Arup**Research+Development**

Maintain our Heritage

Maintaining Value

Research Module 4: Technology- A review of products and services within the field of preventative inspection and maintenance of buildings.

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SUMMARY

This research module, forming part of the Maintaining Value research project undertaken by Maintain our Heritage, looks at products and services available, or adaptable for use, in the maintenance process.

While many of the products identified may be of relevance to all types of building, the focus of the research is on heritage buildings, and the particular needs of such buildings and the restrictions on what may be done to them are considered. Equally, while the research aims to test the case for systematic inspection and maintenance, similar systems and products will be used in many cases for ad hoc maintenance work and also for emergency repairs where these are required.

The area of health and safety is considered, in particular when looking at methods of access to carry out the relevant activities but also as a driver for the implementation of systematic inspection for buildings of all types.

'Technology' looks at the areas of 'products' and 'access' within the field of preventative inspection and maintenance. The research has concentrated on *preventative* work, although evidently much of the content of this report will apply equally to work carried out on an ex-post basis where routine maintenance has not been implemented.

Within this research, the term 'Products' is given a broad definition in order to cover a wide-ranging review of materials, inspection and monitoring techniques that may be used. It also looks at the provision of formalised inspection systems, how such systems operate and the extent to which the various existing organisations concerned with the preservation of heritage buildings might expand their services to move into this area. The existing schemes operating in Europe are discussed.

On access, this research module considers the typical tasks that are undertaken and the issues affecting the selection of access technology and then identifies the 'best fit' solution for these tasks. It sets out several different scenarios to illustrate the considerations for activities such as cleaning the gutters on a church.

While the overall theme of the research is that of **maintenance** some of the considerations for both access and the wider area of 'products' will also be of relevance where **repair** work is to be undertaken. The distinction between the two activities is recognised and the report does not pretend to offer comprehensive recommendations for the latter, in particular in the sensitive area of heritage buildings. This is noted specifically within the report, and identified as an area where there is scope for further work. Equally, it is recognised that the appropriate technologies for small, residential properties may not be the same as those for large public buildings where access is more difficult and remote monitoring systems, for example, may be of use.

The report contains a number of conclusions and recommendations. Amongst these, the following are highlighted:

- The role of innovative technologies in parallel with more traditional methods for maintenance work is emphasised.
- It is recommended that a central repository of information on the care and maintenance of heritage buildings, ideally web-based, should be created, particularly for the benefit of private, domestic owners.
- Further consideration is needed in relation to safe access methods for heritage buildings.

- A detailed owners's logbook should be created for all heritage buildings.
- The case should be made for a subsidised inspection service on the lines of the Monumentenwacht system operated in a number of European countries.
- Further work is needed to determine how to secure unoccupied buildings that are in advanced state of decay.

The impact of climate change on the maintenance of heritage buildings is another area where further research would be of use.

While the research has been carried out to meet the specific objectives identified at the outset by Maintain our Heritage and this report stands alone as a reference, the findings of the other modules within the Maintaining Value project have been considered and are referred to as appropriate.

1. INTRODUCTION

The research module 'Technology' is one of six contained within the project 'Maintaining Value'. The umbrella project is being carried out by the organisation Maintain our Heritage as a Partners in Innovation (PiI) research project.

The objectives for this module, as identified within the brief from Maintain our Heritage, include:

- To make systematic maintenance easier and less costly for the owner or contractor (relative to spasmodic maintenance).
- To identify products/services available or adaptable for use in maintenance process
- To identify how such products/services can be made available to owners or contractors.
- To identify how such products/services can be made known to owners or contractors.

'Technology' looks at the areas of 'products' and 'access' within the field of preventative inspection and maintenance. The report concentrates on *preventative* work, although evidently much of the content will apply equally to work carried out on an ex-post basis where routine maintenance has not been implemented.

The other modules address specific aspects of maintenance practice, new businesses and training and education, and are referenced as relevant. There is an element of synergy between all the various parts of the project as they are concerned with different but related aspects of a common theme.

Aspects of Health and Safety are addressed throughout the research report as appropriate. The issue of inspection has also been highlighted by The Standing Committee on Structural Safety ('SCOSS'), specifically in relation to cladding [1] and more generally in relation to all buildings and facilities [2]. It is believed that this may become a matter for better regulation, a move that could be of benefit in promoting more systematic implementation of inspection and maintenance generally.

One of the aspirations of this research project is to get owners to think of their properties – which are generally assets of great value – in the same way as they think of their cars and even their central heating systems, and consider the benefits, in terms of both finance and avoidance of disruption, of instituting regular 'servicing' at the appropriate intervals. This is true for all buildings. For historic buildings there are additional considerations relating to the retention of cultural significance

2. BACKGROUND – WHY MAINTENANCE IS UNDERTAKEN

2.1 General

Maintenance is defined in BS 7913[3] as "Routine work necessary to keep the fabric of a building, the moving parts of machinery, grounds, gardens or any other artefact, in good order". Within the context of this report it is the work associated primarily with the fabric that is considered.

Maintenance may be carried out for a number of reasons:

- aesthetic
- required – preservation of fabric
- economy
- convenience: disruption may be less than that caused by more significant work required if maintenance is not carried out – where crisis management may be required, and
- operational.

For historic buildings there is a need to respect the cultural significance of the building (or monument) and ensure that any work carried out as part of a preventative maintenance strategy is not more invasive than strictly necessary ("minimum intervention"). This is also emphasised by the University of the West of England ('UWE') in their work on Modules 1-3. [4] see http://www.maintainourheritage.co.uk/findings.htm.

The distinction needs to be made between maintenance and repair. Again BS 7913 defines the latter as:

"Work beyond the scope of regular maintenance to remedy defects, significant decay or damage caused deliberately or by accident, neglect, normal weathering or wear and tear, the object of which is to return the building or artefact to good order, without alteration or restoration."

Thus only a very modest degree of 'repair' would be considered to be included within the 'maintenance' function.

The focus within this report is on technology to improve the maintenance process and tasks before the building fabric gets to the stage where repairs are needed, thus preserving more historic material.

2.2 Selected commentary on the case for maintenance

While this module strictly does not dwell on *the case* for routine inspection and maintenance, in terms of setting the background some brief comment is contained within this report so that the context for sourcing appropriate technology is clear. The following extracts from various articles relate to both the general principle of such work and the more specific case in relation to historic buildings.

The Society for the Protection of Ancient Buildings ('SPAB') was founded by William Morris in 1877 to counteract the highly destructive 'restoration' of medieval buildings being practised by many Victorian architects. He pleaded for those entrusted with old buildings 'to stave off decay by daily care' [5], which might be suitably interpreted here as routine, ongoing maintenance. The SPAB website, in its technical advice section, also provides the following definition, which is of particular relevance to this research work:

"Preventative maintenance is work that, if carried out properly, will reduce the probability of decay. This contrasts with corrective maintenance, whereby decayed material is renewed. The importance of preventative maintenance cannot be over-emphasised. Such action will not only restrain, or even obviate, the need for repairs later, it will prevent the loss of original fabric and is cost-effective. Without such action, owners are often surprised how quickly a structure can deteriorate. Resultant corrective maintenance is disruptive and costly in both fabric and financial terms."

Maintain our Heritage [6] point out that "Maintenance is central to protecting cultural significance because, if properly implemented, it is the least destructive of all the 'interventions' which inevitably occur in the process of conserving historic buildings. The fabric of the building is important in itself - not just the function it performs.

This is recognised in all the key national and international documents on the protection of historic buildings. For example, the *Burra Charter* [7], defines conservation as being "all of the processes of looking after a place so as to retain its cultural significance" and goes on to state:

"a principle of conservation is that the cultural significance of a place is embodied in its fabric, its setting and its contents.."

Closer to home, *BS 7913* emphasises the important role of maintenance:

"Systematic care based on good maintenance and housekeeping is both cost effective and fundamental to good conservation". It should be noted however that the work by UWE in Module 1 [http://www.maintainourheritage.co.uk/findings.htm] concludes that "there is little evidence to suggest that regular inspections and preventative maintenance will always be a cost-effective use of resources". This is an aspect that will be explored further in the overall synthesis of Maintaining Value.

PPG 15 'Planning and the Historical Environment' [8] makes the case succinctly:

"Regular maintenance and repair are the key to the preservation of historic buildings. Modest expenditure on repairs keeps a building weathertight, and routine maintenance (especially roof repairs and regular clearance of gutters and downpipes) can prevent much more expensive work becoming necessary at a later date . . . regular inspection is invaluable".

An article written for *Building Services and Environmental Engineer* (BSEE) continues the theme [9]:

"It has been widely stated that unplanned and unexpected maintenance and refurbishment costs may amount to half of all money spent on existing buildings, with estimates ranging from values of £8 billion to £20 billion per annum.

The words ‘unplanned’ and ‘unexpected’ in conjunction with ‘costs’ are not popular in anyone’s business, but are especially unwelcome when connected with buildings. Like the proverbial uninvited guest, they are high on any building owner or operator’s list of things to avoid. And like most ‘unexpected’ things, they can be avoided with a little forethought and planning — in short good business practice.

Best practice does not cost. It pays!

Best practice in maintenance and refurbishment, as in any other sector, is all about looking at how you do things and then doing them better. It is not necessary to do everything ‘better’ but rather to focus on those activities that provide maximum value and doing them more effectively.

