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COTAC BIM4C
Integrating HBIM
Framework
Report Part 2:
Conservation
Influences

COTAC Study 3

Edited by Ingval Maxwell OBE



COTAC BIM4C Integrating HBIM Framework Report

Part 2: Conservation Influences

The ‘Council on Training in Architectural Conservation’

Established in 1959 as the ‘Conference on Training in Architectural Conservation’ COTAC’s founding principle was its recognition of the need for specialists to properly specify and oversee work involved in repairing and conserving historic buildings and churches. At the time, this ground-breaking approach occurred when industry and professional training and education in modernism, concrete and brutalism prevailed, and the knowledge of traditional building technologies was fast disappearing. Over the years COTAC has successfully, persistently and influentially worked to lift standards, develop training qualifications and build networks across the conservation, repair and maintenance (CRM) sector, estimated (in 2014) at 42% of all construction industry activities. This has involved national agencies, professional and standard setting bodies, educational establishments and training interests.

In its new guise, the ‘Council on Training in Architectural Conservation’ was re-established as a Charitable Incorporated Organisation in July 2015, where COTAC’s 21st century role is no less critical than that of its past. New technologies, including aspirations to low carbon retrofit, demanded energy efficiencies and emerging digital innovations, can too easily obscure the need for a core understanding of traditional materials and how to approach historic structures with a finely honed set of skills. This report aims to address an imbalance in the understanding of these essential areas within the emergence of Building Information Modelling (BIM). In doing so, COTAC enabled a BIM4Conservation (BIM4C) Group in 2015 with the remit of raising awareness and understanding of BIM within the conservation and heritage sector of the built environment, and to link with other BIM4 Communities in advancing knowledge and influencing understanding of conservation needs within the broader context of the BIM industry sector.

This Report, presented in three parts with a supporting selective bibliography, offers some considerations that might be taken into account as the awareness of the particular needs of BIM4C gain ground. Through that development it is hoped that an appreciation of the differences in approach required by Historic Building Information Modelling will emerge. Whilst every care has been taken on the preparation of this publication COTAC and its Editor specifically excludes any liability for errors, omissions or otherwise arising from its contents. Readers must satisfy themselves as to the described principles and practices.

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COTAC BIM4C Integrating HBIM Framework Report Part 2: Conservation Influences

Abstract

It is generally recognised that the built heritage is under threat from a variety of influences - including a lack of knowledge by the professions, and from a lack of understanding by the 'main-stream' construction industry. But what is 'main-stream' when the entire sector virtually operates in two equal halves? In the Farrell Review (April 2014: p71) it is remarked that:

'Today, most architecture is subject to the design of components by others The trusses, cladding systems, windows and doors and the kitchens, wardrobes and bathroom elements all the way down to the door handles have already been "pre-designed", so what is it that the architect does? As Farrell Review Expert Panel member Sunand Prasad has said, the role of the architect today is increasingly about selecting, synthesising and integrating, and they are well placed to do this.'

Whilst this may well be true in the de-rigueur of building anew from catalogued sources, it is far from the case in dealing with the existing built heritage - and especially so with that which was traditionally constructed prior to 1919 - where all the selecting, synthesising and integrating has already been pre-determined from a portfolio of parts and elements that are generally no longer available. The requirement here necessitates a different professional expertise and understanding.

Resolving that matter will be at the heart of any successful HBIM developments as they might be applied to the existing built heritage. To do so will require considerable effort given the scale, promotion and new-build bias of BIM developments that have already taken place. This Part 2 Report aims to identify a wider range of issues and influences that might be contemplated in the development of HBIM considerations. The various Step charts offer a range of 'key words' that might be considered and developed as part of the sequential processes that are involved.

COTAC BIM4C Integrating HBIM Framework Report Part 2: Conservation Influences

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COTAC BIM4C Integrating HBIM Framework Report: Part 2: Conservation Influences

Introduction

The undernoted suggested draft HBIM Framework Evaluation Criteria (FEC) Steps 1 -3 aims to assist in determining the related factors regarding historic importance, functions and surrounding influences on historic/traditionally built buildings and their neighbourhoods. The Steps also aim to suggest the effectiveness of possible methods and techniques that could help determine key factors in considering future HBIM reuse, preservation and maintenance work. However, the three Steps exclude the need to factor in making decision making over the 'unforeseen' that will often be required to be taken into account during progress of the actual work programme (Additional Step 2a).

HBIM Framework Evaluation Criteria (FEC) Outline Structure

Step 1: Definition

- 1.1: Aspects of Urban Entity
- 1.2: Cultural and Humanistic Evaluation
- 1.3: Determination of Significance
- 1.4: Economic and Financial Evaluation

Step 2: Data Collection

- 2.1: Basic Information Needs
- 2.2: Building Element Analysis and Structural Evaluation
- 2.3: Diagnostic Methods
- 2.4: Monitoring of Remedial Works

[Step 2a: Site Work Programme Activity]

Dealing with existing historic and traditionally constructed buildings can be challenging. Inevitably, during work in progress, unforeseen issues will arise that will need to be assessed and understood, and their resolution integrated into the work programme. Each emerging situation is liable to be different, often requiring a re-run of Steps 2.1 – 2.3 to aid an appropriate interpretation and resolution.

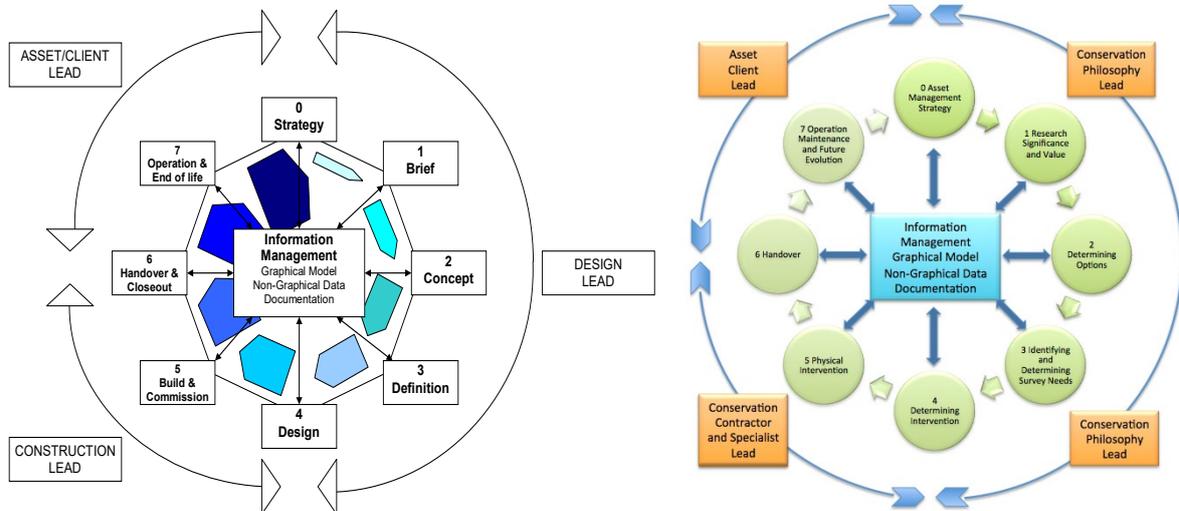
Step 3: Intervention Strategies

- 3.1: Conservation Plan
- 3.2: Maintenance Manual
- 3.3: Perception of Service Life.
- 3.4: Intervention Strategy: The Integrated Loop

The basis of this Part 2 Report, including the repeated Step diagrams, founds on work the author submitted to the *COST Action C5 Urban Heritage – Building Maintenance Final Report* published in April 2001 (EUR 20447: Office for Official Publications of the European Communities: ISBN 92-894-4138-0). The submitted text has been fully revised and illustrated to integrate with current HBIM considerations.

HBIM Framework Evaluation Criteria (FEC) Outline Structure

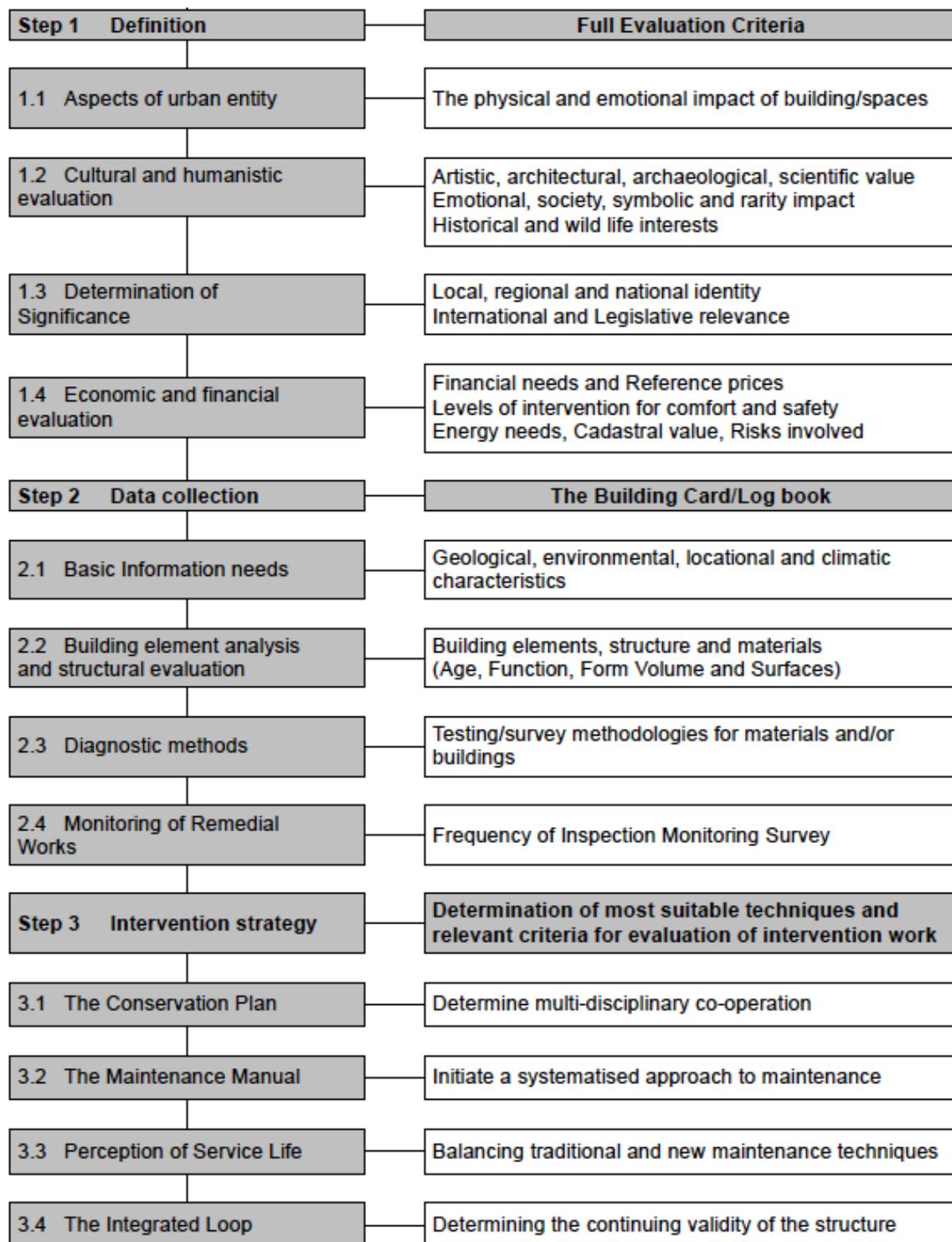
Part 1 of the Report considered the principles behind the cyclical nature of how the existing building stock is materially different from the increasingly innovative techniques adopted in new-build structures. It also overlays this HBIM distinction, in a diagrammatic manner, that mirrors common new-build BIM considerations within the CIC Framework, as represented below:



