The Legacy of 1960's University Buildings

A Report Commissioned by AUDE and Supported by HEFCE

March 2008

hefce HIGHER EDUCATION FUNDING COUNCIL FOR ENGLAND

AUDE

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Foreword

Deciding whether to refurbish, redevelop or simply demolish buildings that no longer meet our needs and aspirations is a complex matter, and one that is particularly relevant to the university sector. The University of Birmingham saw 2.5 million square feet of new floor space completed in the 60's and 70s. That rate of growth was not unusual for the period, and it helps to underline the scale of the legacy that the sector now faces and the importance of effective analysis and evaluation in determining the future of such buildings.

The illustration on the cover is a case in point; it shows an image of one of the 'legacy' buildings at Birmingham, the Muirhead Tower, after refurbishment. The relatively harsh aesthetic of the building is not to everyone's taste and the decision to refurbish the building rather than redevelop the site was not an obvious one. It involved considering a wide range of factors from basic financial and technical issues to questions of aesthetics, environmental impact and the value of preserving those links that trace the development of the University campus through history. Only time will tell whether the tower has an important role to play in the heritage of the University, but in the meantime, we can be confident that thoughtful refurbishment will give the iconic structure a new lease of life and provide the high quality facilities demanded by a new generation of staff and students.

Professor Michael Sterling,

Vice-Chancellor,
University of Birmingham.

1. Executive summary: Dealing with an ageing academic estate

This report considers one of the big issues in Higher Education today – how to renew a very large proportion of the property portfolio that was built in the 1960's. The key question is:

Refurbish or Replace?

Using case studies, alongside research into how other sectors have addressed these same issues, this report provides a 'toolkit' and helpful advice to assist institutions in making these difficult decisions.

Little or no research has previously been undertaken within the sector, and in particular there has been no effective way of assessing the sustainability issues relating to this key decision.

4 Key Points from the Study:

- **Academic buildings can often be refurbished more successfully than residential;**
- **While the financial case for refurbishment might look poor, with costs in some cases as high as 80% of new build, there are often significant other benefits from the refurbishment route, particularly environmental ones;**
- **High standards of environmental performance can be achieved on refurbishment projects, provided that objective is at the core of the design from the outset; and**
- **Architectural excellence can still be achieved in refurbishment projects.**

Ten case studies of projects within Higher Education have been considered. What soon became apparent was that the decision to replace or refurbish a given building is largely determined by factors specific to the institution concerned, at that particular moment in time. However there are some common threads which influence whether successful refurbishment is likely to be achieved, such as:

- Floor to soffit[1] height
- Good vertical access for services
- A frame structure, in sound condition with a suitable grid
- Good vertical movement for building occupants

As noted in the 'Key Points' above, residential projects often more easily justify replacement than non-residential projects, which in turn tend to more commonly adopt refurbishment solutions. This seems to be because residential projects can more easily support the larger capital expenditure associated with demolition and replacement and, can demonstrate a more robust business case. This was certainly the case in the Royal Holloway case study.

While there has been very little evidence available from central agencies associated with the office, health and defence sectors, it is clear that they have encountered similar issues. The report provides a commentary to what has been happening in these other sectors, and contains case studies demonstrating some of the relevant commercial refurbishment projects with which Building Design Partnership, who have been involved in this project, have been associated.

There are good examples of refurbished 1960's buildings, both within HE and outside, that provide good quality, sustainable facilities, avoiding the increased environmental impact associated with demolition and replacement. The ENVEST[2] assessment of projects clearly shows that refurbishment will normally have much less environmental impact than new-build.

There are two specific 'tools' that have been developed as part of this project to help steer institutions to the right solutions.

The **Filter** is intended to assist Estates Directors, and others, to easily determine whether a project is likely to successfully support a refurbishment solution, from the Economic, Social, Vision and Environment perspectives.

The **Matrix** is intended to be used by a project design team to enable various options to be assessed in terms of sustainability issues.