The maintenance of buildings is just one area where good business practice can bring many benefits, not least cost savings, over the period the life of a building.

Just like a car, the cost of a service may seem an inordinately expensive amount, when, to all intents and purposes, there is nothing wrong with it at the time that the service is scheduled. However, as the saying goes, ‘prevention is better than cure’, and with the technology and ‘smarts’ that are embedded in a vehicle and modern diagnostic equipment available to the technician, potential problems can be identified and corrected before they become major and expensive faults.

What applies on this small scale applies just as equally to the much larger scale of a building or campus.”

3. CONTEXT OF THE RESEARCH WORK

3.1 General

The research primarily covers occupied buildings, or those that are empty but actively managed. Derelict or abandoned buildings, while they may be important in a heritage context, are likely to require more proactive intervention as the first step to preservation, even if this is only to make them watertight and maintain them in their present state of dereliction, and are really in a separate category.

The buildings considered may be residential, either tenanted or owner-occupied, institutional or commercial. They may be in active use as, for example, hospitals, schools or hotels, or they may be properties such as stately homes which are open to the public and maintained by government or national bodies.

The focus is on buildings constructed generally up to the end of the Second World War, but some consideration is also given to post-war buildings, and in particular those that are listed or in conservation areas. BS 7913 notes that these pose new technical challenges as they are constructed of different materials and conservation and maintenance were not accorded much importance in their design and construction.

There appears to be a growing awareness of both the extent and the importance of the country's heritage. This has been reflected in the national press with coverage of specific buildings at risk and, in some cases, successful 'rescue' efforts, and most recently with the BBC television programme 'Restoration'.

Within the work a link will be made to the important theme of sustainability in respect of preserving building stock. It is also hoped that the outputs may be used to sustain pressure to create a more sympathetic tax regime as an encouragement to use proactive inspection and maintenance.

Health and safety is of relevance when dealing with the tasks of inspection and maintenance, and perhaps in particular in relation to older buildings. These will not have been constructed with current health and safety requirements in mind; in addition, protection of historic fabric may legislate against standard solutions for safe access where these require temporary restraint fixings etc. Consideration of additional costs, whether real or perceived, in meeting current legislation may be an important factor in deciding whether to implement routine maintenance tasks such as painting and even gutter clearance on some buildings.

Generally the focus is on what technology is available to make maintenance easier and more likely to happen.

3.2 Extent of work

Within the context of historic buildings, the term 'maintenance' will often be associated with the following:

- Timber, joinery and its treatment
- Water ingress.
- Roofs and rainwater goods
- Finishes – renders, plasters and paints
- Masonry – cleaning, repointing, repairs of brick and stone
- Early iron and steel structures.

The effects of water, whether seen as the consequences of leaking roofs, defective gutters, rising damp or excessive condensation probably have the most deleterious impact on buildings in general. For historic buildings in particular, given their use of timber, renders and ornate plasterwork the impact can be significant. The effects of high moisture levels can cause damage to finishes and primary elements alike.

While early iron and steel structures may not be seen as requiring significant maintenance, there have been cases where remedial work has been required due to the effects of sustained water ingress and/or incremental changes in loading. The collapse of a cast iron beam in a London terrace house in 2002 prompted a safety advisory note to be issued by SCOSS [10]. The note included the identification of a number of conditions that could lead to an unsafe situation. These include "longstanding ingress of water leading to corrosion, deterioration of the concrete infill, and loss of any composite action. Extended basements or roof garden arrangements are particularly prone to this action."

For these older buildings the key requirements for inspection and maintenance are the involvement of experienced and skilled professionals and labour, together with the use of appropriate materials and techniques. Issues associated with the provision of an adequate skills market are explored further in Research Module 6: Training and Education [see http://www.maintainourheritage.co.uk/findings.htm].

For more recent buildings, which may also be listed, there will additionally be issues of reinforcement corrosion and concrete repair.

While not strictly part an issue for '*preventative maintenance*', it is worth noting that in setting maintenance policies the requirements of the Disability Discrimination Act 1995 should be given due consideration. For historic buildings this may require sympathetic alterations to the building in order to achieve compliance.

4. METHODOLOGY

The research for this module has been carried out using a number of different methods, as described below:

- Literature search and review.
- Consultations by telephone, e-mail and letter with individuals and organisations.
- Questionnaire to selected organisations distributed as a supplementary mailing with the main questionnaire sent out as part of the research for Module 6 [see http://www.maintainourheritage.co.uk/findings.htm].
- Web searches – including sites of organisations such as English Heritage and SPAB and specialist product manufacturers.

A number of approaches have been made to organisations or individuals who have not responded. This is not unexpected, although it clearly reduces the sample size and limits the breadth of information available. Against this, however, some individuals have been exceptionally helpful.

5. PRODUCTS

5.1 General

The term 'products' is of broad application when used within the context of inspections and maintenance. This section examines, for example:

- the tools that are used in inspection and particular recording systems and databases used where routine inspection and maintenance services are established
- some products and systems that have emerged out of insurance requirements
- some of the different organizations that exist to provide information and services to owners of listed buildings
- how to provide a maintenance recording system for listed buildings (via the "owner's handbook"), and
- how these services might be extended.

It is essential to consider both tried and tested conservation techniques and innovative techniques. The latter may provide more cost effective means of protecting buildings than those that are more familiar. They may be able to solve problems that in previous centuries did not have a sympathetic solution. On the other hand, however, they may not yet be tried and tested and it is therefore unlikely that they will be immediately applicable to historic buildings, but worth developing further with that intention in mind. Of course, unfortunately, there have been some 20th century material and technique inventions that did not always behave as had been initially thought; such mistakes should not be repeated on historically valuable buildings. Both materials and new techniques need a full understanding if they are not to be applied to the wrong buildings by the uninformed user.

Products relating to access are covered separately within Section 6. Generic descriptions are given of various *types* of product. Website references are given additionally for specific proprietary products and organizations. These are necessarily not exhaustive, and neither Arup nor Maintain our Heritage endorse any particular product or manufacturer mentioned. It is the responsibility of the building owner, or any adviser acting on behalf of the owner, to satisfy themselves as to the suitability of particular products, sources of materials and techniques for the conservation of their building.

The extensive amount of material available on the web has been noted through the research. It is suggested that this could be a powerful tool in the dissemination of information related to systematic maintenance.

5.2 Tools for inspection work

5.2.1 General

Inspection is given a wide definition here, including the use of continuous monitoring systems. When dealing with historic buildings in particular there is a need for techniques that avoid disruption to fabric while allowing an accurate picture of the condition of hidden areas. Continuous monitoring may be needed, sometimes in relation to crack propagation but more often in relation to environmental conditions.

While technology becomes more sophisticated, allowing such measurements to be obtained and recorded, any move towards the development and widescale use of such devices would need to include consideration of the vast potential for data gathering and the related issue of what happens to the data, who interprets it and who maintains responsibility for instigating any work identified as necessary. Thought also needs to be given to the effect on historic material of fixing the devices required for monitoring in those cases where they are not free-standing, and to accessing them. On a more positive note, building monitoring systems such as those provided by Hutton and Rostron Environmental Investigations Ltd (http://www.handr.co.uk/Curator/overview.html) may be of great benefit in buildings where occupancy is only partial or intermittent, and where staffing levels may be low. This would include many historic buildings in public ownership.

It is important to recognise that while inspection and monitoring may identify particular problems or defects they will not necessarily identify the *cause*. Such identification is essential in order to determine the appropriate remedy.

Specialist testing houses such as Sandberg [http://www.sandberg.co.uk/]and Aperio [http://www.aperio.co.uk/index.html]can carry out surveys using a number of different techniques and will provide interpretive reports on the findings.

5.2.2 Technologies

A number of techniques are available for monitoring the condition of existing structures. These range from simple visual inspection, combined where required with low technology measurement techniques such as use of a plumb bob, builder's level and tape measure, to the more sophisticated non-destructive techniques. Removal of samples for testing may also be undertaken but agreement may be needed as to the acceptability of such methods, together with identification of suitable representative locations to minimise any visual impact on the fabric.

New techniques for the non-destructive investigation (NDI) of existing structures are being researched, in addition to the variety already established. These include acoustic monitoring and a pulsed infra-red concrete defects detection system, the latter being developed by BRE and trialled for the first time to facilitate long-term monitoring of a concrete strengthening system.

The following sub-sections describe generally the more sophisticated technologies, but the place of more straightforward methods as noted above, including visual inspection by an experienced individual, should not be overlooked. Some of these are still in their infancy in terms of use on building fabric, although they may have had, or been developed from, other applications. Different technologies will be appropriate for different buildings and their particular needs, and it is important that the correct methods are used in order to obtain the required information and to avoid, where relevant, damage to historic fabric.