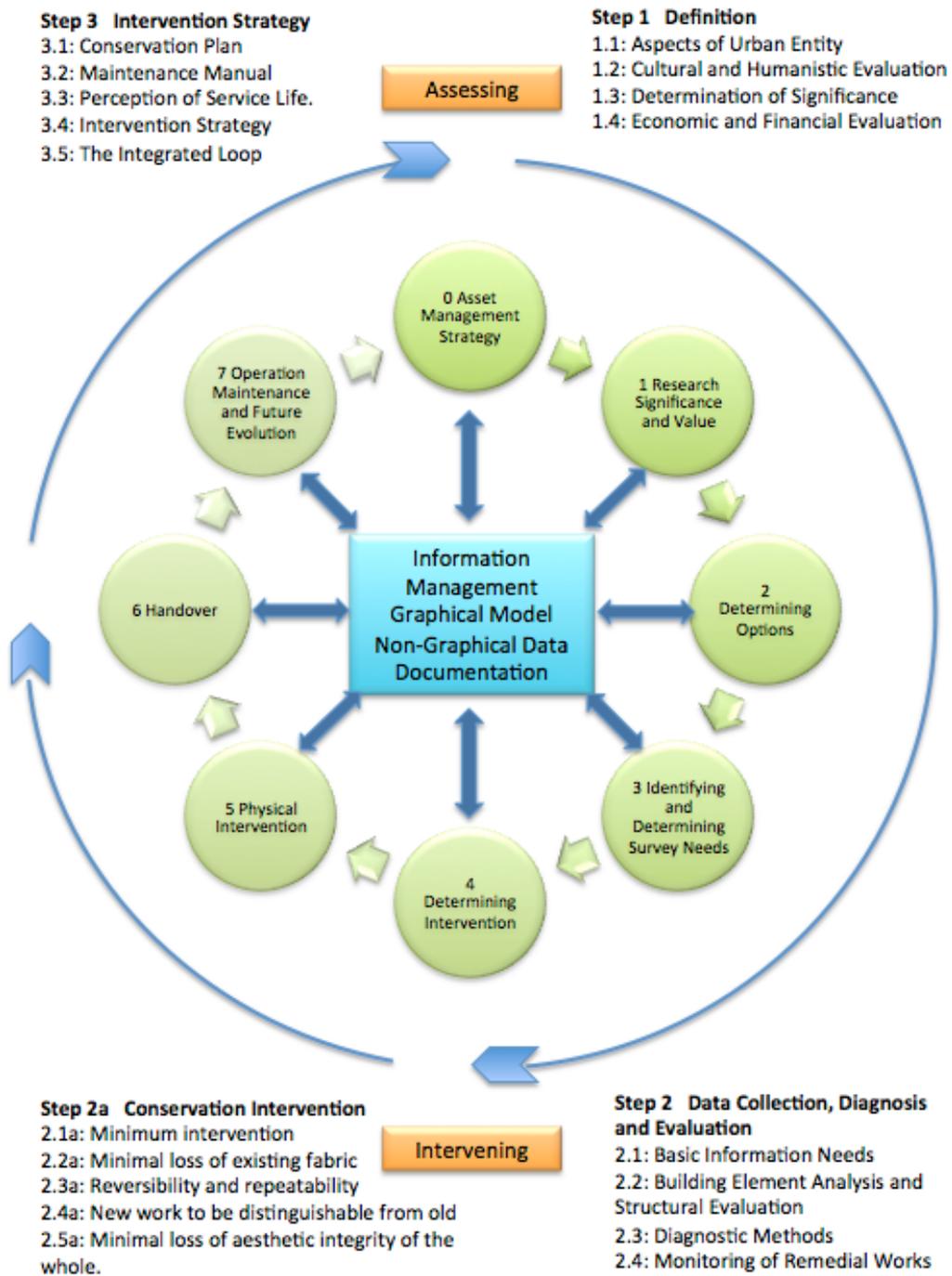
In this Part 2, under the general theme of retaining, reusing, conserving and maintaining the existing traditionally constructed built heritage, the potential range of topics that could be addressed under an HBIM approach is equally broad, but are less well understood. A major challenge exists to simply keep the various aspects in perspective, and in contact with each other. The associated wide variety and diversity of issues that can be encountered greatly adds to this dilemma. Bracketing the actual physical work programme (Step 2a, which needs to be considered separately) two principle contentions emerge, requiring:

- *An evaluation criteria for comprehensively determining the relevant historic importance and physical parameters of existing buildings, their neighbourhoods, and potential for degradation is required (Steps 1 and 2); and,*
- *The effectiveness of the methods and techniques used in their actual preservation work needs to be considered and determined to inform the next cyclical development of further adaptation and re-use (Step 3: with Step 2.4 acting as the bridge)*

The immense scope of related topics embodied in these two themes suggests the need to offer an outline framework into which all relevant elements might be placed, and located: the core objective being to retain the integrity, significance and quality of the existing built heritage stock. The following diagrammatic proposal drafts a *Proposed Framework of Evaluation Criteria for HBIM Activities* that attempts to set out such a methodology:



Through the various Steps and their sub-sections, each relevant activity might be placed and linked back to the common intention of helping ensure the future integrity of the built heritage. Factors that ought to be considered in each of the principle areas of consideration are set out in diagrams that accompany each of the Step 1 – 3 sub-sections, as below. These are intended to create a further overlay within the cyclical nature of the BIM4C approach as developed in Part 1.



As indicated, the suggested approach in the proposed criteria involves 3 Key Steps (With the addition of a site specific Step 2a) -

- 1 Definition
- 2 Data Collection, Diagnosis and Evaluation
- 2a Conservation Intervention: Site specific
- 3 Intervention Strategy

Once the relevant definition of the building or structure's status, significance, value and quality has been established, it should be possible to set about collecting data to assist in

judging the relative effectiveness of technically and methodologically competent solutions. Thereafter, justifiable intentions and actions should flow more readily.



Cambridge DSC09478: A variety of styles and periods in juxtaposition © Ingalv Maxwell

In the process there may be a need to consider other existing aspects of the wider built heritage, of which the historic core is a small, but important, part. Given additional official constraints (such as Building Control, Scheduled Monument and/or Listed Building Consent) that could be applied, these will assist in "specifying" relevant preservation, adaptation and maintenance work of what, in consequence, has been more precisely determined of "historic importance and significance". This integrated complexity needs to be explicitly and carefully described in whatever work approach is chosen for the intervention. In addition, it could be relevant to consider how the guidance emanating from the various international conservation charters and conventions might also inform the process.

In its proposed use as a practical tool for HBIM consideration the FEC might create -

- An understanding of the Significance, Quality and Value of the property
- An aid to prioritising future work
- An understanding of who could/should work together
- The establishment of the extent of necessary multi-disciplinary collaboration
- An aid to the promotion of case studies.

Placed in the wider context, this basic evaluation process might also determine if a proposed or completed project-

- Explicitly determines the site-specific factors on which historic importance has been based
- Preserves and maintains these factors, or causes disturbance to them (in terms of generally accepted conservation principles)

The complete evaluation should, therefore, achieve both intentions whilst clearly establishing the causes of all physical decay and their consequences. Following this the identification of technically effective and robust methods of dealing with emerging issues should flow into the integrated loop.



Glasgow DSC01860: Unattended maintenance needs can readily exacerbate problems. © Ingvál Maxwell

The underlying intention should also be driven by the need to increase the effective service life of existing building and its components whilst decreasing their life-cycle costing through effective reuse, repair and maintenance. Here, the ageing process, service life in use, and "replaceability" of integral parts need to be carefully predicted. With the general portfolio of original traditional constructional materials being no longer available for simple selection and use, this aspect becomes a critical concern if quality-compromising alternative material emerge as chosen possible replacements. To validate the sustainability argument which underlies this intention, the priorities that should guide the assessment procedure might be established as how to effect the -

- Reuse of the whole assembly
- Reuse of the component parts the make up the assembly
- Reuse of the constituent materials that make up the various components

Embodied energy also needs to be recognised as a key factor that underlines the sustainability banner, and its conservation must be borne in mind at each stage of the process. However, this approach may not be solved effectively without the multi-disciplinary joint efforts of industry, researchers, funders, suppliers and owners. The overall objective should be to increase service life capabilities whilst reducing future demands on required resources. To fully endorse sustainability needs a minimal amount of natural and physical assets should be called for, whilst also minimising waste and avoiding the use of environmentally noxious or damaging products.

The question of 'replaceability' should also be guided by the need to try to preserve the significance, authenticity and integrity of the original materials, their inherent substance, craftsmanship and performance in use. In traditional building construction, full 'replaceability' demands the use of jointing and adhesion techniques that are weaker than the original substances being kept together.



Craigneash IMG_6228: Vernacular construction with local indigenous materials. © Ingval Maxwell

Through the choice of indigenous materials that were used in the pre-industrial era, traditionally constructed buildings could be more readily taken apart, thereby allowing an ease of adaptive re-use (and for that matter their demolition!). This is much more difficult to achieve in the modern industrialised world, as adaptation, repair and maintenance needs are often not as well assimilated into the process of building in a more component-integrated manner. A performance mismatch can also occur when 'non-repairable' design technology is imported into the repair processes of pre-industrial building techniques.

To overcome this consequence there is a need to consider changing the current attitude, supply, and teaching approaches, so that the reuse of traditionally constructed technologies can be viewed more acceptably as being 'repeatable'. In the HBIM process, short-term life-span replacements need to be carefully considered so that a closer match emerges between component-life and future building-life expectancies.

This may require a significant change in the day-to-day understanding of promoted information about replacement components and techniques. Here, apparently positive messages advertising the properties of modern products can readily turn into negative

consequences when assessing their impact on traditional construction. For example, the adopted terminology can be contradictory in considering the promoted intentions against the actuality:

<u>Application claims in new-build</u>	<u>Existing building consequences</u>
Excellent adhesion	Difficult to remove
Resistant to abrasion	Difficult to remove by mechanical methods
Resistant to chemicals	Difficult to dissolve: may require the use of aggressive and dangerous applications
Special	Narrow use
New	Not proven
Modern	Short stockholding

With such potential variations emerging, a more balanced HBIM consideration is called for when aiming to determine the effectiveness of the most relevant work approach and technique.



Lion Chambers, Glasgow. DSC01821: Modern technologies can become challenging over time. © Ingval Maxwell

A key aspect in the HBIM process must be the need to understand how to build, repair and rehabilitate while also allowing for the future potential of carrying out repeated refurbishment, reuse and maintenance cycles. This can only be fully achieved through making any intervention works as reversible as possible, and in pursuing such an approach, a wide range of inter-related aspects need to be kept in mind.

The following Step diagrams aim to illustrate those associated factors. The keyword boxes can be read on both the horizontal and vertical axis, where identified topics aggregate to summarise themes that, in turn, aims to offer a cumulative comprehensive HBIM understanding of the issues.

Step 1: Definition

Step 1.1: Aspects of Urban Entity

The physical location of buildings and their surrounding spaces can create powerful consequences for the individuals who experience them. The size, scale and value of the heritage; the interplay of its constituent parts and forms, and the associated visual impact and consequences, all play key parts in the acceptance of what needs to be considered in a HBIM context to sensitively retain, reuse and repair what remains.

A full appreciation of the various factors, and their interaction with each other, is therefore a pre-requisite to accepting the more emotional attributes and requirements of relevant interventions. Without it, the risk of inappropriate, cumbersome and un-sympathetic work being carried out is high.

