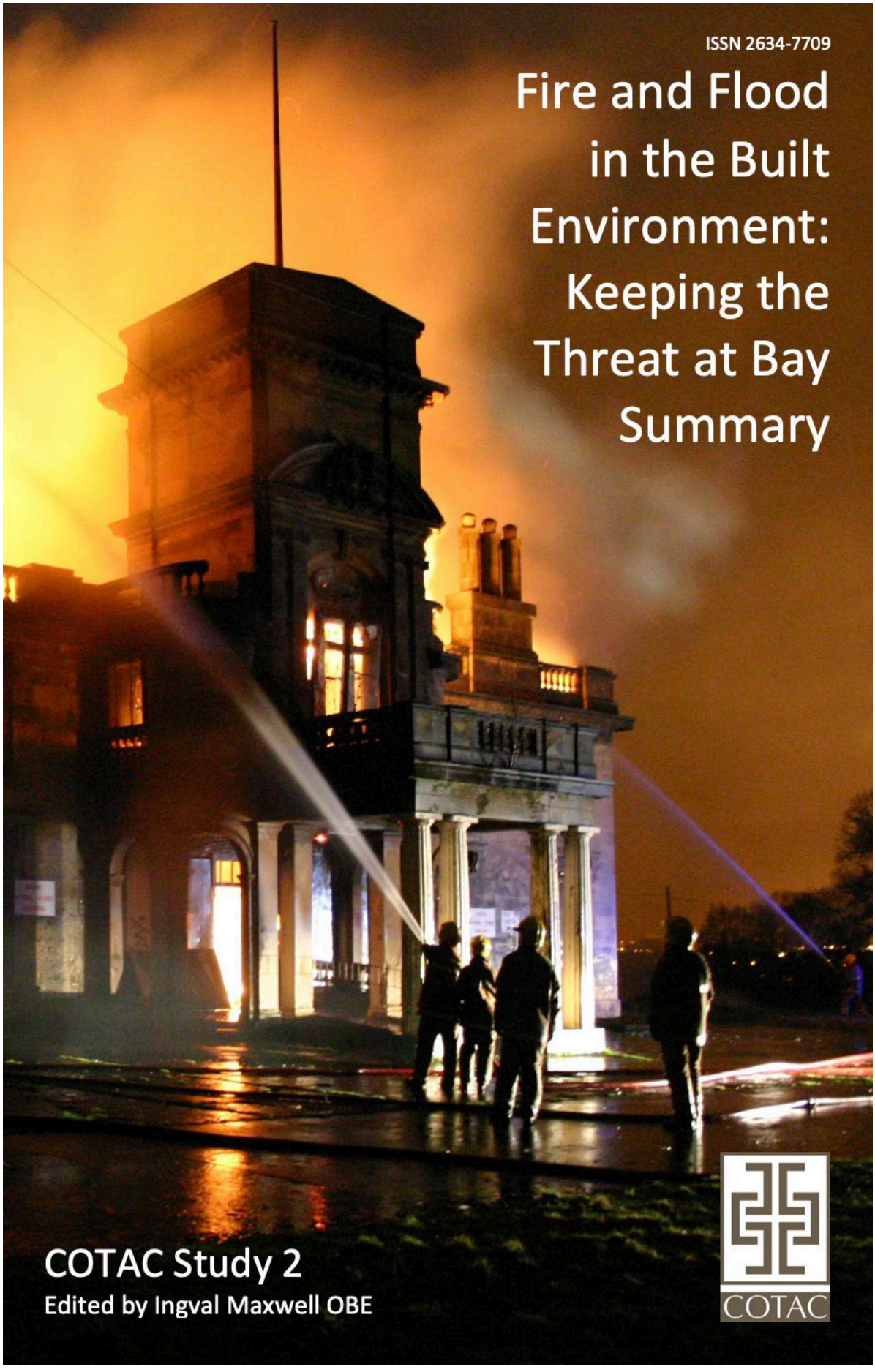
ISSN 2634-7709

Fire and Flood in the Built Environment: Keeping the Threat at Bay Summary



COTAC Study 2

Edited by Ingval Maxwell OBE

COTAC

Fire and Flood in the Built Environment: Keeping the Threat at Bay

On 20 November 2014 COTAC's Annual Conference entitled *"Fire and Flood in the Built Environment: Keeping the Threat at Bay"* was held in The Gallery at Alan Baxter and Associates, 75 Cowcross Street, London. The associated Reports build upon the information and advice that was freely offered by all speakers during the Conference programme. It aims to relate the presentations, and discussion outcomes, to emerging thoughts on creating a Building Information Modelling for Conservation (BIM4C) initiative by identifying what issues need to be considered in a Historic Building Information Modelling (HBIM) environment.