5.2.2.1 Crack monitoring

Appearance of cracks can be major cause for concern. It is important to understand the significance - how big is the crack, is it continuing to move, where is it and what are the implications, are common questions to be answered. In the past a crude test for ongoing movement was the use of a glass 'tell-tale' fixed across the crack. This would fracture if movement occurred but would not provide information on magnitude or whether it was ongoing. A more sophisticated measure may be obtained by scribing marks on either side of the crack and measuring their spacing on an ongoing basis using an optical measure, or by

using studs and a Demec gauge for greater accuracy. In many cases ongoing monitoring may provide sufficient reassurance that no remedial action is required, and a degree of cracking will often be an expected component of historic fabric. A simple device for recording over a period of time is a calibrated gauge that can be read directly, as illustrated below [http://www.prginc.com/Masonry/index-masonry.html]:

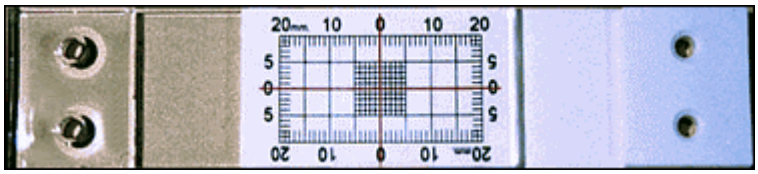


Figure 1. Crack monitor [image from PRG website]

5.2.2.2 Moisture monitoring

Systems such as the H+R Curator can be used to monitor a number of parameters including:

- the moisture content of timber in areas known to suffer from a high risk of decay
- rising damp
- the performance of damp proof courses
- gutter overflows, and
- leaks from downpipes.

The technology has been used, and is currently in use, at a number of significant of important historic buildings such as the Mansion House, Brighton Pavilion and Hampton Court Palace. Remote monitoring is being undertaken from the United Kingdom for buildings in Denmark and Singapore.

5.2.2.3 Infrared Thermography

Infrared thermography is a non-destructive testing (NDT) method that can be used to carry our surveys remotely. While it has been used for some time to monitor electrical and mechanical systems its application to building fabric is more recent. Examples of its use include the testing the bond of a thin layer to a substrate, the identification of 'hidden' structure and the location of wall fixings.

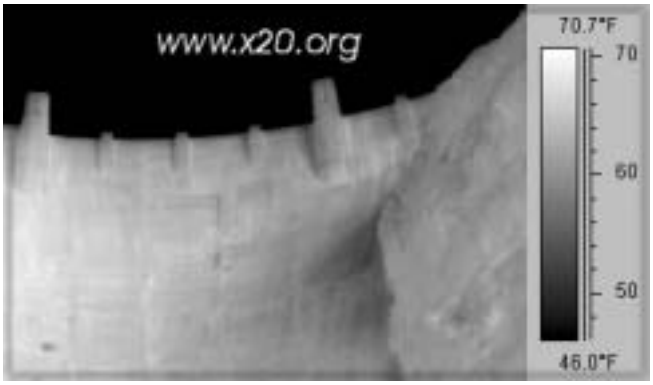


Figure 2 Thermal infrared structural image of Hoover Dam. SPi / United States Bureau of Reclamation [http://www.nationalinfrared.com/x20/shop/image_browser5.php]

5.2.2.4 Ultrasonic pulse velocity

This is a further NDT method used to test properties of a wide range of building materials and to detect defects including delamination, cavities and the depth of cracking.

5.2.2.5 Ground radar

Ground penetrating radar can be used for a number of applications. These include concrete mapping, to determine concrete thickness and the size and location of reinforcement, determination of masonry and the presence of ferrous bars and ties and identification of hidden chimney flues and foundations.

5.2.2.6 Use of duplicate samples

Duplicate samples may be used to monitor degradation of concealed elements.

The Volunteer Monitor's Guide to Quality Assurance Project Plans [11] defines the term as follows:

"*Duplicate sample.* Used for quality control purposes, duplicate samples are two samples taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitor, and/or analyst. More than two duplicate samples are referred to as *replicate sample*s."

Within the context of routine inspection and maintenance, the purpose of such samples may be to keep under review the condition of any part of the fabric which can only be accessed with some difficulty and perhaps at significant cost.

5.2.2.7 Acoustic monitoring

Acoustic monitoring was used initially to monitor fractures in unbonded tendons in post-tensioned structures. The technique has been evaluated subsequently for use on suspension cables and grouted post-tensioned bridge tendons, with encouraging results. More recently it has been investigated as a method for detecting and monitoring crack propagation in concrete structures. This is probably best described as a technique for monitoring that is in its infancy; the same issues concerning data collection and evaluation remain as for other remote monitoring methods, but it equally has the potential to be a powerful non-destructive test method.

5.2.2.8 Surveys and 3-D visualisation

Measured building surveys are becoming more sophisticated and can produce a range of different outputs, ranging from simple floor plans to 3D CAD visualisation. These may be of use for recording complex elevations to a high level of detail to providing a model for looking at possible alterations. This is described in a paper dating from 1996 [12], using the survey of an old castle as an example. The paper contains images of the facades of the castle, together with a textured 3-D model of the building. These illustrate well the potential of the methods described.

Relevant services are offered by a number of different specialists, such as APR Services (http://www.aprservices.net), who undertake measured building surveys using laser technology and also provide other related services including 3D modelling and visualisations.

Aerial photography is used for building inspection, with some examples of companies offering such services being:

- Hawkeye (http://www.hawkeye-scotland.co.uk)
- Sky Eye Aerial Photography (http://www.skyeyephotography.com/technology/htm), and
- Envirosight (http://www.envirosight.com.pdf).

These use a variety of access methods for the recording equipment, be it a digital camera or a videocam, including masts and tethered balloons.

5.2.2.9 Magnetic resonance imaging (MRI)

Joseph Hornak in his book *The Basics of MRI* [13] defines MRI as "an imaging technique used primarily in medical settings to produce high quality images of the inside of the human body. MRI is based on the principles of nuclear magnetic resonance (NMR), a spectroscopic technique used by scientists to obtain microscopic chemical and physical information about molecules." More recently the technique has been investigated as a means of detecting cracking in concrete structures. Because it is a magnetic test it cannot be used for conventional ferrous reinforcement, but is applicability is being studied in relation to concrete reinforced with FRP.

5.2.2.10 Laser shearography inspection

Laser shearography is a rapid inspection technique that can be used to inspect large areas. The technique senses out-of plane displacements in response to applied load, the displacements indicating defects within the material such as delaminations within composite materials. It is used on composite structures such as life boat hulls and pressure vessels. The first application on building construction was in 2003, described in an industry research report.[14]

5.2.2.11 Environmental monitoring

Environmental monitoring is being carried out in some properties to control humidity by both the National Trust and the National Trust for Scotland. This involves the use of radio signalled devices with the output sent direct to computer for recording and subsequent assessment. Conservation heating may be required in some cases, together with humidity controls. Products are available that allow both monitoring and automatic control of the environment through the use of humidifiers and dehumidifiers. [Examples include Moisture monitoring http://www.handr.co.uk/Curator_home.html and Environmental monitoring http://www.hanwell.com]

5.2.2.12 Electrochemical testing methods for concrete durability

A new report, " Testing rein forced concrete durability by electrochemical methods" is to be published shortly by the Concrete Society and the Institute of Corrosion. This brings together best practice guidance on the principal test methods for detecting corrosion activity. It gives guidance on selecting the appropriate test methods and on interpreting the results, together with information on more advanced tests.

5.3 Inspection systems

5.3.1 General

It is perhaps a rather different use of the term ‘product’, but this is used here to look at the role of formalised inspection systems in regular inspection and maintenance of buildings and the contribution that other organizations can make in this area.

While all European Nations have a statutory system for the identification and protection of buildings and structures considered to be of cultural significance [15], the positive contribution from the state towards the ‘protection’ aspects is much more significant in Continental Europe than in the United Kingdom. The establishment of Monumentenwacht (literally ‘Monument watch’) organisations in a number of countries, based on the original model from the Netherlands, provides both a framework for the care of historic buildings and a positive statement as to the importance accorded to such buildings by the state.

5.3.2 Monumentenwacht

Monumentenwacht began in the Netherlands in 1973 with one part-time team of inspectors. By 2002 the number had increased to 52 teams working on a full-time basis, looking after over 15000 monuments. There is now a substantial provincial subsidy for the inspectors’ salaries and labour costs. The building owners pay a membership fee and an inspection fee. The operation of the system is demonstrating the benefits of regular maintenance to both the government and the owners.

Monumentenwacht in Flanders ['Monumentenwacht Vlaanderen vzw'] operates a state-subsidised inspection system for heritage buildings.[http://www.monument.vlaanderen.be]. This is very similar to the original Monumentenwacht Nederland. Other systems have also been established in Continental Europe, including one in Denmark in 2000 and, most recently, one in the Berlin & Brandenburg area of Germany.

A brief description of the organisation and system in Flanders is given below:

There are three different inspection systems, for buildings, mills and interiors. Currently the membership stands at 3700 building owners, who pay 40 euro/year per building to be in the scheme. Inspection costs are charged on an hourly basis, which allows the scheme to be operated equitably for a wide spectrum of property types with very different inspection issues.

The organization employs seven interior watchers, or inspectors, and 34 architectural watchers full time, 10 secretaries and a general coordinator (coordination in the provincial associations is done by staff of the provincial government).

The principal role of the inspectors is to give recommendations for maintenance and repair that is needed, based on their inspection, but they also carry out minor and urgent repairs.

In order to provide some assessment of the inspectors’ work every year the organisation tries to calibrate the reports of the different teams (they inspect all the same building or part of a building). Continuous training is also provided for their staff.

Employees working with high risks (eg inspecting churchtowers with industrial rope techniques) are covered by all necessary insurances, and problems in this area have not been encountered.

