

ISSN 2753-9083

How Does a Building Work? Unit 3 Learning Handbook

COTAC Insight 1



COTAC Insight 1: The Need to Appreciate the Built Heritage

Unit 3 Learning Handbook: How Does a Building Work?

Council on Training in Architectural Conservation (COTAC)

COTAC originated in 1959 in response to the need for training resources for practitioners in the repair and conservation of historic churches. Since its inception the Charity has consistently worked to lift standards across the UK's conservation, repair and maintenance (CRM) sector. This has involved working in partnership with national agencies, professional and standard setting bodies, educational establishments and vocational training interests. Whilst every care has been taken in the preparation of the information in this Learning Handbook, COTAC and its researchers specifically exclude any liability for errors, omissions or otherwise arising from its content. The Unit images are primarily sourced from both authors personal collections. A few historic and archival resources incorporated as fair-use educational material are acknowledged where their source has been readily identified.

Insight 1 Unit 3 Learning Handbook: How Does a Building Work?

A building has to withstand a lot of physical abuse during its lifetime of use and through poor or minimal maintenance. The effects of weather can also play a large part in the destruction of its architecture and detail by breaking down the material from which it is built. This generates a need to understand how it was first built alongside what has happened to it since and resulting from various and progressive changes.

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This COTAC Insight 1 Unit 3 Learning Handbook was researched and written as a joint exercise by Barry J. Bridgwood and Ingal Maxwell in support of COTAC's stated Educational Aims and Objectives.

ISSN 2753-9083

COTAC, London: February 2021

Revised: October 2021

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COTAC Insight 1: The Need to Appreciate the Built Heritage

Unit 3 Learning Handbook: How Does a Building Work?

[Link 1: Understanding Conservation Unit 3: Investigation, Materials, Construction Methods and Technology](#)

A building has to withstand much punishment during its lifetime and the effects of weather can also play a part in its destruction by breaking down the materials from which it is built. This requires an appreciation of what has happened since it was built. This Insight Unit 3 might usefully be read in conjunction with www.understandingconservation.org Unit 3.



Understanding Conservation

Unit 3: Investigation, materials, construction methods and technology:

Unit 3 of www.understandingconservation.org focuses on informing the practical and pragmatic substance of conservation work by integrating a detailed consideration across 8 of the 14 ICOMOS Education and Training Guidelines

[Link 2: Unit 3 Image Set Thumbnails: \(The full Image Set is incorporated as part of Unit 6\)](#)



Insight 1 Unit 3 Image set show some details from heritage buildings and their construction, questioning how they might be repaired and maintained for the benefit of this and future generations. But all of them need to be cared for in the correct manner because, to not do so, would undermine their value and worth. The full Image Set is incorporated as part of **Unit 6: Seeing What You are Looking At** (Image Set © Ingval Maxwell)

Unit 3: Thumbnail Image Set: Brief Captions (See Full Captions in Unit 6.3)

1. An integrated building complex - how Does a Building Work?
2. Limitations of materials used – loss through wear and tear
3. Investigative archaeology
4. Utility works and inserting services
5. Effects of pollution
6. Adjacent materials adversely affecting each other
7. Natural deterioration and breakdown of surfaces
8. Natural faults in materials
9. Structural movement
10. Neglect
11. Maintenance failures
12. Effects of damp
13. Nature taking over - encouraged growth
14. Poor previous repair approaches
15. Mechanical damage – such as poor cleaning techniques
16. Signage and service cabling
17. Poor workmanship
18. Changes in appearance from adopting the work approach
19. Disregard for original features
20. Application of winter surface salt treatments
21. Different personal choices on what is relevant
22. Simple failure – risky resolve
23. Inappropriate design and detailing
24. Structural redundancy

3.1 Introduction

Buildings of any age suffer from a variety of **wear inducing problems**. They are subject to **weather** and the effects of **climate change**, they are worn away by **constant use**, they simply deteriorate because some of the materials used in their construction cannot withstand the **wear and tear of everyday use**; they may also have been subject to **neglect and absence of maintenance**. Sometimes different materials in contact with each other when used in heritage buildings react in a way that causes unduly rapid deterioration and decay. The way that they were built may also be adding to deterioration problems: Historic and even more modern buildings construction may have adopted methods and materials that were in themselves detrimental, either through original construction or retrofit work.

