clear as to what is conjecture, what source material has been used etc.

7.2 It must be stressed again that such aids to understanding should not be seen as a substitute for the 'real thing'. It is sometimes the case that in museums children seem to be interested almost exclusively in the screen displays and 'hands-on' interaction, at the expense of seeing the tangible objects around them. Furthermore, the TV or computer screen tends to 'sanitise' the image it presents, and this can often seriously mislead. The past was a different and often dirty and nasty place. That's as much part of our cultural heritage as the good things, and that needs to be presented as far as practicable, to aid understanding. For example, the Tower of London houses the Crown Jewels, but is also a former prison and place of execution.

7.3 It is also important to recognise that the general public and the specialist have quite different needs. For the former, IT should be used to provide accessible and digestible information. For the latter, it is important that specialised information and raw data is stored and made available by museums, research institutions and heritage projects.

7.4 With regard to the use of the internet, efforts to improve public understanding of, and access to, the UK's cultural heritage would undoubtedly benefit from more scientific

approaches to the provision of information. Because of the sector's reliance on images to convey information, scientific developments in imaging have huge potential for cultural heritage. For example, they offer scope for improving the 'findability' of images on the internet. Images of any description are, by their nature, difficult to find in a digital environment, because they have no inherent 'data' for machine-driven search engines to search on. This means that users are dependent on image providers adding metadata to images. However, the words a museum professional chooses (e.g. artist name) to add to an image may not be the words that a member of the public chooses to search with – often, people will be looking for pictures 'of such and such rather than 'by so and so'. Technological developments in military or medical sectors for the exploration of digital image content (e.g. Content-based Image Retrieval for examination of mammograms), could be invaluable, if developed in appropriate ways, for developing internet-based image search engines.

7.5 Many IT applications in the cultural heritage sector are developed on an ad hoc basis where systems are created without recourse to tools and methods that are used to great effect elsewhere. This can lead to a lot of reinvention of the wheel and, inevitably, to the subsequent failure of a great number of 'technological' projects. Yet, in the world of systems engineering there are a multitude of tried-and-tested ways for developing complex technological solutions which would be of considerable value if employed by the cultural sector. In essence, such tools give focus to the development of IT projects and, most importantly, help to ensure a finished product that is fit for purpose, i.e. an information system through which users can fully engage with the inherent information in successful and meaningful ways.

7.6 There is also a great deal of scope for developing communications at the technological-cultural interface. The late, partial or utter lack of take-up of new science and technology by cultural heritage institutions might be improved if more consideration was given to their needs during the development stage. For example, scientists pursuing a novel area of research for medical purposes could be encouraged to think of the possible applications beyond the specified medical uses. There seems to be a growing desire within both scientific and cultural heritage sectors to work in more collaborative ways. This is not new: the development of virtual reality involved archaeologists and architects from its earliest days, because the problems faced by cultural heritage lent themselves beautifully to the solutions that the new technology offered. But such clear interdependence is not always present. It needs to be built up slowly and deliberately, and this needs clear strategic vision and an appropriate degree of support. Our cultural heritage could clearly benefit from the appliance of science. The key to developing and extending such benefit may be in breaking down the barriers that lie between the two sectors.

8) *What, in the UK and internationally, are the best examples of the use of IT to improve access to and understanding of cultural objects?*

8.1 There are many organisations making good use of IT for the dissemination of cultural heritage information. High profile examples include the British Museum, where many objects can be viewed and information gained about them to augment the visiting experience; the Portable Antiquaries Scheme which provides good images and information; and English Heritage's *Images of England* project, with its use of laser-scanning, e.g., for the Iron Bridge, mentioned above. A good example of using the internet to display artefacts that could be destroyed by being put on view is the site created to allow viewing of the cave paintings in

Lascaux, France. The public were barred from access to the caves, as too much damage was being caused to the paintings.[4]

8.2 There are also helpful examples of initiatives which attempt to cross the apparent arts/science divide. For example, the Wellcome Trust is currently seeking applicants to its Sci-Art Awards, and the Arts and Humanities Research Council (AHRC) is currently funding an array of initiatives into how better use can be made of IT in arts research. One of the projects under the AHRC ICT Strategy Projects scheme is 'The hunt for submarines in classical art; mappings between scientific invention and artistic inspiration'. The project, which is indicative of a growing arena, is concerned with the use, within visual arts, of advanced imaging IT developed for scientific applications.