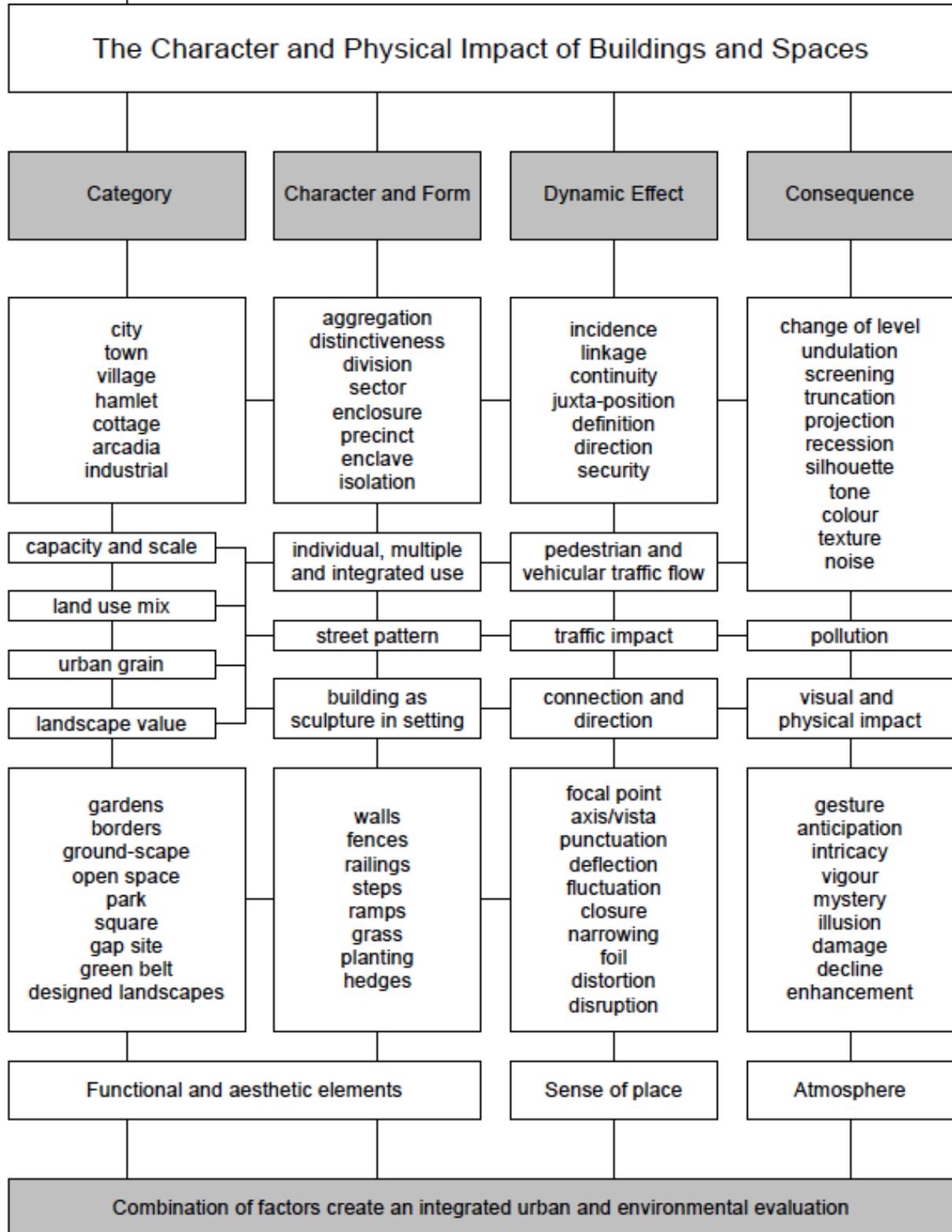


Kendal DSC07651: The Urban grain can be complex. © Ingval Maxwell

To positively pull these issues together a manageable integrated analytical framework is required. Considering the physical impact of buildings and spaces, key factors should amalgamate to offer an understanding of its form, its sensory effect, and visual consequence. Step 1.1 sets out the key aspects that might emerge in this detailed consideration. It aims to blend an awareness of the visual impact with that of the physical fabric so as to help define the character and impact of the complex relationship between buildings and their surrounding spaces.

Aspects of Urban Entity

1.1



Step 1.2: Cultural and Humanistic Evaluation

The emotional impact of the integration of buildings and their surrounding spaces directly stem from their remaining physical being. This offers the chance to experience the entity or ensemble in context; to recognise its relationship with other factors, and to acknowledge the value that society has placed on it – collectively creating its ‘Significance’. This might also embody such aspects as its rarity value; the cultural, functional or artistic quality; and the humanistic impact on the senses, along with a pre-determined legislative identity and protection process.



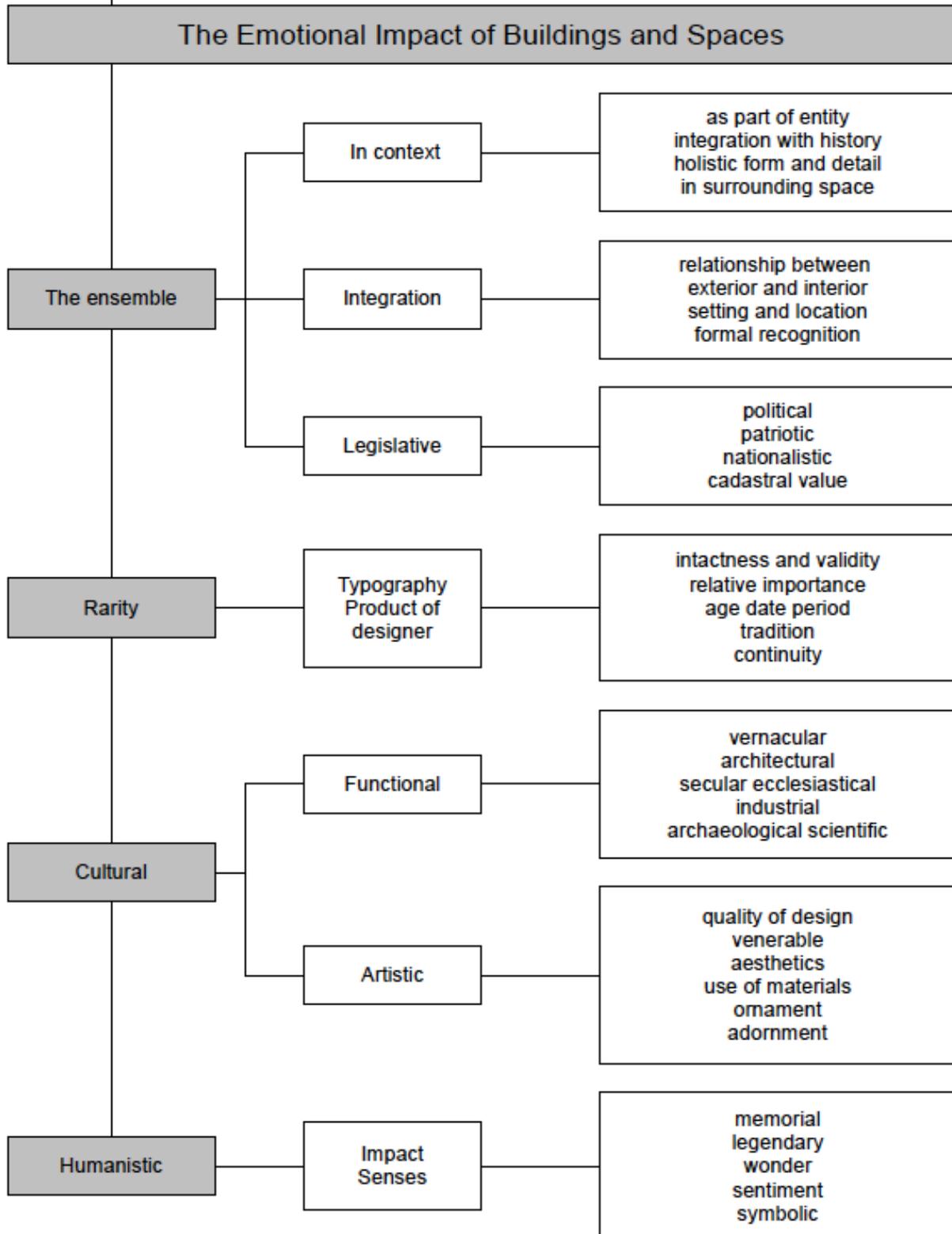
Liverpool DSC05329: Inherent Value and its recognition can take time to develop. © Ingval Maxwell

Such an impact depends heavily upon the ability to effect an appropriate interpretation and assessment of what is being experienced. In general this is, invariably, subjective in nature but it can provide the HBIM starting point from which many could decide the extent of their interest in effecting a value judgement. Collectively, it could also help determine the degree of acceptable or permissible interventions. In consequence, and at the heart of an HBIM approach, the need for an associated programme of awareness and interpretation of how such ‘Value’ is identified is paramount.

Combined, these factors pull strongly on the emotional ties of society, especially where the potential physical impact of the treatment could either strengthen, or greatly diminish, the original quality of the building, site or surroundings. At worst, this could cause over-restoration, or lead to neglect or destruction. At best, a pointedly improved understanding of the harmony and unity between individual buildings and their surrounding spaces will result. Working in detail through a structured process to help determine what is ‘Significant’ greatly assists in promoting the latter option. Step 1.2 sets out factors that might be considered relevant in defining the emotional impact of buildings and spaces. It subdivides what the ensemble might consist of, and identifies what factors might determine its rarity. Through also setting out its cultural relevance it presents a framework that could be thought of as aggregating the issues that drive the human reactions to what is being viewed or experienced.

Cultural and Humanistic Evaluation

1.2



Step 1.3: Determination of Significance

The determination of what is termed ‘Significant’ in the existing built heritage could be a difficult and open question if left unqualified. Its resolution requires a broad range of considerations, interpretations and approaches to be explored. At international level, the preservation of the cultural heritage has been the subject of considerable philosophical debate over the years. Various attempts have been made to clarify and modify acceptable conservation principles, and a number of statements have been issued. In addition to the “*Conventions and Recommendations of UNESCO concerning the Protection of the Cultural Heritage*” more than 100 other national and international statements of principle exist; the best known of which are perhaps the *Burra* and *Venice Charters*. Knowledge of the intentions of these documents is essential in this area of HBIM work. There are also various well-established ways through which each country determines how historic buildings and sites are evaluated and given legislative statutory protection. Different national laws and “Guidelines” exist for these processes and each (as relevant) should be incorporated into the methodology.



Biggar DSC00552: A medieval rig and marketplace footprint readily remains. © Ingvál Maxwell

But, a degree of subjectivity also inevitably exists in each country's approach. Whilst this might also be pre-conditioned by some regional, local, social, cultural, historic, economic, political

or aesthetic values, by their very nature, the national legislative processes are self-limiting and self-selecting. Usually, no more than a small percentage of any nation's existing building stock can or will be covered by the processes involved. Therefore, taking the built heritage as a whole, the 'historic' assessment alone cannot offer the complete picture, as the range of detailed considerations in the process will not be sufficiently broad.

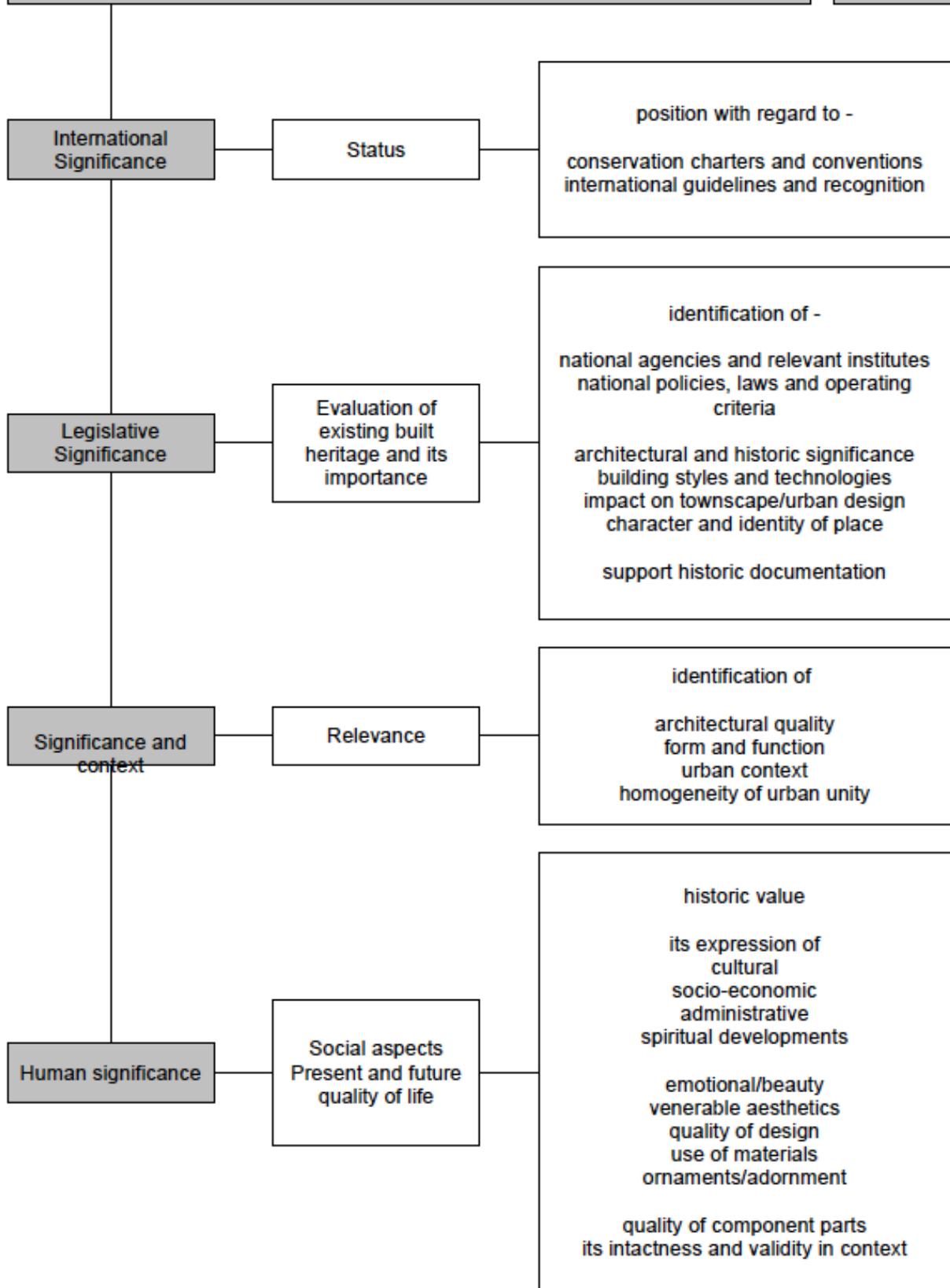
A fundamental need exists to differentiate between what is and is not legislatively determined 'historic', as this will usually have a bearing on the level of care and, consequently, the extent and degree of what work can be carried out. Less significant sites, despite often being of equal age, physical and material being, receive less statutory protection and are therefore liable to have a higher level of risk attached to them. So, there is also a need to consider 'relevant parties' and assess what impact they might have in the process. Here, the Criteria suggest the need for an interface with national agencies and related institutes where national policies and laws should be scrutinised. This would help determine who does what, and how do they do it, through comparing systems. There might also be a need to consider what mechanisms are used to qualify and quantify the HBIM issues; how the data is presented; and what methods are used to define achievements.