Simply stated, heritage structures are not new and, like humans, age and as they age, things start to work less well than when they were new and young. **It is the role of conservation to try to slow this rate of deterioration by appropriate and sympathetic conversion/re-use, maintenance and repair**. This, so that the story told by our built heritage can be read and appreciated, now and in the future for the various types of **Worth** that the Heritage contains. **Worth** can be based on reasons that are social, historic, spiritual and emotional, aesthetic, architectural and, overall where its value is centred on a community whether that is local, national or even international.



Before image © Anthony Williams, and after work to repair and convert a derelict former pub into a refurbished hotel

The most important aspect of conservation based repair, maintenance and re-use is clarity of understanding via research, into why the building is important, how it is important, how it is deteriorating and how it might be repaired or revitalised; this must be done before any work is undertaken to change, conserve and protect it. Such research to understand will involve examination of the **building itself** alongside detailed study of **documents and records of the building's history and development**. It will also analyse how the building has been built, modified and changed over time. This to fully understand what has happened to it, where change might have harmed it (usually for a variety of reasons and causes) and then how best

to repair damage in order to conserve it for future use: Or find an alternative re-use that can be accommodated by the building without damage to its **Worth**.

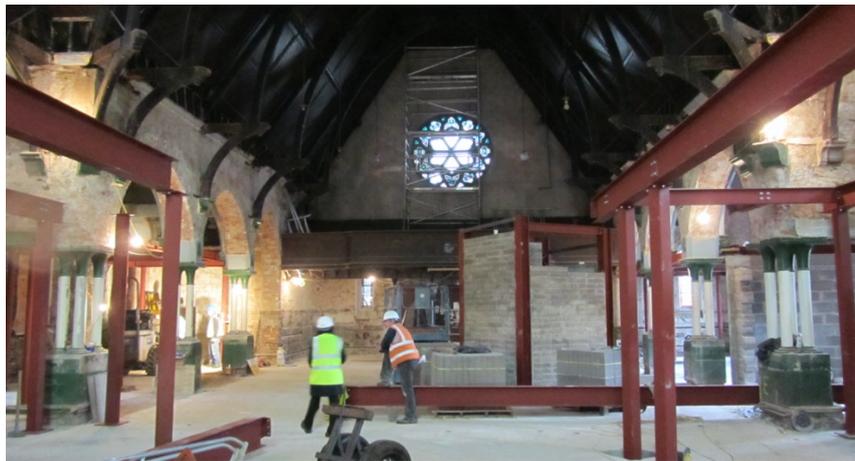
The **object** of built environment conservation being *to prolong the life of historic buildings and to clarify their story without loss of authenticity and record*. Perhaps the *best rule* to understand about conservation is *there are no hard and fast rules, only good guidance about how work needs to be undertaken in order to protect and preserve Worth*.

3.2 What Needs to be Looked For?

The process of investigation and study of a building, its records and documents is the very first step to gain understanding about its **Worth** both to its local society and the wider world. Without this knowledge it is difficult to plan for decisions that must be made to return a damaged or deteriorating structure to a state that reflects its **Worth**. Once a plan or strategy has been devised to return it to a useable state it might also be necessary to plan for its conversion to an appropriate new use - not necessarily one that reflects the original. The important word contained in the previous sentence is *appropriate*. Not all conservation projects can return a building to an original use. It might be necessary to plan for an alternative use that does not damage **Worth**. You might consider that changing the use of a redundant or abandoned church or chapel to a night club/disc/pub is wrong: a new use should ideally reflect and respect what previously existed. But, remember, if a structure is left unattended without carrying out day-to-day repairs and maintenance the effects of nature and decay will eventually take over to its greater detriment.



Temporary roof repairs may be insufficient to arrest decay



Adopting a 'plug-in, plug-out' approach with a new structure to effect a change of use can allow the original intent and worth of the building to still be recognised

What the previous paragraph emphasises is not specifically to do with a need to return to original values, but to understand the social and historic **Worth** contained within a building or structure, alongside determining what is important when considering change of use. The peace and tranquillity of a place of worship is not reflected by a bar or disco. We need to

properly understand what **Worth** is embedded in a building and how it might accommodate a new use without damage to **Worth**.

So how do we go about gaining this clarity or knowledge about a building or its history – it is contained in a detailed investigation of the history of the building via written records, paintings, photographs (where these exist), contemporary literature and writings about the society that might have existed and had an influence on its creation and use: And, of course, the building itself.

The thing that allows us to make suitable decisions about how we conserve a building is clarity about its origins and history.