Access can present problems in terms of both establishing a safe route/method and at the same time avoiding damage to historic fabric. The former has proved to be more of an issue: the organisation has very strict regulations for risk and evaluation and protection of its staff. On historic buildings there are often no hooks on the roofs, the gutters are inaccessible, and the roof structure may be dangerous. Industrial rope techniques are used (to a similar level to the British association IRATA) to inspect as much as possible in a safe way.

In terms of particular methods/ materials used for repair and maintenance work, they carry out only minor and urgent repairs with traditional methods according to the original materials and techniques used on the building. Again, the necessary training is arranged by the organisation.

Monumentenwacht has an accessible database for all data of owners and buildings. This includes pictures, inspection reports, records of works that have been carried out. The system is also used to draw up statistics. Once a property has been inspected a maintenance schedule is produced to accompany the report.

An example of the inspection system is included as Appendix A1.

The organization also organizes workshops where specialists can share their knowledge with maintenance teams from different buildings, and produces maintenance brochures covering different areas.

Within the United Kingdom no such system exists at present. Research carried out by UWE as part of the Maintaining Value project suggests that there is limited demand for such a service and that the demand would be significantly reduced if the cost were unsubsidised.

5.3.3 Pilot Maintenance Inspection Service

Maintain our Heritage have recently operated a similar system as a pilot service in Bath & North East Somerset. This will be evaluated in order to assess the feasibility of setting up a permanent service throughout the country in the future. The UWE research referred to earlier will also be of relevance here.

The pilot is described below in an extract from the interim review produced by Maintain our Heritage [16]. The final report will be published in November 2003.

The service envisaged would offer subscribing owners, whether individuals or organisations:

- An inspection;
- A report containing prioritised recommendations, in layman's terms, for maintenance and repair work. The report will contain digital images to aid communication;
- An explanation of the report in person; and
- The carrying out of a limited amount of first-aid on-the-spot repair where small, but critical, areas of disrepair are encountered during the inspection.

The service would be delivered on site by specially selected and trained two-person teams. The charge for the service, which would be run on a not-for-profit basis, would be low to encourage wide participation. The pilot scheme has been funded from a number of public, private and charitable sources.

It includes working in parallel with approved contractors who would carry out a limited number of inspections in parallel with the MoH inspectors and provide an indication of the costs of the work identified as being required.

Research carried out by UWE for Module 3 " The Provision of Commercial Maintenance Services for listed Buildings" [see http://www.maintainourheritage.co.uk/findings.htm] suggests that there may be some latent demand amongst both individual owners and organisations for the type of service offered by Monumentenwacht, but among the former in particular this would not be taken up to any significant degree at commercial rates. The European system is heavily subsidised; it is not obvious that similar financial backing from the Government would be available in this country, an aspect that might be pursued as a follow-up to this project.

5.3.4 National Trust for Scotland

The National Trust for Scotland (NTS) operates the Little Houses Improvements Scheme ('LHIS'), a part of NTS' activities which "aims to put redundant buildings back on their feet". This provides a sound base for the rehabilitation and repair of worthy historic buildings that are facing terminal decline through their initial acquisition and subsequent onward sale to third parties. The future of the buildings once they are sold on from the NTS is protected by a Conservation Agreement, although this cannot provide a long-term guarantee as to future maintenance.

The essence of the scheme is the adaptation and development of these buildings – approximately 230 have been completed to date – without compromising their essential character. NTS Building Conservation Policy governs the philosophy of LHIS, and the principles of the Burra Charter are followed.

The NTS Director of Conservation and Property Services writing in the Spring 2003 issue of 'The Slate', the newsletter of the NTS Buildings Team, expressed a desire "to see in place a coherent system for the maintenance of all the Trust's buildings [17]

While money is available for repairs of historic buildings (the Historic Buildings Repair Grants Scheme was established in 1953), it is recognised that there should be more emphasis on the need for continuing maintenance once the repairs have been completed. Various recommendations have been made to tie such activity to the grant.

5.3.5 Conservation areas

Conservation areas may offer a possible route into the provision of routine maintenance inspection services, given the degree, albeit modest, of planning regulation that applies to buildings that fall within these areas. They could perhaps be used as vehicles for providing more detailed guidance on the strategic need for preventative maintenance. Possibilities might include the establishment of individual firms who dedicate at least a proportion of their capacity to maintenance work within a particular conservation area, recognising that there could be opportunities for economy of scale and scheduling if work is carried out at a number of properties in a limited area within a defined period of time.

Information on a number of conservation areas may be found through their various websites. This has been found to vary from general information on the character of a particular area, together with an explanation of the significance of the designation of a conservation area, to in some cases detailed technical information on the construction materials used within the area and recommendations for cleaning and repair. Examples here include the notes on brickwork and timber available from the *Bedford Park Society* [18]. Bedford Park is the earliest 'Garden Suburb' and the Society, now forty years old, fulfils an important role in maintaining the work of the various architects in the area such as Norman Shaw. The Society also pioneered the use of the *owner's logbook.*

Hampstead Garden Suburb Trust has an extensive design guide on its website [19] which contains brief information on a variety of aspects of construction, planning requirements, materials of original elements and other information of use to the residents. The Trust became the ground landlord of most of the leasehold properties in the suburb in 1989. It is able to keep control over architectural standards on the suburb through both the Scheme of Management and stipulations in the freehold transfer for freeholders and covenants in the leases for leasehold properties.

The Trust's Articles require it to do all things possible to maintain and preserve the present character and amenities of Hampstead Garden Suburb. It is a non-profit-making concern and all residents are eligible for company membership after a minimum of three years' residence in the suburb.

Although the Trust has an architectural advisor the website is run by the residents and all the information on it is obtained by them. The advisor maintains lists of contractors, services, materials that generally come from 'satisfied' residents who have used them, but this does not have official approved status and he cannot recommend any individual firm or product. In terms of control, any external works – including some gardening works – have to be applied for and agreed with the Trust. The system works quite well, although some policing is needed. However, there is not really any control over, or involvement in maintenance, although occasionally advice may be asked. There are no specific maintenance requirements and no log book/database scheme, although in general this does not seem to be an issue and the Suburb residents are generally prepared to arrange the necessary work.

There are different arrangements for work to blocks of flats, both in the Suburb and more generally. These are often organised by a management company and may be less satisfactory. This may be an area for further consideration.

5.3.6 Building Preservation Trusts

Although the main focus of the research has been on occupied buildings with an ongoing use (3.1), a brief note on building preservation trusts is included as an alternative vehicle for buildings that are in a poor state of repair and generally vacant. Building preservation trusts are charities whose objectives are firmly related to "the preservation of historic buildings for the benefit of the public". Their target is "to return buildings to practical use once restored, to ensure ongoing maintenance". There is a parallel here with the Little House Improvement Scheme operated by Historic Scotland, referred to in 5.4.4 above.

While there can be no absolute guarantee that the required maintenance will be effected once the building has been restored, there is probably a greater likelihood that this will be done, and this thus does provide a route to restoring as well as maintaining value.

Derbyshire Historic Buildings Trust (http://www.derbyshirehistoricbuildings.org.uk/index/htm) was formally incorporated as a limited company in 1974 and registered subsequently as a charity. It works to preserve neglected or abandoned historic buildings "without damage to their essential character", and in addition to maintaining the register of Buildings at Risk they host the Crafts Register produced by the County Council on their website.

5.3.7 Databases

As early as 1990 a guidance note written on planned building maintenance by the RICS [20] recognised the advance in ICT and the contribution this might make to the efficient planning, prioritisation and recording of maintenance–related activities. Build Assured (see 5.5.1 below) rely on the use of high quality software to track and record the very substantial volume of work planned and in progress at any one time. Other organisations use databases to record maintenance inspections and activities in defined areas eg the Bedford Park Conservation Area. Systems can be used to flag up outstanding works and to store photographs and drawings of individual properties.

The development of more sophisticated databases may be part of a move towards greater prioritisation of maintenance work in general. Software that can be run from a Palm or similar device allows the rapid collection and transfer of data direct from a site inspection. This can be used to generate work orders and directions for future work. Using the same software, maintenance history and costs can also be recorded against individual assets/equipment for later use and reference. An example of such a system is the *Hardcat* maintenance module, part of the wider Hardcat software Core Module used for asset management (http://www.hardcat.com/software-maintenance.html).

5.4 Other organisations

5.4.1 General

This section provide a brief overview of some of the different organisations and websites that currently provide contacts and information for owners of listed properties. While these have not been benchmarked in any sense for the depth or quality of information they provide it is felt that their existence is an indication of the market for web-based systems in particular. The website by Derbyshire Historic Buildings Trust is one example of such a site, as referenced above in 5.3.6.

5.4.2 Heritage Information Site

Dorian Crone has established a website providing information on all aspects of conservation (http://www.heritageinformation.org.uk). The Heritage Information Trust is a charitable trust that 'is a national resource for the care of our heritage'. The establishment and maintenance of such a resource is seen as a vital component of a national strategy for ensuring that informed 'care' becomes an accepted and routine method of operation.

5.4.3 Listed Property Owners Club

This organization [http://www.listedpropertyownersclub.co.uk] provides information and advice for listed property owners. Among the services it provides are:

- specialist insurance

- logbook containing the LPOC's information sheets, background notes on historical properties, FAQs and space for photographs and records of work undertaken.
- Information sheets covering topics from repointing to VAT and the listed building.
- magazine directed at listed building owners
- legal advice
- help line.