However, as the quality of a 'place' aggregate from the summation of its parts and surrounding spaces, it is important to identify what the context of these factors might be. Whether there are many buildings of the same design; how and where they are grouped; how they are located and mixed by age and design; and how the importance of individual structures bears on their neighbours. These are all issues that should be taken into account. With this comes a need to acknowledge that social factors and related implications will also have an impact on HBIM considerations.

Step 1.3 sets out the different veneers of influence that might be encountered in the determination of 'significance'. At the highest level, internationally important locations such as World Heritage Sites, will likely over-ride the legislative determinations of national priorities, especially if these are based on locally defined contexts and subject to comprehensively pre-approved Site Management Plans. Whilst these processes will aim to be as objective as possible, their outcomes will be no more than the accumulation of subjective opinions, views and assessments placed into a balanced context. Step 3.1 aims to group these interests in a structured way that readily sits within the top right-hand quadrant of the BIM4C cyclical process.

Determination of Significance

1.3



Step 1.4: Economic and Financial Evaluation

At the start of each HBIM assessment process, a variety of players and interested parties will be concerned with determining the relevant possibilities, renovation and intervention needs of the targeted property. Each will have their own degree of involvement and responsibility so that, collectively, their aspirations and intentions need to be effectively integrated to achieve an appropriate result. An impact can also be expected from user requirements, such as security, performance and energy needs that might also be linked to operational functions and demand.

Commercial needs will similarly dictate, as will the degree and extent of funding. In determining this, the anticipated levels of HBIM interventions must be resolved, and linked to functional intentions through appropriate management of cost estimates, expenditure and controls. At this stage a validated approach, linking risk and gains, should emerge. But, to produce a more holistic understanding a greater emphasis needs to be placed on full life-cycle costing analysis.

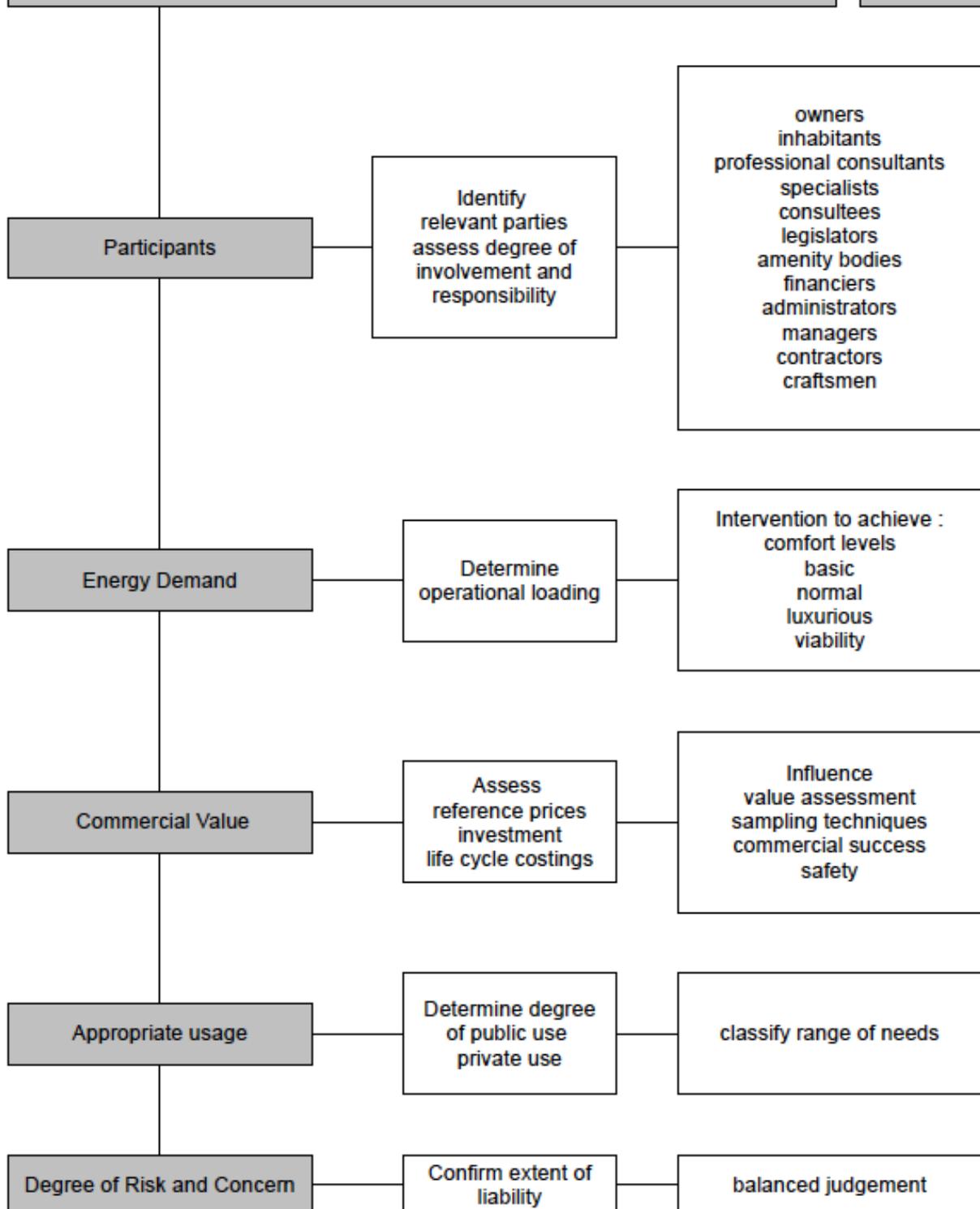


Cambridge DSC09397: An integrated approach involving commercialism can ensure survival. © Ingvál Maxwell

Through integrating such a system as suggested by Step 1.4, improved value for money should result from the longevity of adopting the most appropriate approach. Relevant participants need to weigh up how future operational HBIM commitments might also challenge perceived commercial values through intended usage. Future risk must be offset by appropriate judgement of expected commitments and gains.

Economic and Financial Evaluation

1.4



Step 2: Data Collection

As stated, the principal HBIM contentions are in two parts. The first can be paraphrased as being the “determination of qualities and values”, the second as the “determination of the effectiveness of possible methods and techniques” that could also be used in future adaptation and preservation work. This points to the need to have a co-ordinated system of detailed monitoring of existing work - specifically with regard to the effect it might have on the degree of ‘quality’ that should have been established before work started. This approach would identify, for example, whether or not erosion of stonework has ceased or accelerated; whether the historic evidence was clear, untouched, or obscured; and whether or not the aesthetic remained unchanged, or had become damaged.

At the heart of an HBIM approach, the creation and emergence of a central data bank of related information on monitoring all present (and future) adopted techniques and methodologies, and their results, would be invaluable. This would greatly limit the endless repetition of obvious mistakes (to those who know), and the high incidence of misdirected ‘help’ that is often given due to a systemic widespread lack of relevant understanding, education and training in traditional constructional technologies.

Detailed briefs, outlining the relevant approach would have to be produced. These might also include themes on-

- Creating inventories of data and information
- Analysing and determining the level of required action
- Identifying gaps in current understanding
- Promoting political aspects based on researched analysis

Identifying what is appropriate also depends on achieving an understanding of values, needs and intentions. To do this, there is a need to establish HBIM indicators to confirm what criteria can be fulfilled. To make this workable, the technical aspects should be based upon, and consider in critical detail, relevant scientific and historical evaluation information. The aggregated consequences could result in the development of an intervention strategy in Step 3 that considers future potential needs, opportunities and constraints through the creation of an informative and building specific "Building Card" or "Log Book"

Step 2.1: Basic Information Needs

The preliminary stage of establishing the range of HBIM influences that impact on the physical wellbeing of buildings should involve the identification and collection of basic information. This might set out to define the fundamental criteria that will exist on, and around, any building or site. Identifying and understanding the full range of *Geological, Environmental, Locational and Climatic Parameters and their Effect* on the materials used in the original construction have a profound impact on how emerging problems are assessed and resolved. Here, factors such as material mineralogy, porosity, function, water run-off performance, detail, form and volume could all be considered relevant. The chemistry and physical being of the surroundings will also be relevant, particularly where the risk of salt transference is high.



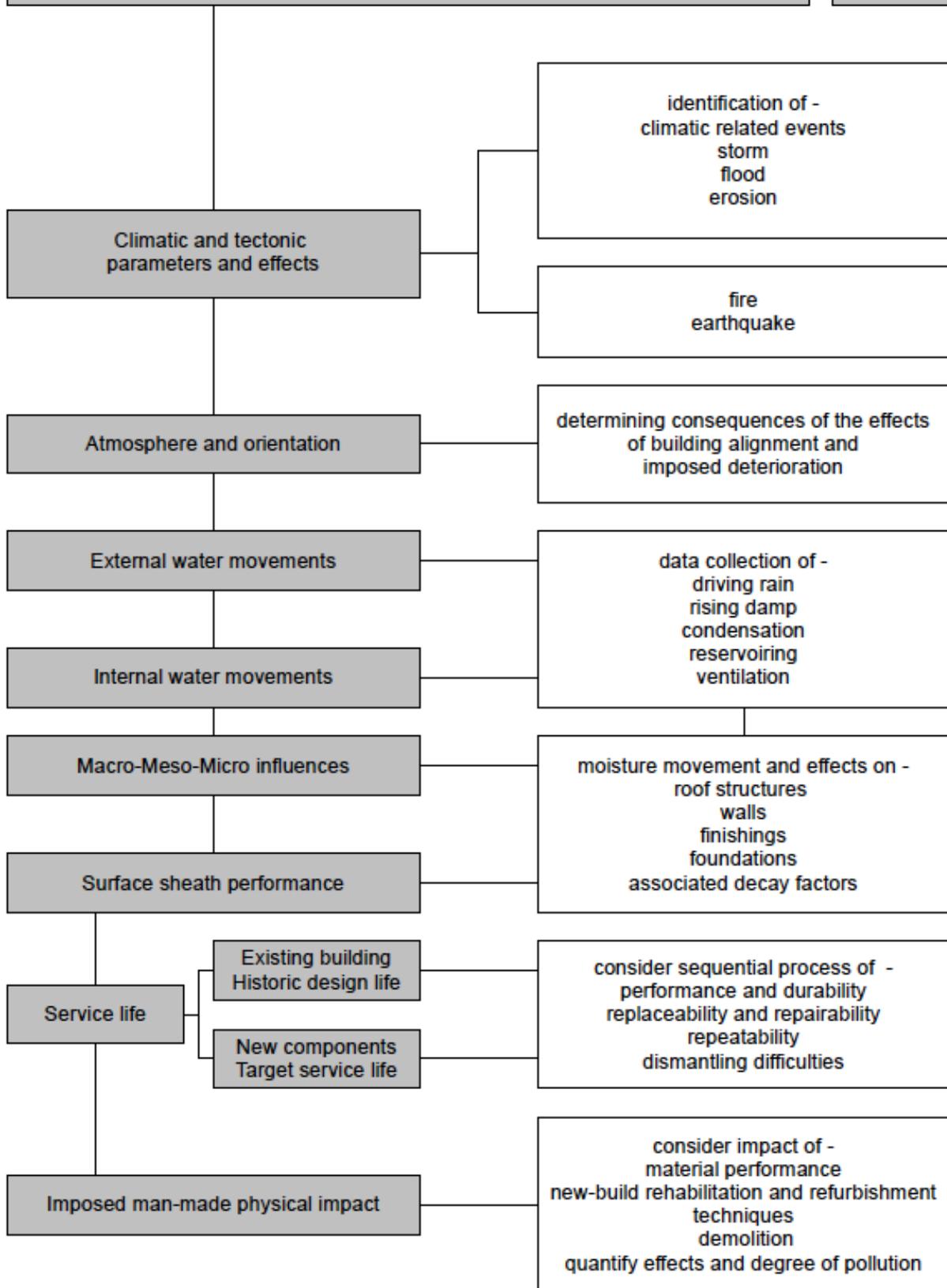
Castletown IMG_6593: Exposure to all aspect of the environment. © Ingval Maxwell

Knowing how the environmental, meteorological, and micro-climatic influences manifest themselves will aid an understanding of how well the structure is performing. This should also help determine what levels of pollution exist, its effects, and how serious it is. Each facade could act in a different manner, dependent upon the degree of exposure and the extent to which it is exposed to the prevailing weather conditions (although this can be significantly adjusted through micro-climatic effects). In particular, this investigation should focus on what is occurring on, at and near the actual surface itself. How the surface sheath is responding; how water is moving over and through the structure; and what is happening where water actually penetrates the interior.