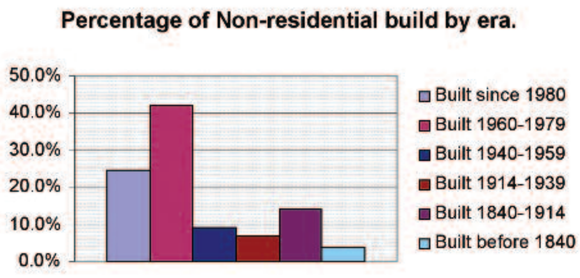
1 The exposed underside of any component of a building
2 Envest is a software tool developed by the BRE (Building Research Establishment) that can be used to evaluate the environmental benefits or disadvantages of design decisions

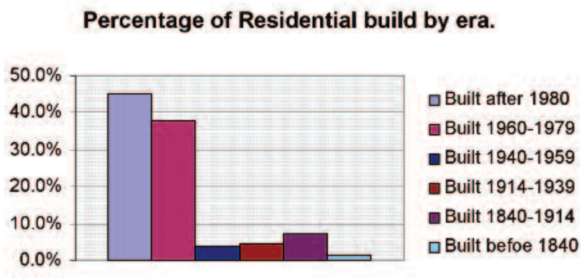
2. Background to the Report

2.1. This report is the output from a research project which is essentially an assessment of good practice in relation to the re-use or replacement of the 1960's buildings. The demand for the project arose from Estate Directors though their membership of AUDE[3] at discussion in regional meetings. Following consideration by the AUDE Executive, the project was considered to be sufficiently beneficial to the sector to warrant financial support. For example at the University of Bath alone, the Estate Strategy identifies nearly £40M of investment decisions that will need to be taken which directly impact 1960's buildings.

2.2. Buildings constructed and planned during the 1960's and early 1970's tend to exhibit a common range of characteristics which often make effective refurbishment and adaptation for future use difficult to achieve, disruptive and costly.

2.3. EMS[4] research indicates that in England, over 40% of the university estate was built between 1960 and 1979 with much higher percentage figures applying to some institutions including Bath, Sussex and the University of East Anglia.





2.4. While a range of specific problems, such as dealing with deleterious materials, relating to this era of buildings, have been addressed by organisations such as the Building Research Establishment and the Health and Safety Executive, little has been done to assess buildings from the sustainability standpoint nor develop guidance on the refurbish or replace question.

2.5. In the private sector, commercial buildings of this age are usually of a 'stand alone' nature and not located on any equivalent of a university campus. The operators of such buildings have a range of choices available to them such as disposal, relocation, change of use, rent adjustment, which are not generally available in the same way to those managing a university estate

2.6. Following discussions with HEFCE[5], it was agreed that the subject matter may be suitable for funding support under the Leadership, Governance and Management Fund initiative.

2.7. Notification that a Stage One application for partial (50%) funding was approved was received in December 2006. The Stage Two approval was received in March 2007.

2.8. To take the project, AUDE appointed firstly a project manager, John Burton of B2 Solutions Ltd and then Sustainability and Cost Consultants, BDP Sustainability and Clarus PCM.

2.9. The overall development of the project was supervised by a Steering Group comprising:

Patrick Finch
Director of Estates, Bath University,
Deputy Chairman of AUDE,
Chairman of the Steering Group

Ian Barker
Director of Estates, University of Birmingham

Roger Bond
Director of Estates, University of East Anglia

Derry Caleb
Director of Estates, University of Surrey

David Kirkwood
Director of Estates, University of Sussex

Jeremy Lindley
Director of Finance, University of Exeter

Andrew Nightingale
Director of Estates Management, University of Essex

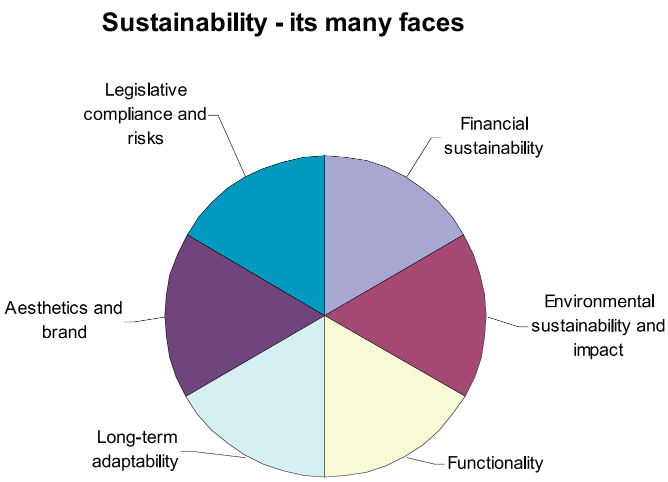
Alex Pettifer
Director of Facilities Management,
Sheffield Hallam University

Mark Swindlehurst
Director of Estates, University of Lancaster

3 Association of University Directors of Estates
4 Estate Management Statistics; which are collated nationally for the HE sector
5 Higher Education Funding Council for England

3. Purpose and scope of this report

The purpose of the report is to provide an assessment of how institutions have been handling the issues relating to unsatisfactory 1960's building stock, to identify best practice procedures and to provide a toolkit to assist institutions in making informed decisions, in terms of the following sustainability issues:



3.1. Financial sustainability (including lifecycle costs and lifecycle benefits e.g. increased space occupancy).

3.2. Environmental sustainability and impact (including energy conservation and embedded carbon considerations). This will include the embedded carbon assessment relating to possible demolition options.