Alongside any documentary trawl, runs a parallel study of the building itself – its design, its use of materials, its pattern of deterioration and decay and how best to remedy this deterioration. The way that we can achieve this is via a composite of methods including detailed survey/analysis of the building, its structure and use of materials using minimally invasive investigative methods to ensure minimum damage. Modern technology helps to achieve this via the use of electronic measures that reveal hidden fabric and structure without having to remove or destroy historic covering material. Perhaps the simplest of investigation tools is to look at the building and visually assess how it is deteriorating, how it is wearing, decaying or simply what it is in need of to protect its embedded **Worth**.

But in addition to these simple observations there must also be a sound ability of the observer to know why all these things are happening; are the faults with its use of materials, its construction methods, its wear pattern, or other hidden faults with its basic structural method, frame or foundations. Or is it down to a combination of all these factors of decay plus others that are adding to deterioration – this being a very common complex pattern of issues facing whomsoever is dealing with conservation work requiring planning to achieve a satisfactory solution with minimum damage to **Worth**. Part of the work will be to identify the source of specific or on-going damage caused by dampness, structural failure, material deterioration, neglect and general wear and tear.

The three main causes of defects in historic buildings are identified as follows:

- ***Dampness*** can have its source in groundwater, leaks, rainwater (usually associated with poor rainwater dispersal via gutters and downpipes) and condensation.
- ***Movement*** can be caused by changes in moisture levels and temperature differences resulting in parts of a building moving differently one to another or chemical reaction; or failing foundations including subsidence from geological forces or decaying mine workings.

- **Damage caused by invading insects or fungal attack, corrosion or chemical interactions:** all of which might be labelled as forms of biological or, chemical attack.
- **But there are other causes such as vandalism, graffiti, theft and general neglect.**



Various effects of damage

The questions then that need to be asked are:

- **What is causing decay and deterioration what is the source and can it be rectified?**
- **What is the cause of structural movement and can it be corrected?**
- **What is the cause of rot and insect attack and can it be overcome?**

In all of this initial investigation it is important to keep an open mind about these issues as things might need to change as the project progresses and understanding become clear.

Throughout any initial observation or investigation to establish condition some simple questions need to be answered and can be summed up as follows:

- What is the overall **Worth** of the building, based on social, spiritual, historical, aesthetic and architectural reasons?
- When was it built, how has it changed over time, why has it changed and what caused it to change?
- Why was it built in the first place and who wanted it built?
- Who designed it and who built it?
- How was it built what was it built with?
- Which parts are original and which alterations?
- How has our use and value of it changed over time?
- How has its immediate setting and location changed and how has this affected the building and its **Worth**?

- Are previous repairs and modifications damaging original work?
- How is the building deteriorating and how is this affecting **Worth**?
- What is its structural condition and is it stable?

Answers to these basic questions and appraisals will start to form an idea about how to tackle repair, maintenance or change of use and, additionally, provide the beginnings of a structured approach to managing it and its future.

3.3 What Materials Might be used for Buildings?

Buildings were/are constructed from a complex variety of materials: from early mud and earth buildings, probably under a form of thatched roofing, through timber frame with plastered panel infilling under a thatched or tiled roof, then stone or brick built structures, through to modern buildings using concrete and steel with lots of glazing and plastics.



Different types of materials used in the historic and modern built environment

All these materials can and do create problems as they deteriorate. It is the ability to fully understand these materials and associated problems that enables appropriate repairs and renovations to return the Heritage to a healthy state ready for use or change of use. The ability to re-use old buildings is good sustainable practice. The embodied energy used to create them is a finite resource and needs to be recognised through beneficial re-use.

Materials decay and fail for a variety of reasons including:

- | | |
|--|--|
| 1. Weathering | 9. Structural movement |
| 2. Adjacent materials interacting | 10. Mechanical damage |
| 3. Overloading of structural elements | 11. Natural deterioration |
| 4. Poor design and detailing | 12. Natural break down (e.g. sunlight) |
| 5. Limitations of materials used | 13. Simple failure |
| 6. Limitations of life expectancy | 14. Natural faults in materials |
| 7. Effects of damp | 15. Neglect |
| 8. Effects of fungal and insect attack | 16. Fire and flood |