It is important to discover and understand such factors as they offer significant clues about how well the building is actually performing. Catastrophic loss or impact might also result though the effects of flood or fire. Whilst nature will greatly influence the former a number of man-induced aspects could result in the latter. Identifying what other man-made effects have been imposed will further assist in focusing on topics that need resolution. Taken collectively, the amassed information on the imposed natural, and man-made, forces should provide a comprehensive awareness of how, and why, the structure is acting the way it is. A possible HBIM framework for gathering this data is set out in Step 2.1.

Basic Information Needs

2.1



Step 2.2: Building Element Analysis and Structural Evaluation

A full HBIM technical and structural evaluation of all the building elements is necessary to understand how the structure is performing. It is also required to identify what needs to be done to secure it. A complex inter-relationship of building materials, applied skills and technical developments need to be assessed, along with the relevance, or otherwise, of previous work. Legislative needs and requirements should also be considered and integrated within this activity.



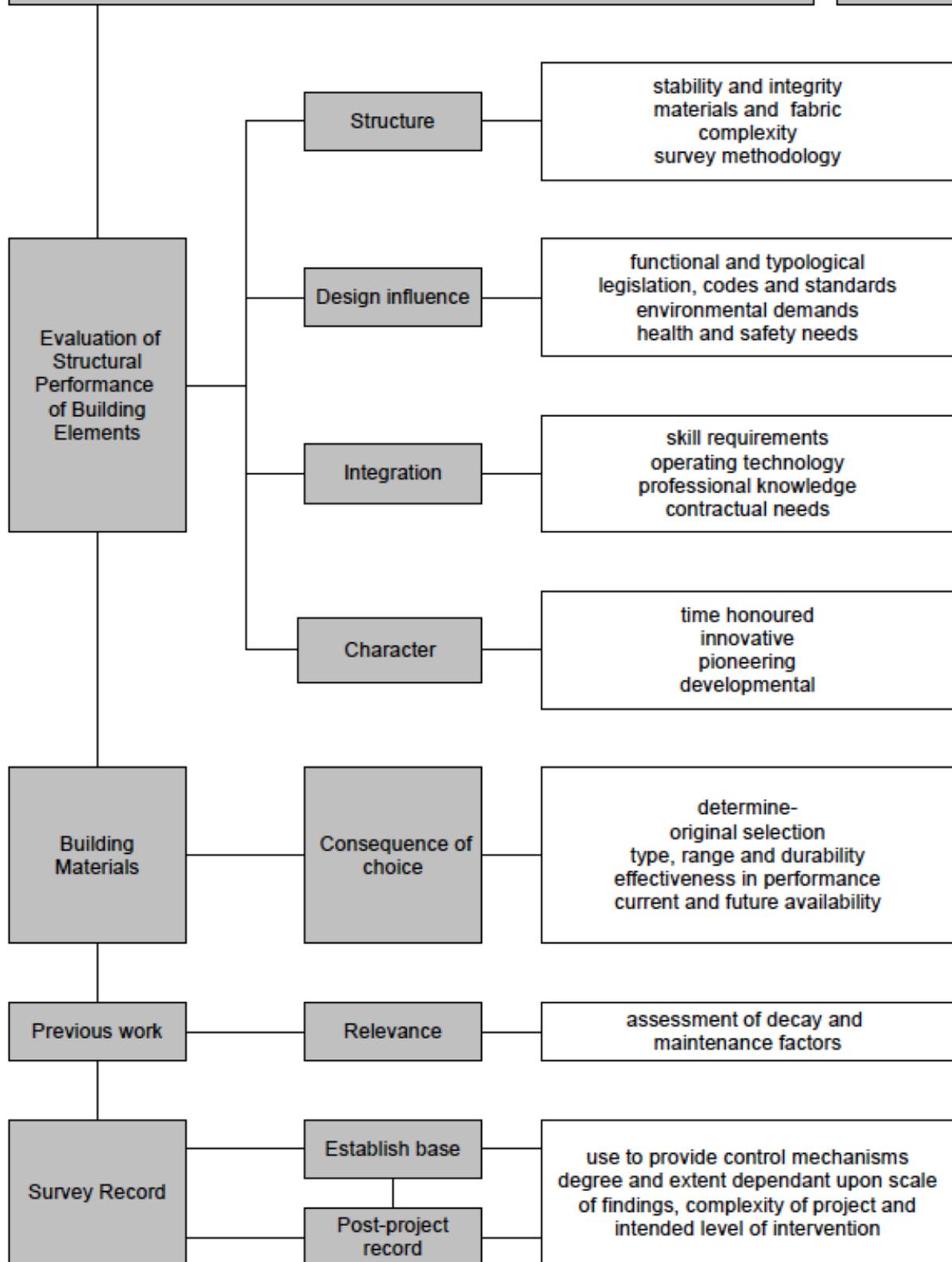
Norwich IMG_2265: Complex evidential remains of different building periods and needs. © Ingval Maxwell

The aim of this stage of the evaluation process should be to help determine what is likely to be the most successful repair strategies or relevant maintenance work approaches. Innumerable reference books and established methodologies already exist and the detailed guidance offered by them should not be ignored or dismissed. Many deal with the identification of causes of decay and structural problems as a matter of fact. But the methods of inspection will vary dependant upon a number of associated factors. Information may flow from objective investigation; archival research; monitoring programmes and materials testing.

In the process, a key aspect will be the level and extent of survey that is undertaken in support of the project. This will inevitably be exercised in different degrees, commensurate with needs and intentions. It will range in technique from the relatively superficial to the detailed archaeological. It can be used to plan for and monitor progress of intended levels of intervention and, in its own right, will emerge as a valuable document with numerous future uses. It may be necessary to consider at the outset where would be an appropriate location to lodge this significant record on completion of the project. Step 2.2 sets out to illustrate how structural performance, the choice of building materials that have been used, and the relevance of previous work, combine to create a more holistic overview, and how this might be recorded.

Building Element Analysis and Structural Evaluation

2.2



Step 2.3: Diagnostic Methods

The intention of any HBIM related inspection or testing programme should be to suggest a detailed framework that will be useful in arriving at a decision as to the most appropriate method, or methods, that might be used to aid a diagnosis. In broad terms, the processes under consideration are liable to range from simple to sophisticated, appropriate to inappropriate, economic to expensive, and non-destructive to destructive in their use.

Prior to a satisfactory conclusion being reached, each proposed technique might have to be considered against each of these factors, where the need must be to focus in on what is most germane and relevant. The concluding intention, therefore, should be to guide the most suitable approaches and procedures to the range of problems in hand. That way, effective results should be determined from the agreed types and levels of intervention that might be applicable.



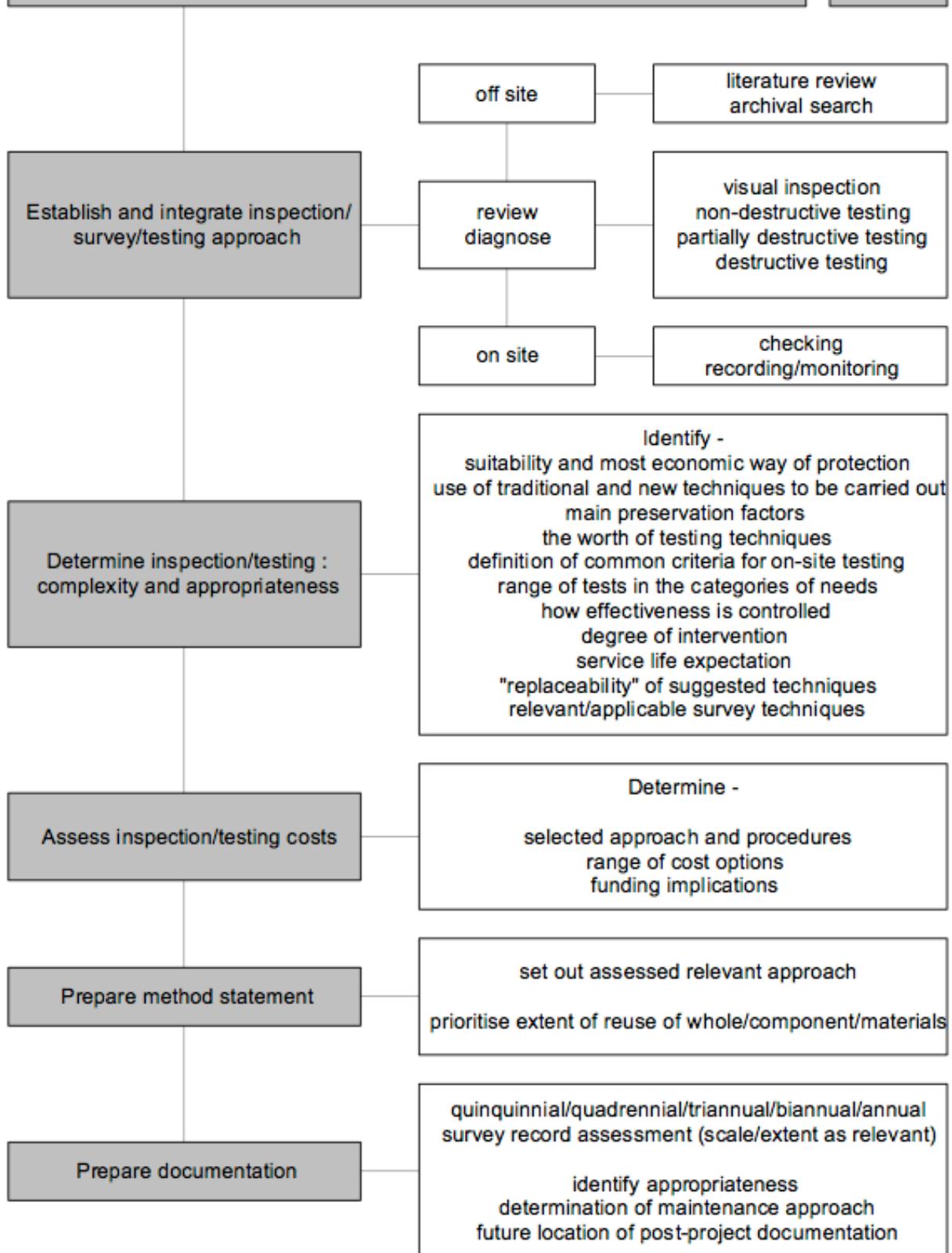
Norwich IMG_2341: Understanding materials and what they are capable of is important. © Ingvál Maxwell

To be fully effective in ensuring the maximum degree of service life, the application of new techniques to existing structures should be based on unlimited 'repeatability'. Techniques should be completely understood with regard to their make-up, properties, durability, function, limitations, consequence of ageing, and methods of application and removal. They should allow the full freedom, without hindrance, for future choices of technology, materials and methods whilst, at the same time, be capable of being easily taken apart, disassembled or dissolved, without risk or damage to the underlying original sub-structure.

Modern protective agents or methods should also be fully tested in order to detect their ability to perform adequately, and to determine any risk of a negative side effect or failure whilst in use. The associated factors as set out in Step 2.3 deliberate on the sources of influence on testing, their relevance, complexity and appropriateness. It reflects on the need to assess costing, and on how to determine a suitable methodology and outcome.