5.4.4 Period Property UK

This is a website [http://www.periodproperty.co.uk/index.shtml] that offers a variety of services and information to owners of, or even enthusiasts for, period property**.**

In addition to offering a directory of craftsmen and specialists it also includes a number of useful articles and, perhaps of most interest, a discussion area where users can enquire about particular issues on their property

5.4.5 Listed Property Owner's Forum

A forum for listed property owners [http://www.williamthatch.co.uk/cgi-bin/ubb/ultimatebb.cgi] is maintained on the Period Homes Policy website. As with the above, this is believed to be a service that could assist with maintenance activities in terms of providing information and reassurance to owners.

5.4.6 Association for Preservation Technology International

This association (http://www.apti.org) is "dedicated to promoting the best technology for conserving historic structures". As the name implies, it operates on an international basis, with members in 28 countries.

5.5 Insurance

5.5.1 Insurance –based maintenance work

Build Assured is "the first internet-driven managed property repair service", an organisation whose work includes a substantial proportion of repairs based on insurance claims.

The organisation (http://www.buildassured.com/home.html) retains a network of approved local tradesmen who commit to a certain amount of work in a given period, together with regional managers.

Because of the nature of such work, an individual job may only be up to £3000 or 4000 in value. In order to maintain the necessary turnover this means a huge number of jobs may be on the go at any one time, in turn requiring an excellent information and tracking system. The software used, which is available commercially, is deemed to be the market leader.

The software that Build Assured operate provides a model for 'cost effective claim management'. This could well have a parallel with 'cost effective maintenance management', possibly using a similar database system.

The form has three levels – planned (low value) and managed (medium and high value) and emergency works. Even with the highest level of inspection and maintenance, an emergency may always be a possibility and systems need to be in place to deal with such incidents. An advantage of a planned maintenance system would be the provision of emergency cover.

There is no specific heritage brief or focus – the firm is only involved specifically with heritage buildings if there is an insurance claim related to one. They use approved tradesmen to implement the work and would be able to call on the appropriate organization where relevant.

Loss adjusters are often involved to agree the work. The inspectors are employed by Build Assured and are therefore covered by the firm's insurance. Contractors used by them will have their own insurance but Build Assured will provide further cover if this is not adequate.

The firm acts as the Principal Contractor. They have contemplated an MOT type of service – also as part of the proposed 'seller's pack' initiative – but this has not yet been seen as a viable opportunity. It might be progressed on a subscription basis. This is explored further in the work from Module 5 [see http://www.maintainourheritage.co.uk/findings.htm].

British Gas provide Home Emergency Cover when a property is insured through them. This service provides a 'qualified tradesperson' usually within two hours when there is an emergency. They offer additionally a raft of inspection and emergency repair systems for different parts of the domestic services installation but not for the main building fabric.

Direct Line Insurance also offer a service called Home Response 24. As the name implies, this provides a 24-hour service, again to cover emergency breakdown

As implied above, there seems to be more availability of *emergency* work rather than *planned.*

5.5.2 Insurance issues for listed buildings

While most building insurance requires a general degree of upkeep on the property so that the risk of an insured event occurring is minimised, the extent of such an obligation is not generally spelled out.

For historic buildings there are particular insurance issues. Reinstatement costs may be significantly higher than the market value of the property, and themselves require expert input. The cost of tracing leaks may be high, and require disruption to historic fabric, and availability of both the appropriate materials and specialist contractors may be limited. The advantage here may be – or could be - that a specialist insurer might require more specific maintenance procedures than a 'mainstream' house insurer

There are limited numbers of specialist insurance providers for such properties. This field might be explored further, and the possibility of linking an inspection and maintenance system to this, possibly with some premium reduction, investigated as part of further work.

5.6 Owner's handbook

For heritage buildings it is suggested that the purchaser should be provided with a *maintenance handbook.*that would include:

- history of the property, including construction materials and special features
- anticipated maintenance regime [activities, frequency]
- date of last works and recommendations for future inspection(s)
- recommended products
- contact details for specialists and maintenance contractors, including any term arrangements that have been established.
- description of those tasks that might be undertaken by owners – witb advice where needed eg cleaning gutters may be straightforward, window repairs less so.
- sources of advice/guidance etc – EH/SPAB/HS etc.

A pro-forma for such a document is provided in Appendix A3. The use of such a document could undoubtedly assist in conserving properties in good condition, and engaging the owners in the cultural importance of their assets. It is a recommendation of BS 7913 that both a log book and a conservation manual should be prepared and maintained as appropriate "as an aid to the proper care of any building, particularly a large and/or complex historic building".

This is also foreseen in the consultation document *Protecting our historic environment: making the system work better* issued by the Department for Culture, Media and Sport [http://www.culture.gov.uk/default.htm] in July 2003 at Paragraph 46 "The Government proposes to supply owners with a more comprehensive pack explaining what listing means and what they can do to protect and enhance their asset." On a positive note also, at Paragraph 47 the idea of creating a 'log book for historic assets' is sensibly linked to the requirement in the Consultation Draft Housing Bill for those selling property to compile a Seller's Pack. This idea is important and should be pursued; there is clearly some interest in this idea in Government but as yet no commitment. The Seller's Pack would also include a mandatory report on the condition of the property. While this would only provide a snapshot of the property at a particular time, and possibly with some restrictions on the extent of the survey, it could provide a basis for a future inspection record.

The idea of a logbook is not new: in addition to the references above, such a document is produced by the Bedford Park Society for Listed Building residents within the area and the Listed Property Owners Club. King's Lynn and West Norfolk Borough Council are currently producing a very comprehensive document for each of the listed properties in their area. Extracts are included in Appendix A4.

British Waterways also has a system of 'heritage data sheets' for its core estate of listed buildings. This record can be added to over time and is used as reference material for cyclical inspections.

The "Recommendations for future inspections" should contain a schedule of what is to be inspected and when. More vulnerable elements, or those showing signs of deterioration, will require more frequent inspections than, for example, solid stone walls showing little sign of weathering or distress.

BS 8210 [21] at Appendix D has an "Example pro-forma for use in the visual inspection process". Appendix A of the BS has a checklist of building elements together with examples of some common causes of failure. This does not relate specifically to historic buildings, but covers a wide range of elements, materials and construction types.

A more detailed "Inspection checklist" as used by Monumentenwacht Flanders is also included in Appendix 1 to this report.

Interestingly, Princeton University in the USA appears to understand the basic philosophy of routine maintenance, although this relates more to internal fittings and finishes. From their maintenance website: http://facilities.princeton.edu/maintenance/maint_b_inspec.htm:

"One essential element of a pro-active maintenance program is to inspect all facilities on a regular basis, looking for incipient problems….

There is a Maintenance Representative for each [principal] building on the campus. A periodic inspection program (sic) focuses on the following:

The Department of Grounds and Buildings Maintenance also has a periodic inspection program in place, that focuses on the following:

- General condition of wear and tear features such as paint, floor covering, and window covering.
- Proper operation of doors and windows, especially exterior and fire doors.
- Examination for leaks, or other latent water problems.
- The condition of electrical and mechanical rooms and other utility spaces.
- The condition of built-in safety features and building protection devices such as exit lights, emergency lights, and sump pumps.
- The condition of rest rooms, especially toilets, faucets, and drains.

Each Building Representative Provides primary input regarding the prioritization of building needs for major maintenance programming."

6. ACCESS

6.1 General

When considering access for maintenance it is important to recognise that access can be required for a number of tasks ranging from inspection and monitoring, Cleaning, Repair/Maintenance or Replacement/Refurbishment.

A typical range of tasks that are required on historic buildings. These have been categorised in Table 1 and provides a discussion on particular issues such as;

1. Tools

2. Factors Affecting choice of access used

3. Typical best fit solutions

The frequency at which access is required will often be a factor in deciding which method is chosen. The choice of access method will also impact upon cost.

For example, if a frequent task is identified (say 6 monthly or annually) then long-term consideration must be given to providing some form of permanent access. This need not be in the form of 'ugly' steps or fixed ladders. A sympathetic approach and consideration can often result in a visually intrusive.

The way in which an owner/organisation goes about work on their buildings will also influence the type of access required. In cases where work is planned well in advance, adequate provision can be made after careful consideration of all the issues. Where emergency repairs are required, for instance to avoid water damage from a leaking roof, the access method may simply be a ladder or a mobile cherry picker to effect a temporary repair.

Access solutions for buildings are often difficult to achieve when you consider the conflicting requirements of:

1. Health and Safety legislation

2. Cost

3. Frequency

4. Aesthetics

The flow process by which an owner might come to a decision about the best-fit solution is illustrated in a typical access consideration flow chart.