3.3. Functionality (i.e. current functional suitability and / or adaptability to meet current standards).

3.4. Long-term adaptability (i.e. future flexibility as requirements change again over a period of years).

3.5. Aesthetics and brand (enhancement / support for the university image / brand).

3.6. Legislative compliance / risk (i.e. something may not comply but is acceptable / manageable).

Additionally, from the outset, it has been considered that there is merit in extending the exercise to embrace Post Occupancy reviews of any completed projects which emerge through the case studies and, to later projects undertaken in the light of the advice and guidance resulting from this exercise. AUDE intends to support this extension of the project

4. Scale of the problems and range of approaches adopted

4.1. As previously indicated, EMS research indicates that in England, over 40% of the university estate was built between 1960 and 1979 with much higher percentage figures applying to some institutions such as Bath, Sussex and University of East Anglia. At Bath, the Estate Strategy indicates that investment decisions with a total value of circa £40m, to repair and make buildings compliant with statutory requirements, will be under consideration in relation to buildings of the 1960's era. A conservative estimate of the replacement cost of all 1960's buildings within English university institutions is circa £ 11 billion[6], excluding demolition and decanting costs.

4.1.1. Problems which relate to 1960's buildings are often associated with;

- Asbestos insulation and asbestos containing materials
- Single pipe heating systems
- Lack of adequate zoning of heating circuits
- Full fresh air ventilation systems
- Single glazing
- High alumina cement
- Panel cladding systems
- System building techniques
- Deep plan buildings

4.2. In undertaking the project, all HE institutions nationally were approached and asked to submit brief details of any project relating to the major refurbishment or replacement, completed or planned, relating to 1960's and early 1970's buildings. In total twenty nine responses were received. Seven institutions have been visited in relation to ten projects considered as case studies.

4.3. Option appraisals would appear to have been undertaken in all cases, though local circumstances may limit the range of options considered. While some case study projects have compared a range of options relating to new build, refurbishment, and perhaps a combination of the two, others have started from the assumption that the project will relate to refurbishment only.

4.4. A range of methods has also been employed for the options appraisals that have been reviewed. From the sample studied, it appears that there is not a consistent method of appraisal for development options that addresses the wider sustainability issues.

4.5. One institution felt it was restricted to refurbishment because of planning restrictions, at that time, which precluded increasing the developed footprint of the campus. Although refurbishment costs were high and the refurbished space had operating constraints, it was still considered that this had been the appropriate option.

4.6. Seizing the opportunity to secure and convert embedded space within an NHS building, close to other related research activity, outweighed some cost issues and limitations of not being able to upgrade fenestration and incoming services. The resulting project has provided high quality research laboratory facilities in an ideal location but at high cost.

4.7. While refurbishment will always improve a building, the outcome may not generate benefits sufficient to merit the expenditure, or may not offer the best return on investment. This was the conclusion of one institution when considering how to improve the quality of its residential accommodation. Refurbishment would have still fallen short of achieving standards sufficient to allow rental income to increase. Thus there was no income stream to fund a refurbishment project, whereas demolition and replacement provided attractive facilities, fully addressing student and conference needs and providing an income stream capable of funding the project.

4.8. While past changes in legislation may have been addressed to a large degree by changes in management regimes e.g. asbestos, disabled access and water hygiene, the compromises which such approaches may involve, should not be accepted indefinitely. At some stage, such issues collectively warrant solutions which will involve either demolition and replacement of the building or a major refurbishment programme.

4.9. When considering options, the 'do nothing' option, in reality, will probably entail undertaking a significant amount of work, incurring significant expenditure but, at the same time fail to generate any additional income to fund the work.

4.10. The Listing[7] of a building or its potential Listing, particularly when viewed alongside programme requirements, can readily preclude any serious consideration of demolition and replacement. This has been the case at two institutions. In one instance, potential Listing as the result of interest by a local amenity group justified focussing on what could be achieved by refurbishment rather than demolition and replacement. In the other instance, a residential building which is Listed is also considered to be 'iconic' and so closely linked to image and brand of the institution, that refurbishment, even though it imposes constraints and costs, is the only realistic way forward.