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Background

COTAC's Annual Conference: 2014

Following preliminary work by COTAC in 1992, the International Council on Monuments and Sites (ICOMOS) ratified a set of guidelines for training and education the following year. These provided a concise framework within which a wide range of professional, technological and vocational interests could be developed by enhancing their skills set in a better understanding the needs of the built heritage.

Although the 1993 ICOMOS approach was addressing an international need, COTAC has long held the view that the guidelines provided core direction that transgresses the requirements of all aspects of the conservation, repair and maintenance sector of the UK and Ireland's construction industry. Specifically, the breadth of what heritage assets need to be considered is set out in the Introduction, which states that:

> *The aim of this document is to promote the establishment of standards and guidelines for education and training in the conservation of monuments, groups of buildings ("ensembles") and sites defined as cultural heritage by the World Heritage Convention of 1972. They include historic buildings, historic areas and towns, archaeological sites, and the contents therein, as well as historic and cultural landscapes. Their conservation is now, and will continue to be a matter of urgency.*

Emphasising the need to respect 'authenticity' and the extensiveness of those who should be considered active participants, the guidelines further indicates that:

> *The object of conservation is to prolong the life of cultural heritage and, if possible, to clarify the artistic and historical messages therein without the loss of authenticity and meaning. Conservation is a cultural, artistic, technical and craft activity based on humanistic and scientific studies and systematic research. Conservation must respect the cultural context.*

With regard to the damaging consequences of fire and flood, it is suggested that:

> *Training in disaster preparedness and in methods of mitigating damage to cultural property, by strengthening and improving fire prevention and other security measures, should be included in courses.*

In COTAC's remit, its understandingconservation.org on-line learning website, based on the ICOMOS guidelines, is essentially a structured suit of conservation CPD support units. With a view of enhancing the site in 'disaster preparedness' COTAC planned and held the fourth of its current annual conference series (2014) on the impact of fire and flood in the built heritage.

In setting the scene, there has been no shortage of the number of disastrous situations that have emerged to threaten the integrity of the built historic environment. Significant buildings have been regularly lost to the effects of fire due to a variety of causes, and the impact of climate change seems to be directly related to the increasing number of flooding incidents that have seriously affected both national and international heritage assets.

With regard to fire, the declared aim of UK building codes is for occupant safety, not the built fabric or its contents. Any development from such a prescriptive approach toward an alternative, based on a better understanding of potential threats and their impacts, needs to be encouraged. Building upon recent work, the conference examined principles and case histories to help designers and users benefit from lessons learnt in consequence of dealing with such experiences. It also aimed to combine resultant practices and evolving knowledge to assist in developing associated thoughts in the application of BIM for Conservation (BIM4C).

Acknowledgements
Thanks are due to the following speakers for the information that was offered through their various presentations which underpins this report:

Ingval Maxwell, COST Action C17 Chair:
COST ACTION C17: Fire Loss to Historic Buildings
Johanna Berntsson-Arje, Head of Heritage, NW Area FSR, London Fire Brigade:
Fire Safety in Heritage Buildings: Providing guidance within the context of the built heritage
David Mitchell and Chris McGregor, Historic Scotland*:*
The Glasgow School of Art Fire: Lessons learnt
Toby McCorry, Chartered Fire Engineer, TOGA Fire:
Building Regulations: Sympathetic Interventions in the Care of Heritage Buildings
Stewart Kidd, Loss Prevention Consultancy Ltd:
Selection of Fire Suppression Systems for Cultural Resources
David Pickles, Senior Architect, National Planning and Conservation Department, English Heritage:
Flooding and Historic Buildings
Henry Russell, OBE, Chair Gloucester Diocesan Advisory Committee for the Care of Churches:
Flooding: Tirley Church Case Study Lessons Learnt
Katy Lithgow, National Trust Head Conservator:
Flood and Fire: The National Trust Experience
Stephen Hodgson, CEO, Property Care Association:
Code of Practice for the Recovery of Flood Damaged Buildings