TYPICAL TASK HISTORIC BUILDINGS	TOOLS/PLANT/EQUIPMENT/ MATERIALS	ISSUES AFFECTING CHOICE OF ACCESS TECHNOLOGY	BEST FIT ACCESS SOLUTION
INSPECTIONS	Limited in weight (cameras, survey equipment etc) dependent on survey type.	Choice of access technology must allow contractor specialist to perform inspections e.g. some rope access people are trained Structural Engineers.	Cherry pickers/rope access or visual from ground level using aids such as binoculars. If inspections are to be undertaken on a annual basis then consideration should be given to providing suitable access equipment on a permanent basis e.g. a protected area on a roof, a fall protection system etc. Clearly any alterations should only be done in consultation with the appropriate conservation body.
STONE CLEANING	Specialist equipment needed: spray bars, washers, grit blasters, scrappers, brushes, etc.	Stone cleaning is a specialist activity that if not done correctly can cause more harm than good. However if stone is to be cleaned then Contractors will need plenty of working platform space to work from.	Traditional scaffolding.
RE-POINTING	Dependent on extent of operations. Tools can vary in number and would typically compose of hand tools, buckets, brushes etc.	Often a poor repair of pointing using non-traditional un-porous mortar will cause more fabric damage than if left to weather. However, if re-pointing is to be done, operators will require a good working platform that allows them to bring up buckets of mortar for work.	Traditional scaffolding may be suitable for a significant re-pointing exercise. Small pointing jobs might be done from mobile scaffolding tower or cherry picker type devices. Rope access can be used but is costly and the tradesmen supplied by some rope access companies may not be suitable to undertake the sensitive work required. Ladders should be avoided as pointing with a hawk and trowel is a two handed operation.
PAINTING	Painting may require brushes, rollers, kettles, mixers, sanders and scrapers etc.	Modern paints are often not suitable for older traditional buildings that would have a porous lime wash applied. However where painting/lime washing is needed on windows and walls etc. operators will require a good working platform to work at. Typical Task – Table 1	Ladders although often used should ideally be avoided. The temptation is to abuse their use on the difficult to reach areas and over stretch/reach to speed up the job. Ideally traditional scaffolding should be used or a mobile tower. A modern alternative to this however is a cherry picker type device.

Historic buildings Access/Tasking Guidance - Typical Task Table 2

TYPICAL TASK HISTORIC BUILDINGS	TOOLS/PLANT/EQUIPMENT/ MATERIALS	ISSUES AFFECTING CHOICE OF ACCESS TECHNOLOGY	BEST FIT SOLUTION
RE-ROOFING/THATCHING	Major re-roofing requires, felt (*but not on all restorations*), tiles, nails, wood for repairs, mortar, hand tools etc.	Re-roofing of historical buildings is a last resort, second hand or reproduction tiles are often needed to blend in better with this type of building. If re-roofing is to be done multiple tradesmen will often be needed at anyone time to perform the works.	Traditional scaffolding is the best technology for this as it allows a very strong working platform and it provides good edge protection. Care should always be given to how materials that can be heavy (lead etc) are raised onto the working platform. A wheel is not always safe. A powered lift might be a solution on larger projects. Also consider rubbish shoots for debris.
WINDOW CLEANING	Window cleaning requires relatively light tools.	Window cleaning is often a low-tech industry: methods that are ok for many types of windows may not be suitable on historical buildings. For example a misplaced ladder on a stained or historic pane of glass could cause irreplaceable damage.	Consideration should be given to the use of pole type high reach washing systems for outside elevations. If traditional ladders are to be used for access, then clear site-specific method statements and risk assessments should be provided by the contractors.
STONE REPAIRS	Minor repairs usually require hand tools, pre-fabricated stone pieces and mortar.	Stone repairs, if done correctly, are a specialist artisan job.	Mobile access platforms may be ok. Consider the use of a traditional scaffolding tower with ginny wheel for materials.

GUTTER CLEANING AND REPAIRS	Tools needed include a gutter cleaning trowel, bucket for debris and paint for touching-up damaged surfaces. Any repair should always be in keeping with the historic building e.g. cast iron or aluminium reproduction rainwater goods etc.	The regular cleaning of gutters and hoppers can have a significant effect on the longevity of a historic buildings. Avoidable water damage is a common problem on historic buildings. Ladders are traditionally used but as debris in gutters can be significant and heavy this is not always the best access method.	Consider use of a cherry picker mobile access platform or mobile zip-up scaffolding as this will provide a safer working platform than a ladder when dealing with wet sludge etc. Old gutters do not always provide a safe surface for a ladder to be rested on. Alternatively the use of grid covers will prevent the annual accumulation of leaves.

TYPICAL ACCESS CONSIDERATIONS WHEN UNDERTAKING MAINTENANCE/INSPECTION/REPAIRS OF HISTORIC/LISTED BUILDINGS

Is the maintenance / repair task likely to occur ever two years or less?

Yes

No

Consider the need for a (sensitive) modification to allow safe regular access to high areas e.g. provide safe walkways etc.

Others issues to consider include;

- Is the material sensitive to touch?
- Is location of potential problems in hard to reach location?
- Is heavy equipment needed for maintenance task?

Consider a one-off solution for access

Try and avoid the use of ladders and roof-ladders

Consider an (additional) access technology if needed for working at heights…

Rope access techniques: Can be used to reach difficult locations at height. Must consider skills of qualified users for job and weight of tools materials needed to perform task if chosen…

Traditional Scaffolding good for larger refurbishments but often obtrusive

Mobile access platforms such as cherry pickers, scissor lifts, tower platforms good for inspections, tests and minor repairs and in some instances more major repairs.

All **rope access users should be IRATA Trained** at grade 2 and a supervisor should also be on site at all times with Grade 3 rating. All equipment to be visually checked and certified before use.

Scaffolding installer must **certificated scaffolding** installation before use and that it is inspects it regularly

Have Operators must have attained a **powered access training** scheme or PMSA Certificated training for mobile scaffolding tower.

GENERAL GUIDANCE

- ENSURE WORKS AT HEIGHT ARE SUPERVISED AT ALL TIMES
- TALK THROUGH CONTRACTORS METHOD STATEMENTS AND RISK ASSESSMENTS
- CLEAR AREA BELOW AND TO THE SIDES OF THE WORKS AND CORDON-OFF TO PREVENT PUBLIC GETTING HURT
- CONSIDER TYING-ON TOOLS
- CONSIDER BEFORE WORKS BEGIN WATER, POWER AND MATERIALS PROVISIONS
- ALL LADDERS MUST BE TIED ON
- CHECK OPERATORS HAVE A MEANS OF COMMUNICATION TO THE GROUND
- CONSIDER HOW RUBBISH AND DEBRIS WILL BE REMOVED TO GROUND LEVEL (SAFELY)

6.2 Health and safety issues

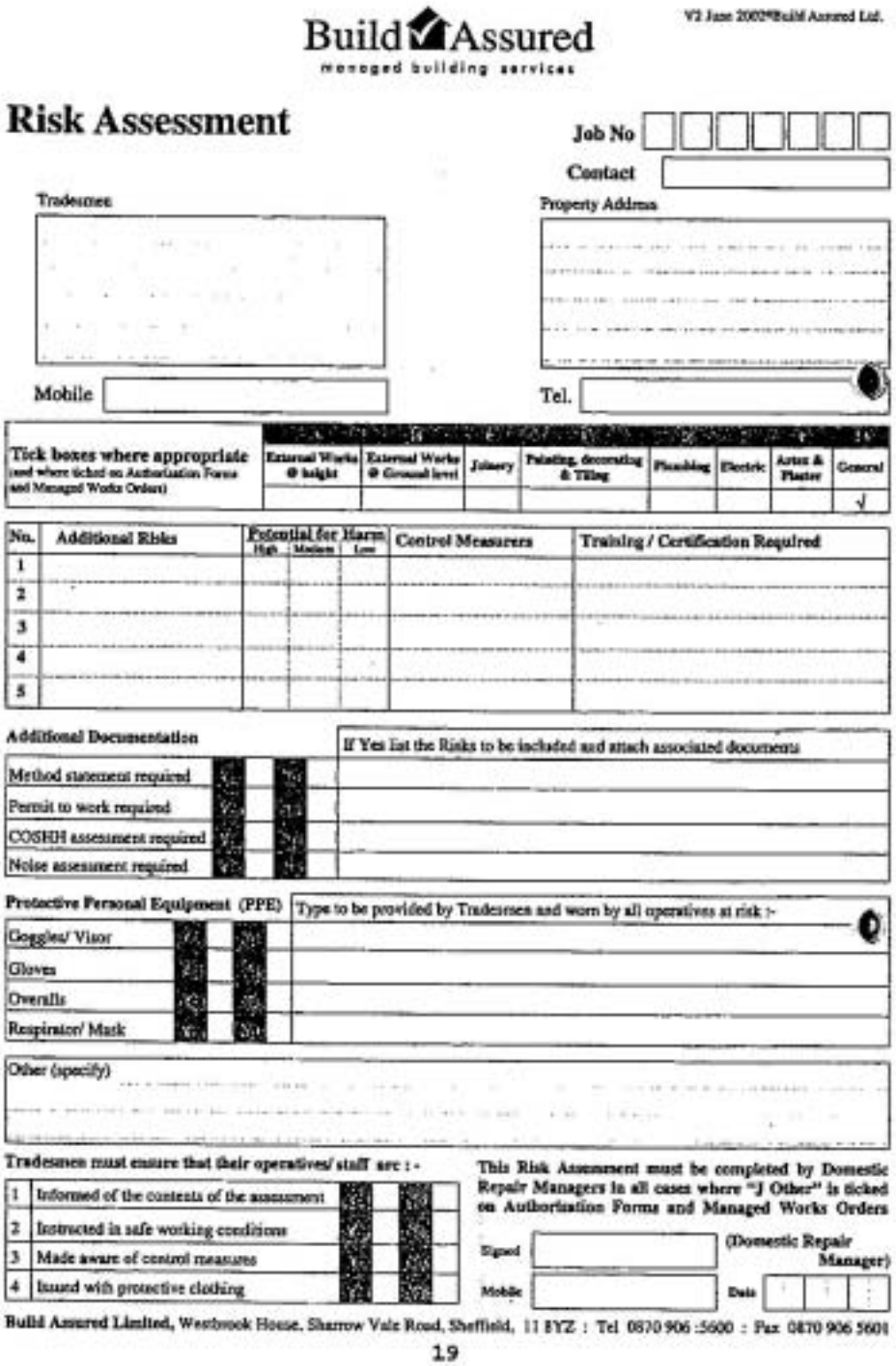
BS 8210 [21] Guide to Building maintenance management draws attention to the need for safe access and the health and safety requirements applicable for both inspection and subsequent work.