4.11. Refurbishment, particularly if extensive, can attract a high level of risk in terms of cost planning. One institution considered this level of risk, along with other risks associated with refurbishment, to be too great and as a

result chose to demolish and replace. A second institution chose major refurbishment as it would avoid delays likely to result from a planning application to demolish and replace and then allocated sufficient resource to quantify the cost risks before proceeding. A third institution has chose major refurbishment as the only route to provide appropriate use of redundant space within a much larger building sited in a prestigious, strategic location.

4.12. A project involving major refurbishment and a new build extension has proved to be the way forward for one institution. This has allowed the reuse of a building vacated following a rationalisation exercise and provided specialist space in adjoining new build. The remodelling of space and new external cladding to the refurbished element has resulted in an attractive and very functional facility, highly regarded by its occupants.

4.13. Some buildings prove to be highly flexible in providing scope for remodelling space and when suitably located, become ideal candidates for refurbishment. One institution appears to have taken future flexibility issues into account when undertaking original construction. Now, generous floor to soffit heights and a good distribution of large risers facilitate conversion to new uses. While such buildings maintain structural integrity, it is difficult to see why remodelling to meet further changes in use, should not occur.

4.14. Interior design and the resulting image of refurbished space can vary significantly. Some refurbishment projects appear to have been successful in meeting their fundamental requirements, yet still retain overriding characteristics or just impressions of the era of the original construction. Others manage to achieve the internal 'feel' of a new or at least more modern building.

4.15. Time scale can be an overriding factor in determining whether to refurbish or replace. Provided that that the building is not Listed, then a refurbishment solution is unlikely to attract the planning approval delays and risks which will apply to a demolition and replacement proposal. The likelihood and extent of such delays needs to be assessed on a project by project basis, at the earliest possible opportunity.

6 Based on a construction cost of £3200 per m2 and 40% of a non-residential estate of 8.4 million m^2

7 The word 'listing' is a short-hand term used to describe one of a number of legal procedures which help English Heritage to protect the best of our architectural heritage. When buildings are listed they are placed on statutory lists of buildings of 'special architectural or historic interest' compiled by the Secretary of State for Culture, Media and Sport under the Planning (Listed Buildings and Conservation Areas) Act 1990, on advice from English Heritage. Listing is not intended to fossilise a building. A building's long-term interests are often best served by putting it to good use, and if this cannot be the one it was designed for, a new use may have to be found. Listing ensures that the architectural and historic interest of the building is carefully considered before any alterations, either outside or inside, are agreed.

5. Cost of space – refurbishment and replacement

5.1. The cost of refurbishment versus the cost of redevelopment is more often than not driven by the extent of adaptation that is required to create a modern facility, particularly relative to the intended use of the building. For example the needs for an administrative building can be more easily accommodated into an existing building than a science building.

5.2. In addition, the other factors which can influence the decision to refurbish or redevelop will override the financial benefits of the most favourable choice.

5.3. Whole life costs should be properly considered when embarking upon a capital project, as operational cost benefits over the duration of a building's life may be used to justify additional capital cost at the time of construction. While funding streams are usually related only to the initial capital cost, the inclusion of robust whole life costing elements should receive favourable consideration.

5.4. Additional costs which may influence the balance between refurbishment and replacement relate to any need for Section 106 Agreements, Environmental Impact Assessments, and decanting space.

5.5. As indicated by the case studies, the financial cost of major refurbishment can be close to the cost of demolition and replacement. In such circumstances, assessment of whole life costs is particularly useful in potentially giving greater clarity to option assessments.

5.6. No two projects will have the same considerations and what works for one project as a set of criteria will not work for another. However, stakeholders whether they be, for example, funders or research staff, expect their criteria to be met and donors in particular expect to see a 'good return' for their investment.

5.7. Unlike the commercial sector, universities and educational establishments are not driven by the need to satisfy shareholders and make a bottom line return on their projects. However, options may be limited by the need to address local agendas.

5.8. In addition to basic capital costs, commercial developers have the luxury of not only considering whether to refurbish or redevelop, but also location, which can also have a dramatic impact on cost. Conversely, universities do not have that luxury of choice on site locations, whether it be within the confines of a campus or an inner city site, although the premium for releasing inner city sites may be a great attraction in raising capital where there is an option to develop on cheaper city outskirt sites.