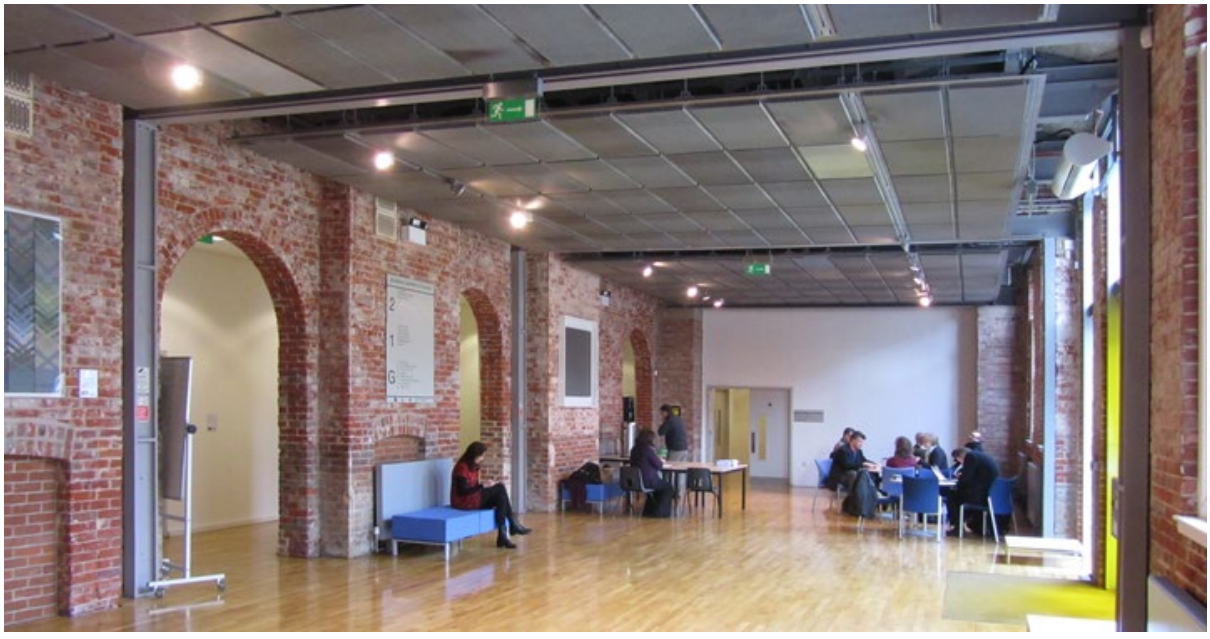
Thanks are also due to Alan Baxter Associates for providing the venue, the Conference Sponsors: Historic Scotland; British Automatic Fire Sprinkler Association; Institute of Historic Building Conservation; Henley Business School, University of Reading; Building Crafts College; and to Graham Lee and Sophie Harman of COTAC, upon whose copious notes of the conference, this report is also founded.

The Challenges

A nation's patrimony is an essential component of its identity, where the built heritage and other cultural resources, such as building contents, are key parts. Whether by accident or design, the destruction of cultural resources might be considered a 'crime', which, if left unaddressed, future carers could well be critical of how we currently deal with the issues

Traditionally constructed and historic buildings derive their value from their period, context, method of construction and fabric, and any changes to these can significantly negate their value. Whilst fire and water damaged or destroyed buildings can be reconstructed, and their contents replaced, their quality, authenticity and significance is either significantly reduced or lost entirely. In addition, empty and 'unloved' buildings are also at high risk from intrusion, vandalism and the weather, and experience suggests that, eventually, most are 'burnt to destruction', fire being a most effective device to change values and authenticity.

From a conservation perspective, any loss of authenticity can be as serious as destruction, and, although adaptive reconstruction of a damaged or neglected building may be undesirable, finding a new use for an old building may be its only hope for continuing survival. But, adaptive reconstruction generally means compliance with modern building standards and legislation. However, sympathetic implementation of sensible improvements, undertaken in accordance with a set of peer-reviewed protocols, can serve to provide a building that it not only fit for purpose in respect of legislation compliance but also goes some way towards retaining its value as a cultural resource. 'Use it or lose it' in this context is a driver.