8.3 There are a number of interesting projects which Fellows of the Academy have had direct involvement with. One is the CTRL heritage project, referred to in earlier comments. Another is the 'Connected Earth' initiative (www.connected-earth.com/) which deals with the heritage of the telecommunications industry. It addresses the heritage that BT had amassed and the increasing difficulty of balancing the commercial interests of a company with its wider social and national responsibilities. The initiative also opened up the collection to a wider audience through use of web technologies and partnerships with the museums sector. The website is interesting in that it showcases a lot of artefacts, but in the context of encouraging people to see them directly – encouraging the audience to visit the museums that house the exhibits. A further major project with which a Fellow is actively involved is the 'Engineering Timelines' project. As this project seems particularly pertinent to the interests of the inquiry, it is described in detail in an appendix to this response.

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8th February 2006

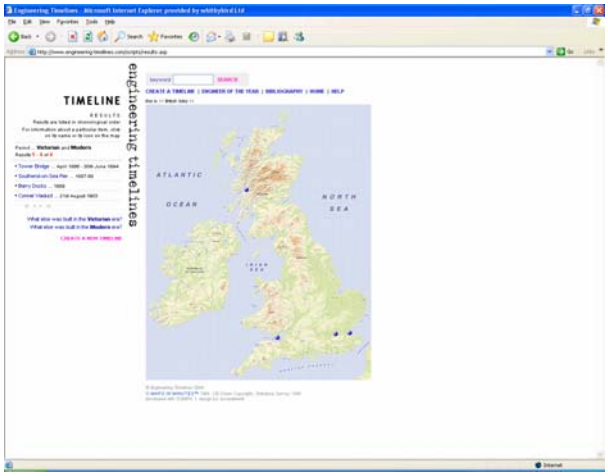
[4] The paintings can be viewed here: http://www.culture.gouv.fr/culture/arcnat/lascaux/en/index.html

Appendix: Engineering Timelines

A.1 Engineering Timelines was developed with the following three challenges for improving access to and understanding of cultural objects in mind: Firstly, information about cultural objects is maintained by competing systems such as the National Trust and English Heritage. Details of the collections are available on the internet but it does mean consulting many different lists, which do not necessarily work in the same way: some work geographically, some thematically, a few historically. Secondly, getting enough information about a cultural object, in advance of a visit, is often a problem. Often the best stock of information about a cultural object is contained in visitor information on sale at the site, but this is of no use when one wishes to find out if a site or exhibition is worth visiting, and this is of course a problem for small sites without visitors' centres. Finally, engagement with culture is improved if it can be put in context. Interest in a structure or artefact is increased by understanding where it fits geographically, chronologically, or within a body of work by a given engineer.

A.2 Engineering Timelines (www.engineering-timelines.com – a sample entry is included below), a not-for-profit company and part of the National Grid for Learning, has been developed to address these problems. It is a database of UK engineering achievement and innovation. It shows where the UK's engineering cultural objects are by combining the many separate lists into one and then displaying entries on a scale map of the UK. It allows access to information about cultural objects in advance of a visit by providing information on the internet with references for following up (and all entries are written in a way that children can understand). It sets sites and exhibits in context by allowing the user to make connections between different engineering achievements by location, engineer, time period and type. This is a very interesting example of how science and technology can be used to improve access to and understanding of our cultural heritage, as it both shows how our scientific, technological and engineering heritage can be preserved, and how we can use technology – namely IT – to enable that.

Example of an Engineering Timelines entry



Turvey Bridge

west of Turvey, Bedfordshire

engineer

Anon

date 12th century

era Medieval | **category** Bridge | **OS grid reference** SP938524

ICE reference number HEW 40

A 600ft long masonry causeway that crosses the River Ouse west of Turvey. The earliest mention of a bridge here is in the charter of Harrold Priory in 1132 but it's not known when the current bridge was built. There are various records concerning disputes about its maintenance, however.

The bridge is made of local stone and has 11 arches of various spans, ranging from 10ft 9in to 20ft 3in.

Maintenance passed to the County Council in 1889. It was widened in 1931-32 using reinforced concrete with 10in of limestone facing. The bridge carries the A428 Bedford to Coventry road.

reference BB, CEH E&C

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