There are also numerous HSG and other publications relating to safety. A document currently in publication by CIRIA [22] is particularly good at setting out the main issues in some detail.

It is however important to recognise that often the work undertaken on historic buildings is procured through a simple exchange of letters and may often be very much on the domestic scale. In this instance it is often the 'local' builder who undertakes the work. While he may often have a very good safety record by virtue of his experience, he may not be aware of the publications and therefore strictly adhere to the advice available. Where he is not a sole operator, the cost of providing the necessary insurances for employees may also be felt to be disproportionate.

Build Assured, who carry out a substantial proportion of insurance based work (see 5.5.1) have prepared a 'Tradesman Health & Safety Manual' that provides very good basic information in the form of a checklist of Control Measures and a very simple method to record that a Risk Assessment has been undertaken.

The following are samples of the documentation they use:



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Risk Assessment

Job No

Contact

Tradesmen

Property Address

Mobile

Tel.

Tick boxes where appropriate (and where ticked on Authorisation Forms and Managed Works Orders)	External Works @ height	External Works @ Ground level	Joinery	Painting, decorating & Tiling	Plumbing	Electric	Artex & Plaster	General
								√

No.	Additional Risks	Potential for Harm: High	Medium	Low	Control Measures	Training / Certification Required
1						
2						
3						
4						
5						

Additional Documentation			If Yes list the Risks to be included and attach associated documents
Method statement required			
Permit to work required			
COSHH assessment required			
Noise assessment required			

Protective Personal Equipment (PPE)			Type to be provided by Tradesmen and worn by all operatives at risk :-
Goggles/ Visor			
Gloves			
Overalls			
Respirator/ Mask			

Other (specify)

Tradesmen must ensure that their operatives/ staff are :-

1	Informed of the contents of the assessment		
2	Instructed in safe working conditions		
3	Made aware of control measures		
4	Issued with protective clothing		

This Risk Assessment must be completed by Domestic Repair Managers in all cases where "J Other" is ticked on Authorisation Forms and Managed Works Orders

Signed (Domestic Repair Manager)

Mobile Date

Build Assured Limited, Westbrook House, Sharrow Vale Road, Sheffield, 11 8YZ : Tel 0870 906 :5600 : Fax 0870 906 5601

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Risk Assessment Table

User note
This table identifies common risks only. All Additional Risks must be identified on the Risk Assessment form.

	A External @ height	B External @ ground level	C Joinery	D Plast, Dec Floor tiling	E Plumbing	F Electric	G Artex Plaster	H General
1. Asbestos	√			√	√		√	
2. Bitumen	√	√						
3. Electricity			√	√	√	√	√	√
4. Gas Work					√			
5. General Access	√	√	√	√	√	√	√	√
6. Hand Tools	√	√	√	√	√	√	√	√
7. Highly Flammable Liquids				√				
8. Hoists	√							
9. Ladders	√		√	√		√	√	√
10. Lead	√			√	√			
11. Lifting Gear	√							
12. LPG	√	√		√	√			
13. Power Tools	√	√	√					
14. Roofing	√							
15. Platforms Towers Scaffolds	√							
16. Step Ladders		√	√	√	√	√	√	√
17. Contractors Vehicles	√	√	√	√	√	√	√	√
18. Trestles				√			√	
19. Waste Disposal	√	√	√	√	√	√	√	√
20. Welding & Hot work	√			√	√			

For Health and Safety issues the Health and Safety Executive (HSE) when considering access will undoubtedly almost always start from the position of requiring a permanent walkway and handrail. With the type of building group being considered in this research, the visually sensitive nature and the restrictions arising from listed status will often mean that this first line approach by the HSE would not be the favoured option. However, it is important that users/owners of historic buildings consider a structured assessment / approach to the requirements of safe access in order to fulfil their obligations under health and safety legislation. It is also imperative that this process is recorded. In addition to the use of the appropriate access equipment, the necessary checks should be carried out on the equipment and those involved should also have the appropriate training. In the case of rope access, this will mean membership of the Industrial Rope Access Trade Association.

Four typical scenarios are presented, there are many others but they show the thought process that we believe to be fundamental to having a safe, cost effective and visually acceptable approach to maintenance access. The normal text shows the general decision process. The italicized text shows how that process is applied to each scenario.

When considering the suitability of the existing availability of access equipment that can either be hired or purchased, often it is the limitations imposed by the building and surrounds for providing a suitable access route to get the equipment close to the work place that can cause the problem. For example, considering and assessing the implication of using a mobile cherry picker inside a Church and the potential for damaging the floor.

Figure 3. Carrying out work inside St Giles Cathedral, Edinburgh

FLOW DIAGRAM FOR TYPICAL ACCESS REQUIREMENTS SCENARIO 1 – LEAKING ROOF ON LISTED BARN

A leaking roof, caused by multiple missing slates and historical poor repairs is causing damage to the fabric of the building. A major roof refurbishment was embarked upon after grants had been obtained.

Is the task likely to occur every two years or less?

Yes

No

Consider a one-off solution for access

Try and avoid the use of ladders and roof-ladders

Consider (additional) access technology if needed for working at heights.

Traditional Scaffolding good for larger refurbishments or inspections but often obtrusive.

The weight of pan tiles needed for major roof refurbishment was considered too much for other access types and as the building would be out of use during the works the obtrusive nature of scaffolding was not an issue

Scaffolding installation to be certified before use and inspected at regular intervals during the works.

Mobile access platforms such as cherry pickers, scissor lifts, tower platforms are good for inspections, tests and minor repairs and in some instances more major repairs providing suitable access is available.

In this instance the land was not suitable around the barn to allow safe use of mobile platforms

Rope access techniques: Used to reach difficult locations at height.

All **rope access users should be IRATA Trained** at grade 2 and a supervisor should also be on site at all times with Grade 3 qualification. All equipment to be visually checked and certified before use

GENERAL GUIDELINES

- ENSURE WORKS AT HEIGHT ARE SUPERVISED AT ALL TIMES
- CONTRACTORS METHOD STATEMENTS AND RISK ASSESSMENTS MUST BE PROVIDED
- CLEAR AREA BELOW AND TO THE SIDES OF THE WORKS AND CORDON-OFF TO PREVENT PEOPLE GETTING HURT
- CONSIDER BEFORE WORKS BEGIN WATER, POWER AND MATERIALS PROVISIONS
- ALL LADDERS MUST BE TIED ON
- CONSIDER HOW RUBBISH AND DEBRIS WILL BE REMOVED TO GROUND LEVEL (SAFELY)

FLOW DIAGRAM FOR TYPICAL ACCESS REQUIREMENTS SCENARIO 2 – STRUCTURAL SURVEY ON 1960'S POST MODERN RECENTLY LISTED PUBLIC LIBRARY

Concern has risen that the building may be structurally unsound as concrete was not specified in the correct manner during construction. It has therefore been recommended that a structural inspection be undertaken.

Is the task likely to occur every two years or less?

Yes

No

Consider a one-off solution for access.

Try and avoid the use of ladders and roof-ladders

Consider (additional) access technology for working at heights.

Traditional Scaffolding good for larger refurbishments but often obtrusive if chosen.

Scaffolding installation to be certified before use and inspected at regular intervals during the works.

Mobile access platforms such as cherry pickers, scissor lifts, tower platforms good for inspections, tests and minor repairs and in some instances more major repairs if chosen.

A suitable 'spider' type cherry picker was hired to reach difficult elevations. This was supplemented by the use of rope access.

Rope access techniques: Can be used to reach difficult locations at heights. Must consider skills of qualified users for task to be undertaken and weight of tools/materials needed to perform task.

A rope access company was found that has Chartered Structural Engineers capable of surveying such a difficult to get at buildings. The extra expense of rope access compared to scaffolding has been off set against public convenience and image

Operators must have been on a **powered access training** or PMSA Certified training for mobile scaffolding tower.

All **rope access users should be IRATA Trained** at grade 2 and a supervisor should also be on site at all times with Grade 3 qualification. All equipment to be visually checked and certificated before use.

GENERAL GUIDELINES

- ENSURE WORKS AT HEIGHT ARE SUPERVISED AT ALL TIMES
- CONTRACTORS METHOD STATEMENTS AND RISK ASSESSMENTS MUST BE PROVIDED
- CLEAR AREA BELOW AND TO THE SIDES OF THE WORKS AND CORDON-OFF TO PREVENT PUBLIC GETTING HURT
- CONSIDER TYING-ON OF TOOLS
- CONSIDER BEFORE WORKS BEGIN POWER AND MATERIALS PROVISIONS
- ALL LADDERS MUST BE TIED ON

FLOW DIAGRAM FOR TYPICAL ACCESS REQUIREMENTS SCENARIO 3 – CLEANING GUTTERS/DRAINAGE CHANNELS OF CHURCH

The existing gutters and drainage channels were found to be blocked with leaves and required cleaning to prevent fabric damage to the church.