The law mandates for the protection of people, and there is little obligation in it to protect property. It is therefore critical to consider the integrated needs of the building and contents, as well as occupants. A structured management approach to the protection of traditional buildings is a powerful mechanism to the holistic retention of the heritage, and such an approach ought to feature in any HBIM data considerations.

Disaster Planning and its Implementation for BIM4Conservation

The government strategy paper published in March 2011 defined four maturity levels of BIM, based not only on the level of technology used to design a building, but the level of collaboration within the process. These are:

- *Level 0 Unmanaged 2D CAD, with data exchanged in paper or electronic paper form.*
- *Level 1 Managed CAD in 2D or 3D format, with data shared via a collaborative tool to provide a common data environment (CDE) with a standardised approach to data structure and format. No integration of commercial data.*
- *Level 2 Managed 3D environment where each discipline creates its own model, with information electronically shared in a CDE. Commercial data is integrated into BIM by proprietary interface or bespoke software. Level 2 BIM may use 4D construction sequencing and/or 5D cost information. This level of BIM is the target for 2016.*
- *Level 3 Fully integrated, collaborative process with models shared between the project team on a web-enabled BIM hub.*

By 2016 it will be compulsory for fully collaborative BIM processes to be used on UK governmental projects greater than £5m in value (by 2017 in Scotland). Consequently, the wider industry is adopting BIM to more accurately predict and ensure performance throughout the life of a building as set out below in the PAS 1192-3:2014 Figure 3 [incorporating the 2008 Bew-Richards Wedge Diagram]. However, to date, the approach has been virtually entirely new-build orientated. Much awareness therefore needs to be initiated with regard to the implications of BIM on the existing built heritage.

The crucial difference between traditional 3D modelling and level 2 BIM is data. BIM software can differentiate between different types of element and store a great deal of information about their real-world properties and behaviour. The key to BIM is therefore not the visual model, but the database of information that sits behind it.

But, significant other differences in approach and adopted methodology need to be bourn in mind.

The Introduction to '*BS7913: 2013 Guide to the conservation of historic buildings'* states:

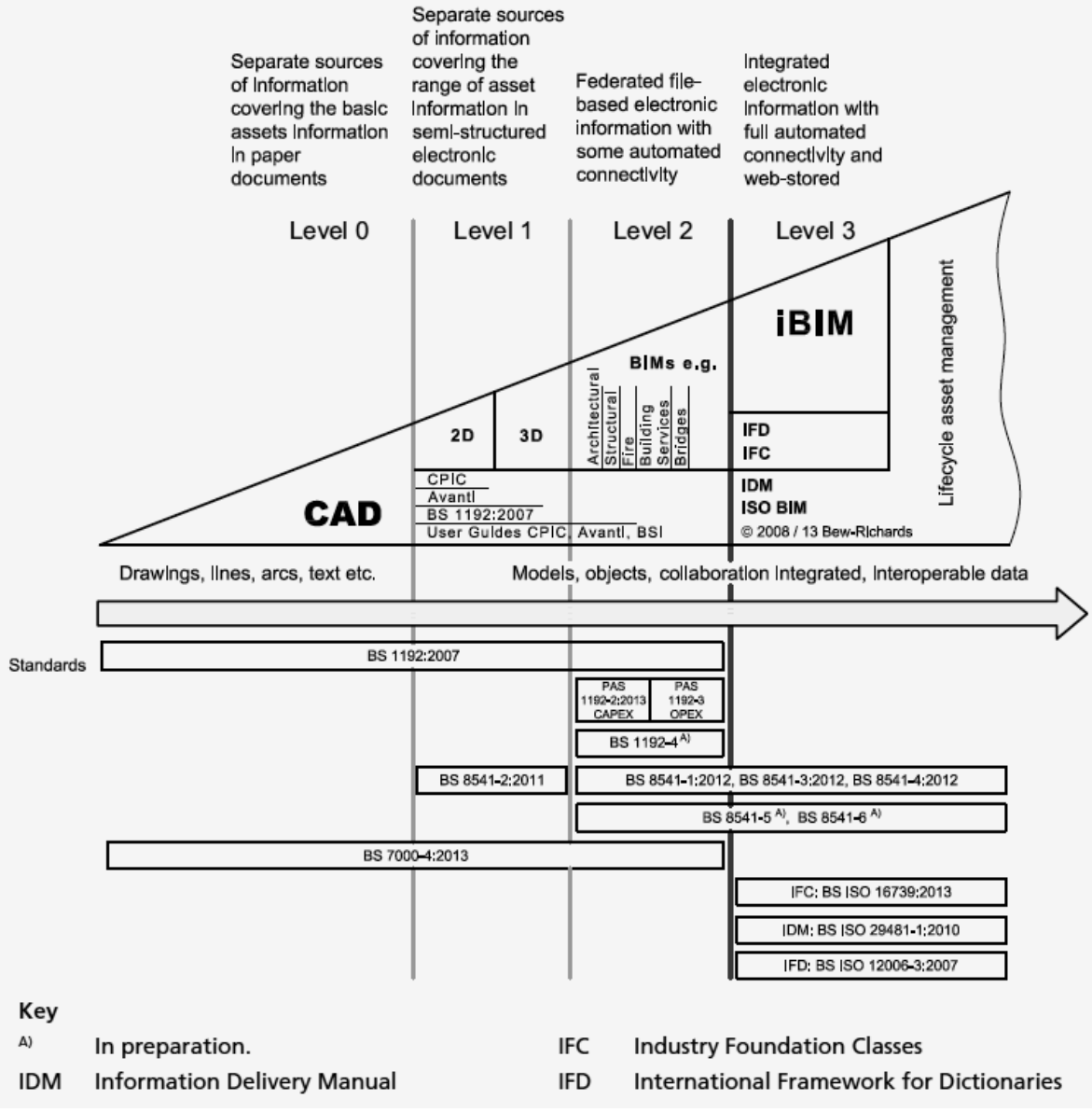
> *The immediate objective of building conservation is to secure the protection of built heritage, in the long-term interest of society. Issues relating to building conservation are often complex and interwoven. The conservation of historic buildings requires judgement based on an understanding of principles informed by experience and knowledge to be exercised when decisions are made.*