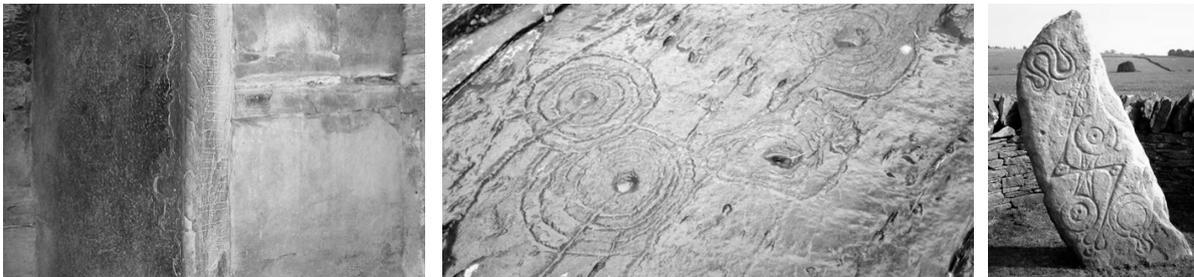
A building material may be subject to decay but it may not be necessary to replace it simply because it demonstrates decay.



Various examples of damage and neglect

But some causes of decay and deterioration are not necessarily related directly to the building - these can be external causes such as: fire, flood, pollution, general neglect, subsidence, vandalism, theft, and graffiti: these too may need to be identified and addressed during conservation work.

Difficult decisions are usually based on situation and circumstance that are part of the history of the site and building and may be detracting from it and its record or even adding to it! The two images bottom right are of stonework that has had a lot of '*socially*' historical identity in the form of prehistoric incisions on bedrock and a 6th century standing stone. Some graffiti might even offer a record of a historic invasion, such as with the Norse runic 'graffiti' inscribed on internal walls of a Neolithic tomb. Whilst various medieval masons' marks might be described as 'graffiti' by some, given their purpose of identifying the individual hewer-mason who worked the stone, their marks offer a personal link with the past and need to be respected.



Graffiti or art form

Some issues that are affecting a building will need addressing under *various stages of priority*:

- **Immediate** – requiring urgent attention
- **Urgent** – requiring attention but not necessarily immediately
- **Necessary** – essential to be addressed as work progresses
- **Desirable** – it would be good to deal with if funds and time allow

These 'priority' matters will help in forming a plan of action in order to undertake conservation work - what needs to be done first and what can wait until later?

3.4 An Approach to Methods of Repair

Vital to how repair work is carried out is the need to be in full knowledge of the building and its **Worth**, its original use of materials and its construction methods. Old buildings were not built like modern ones so any repair work must adopt sympathetic methods and materials. One would not use modern plastic based paints on a building that had previously only used lime based paints. Lime washes are breathable whereas modern coatings are not. Old buildings are 'breathable' as they allow moisture to move from inside to outside (and vice versa) without too much resistance. Place a barrier (like modern plastic based paints) on walls

that had previously been painted with lime immediately stops the natural movement of moisture through the wall causing a build up of damp and loss of thermal performance.

The use of cement based materials for re-pointing existing brick or stonework (originally using lime mortar) can lead to catastrophic long-term erosion. Damage will result from the fact that cement (once set) is water shedding, as opposed to lime mortar which allows moisture to be absorbed and evaporated at a steady rate from the whole wall. The result will be that as rainwater runs down the wall cement mortar will not absorb it whereas the bricks or stone will. This concentrates moisture in the bricks or stone and can lead to erosion in frost conditions or simply by an excess of retained moisture leading to softening of the brick or stone.

The use of cement mortars where lime should be used is also very damaging functionally regarding performance and visually, as the following images show.



Inappropriate use of cement mortar repairs and the effects

Trying to use new methods and materials on old buildings could be a fundamental error and will most likely lead to on-going and damaging future problems.

However, new materials, their use and technology are constantly being advanced. Some new materials or processes may well be appropriate for use on or within an historic asset. Some may be positively damaging to the fabric therefore great care must be taken in order to understand impact on the Heritage. Research into impact, both short and long-term, must be done before any new/alien or modern materials are used on heritage projects.

All repairs should be an honest statement of intervention with no attempt to conceal or mislead the observer under close inspection. Repairs may be affected to have minimal visual impact, but they should not attempt to deceive the observer into thinking they are original work. Repairs can be reasonably unobtrusive but they should be obvious to an informed eye: Where possible repairs should be reversible, again without loss of character or **Worth**.



Argyll castle



Norwich Cathedral Close

Remembering at all times the basic **five principles of conservation work**:

1. **Minimum intervention** – only carrying out minimum work which is necessary to repair, maintain or change the use
2. **Minimum loss of authenticity** – only carrying out work that does not change too much of what is thought to be valuable
3. **Minimum loss of original fabric or material** – by not removing anything that is required to keep the building special along with its record, chronicle or archive of history
4. **The ability to reverse any changes** – making sure that what might be added can be removed in the future without creating more damage to contained record
5. **The need to be clear and ‘honest’** about what is new work and thus avoid deceiving the viewer

3.5 An Approach to Caring for Worth

We have established that a primary action when starting to undertake a conservation projects is first to investigate and determine **Worth**. Then using this gathered knowledge or understanding to form a management plan to deal with the issues discovered.