Is the maintenance/repair task likely to occur ever two years or less?

Yes

No

Consider the need for a (sensitive) modification to allow safe, regular access to height e.g. walkways etc.

Yes

Consider a one-off solution for access

Try and avoid the use of ladders and roof-ladders

Consider (additional) access technology if needed for working at heights.

Rope access techniques: Used to reach difficult locations at heights and where the mobile access platform could not reach or gain access.

Mobile access platforms such as cherry pickers, scissor lifts, tower platforms good for inspections, tests and minor repairs and in some instances more major repairs if chosen…

Traditional Scaffolding good for larger refurbishments but often obtrusive chosen. Scaffolding was not used in this instance.

A suitable 'spider' type cherry picker was hired to reach difficult gutters and gullies. The ground around the church was considered firm enough to take the weight of the device using boards to provide stability and spread the weight.

Operators must have a **powered access training** scheme or PMSA Certified training for mobile scaffolding tower.

All **rope access users should be IRATA Trained** at grade 2 and a supervisor should also be on site at all times with Grade 3 qualifications. All equipment to be visually checked and certified before use.

GENERAL GUIDELINES

- ENSURE WORKS AT HEIGHT ARE SUPERVISED AT ALL TIMES
- CONTRACTORS METHOD STATEMENTS AND RISK ASSESSMENTS MUST BE PROVIDED
- CLEAR AREA BELOW AND TO THE SIDES OF THE WORKS AND CORDON-OFF TO PREVENT PUBLIC GETTING HURT
- CONSIDER TYING-ON OF TOOLS
- CONSIDER BEFORE WORKS BEGIN WATER, POWER AND MATERIALS PROVISIONS
- ALL LADDERS MUST BE TIED ON
- CHECK OPERATORS HAVE A MEANS OF COMMUNICATION TO THE GROUND
- CONSIDER HOW RUBBISH AND DEBRIS WILL BE REMOVED TO GROUND LEVEL (SAFELY)

FLOW DIAGRAM FOR TYPICAL ACCESS REQUIREMENTS SCENARIO 4 – REPAIRS TO CHURCH TOWER & SPIRE

Re-pointing of the Tower Spire and replacement of damaged weather cock

Yes

No

Is the maintenance/repair task likely to occur ever two years or less?

Consider (additional) access technology if needed for working at heights.

Consider a one-off solution for access

Try and avoid the use of ladders and roof-ladders

Traditional Scaffolding Good for larger refurbishments but often obtrusive.

Mobile access platforms such as cherry pickers, scissor lifts, tower platforms good for inspections, tests and minor repairs and in some instances more major repairs if chosen.

Rope access techniques: Used to reach difficult locations at heights and where the mobile access platform could not reach or gain access.

A large mobile crane and working platform was used to replace the damaged weather cock. In this instance access was available from an adjacent road. Re-pointing of stonework was undertaken from scaffolding with working platforms fully enclosed in plastic sheet to protect the exposed stonework and to control dust and debris.

Operators must have a **powered access training** scheme or PMSA Certified training for mobile scaffolding tower.

All **rope access users should be IRATA Trained** at grade 2 and a supervisor should also be on site at all times with Grade 3 qualifications. All equipment to be visually checked and certified before use.

GENERAL GUIDELINES

- ENSURE WORKS AT HEIGHT ARE SUPERVISED AT ALL TIMES
- CONTRACTORS METHOD STATEMENTS AND RISK ASSESSMENTS MUST BE PROVIDED
- CLEAR AREA BELOW AND TO THE SIDES OF THE WORKS AND CORDON-OFF TO PREVENT PUBLIC GETTING HURT
- CONSIDER TYING-ON OF TOOLS
- CONSIDER BEFORE WORKS BEGIN WATER, POWER AND MATERIALS PROVISIONS
- ALL LADDERS MUST BE TIED ON
- CHECK OPERATORS HAVE A MEANS OF COMMUNICATION TO THE GROUND
- CONSIDER HOW RUBBISH AND DEBRIS WILL BE REMOVED TO GROUND LEVEL (SAFELY)

6.3 Adaptation of Existing Access Equipment

Our review has been limited in scope and therefore we have not been able to consider all possible scenarios or consulted with all interested parties. However, at this stage, it is not believed that presently there is a need for existing equipment to be modified. While some jobs are more difficult than others there is no one piece of equipment, perhaps with the exception of scaffolding, that would meet the access requirement of all projects. It is often the process and planning that are the key issues to providing a successful, safe and practical Access Strategy.

6.4 The Future

In general we believe that the type of access equipment available for historic buildings is fairly well established and is essentially that which is commercially available on the high street. A simple search of the Internet shows that many Parish Churches documenting work on their church involving the use of scaffolding, mobile cherry pickers and rope access all of which have proved successful for the application required.

However it may well be appropriate to hold a series of workshops across the country as a follow-up to this research. These could be held at strategic locations, perhaps in a village hall or similar venue to give an informal environment. People and organisations responsible for maintaining historic buildings would be invited to discuss the whole issue of Access to historic buildings in particular to raise awareness and to make them aware of the need to take a structured approach in a simple way that does not burden their already difficult task of maintaining the buildings. The workshops would need to be preceded by a more extensive review of how the issue of Access for Maintenance is dealt with across a range of organisations so that this information could be fed into the workshops.

7. CONCLUSIONS, RECOMMENDATIONS AND PROPOSALS FOR FURTHER WORK

1. It is expected that there will be an increased focus on inspection and maintenance of existing buildings, driven partly by regulatory intervention and in part by an increased awareness of and concern for the historic environment. Programmes such as BBC's 'Restoration', in Summer 2003, are likely to contribute to the latter. Sustainability may also contribute to a changed consideration of existing building stock, with a growing awareness of the potential of re-using existing construction.

2. A number of different technologies are currently being developed which will assist in the non-destructive investigation and monitoring of existing buildings.

3. It is essential to consider both tried and tested conservation techniques and innovative techniques. The latter may provide more cost effective means of protecting buildings than those that are more familiar. They may be able to solve problems that in previous centuries did not have a sympathetic solution.

4. Strategies are needed to ensure that remote monitoring is effective and does not produce information overload. Long-term consultancy appointments may be required to ensure that data is analysed and appropriate action identified over a period of time.

5. Information on historic buildings, their care and maintenance is currently available through a number of different sources: a central repository, ideally web-based, such as that set up by the Heritage Information Trust, could assist owners, particularly private domestic owners.

6. Local information should be provided by Local Authorities in a consistent form. The site operated by Derbyshire Historic Buildings Trust might be a good model for this.

7. A web-based advice service/forum might be a useful way forward, building on the model of the Civil Engineering History and Heritage Exchange Forum (CEHX) operated by the Institution of Civil Engineers and the discussion area on the Period Homes Policy insurance scheme site.

8. Although health and safety has been identified as a concern, and may affect the costs of such work, it is not believed that this is a fundamental factor in determining whether routine inspection and maintenance tasks are carried out. This is an issue to be explored further with the HSE.

8. Risk assessments should be carried out and documented when planning access for inspection and maintenance.

9. Consideration should be given to the provision of sensitive, permanent access routes where frequent access is required

10. Wider debate might be held on the issue of safe access to historic buildings for inspection and maintenance activities, possibly through the medium of a series of workshops.

11. Each building should have an owner's logbook providing information on the building, its cultural significance and original construction, and carrying a record of inspections and interventions, including details of the materials used and who did the work. Part of this is likely to be of more importance for older buildings using traditional materials and

construction methods, but the principle is of more general application. This should also contain information on inspections – frequency, what to look for etc

12. Routine inspection and maintenance is likely to be more efficient, and possibly also more effective, if carried out under a term contract.

13. Further investigation is recommended of the feasibility of providing an insurance-linked inspection and maintenance system, where discounts on premiums might be available where regular maintenance by 'approved' organisations is implemented.

14. An inspection service on the basis of Monumentenwacht in Europe, as trialled in the Bath Pilot organized by Maintain our Heritage, could provide the model for such contracts. A significant government subsidy would be required to bring subscriptions to a level where the scheme was seen as attractive.

15. The tax regime for work on historic buildings should be reviewed to encourage such work: in terms of preserving the built environment and encouraging the sustainable use of existing construction it is suggested that all maintenance work should be favourably taxed. As a separate issue, the threat to the zero rate for alterations to non-residential listed buildings posed by proposals from the European Commission needs to be removed.

16. The research has been focused on occupied buildings. Further work is required to determine how best to proceed with buildings on the Buildings at Risk register that are vacant and in an advanced state of decay. This would include recommendations for interim maintenance to keep such buildings watertight as a minimum.

17. Equally the work has covered *maintenance*, taken to include only minor repair work. It could be developed further to consider repairs in more detail.

18. The impact of climate change on historic buildings is a further area for research. The options here are more limited than for the case of either new buildings, where mitigation can be part of the original design, or more recent construction where the cultural significance is either less or not an issue.

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