Importantly, *BS7913* goes on to indicate that:

> *British Standards that are applicable to newer buildings might be inappropriate. The decision to conserve historic buildings can be justified on social, cultural, economic and/or environmental grounds, and usually a combination of these. Conflicting pressures often need to be balanced to assist good decision-making. Good conservation depends on a sound research evidence base and the use of competent advisors and contractors*

PAS 1192-3:2014

Figure 3 – BIM maturity levels extended to asset information management



Key

A) In preparation.

IDM Information Delivery Manual

IFC Industry Foundation Classes

IFD International Framework for Dictionaries

Following the 2013 COTAC Conference *'A Digital Future for Traditional Buildings: Practical Applications for Survey and Management'*, a related report was produced in April 2014 that identified a number of issues that a Historic Building Information Modelling (HBIM) initiative needed to take into account with regard to the existing built heritage. In the following table of 17 points, 7 of them have a direct bearing on what the consequences of fire and flood might amount to with regard to the future wellbeing of that heritage, and how consequential remedial work should be affected.

HBIM Approach Key Elements (COTAC: April 2014 Report)

*Within an HBIM approach, **in addition to holding surveyed material**, data management systems for historic and traditionally built structures might include information on key elements such as:*

1. Significance and Value;
2. Legislative parameters;
3. Existing archival records;
4. Historic evolution and developments;
5. Researched findings;
6. Architectural styles and structural details;
7. Location and setting; Flood
8. Environmental concerns; Flood
9. Functional uses; Fire
10. Material performance criteria and degradation details; Fire + Flood
11. Material sources and supplies; Fire + Flood
12. Vocational skill requirements;
13. Specialist requirements; Fire + Flood
14. Maintenance records;
15. Servicing requirements;
16. Ownership;
17. Other pertinent matters e.g. Disaster preparedness Fire + Flood

The 2014 COTAC Conference took this approach a stage further through offering a series of well-informed presentations in a three-part day, initially looking at the Fire question, followed by Flood, and culminating in discussion. This follow-up report aims to build on the key aspects of the conference process in a manner that fits within the overall predetermined HBIM Approach of Key Elements suggested in the 2013 COTAC Conference Report *'Integrating Digital Technologies in Support of Building Information Modelling: BIM4Conservation (HBIM)' of April 2014.*

In doing so, it takes the theme of disaster preparedness, as being a critical element, where knowledge of associated data is essential. Building upon the information presented in the series of excellent presentations during the Conference, and associated research investigations; a number of key HBIM considerations can be highlit, to better inform on conservation requirements.