5.9. Whilst this report relates to the legacy of 1960's buildings, which was a time of rapid expansion in university buildings, the same principles could be applied to other buildings whether older or newer.

5.10. There is little to show in the case studies that have been gathered that there is a clear link between costs, the decision to refurbish and sustainability considerations.

6. Sustainability – its many faces

6.1. The end of the 20th Century and beginning of the 21st has seen a great increase in international awareness and recognition of the importance of sustainable development to the future of our planet. Perhaps the most widely accepted definition of sustainability was one which was set out in the Brundtland Report[8] of 1987 – 'meeting the needs of the present without compromising the ability of future generations to meet their own needs.'

6.2. Sustainability can be defined as consisting of three primary facets. These are the social, environmental and economic considerations that make up a balanced, holistic approach to sustainability, and are often referred to as 'the triple bottom line' of sustainability. The toolkit that has been developed from this project provides analysis of the refurbishment potential for a 1960's or 1970's building based upon these three primary criteria.

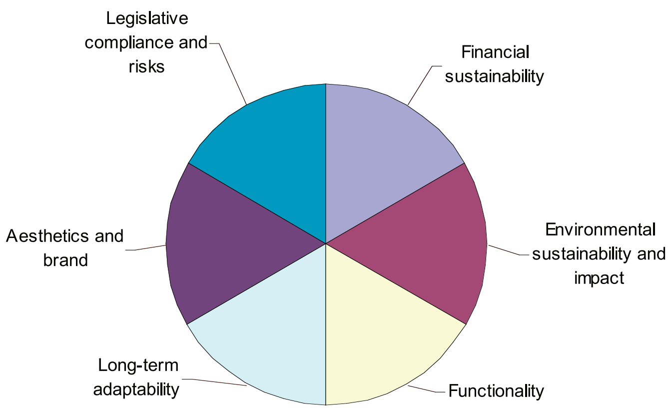
6.3. Sustainability has been accepted as the approach by which this project be tackled. To quote from 'High Performance Buildings-2. The Process of Delivery for Universities and Colleges', *Ultimately all universities and colleges will adopt such an approach – forced by impending legislation, rising energy costs, tightening of building regulations and changing stakeholder expectations. Those who anticipate the trend can avoid associated additional fuel bills, expensive retrofitting measures, and other costs which will impact on their less proactive peers. They will also benefit from enhanced reputation, and from improved well being and productivity of building users.*

6.4. In the commercial world Corporate Social Responsibility which embraces both environmental and sustainability issues is of increasing importance to both customers and shareholders and the performance of one or other major company is seldom out of the news. It cannot be long before universities and colleges are given equal prominence for their environmental and sustainability performances.

6.5. In the context of university / higher education estate, the key issues that sustainability has been considered as embracing are:

- Financial sustainability including lifecycle costs and lifecycle benefits e.g. increased space occupancy.
- Environmental sustainability and impact, including energy conservation and embedded carbon considerations (including those relating to a demolition process)
- Functionality i.e. current functional suitability and / or adaptability to meet current standards.
- Long-term adaptability i.e. flexibility to meet the requirements of change, over a period of years.
- Aesthetics and brand i.e. enhancement / support for the institution's image or brand.
- Legislative compliance and risks associated with accepting and managing non-compliant buildings.

Key information in the case study reports has been summarised under the above headings.



6.6. Financial sustainability

6.6.1. Universities and other HE institutions operate with very different objectives from those adopted by most commercial companies. Universities can take a long term or open ended view of future development and operation and are not generally planning to release asset value and 'move on'. However, institutions must be able to satisfy themselves and other stakeholders, that each project provides both optimum value and sustainability. While institutions may of course dispose of sites or buildings and may consolidate in specific locations, property management is good practice and a means to an end, but property development with the sole aim of disposal, is not a core business activity.

6.6.2. Institutions are often faced with a very difficult task of creating a realistic and robust financial assessment of financing, construction, furnishing, operating, periodic maintenance and periodic refurbishment costs, to set against various income streams. The dilemma is further complicated by the fact that utility costs and the consequences of utility consumption related legislation, are likely to change significantly over time.

8 The Bruntland Report, or Our Common Future, is the report made by the World Commission on Environment and Development in 1987. It is often called the Bruntland report after the chairperson of the commission, the then Prime Minister of Norway, Mrs Gro Harlem Bruntland.