Diagnostic Methods

2.3



Step 2.4: Monitoring of Remedial Works

The HBIM framework should allow checking and monitoring of remedial works as they proceed. Furthermore, such a base could usefully be updated as part of a routine approach undertaken as appropriate on a regular en-year basis. The proposed procedures should therefore inform the development of an appropriate conservation plan and/or maintenance manual in determining the intervention strategy (Step 3).

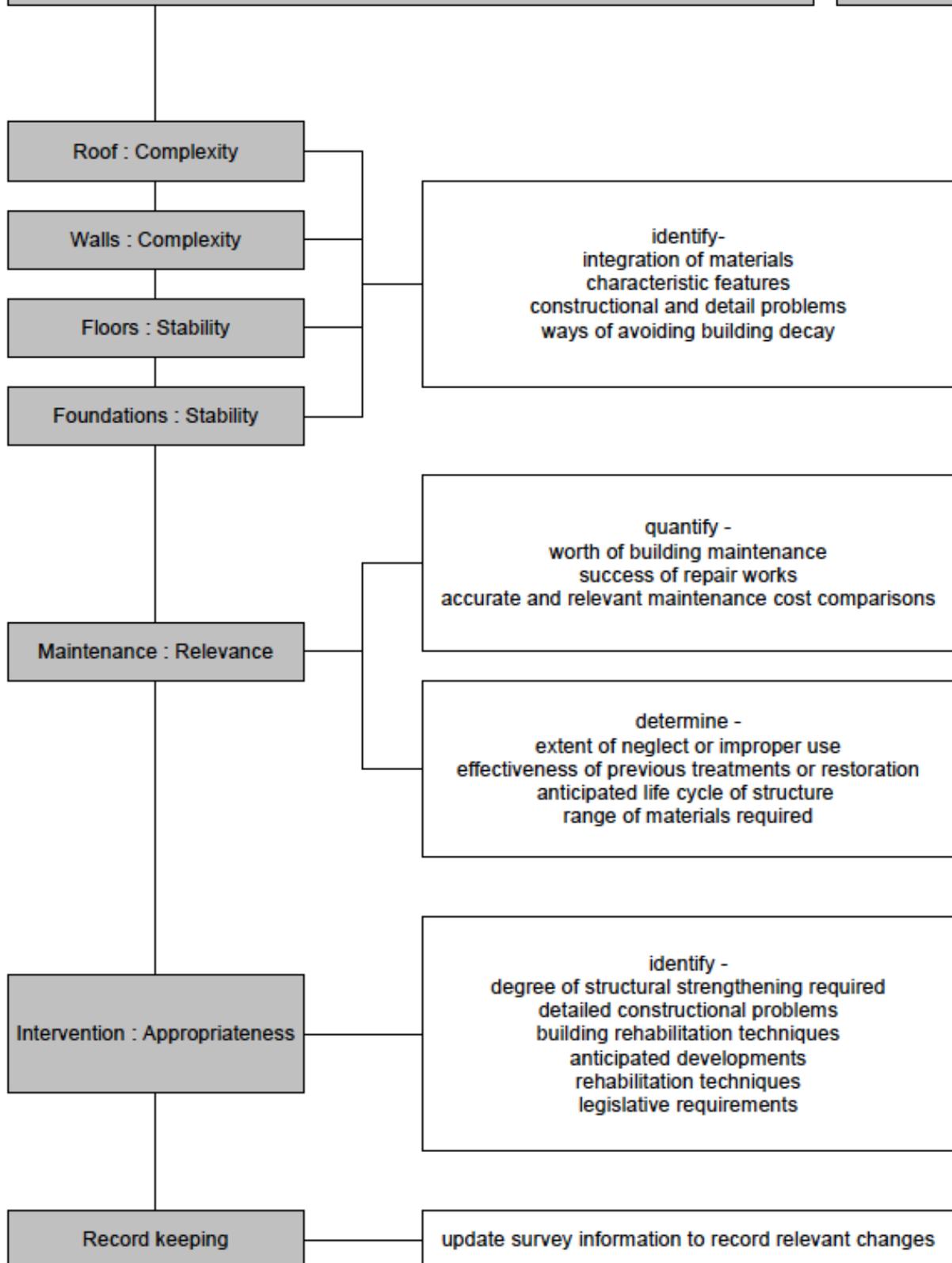


Crail DSC08218: Regional architectural details will vary from place to place. © Ingal Maxwell

As set out in Step 2.4, by taking an elemental approach to assessing features (roof, walls, floors and foundations) the identification, quantification and determination of the effectiveness of relevant remedial works should emerge. This can then be followed with a detailed investigation into the associated importance of each, its finish; what energy demand is anticipated and achieved; how previous repair work has performed; and how the degree of associated risk and concern might be measured. Appropriate record keeping will emerge as an important issue during this stage, and ways of accommodating and safekeeping this archive for the future should be considered. Combined, this Step should offer information on how to judge the relevance of the work, and the effectiveness and intended durability of any proposed remedial activities.

Monitoring of Remedial Works

2.4



Step 3: Intervention Strategy

As the various HBIM steps are worked through in detail, an increasing level of pertinent information should flow, and come together. This should include assessed details of the -

- Physical and environmental conditions
- Legislative and associated constraints
- Buildings physical condition
- Identified analytical processes

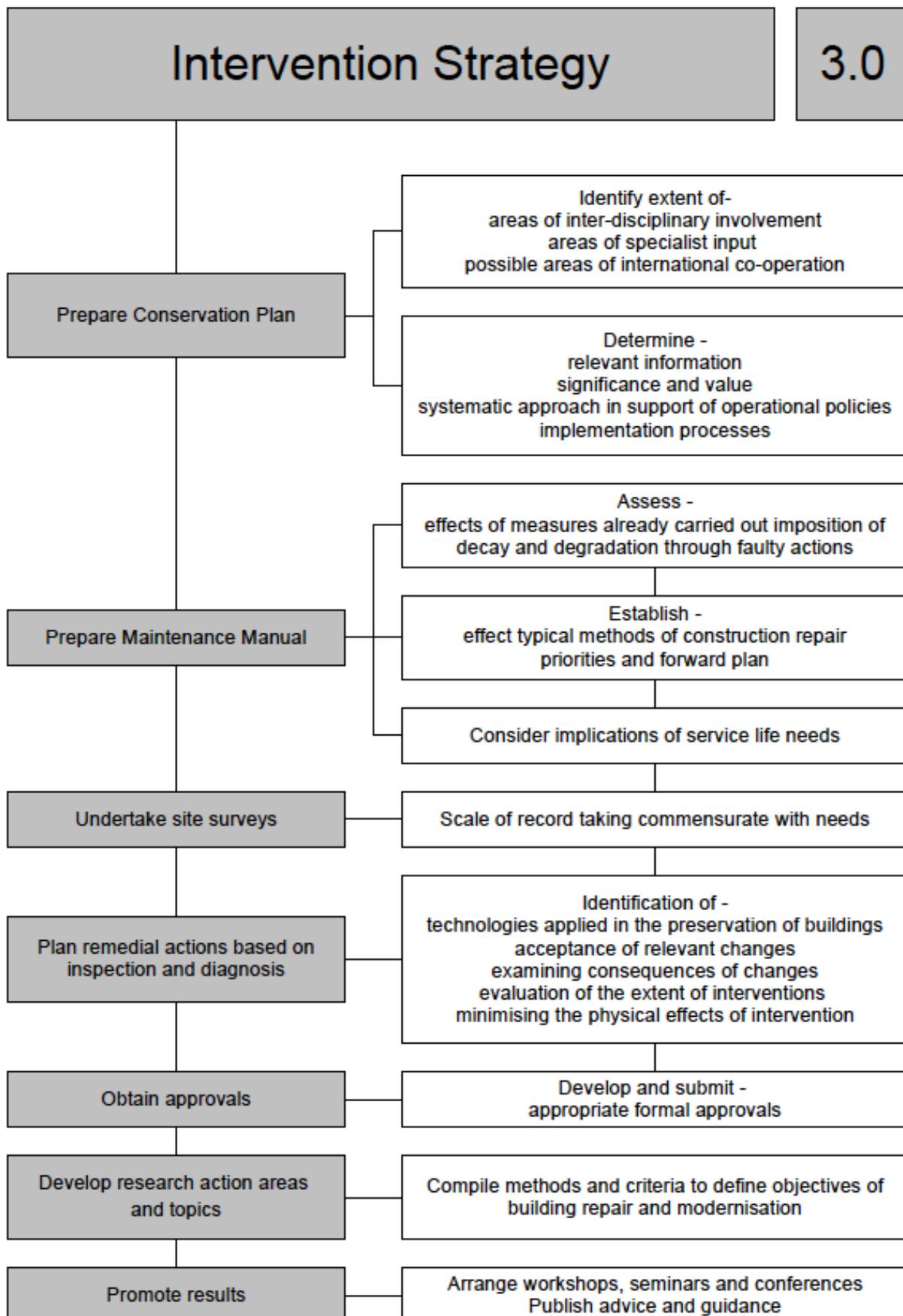
This combined and balancing process should assist determine what the most relevant level of physical intervention might be. But, the identified scale of what emerges from the process will vary dependant upon need. In some circumstances it will involve major reconstruction, where much original fabric could be lost. In others, it will conclude that during rehabilitation a high level of the retention of existing fabric will be essential. At a lesser level of intervention, a programme of repair and maintenance could result and, at the most basic of levels, a programme of 'housekeeping' could emerge. In addition, the range of activities involved could also identify associated research needs, in turn, pointing the way to initiating relevant research projects.



Norwich IMG_2536: Understanding how a building is performing is essential. © Ingal Maxwell

On the basis of collected information it should be possible to draw up for submission and presentation to the client, building owner or approving authority a number of relevant recommendations. To offer meaningful HBIM documentation this information might be developed and presented in two standard formats - the Conservation Plan and/or the Maintenance Manual - within a strategic framework such as that outlined in Step 3.0.

However, a broader requirement underlies any form of physical intervention, and this emerges in the shape of an Integrated Loop. This cycle reflects the reality of most existing structures during their life where they inevitably have undergone a series of changes. In an era when a growing recognition is emerging of how finite our historic built resources actually are, there must be an increasing recognition of the need to ensure that the existing building stock is sustainable in its own right. Key factors in this process should involve recognising the energy-embodiment that already exists in each structure and the need to ensure an appropriate service life for each exercised intervention and decision. Effective record keeping will emerge as being a significant element in this process.



Step 3.1: Conservation Plan

The conservation plan should present an overview of HBIM work that is required to be done against an established understanding of the issues involved.