Fire incidents can easily start.....

and can continue unabated even if there is sufficient water to hand

Informing Conservation

The practical requirement of undertaking effective and appropriate conservation work in the conservation, repair and maintenance (CRM) sector requires detailed information on:

- Accurate survey material
- Understanding the construction
- Condition monitoring
- Deviation mapping
- Integrated approach to:
    - Structural movement
    - Voids and surface disruption
    - Water penetration
    - Mechanical and Electrical malfunctions
- Risk Monitoring
- Post-disaster recording
- Physical replication

Within this grouping of issues, taking an integrated approach is critical. In doing so, an awareness of understanding a broader approach and a wider range of factors needs to be appreciated with regard to specific threats that could emerge. With regard to fire these will inevitably focus on building-specific matters, whilst the effects of flooding are more likely to emerge in a geospatial context.

Whilst each is equally devastating, there are differences in the degrees of concern and scale of the issues that need to be addressed within a HBIM context. In outline, these datasets might be summarised in a series of what might be considered as 'Unique Challenges'.

Water can also be unrelenting: Cockermouth, Cumbria (2009) © National Trust

Unique Challenges: Summary Considerations

Fire - Building Specific Data

Requiring the combination of fuel, oxygen and an ignition source, an awareness of the risk of a fire propagating should be considered within an HBIM context.

Material performance criteria and degradation
Material sources and supplies
Specialist requirements:

- Materials and source identification
- Function vulnerability assessment
- Determine risks and potential threats
- Retrofitting services
- Management preparedness
- Post-incident mitigation support

Flood - Contextual Geospatial Data

Within an HBIM context water might be considered as the primary vehicle involved in creating varying degrees of damage to a historic or traditionally constructed building.

Location and Setting:

- Environmental Concerns
- Aggregated hazard identification
- Vulnerability assessment
- Determine risk levels and potential/frequency of threats
- Historic incident data
- Preparedness

Flood - Building Specific Data

- Immediate mitigation
- Response and recovery

To ensure a consistency in approach, and more effective integration, as many as possible of these data sets should be GIS related. Not only will this assist in better decision-making, cost savings and greater efficiencies, improved communications through having the data managed geo-spatially will greatly increase the ability to understand the needs more fully when prescribing appropriate actions, particularly in flood situations.

The associated COTAC Reports, *'Part 1: Fire'* and *'Part 2: Flood'* considers these matters in greater detail.

Annex A

Fire and Flood in the Built Environment: Keeping the Threat at Bay

A COTAC Conference, Thursday 20 November 2014, London

Presentation Abstracts

COST Action C17: Fire Loss to Historic Buildings

Ingval Maxwell, Chairman COST Action C17

In addition to the existing serious levels of loss to life and contents, the number, authenticity and quality of European historic buildings is being steadily eroded through the effects of fire. In 1993 this loss was recognised by the Council of Europe Committee of Ministers, who in the *Protection of the Architectural Heritage Against Natural Disasters, Recommendation No R(93)9* recommended that *'governments of the Member States adopt all legislative, administrative, financial, educational and other appropriate measures'* with the aim of reducing the levels of risk. Then, as now, there was a need to balance technological and management solutions in achieving this aim. The full extent of the physical loss by fire to Europe's built heritage is still unknown, although some suspect it to be as high as one important historic building each day.

In December 2002 the *European Science Foundation Co-operation in Science and Technology Urban Heritage* programme *COST Action C17 'Built Heritage: Fire Loss to Historic Buildings'* initiative was established. Its four-year programme involved a wide range of disciplines and professions from 20 countries with corresponding member in the Baltic States, USA and Russia. Its main objective was the definition at a European level of the degree of loss to the built heritage to the effects of fire, and for the proposal of remedial actions and recommendations to combat such loss, using minimal invasive techniques. The programme was managed through a series of 12 working meetings, and a referenced series of 147 original papers were presented and compiled. By 2008 the Action had resulted in the subsequent publication of 18 related reports on the topic. Ten of these were supported or published by Historic Scotland, four by Riksantikvaren, Norway, and one each by authorities in Bulgaria, Slovenia, Switzerland and, subsequently, Italy.