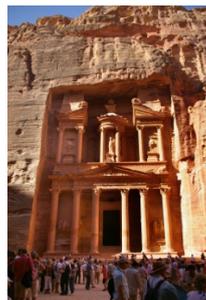
It will also involve making contact with the people to whom the asset is important – let’s call them ‘Stakeholders’. This group of people will primarily include owners, local authorities, local history societies the general public as users and to whom the asset is vital for **local identity and sense of place**. This is particularly important when dealing with internationally important assets’



Callanish, Lewis



Chowmahalla, India



Petra, Jordan



Karnack, Egypt



Rome, Italy

Thus, management of a project's process should follow a strategic approach perhaps summed up by the following set of bullet points:

- *First understand the building and its **Worth***
- Second set out what the aims of the project are or should be
- Discuss the plan with the people to whom the asset is important
- Avoid imposing personal views about how the work should be done
- Bring in experts whose focused knowledge will assist how the work is to be done
- Work out an order of priorities covering urgency, necessary actions and desirable work in that order
- Record the project before work starts, during and after it is completed – to ensure people in the future will be able to see and understand what was done and why it was done
- Use the plan to manage project progress and allow for unforeseen things happening as the work proceeds
- On completion monitor what happened during the work, record any changes to the original plan and explain why the changes became necessary

3.6 Conclusions

Hopefully you will have learned that the most important aspect of investigation into any heritage project is to establish by detailed research and investigation, what is the **Worth** of the Heritage – particularly where this relates to aesthetic **Worth**. How it was built, how it is deteriorating and how it might be conserved. It is also important to recognise that conservation is not, principally, about preservation but more about appropriate repairs, renovation, maintenance, and re-use and/or conversion to an alternative use.



Glasgow. Adaptive reuse

Unit 3 Questions: (Answers are based directly on the wording contained in Unit 3)

What have we learned about how a building works?

1. Heritage buildings are subject to a variety of wear inducing problems: List at least five causes of deterioration in them.
2. Complete the following sentence: ***It is the role of conservation to try to...*** ?
3. What in addition to the *building itself* can help in the investigation to determine **Worth**?
4. What is the **object** of built environment conservation?
5. What is the **best rule** to understand about conservation?
6. What allows us to make *suitable decisions* about *how we conserve a building...*?
7. What is *a very important element of conservation work...*?
8. List three main causes of deterioration.
9. What other factors will affect a building's deterioration?
10. What are the questions that need to be asked about building condition?
11. List possible sources of dampness.
12. List possible sources of movement.
13. What is it important to keep during initial investigation of conservation projects?
14. List four **various stages of urgency...**
15. What may it not be necessary to do if a material is showing signs of decay?
16. Complete the following: ***All repairs should seek to be...***

Unit 3 Answers

1. **Dampness, Movement, Damage caused by invading insects or fungal attack, corrosion or chemical interactions, vandalism, graffiti, theft and general neglect.**
2. **...to try to slow this rate of deterioration by appropriate and sympathetic re-use, maintenance and repair.**
3. **... documents and records of the building's history and development.**
4. **... to prolong the life of historic buildings and to clarify their story without loss of authenticity and record.**
5. **... there are no hard and fast rules, only good guidance about how work needs to be undertaken in order to protect and preserve Worth.**
6. **... is clarity about its origins and history.**
7. **... recording and making easily accessible evidence of what has happened so that in the future people can understand the work that was done.**
8. Dampness, Movement, Damage caused by insect or fungal attack, corrosion or chemical interactions.
9. Vandalism, graffiti, theft and general neglect
10. **... What is causing decay and deterioration what is the source and can it be rectified. What is the cause of structural movement and can it be corrected? What is the cause of rot and insect attack and can it be overcome?**
11. **... groundwater, leaks, rainwater (usually associated with poor rainwater dispersal via gutters and downpipes) and condensation.**
12. **... can be caused by changes in moisture levels and temperature differences resulting in parts of a building moving differently one to another or chemical reaction; failing foundations from geological subsidence or mine workings**
13. An open mind
14. Immediate, Urgent, Necessary and Desirable
15. It may not be necessary to replace it
16. **...an honest statement of intervention with no attempt to conceal or mislead the observer under close inspection.**