Within a structure outlined in Step 3.1, topics relevant to the plan might include detail on-

- Defining the parameters of urban spaces
- Policy making requirements in social, cultural and architectural terms
- Assessing the effects of tourism, linked analysis and relevant economic issues
- Translating conservation needs into renewal project planning processes
- Effecting appropriate surveying techniques
- Defining the relevant level of repair work
- Undertaking effective building maintenance

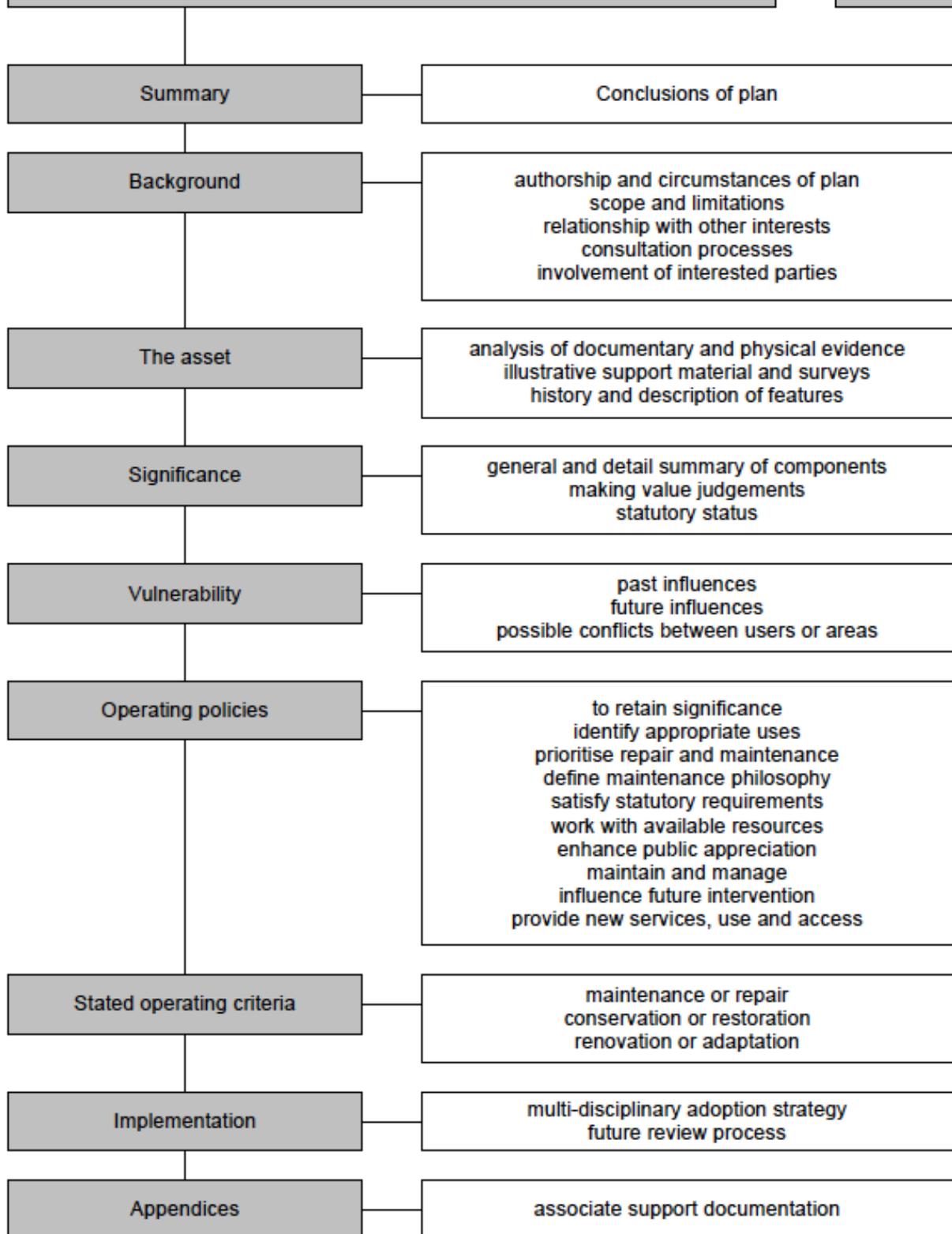


Norwich IMG_2641: False work and adequate protection will be called for as work progresses. © Ingval Maxwell

It is suggested that such a document should incorporate the considerable range of topics already examined as part of the suggested Framework Evaluation Criteria procedures. This could entail either the development of existing methodologies, or the recasting of current procedures to produce a more focused approach.

The Conservation Plan

3.1



Step 3.2: Maintenance Manual

The ultimate aim of any evaluation process should be the production of a meaningful package of relevant documentation that will assist in the aftercare of the site, building, or buildings, which it purports to assist. The maintenance manual, the outline of which is set out in Step 3.2, should record planned actions taken, and contain key reference material for future needs.

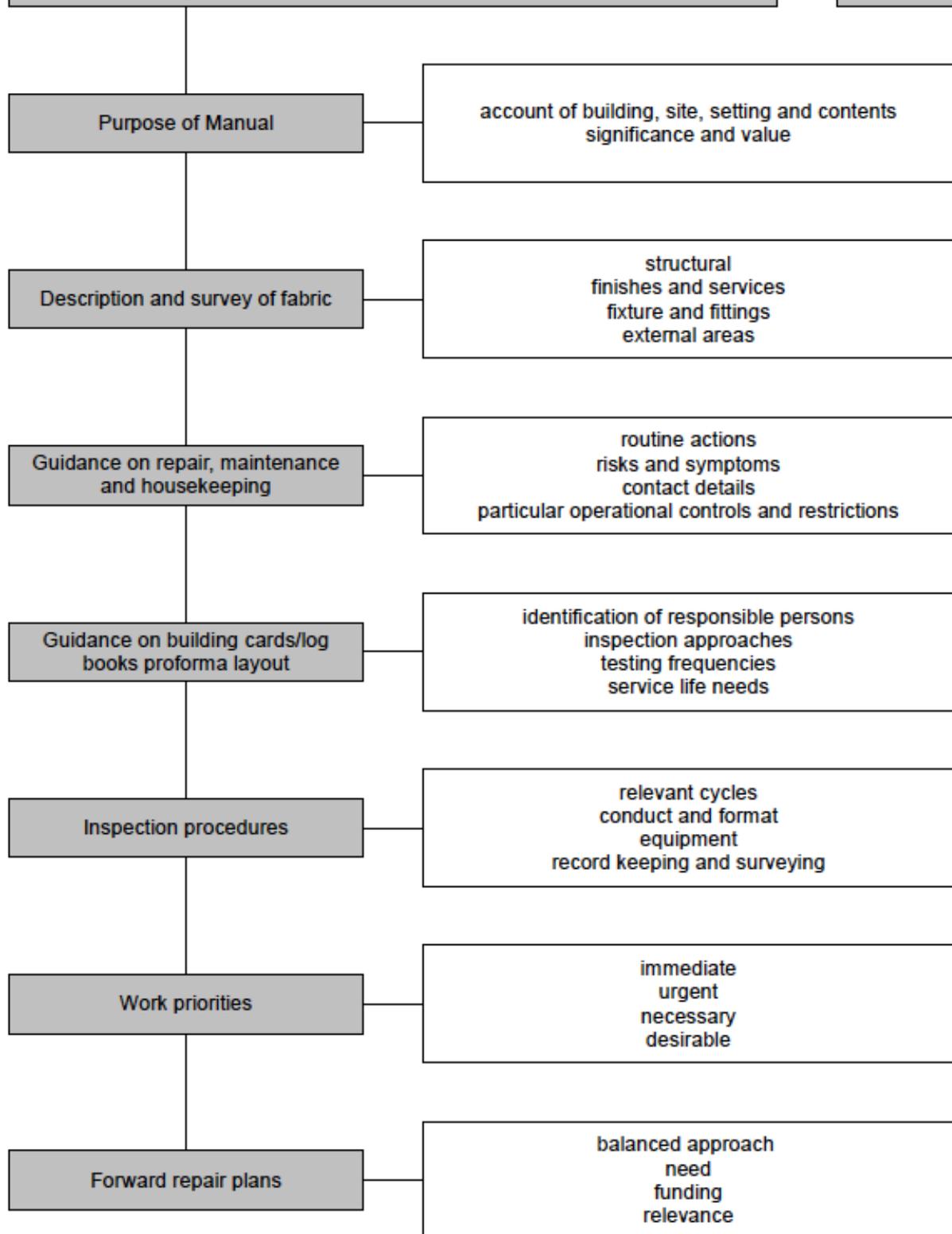


Glasgow DSC01797: Variants can also be found in otherwise repetitive elements. © Ingval Maxwell

This document should be prepared in the form of a prescribed template, so that its relevance can be upheld, irrespective of the subject under consideration. Advice on how to undertake necessary housekeeping, repair work and maintenance should be offered, and guidance given on relevant tests, trials and monitoring needs. It should also help define alternatives to established problems so that the most relevant approach can be considered and prioritised for future adoption.

The Maintenance Manual

3.2



Step 3.3: Perception of Service Life

The building technology normally adopted in the construction industry sector is principally designed for new buildings. Their service life is also mostly undefined but suggested to be some decades (50-60 years) and, in rare cases, to be around a century. The planned service life underlies this technological norm, and the associated attitudes to it pervade current industry thinking and education. Inevitably, buildings erected with a more limited design life will likely be built with materials and components only durable enough to avoid extensive maintenance and repair during that period. Such maintenance free materials and components are regarded highly by the market, and are often regarded as being synonymous with durability.

Much research and development within the building materials sector aims at better durability, thus increasing the service-life of the product. 'Durability' is perceived as a word of honour, 'low-maintenance' another. Components needing repeated maintenance are not favoured. Each repair is regarded a failure, repeated repair almost a catastrophe. Durability, however, is time dependent. Components and materials do not last forever. The reality is that different parts of a building have dissimilar service lives. The load-bearing structure lasting longer than windows or doors, interior surfaces last longer than exterior ones. Also, service life is affected by different compositions - concrete lasts longer than timber, granite being more durable than concrete. In practice, the more vulnerable parts of a building will have to be maintained and repaired, or even replaced, whilst other parts continue to perform without need for attention.

On analysing the cost of repair and replacement work, the price of the new material or component is only a minor part. As they are not easy to be removed, the more costly element is generally the repair of the associated destruction occasioned by the removal of the part. The reason for this is simple. Because it is perceived that modern materials and components are planned to last (be durable), and be easily applied or mounted, future repair and replacement needs are generally not considered to be part of the original design or decision making process.

As ensuring long service life is one of the significant criteria to ensure the longevity of the existing built heritage, the application of building technology meant for the modest design life of new structures might not be the best choice. Indeed, for repeated repairs, it can result in a very destructive process in itself due to the harsh methods required for the removal of the supposed 'durable' materials and components. Properties regarded as being very positive factors when designing the 'durable' building are excellent adhesion; high mechanical strength; chemical resistance; a bond stronger than the component etc. turn out to be equally negative when the parts have to be taken apart, de-mounted, or removed. The monolithic design, created by the permanent fixing, makes repair work costly, and often very risky, to undertake.

A significant factor in the effective maintenance of the built heritage is the need to accommodate repeated actions of repair and replacement. To achieve this it is necessary to turn away from the common acceptance of the ideas of 'Durability' and 'Maintenance Free' elements. Whilst 'Durability' in itself is a positive issue, it must be combined with 'Repairability' and 'Replaceability' factors for it to be fully effective in performance. This, in

turn, means that the ability to take components apart, to make them easily removable, should be as equally an important design criterion as durability. To be more effective in considering future needs of the built heritage, those responsible must start thinking about 'durability, combined with removability' instead of 'durability and maintenance free'. To ensure a 'long service life', technically appropriate maintenance methods must be evaluated against the criteria of 'efficiency, durability and removability'. This concept is equally alien to those who producing new buildings, and to most people involved in maintenance work. Associated factors are set out in Step 3.3.



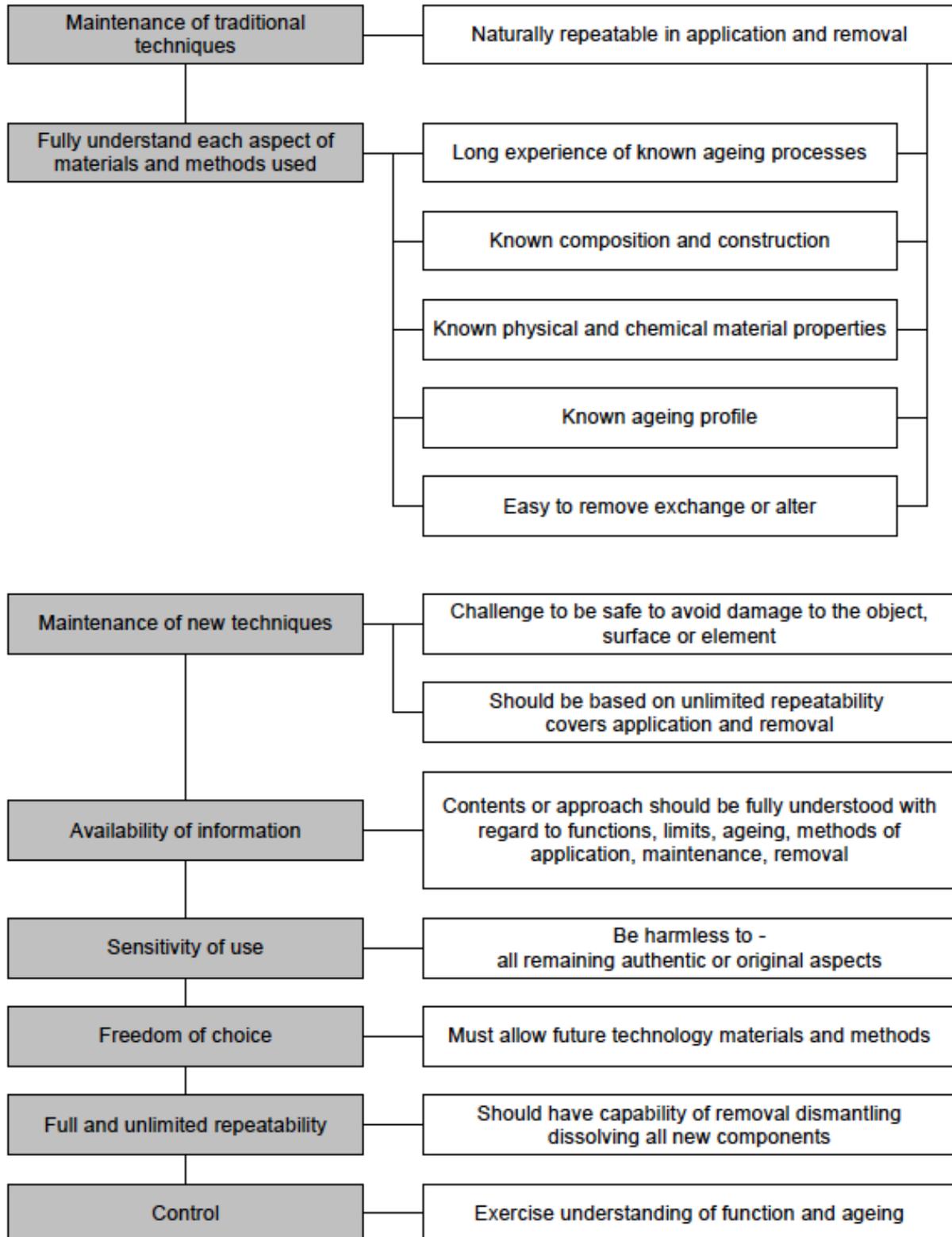
Falkland DSC08759: Variations contribute to the sense and continuity of a place. © Ingal Maxwell

As service life is only one of the significant criteria constituting the built heritage, it is not enough that a maintenance approach should only meet the technical criteria of long service life. The other significant factor is that the cultural value of its 'authenticity' should not be falsified.