Fire Safety in Heritage Buildings: Providing Guidance in the context of the Built Heritage

Johanna Berntsson-Arje, Area Fire Safety Manager and Head of Heritage
London Fire Brigade

The built heritage and buildings containing valuable collections presents a range of specific fire risks and hazards. The Fire Safety Heritage group in the London Fire Brigade have created two Fire Safety Guidance Notes for best practice how to manage these risks and hazards. The Guidance Notes are aimed towards people who manage the fire safety in listed buildings, and/or buildings with valuable collections, and cover a range of topics including salvage and damage control, fire risk assessment, liaison with the fire service and how to tackle common fire risks in historic buildings.

This presentation will provide an overview of what is included in the Guidance Notes as well as providing information of the work that London Fire Brigade do to try and prevent and reduce the impact of fires in historic buildings.

Glasgow School of Art Fire: Lessons Learnt

Dr. David Mitchell, Director of Conservation, Historic Scotland
Chris McGregor, Head of Major Projects, Historic Scotland

The fire at Glasgow School of Art in May 2014 prompted a highly emotive response from the heritage sector and most particularly the broader public. Dr David Mitchell and Chris McGregor of Historic Scotland were on site in the immediate aftermath to assist Glasgow School of Art. They will talk through the challenges, events and successes of the week immediately following the fire.

Building Regulations: Sympathetic Interventions in the Care of Heritage Buildings

Toby McCorry, TOGA Fire

Refurbishment or re-purposing of our heritage buildings typically imposes the requirements of the Building Regulations to address a 'material alteration' or ' change of use'. Often, the fire safety provisions required to meet current Building Regulations (Part B) and the recommendations of contemporary life safety guidance or Regulatory bodies cannot be achieved without significant intervention or upgrades to the building fabric. This can be at great detriment to the historic and important features of our heritage buildings. Can a resolution be sought that marries a sympathetic and sensitive intervention philosophy with the rigours of modern fire life safety requirements?

The answer is thoughtful and pragmatic fire safety design advice supported by performance based engineering. If applied throughout a project, this approach will play a key role in achieving and demonstrating an appropriate and robust level of life safety whilst preserving the fabric, character and integrity of the building. Though case studies, the legislative requirements of the Building Regulations are explored and examples of the application of fire safety design advice and performance based engineering in heritage buildings will be discussed, together with key lessons learnt.

Selection of Fire Suppression Systems for Cultural Resources

Stewart Kidd, Loss Prevention Consultancy Ltd

Fire can cause the total destruction of a building and its contents in only a few hours; areas not directly damaged by flame or heat may be damaged by smoke, dirt and falling debris or by the huge volumes of water which may be used in fighting the fire. One threat, which cannot be over-stressed, is the potential loss of authenticity - which is, after all, the quality from which the importance of the cultural heritage flows.

Following pioneering work in Scotland and the US there is now a greater understanding of the role that modern fire suppression systems can play in mitigating the risks and extent of fire loss in historic and heritage buildings. The proper selection and installation of fire protection can also play significant part in the reduction in the loss of heritage fabric or visual and aesthetic impact which is sometimes called for in adaptive reconstruction as a means of complying with contemporary building standards and fire regulations.

This presentation reviews the available types of fire suppression equipment and by the use of case studies suggests the optimum solutions that can be achieved to satisfy all parties.

Flooding and Historic Buildings

David Pickles, Senior Architect, English Heritage

We know the risk of flooding is likely to increase as a result of a changing climate and increased urbanisation. Many properties which are at a high risk are historic buildings of traditional construction that need particular care if damage is to be minimised from inappropriate property protection measures, the flooding event itself, and subsequent recovery and repair work.

Establishing the flood risk and methods to mitigate damage are emerging areas of expertise. Government policy is increasingly looking to the use of property level protection to emphasise individual and community responsibility, alongside engineered flood alleviation schemes.

The talk will focus on the three key areas of resilience, recovery and repair in respect of the risks and vulnerabilities for historic buildings and their contents. It will also discuss areas where a better evidence base is needed to inform future guidance and best practice advice.