Part of this cultural authenticity is the buildings' traditional (historic) materials, its form, design and workman-ship in addition to its location, use, function, spirit, feeling etc. This requires that appropriate HBIM technologies should respect these values so as not to falsify the significance. Performance in use has shown that, generally speaking, the use of traditional materials and methods are better at maintaining the cultural value than new ones. Whilst new materials, components and methods should not be excluded from consideration they must be used in such a manner that they do not diminish, destruct or falsify inherent significance or value. The technical criteria of Removability must also respect these factors. Ideally each and every added substance should be capable of being removed without damaging, or adversely affecting what it has been applied to. But, in the practice, decisions involving a compromise will be inevitable. Put simply, full access to the historically available portfolio of traditional building materials is no longer possible, so alternatives will need to be considered. Determining how effective these will be in service greatly adds to the dilemmas of decision-making in an HBIM context.

Perception of Service life

3.3



Step 3.4: Intervention Strategy: The Integrated Loop

In addition to all the associated values resulting from the depth of associated details being considered it needs to be borne in mind that each building or structure also contains a considerable reservoir of embodied energy. With each component resulting from an inherent process, the building sequentially aggregates energy as it is won, manufactured, tooled, worked, transported and manoeuvred into position. Within the existing building stock all this gain has already happened but, more often, glossed over. In a world where a growing awareness of sustainable needs is emerging critical there is a fundamental requirement to have this stored energy input more fully recognised. To disregard doing so is doubly wasteful given the additional energy demands needed to demolish what remains and to build afresh.

To avoid unnecessary loss an integrated loop of strategic HBIM thinking is required. Step 3.3 outlines such a framework where Conservation Plan and Maintenance Manual inform the remedial work schedule, following which routine monitoring of works and an understanding of the degrees of repeatability in service life, can confirm its effectiveness. This in turn, can inform Plan and Manual updates whilst also accommodating new influences and changes of use.

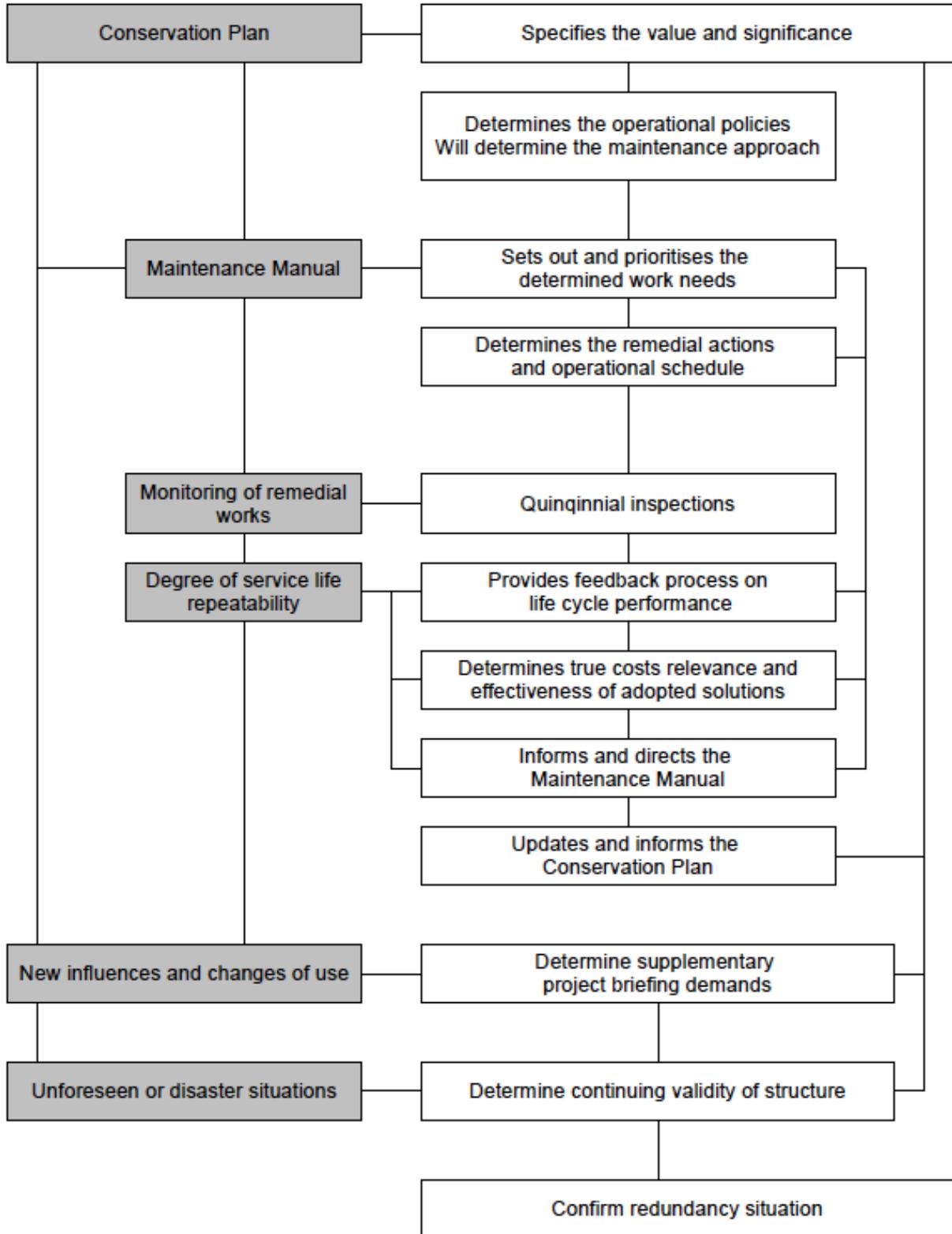


Laxey UAV Survey DSC04691: UAV Survey in progress. © Ingval Maxwell

The underlying need in an era of sustainability thinking is to recognise the true value of what has been previously built and determine ways of ensuring its continuing validity. Inevitably, there will be occasions where a redundancy situation will arise but with a greater acceptance of the energy embodiment case, a more reasoned argument to ensure survival should emerge through core HBIM considerations.

Intervention Strategy: The Integrated Loop

3.4



Conclusion

As noted at the outset, bracketing the actual physical on-site work programme, two principle contentions emerge in the development of a fuller understanding of the factors underpinning an HBIM approach. These require:

- *An evaluation criteria for comprehensively determining the relevant historic importance and physical parameters of existing buildings, their neighbourhoods, and potential for degradation is required; and,*
- *The effectiveness of the methods and techniques used in their actual preservation work needs to be considered and determined to inform the next cyclical development of further adaptation and re-use*

Two principle problems have to be resolved when considering how to address the first contention - that of determining what is historically important, and that which constitutes degradation. By concentrating on the 'historic' existing building stock, undue emphasis might only be given to legislative 'quality', whereas current conservation practices, as expressed through the International Charters, potentially gives a variety of other emphasis e.g. aesthetic, technical and social. Combine, such comprehensive aspect needs to be fully recognised and considered. In do so the key words identified in the various Step charts 1.1 to 3.4 aims providing some support to aid the process.

The determination of what constitutes degradation is also needed to help differentiate between adopting one technical solution over another, and between one functional intervention and another. This implies that the technical and functional efficiency of possible solutions might have to be established initially. Then, additional historic criteria, specific to preserving the quality of historic importance, could come into play before deciding on its relevant effectiveness whilst still retaining appropriate quality and value.

As collectively indicated in this Part 2 Report, a considerable range of issues need to be addressed and holistically integrated in the HBIM process in moving towards adopting a specific physical intervention in the intermediary, but critical, additional Step 2a – deciding on what actually happens on site. In this process, which will be site specific, additional challenges can readily emerge during on-site activities. In accordance with generally accepted conservation principles, the consequential decision-making will require a sensitive consideration in the need for adopting a methodology that respects:

- Minimum intervention
- Minimal loss of existing fabric
- Reversibility and repeatability
- New work being distinguishable from old
- Minimal loss of the aesthetic integrity of the whole.

The resolution of such a Step 2a will be best addressed through the analysis of a series of relevant Case Studies, and how these fit within the Integrated Loop associated with an HBIM approach. This will be dealt with in the related Part 3 Report

Annex: Definition of Key Terms

There is a range of terms used in the Framework Evaluation Criteria. Whilst these terms can be partially defined by reference to Standard English dictionaries, more explicit definitions can be found in a variety of conservation charters and conventions, including:

Alteration	Work, the object of which is to change or improve the function of a building or artefact or to modify its appearance.
Conservation	Action to secure the survival or preservation of buildings, cultural artefacts, natural resources, energy or anything of acknowledged value to the future
Conversion	Alteration, the object of which is a change of use of a building or artefact, from one use or type to another.
Design	Abstract concept of a building or artefact. It can exist in the mind and realised, it can be represented in the building or artefact itself.
Durability	The capability of a building, assembly, component, product or construction to maintain serviceability over at least a specified time.
Fabric	Physical material of which a building or artefact is made
Intervention	Any action which has a physical effect on the fabric of a building or artefact
Maintenance	Routine work necessary to keep the fabric of a building, the moving parts of machinery, grounds, gardens or any other artefact, in good order
Management	Activities appropriate for maintaining the feature or area in good condition
Preservation	State of survival of a building or artefact, whether by historical accident or through a combination of protection and active conservation
Protection	The provision of legal restraints or controls on the destruction or damaging of buildings or artefacts, natural features, systems, sites, areas or other things of acknowledged value, with a view to their survival or preservation for the future
Rebuilding	Remaking, on the basis of a recorded or reconstructed design, a building or part of a building or artefact that has been irretrievably damaged or destroyed.
Reconstruction	Re-establishment of what occurred or what existed in the past, on the basis of documentary or physical evidence.
Record	The description, depiction and analysis of any feature or area using drawings, survey, photographs and any other suitable means as well as the preservation of documents, photographs and other material relating to the feature or area in an earlier condition or use
Refurbish	To partially renovate or restore to former good condition
Rehabilitation	The modification of a resource to contemporary standards which may involve adaptation for new use
Renovation	To make, repair or restore into a sound state so as to be almost as good as new

Repair	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 or which is to return the building or artefact to good order, without alteration or restoration
Replication	Making an exact copy or copies of a building or artefact
Restoration	Alteration of a building or artefact which has decayed, been lost or damaged, or is thought to have been inappropriately repaired or altered in the past, the objective of which is to make it conform again to its design or appearance at a previous date,
Reversibility	Concept of work to a building, part of a building or artefact being carried out in such a way that it can be reversed at some future time, without any significant damage having been done.
Serviceability	The capability of a building, assembly, component product or construction to perform the function(s) for which it is designed and used.
Service life	The period of time after installation during which all essential properties meet or exceed minimum acceptable values, when routinely maintained.
Sustainability	Using the heritage in a way that meets the needs of today without compromising the ability of future generations to understand, appreciate and benefit from the historic environment.