Flooding: Tirley Church Case Study, Lessons Learnt

Henry Russell, Chair, Gloucester Diocesan Advisory Committee for the Care of Churches

St Michael and All Angels Church sits on the edge of the village of Tirley. It was severely affected by the 2007 floods in Gloucestershire and received national attention when it was featured on the front page of newspapers, pictured in the midst of the surrounding flood-waters. After much work St Michael and All Angels has been restored, with a new organ gallery especially designed with stainless steel columns, and an open worship space.

Flooding and the National Trust Experience

Katy Lithgow, National Trust Head Conservator

Over the past three decades, flooding impacts on historic properties in the care of the National Trust seem to be happening more and more often. Whether due to severe rainfall, tidal surges, or the consequences of freezing weather, these events expose damage to building structures and weaknesses in their design in particular lack of capacity. This presentation will reflect on flooding impacts, relate these to the conservator's professional framework, and consider the Trust's response at both an interiors, building and landscape level.

Code of Practice for the Recovery of Flood Damaged Buildings

Stephen Hodgson, CEO Property Care Association

Stephen Hodgson will present a summary of the PCA Code of Practice for the Recovery of Flood Damaged Buildings. The code encourages focus on the building, its characteristics, underlying condition, and how best to affect recovery. Sections of the document describe how to approach an initial assessment, drying out, and the importance of a considered approach to refit. Stephen will talk through how and why the PCA created the code, why it differs from other guides to flood recovery, and the current thoughts of the Property Care Association in respect to flood recovery, resilience and resistance.

Annex B

Fire and Flood in the Built Environment: Keeping the Threat at Bay
Part 1: Fire

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COTAC, the 'Council on Training in Architectural Conservation'
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Building Regulations and Fire Risk Assessments
Advice and Support from the Fire and rescue Services
Fire Safety Engineering Guidance in the Context of Built Heritage
The Selection of Fire Suppression Systems
Automatic Suppression
Gas Systems
Powder Systems
Air Inerting (Hypoxic) Systems
Foam
Automatic Water Sprinkler Systems
Water Mist
Pipework Choices
Water Storage Tanks
Fire Incident-related HBIM Documentation
Fire Safety Handbook
Fire Safety Log Book
Salvage Plans
Salvage Equipment
Learning from the Glasgow School of Art (2014) and Other Post Disaster Recovery Incidents
Conclusions

References: Standards and Guides

- BS 9991:2011 Fire safety in the design, management and use of residential buildings. Code of Practice
- BS 9999:2008 Code of Practice for fire safety in the design, management and use of buildings
- Integrated risk management planning guidance for fire and rescue authorities: protection of heritage buildings and structures: August 2018: DCLG: ISBN 9781409804017
- Historic Scotland: Guide for Practitioner's No 7: *Fire Safety Management in Traditional Buildings*
- NFPA 909:2013 Code for the Protection of Cultural Resource Properties – Museums, Libraries, and Places of Worship

Annex C

Fire and Flood in the Built Environment: Keeping the Threat at Bay
Part 2: Flood

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COTAC, the 'Council on Training in Architectural Conservation'
Acknowledgements
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Climate Change and World Heritage: UNESCO Discussion 2005
Global Climate Change Impact on Built Heritage and Cultural Landscapes: 2007
Vulnerability of Cultural Heritage to Climate Change: Report 2008
A Climate Change Action Plan for Historic Scotland: 2012 -2017
Climate for Culture: 2014
Pitt Review: Learning the Lessons from the 2007 Floods: 2008
Mapping
EUROSION database
Accelerated Coastal Erosion Mapping Risk
Flood Maps and Planning
The Scale of Properties at Risk of Flooding
Working with Natural Processes
Flash Flooding
Making Space for Water Defences
Advisory Publications
Flooding and Historic Buildings 2nd Edition: 2010
Guidance and Standards for Drying Flood Damaged Buildings: 2010
INFORM: Flood Damage to Traditional Buildings: 2014
The Need for Resilience
Resilience at Community Level
Resilience at Property Level
Post Flood-assessment and Recovery Approach
Understanding the Building
Property Care Association (PCA) Code of Practice 'For the Recovery of Flood Damaged Buildings' 2013
BRE Digest 245 'Rising damp in walls: diagnosis and treatment'
Drying the Building
Drying out
Certificate of Drying
Remedial Work
St Michael's Church, Tirley, Gloucestershire
Inadvertent or Inappropriate Damage During Recovery Work
It Will Happen Again
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