6. Sustainability – its many faces

6.6.3. Financial option appraisals are now a generally accepted method of considering one potential project against another. While initial construction and other set-up costs can be forecast with reasonable confidence, along with those relating to cyclical and periodic maintenance and refurbishment, those relating to utility costs and consumption, in particular, need to be considered as part of a sensitivity analysis exercise and, this should be extended over the full life of the building / project.

6.6.4. Case studies reveal that the capital cost of a refurbishment project may be up to 80% of the cost of an equivalent re-build project. In this context, the building running costs are critical to the comparison of whole life costs between the two options.

6.6.5. It is evident that benefits of introducing water and energy consumption reducing measures, while possibly adding to initial costs, may have significant financial benefits over the life of the project. However, as many of the possible measures relate to the basic design of a building, they need to be borne in mind by the design team at the outset, not considered at a later cost engineering stage. The incorporation of such measures into a refurbishment project largely depend upon the original building fabric design i.e. floor to soffit height, depth of original floor plate and exposed thermal mass

6.6.6. Opportunities in refurbishment and remodelling projects include, but are not restricted to the measures indicated in the following table:

Passive Measures	Enhanced thermal performance glazing systems	Further Sustainable Technology Measures
• Where the opportunity exists, the floor to soffit height of the refurbished space should be increased. This is typically successfully achieved in the conversion of laboratories or other highly serviced space into standard teaching or administration accommodation, where services can be removed to create greater height.	• Maximising the benefits of BMS and other control systems e.g. to allow night-time purging and pre-cooling of thermal mass in building	• Use of renewable energy systems.
• External solar shading to prevent overheating in summer.	• Low energy use air-conditioning systems to be considered e.g. passive cooling systems, low-velocity / low-volume air distribution requirements.	• Rainwater harvesting systems.
• Maximising use of daylight by design of the façade and structure. This can be achieved through introduction of better fenestration arrangements, typically the introduction of high level glazing.	• Energy efficient zoning of heating circuits and lighting with daylight and occupancy linked controls.	• On-site borehole water supply.
• Maximising the heat / coolth storage properties of the building fabric by exposing thermal mass, e.g. concrete soffits or blockwork walls where possible. Alternatively greater provision of exposed thermal mass in the refurbishment partition walling should be considered.	• Replacement of sanitary fittings to low water use type.	• Installation of adequate metering to allow effective energy management.
• Maximising natural ventilation, minimising mechanical ventilation requirements.	• Introduction of water management control systems and leak detection equipment.	
• Optimising the zoning configuration of heating circuits.	• Use of CHP / tri-generation systems. This is often linked to the site-wide energy system and is not an isolated building consideration.	
• Enhanced fabric insulation. On a Listed façade this may not be possible to achieve, but in most cases there is potential for adding insulation as an over-cladding or internal dry-lining.	• Replacement of heating systems to allow low temperature output condensing boiler application.	
• Enhanced thermal performance glazing systems.		
• Overall improvement in air leakage to meet modern best practice standards where the replacement of wall and roof systems will allow		

6. Sustainability – its many faces

6.6.7. Benefits are not restricted to savings which may accrue in relation to utilities. The selection of specific materials or construction systems may offer life cycle savings not only in relation to their purchase cost, but also in relation to their cost in use.

6.6.8. To quote the Office of Government Commerce – *'Long-term costs over the life of an asset are more reliable indicators of value for money than the initial construction costs.'*

6.6.9. Building layout as well as technological features can significantly affect operational costs in relation to the provision of security services.

6.6.10. Striking the appropriate balance between the number and size of teaching rooms can have significant implications for space utilization and resulting costs. Equally important is the ability to change room sizes, and uses, over time as needs inevitably change.

6.6.11. Potential business risks need to be considered and will include ability and certainty of project delivery to programme. Refurbishment will have a shorter lead time than a replacement project.

6.6.12. A common issue for most of the case studies has been the absence of an easily accessible commentary on the various options considered and why a specific option was adopted. It is considered that records of how such decisions evolved are highly relevant when future / cyclical changes to a building are again considered.

6.7. Environmental sustainability

6.7.1. From an embodied environmental impact point of view, refurbishment is generally preferable to demolition and rebuild. This results from the lower environmental impacts of energy, water, volume of materials and extent of site operations, compared with demolition, disposal of waste materials and re-building. Environmental pollution due to construction site activities that lead to noise, dust and water pollution along with transport impacts are also lower.

6.7.2. Envest 2, a software package developed by BRE[9], was used to compare the embodied and operational impacts of two AUDE case study projects. The two projects are the refurbishment of the Vanbrugh block at the University of York and the rebuilding of Building 4 West at the University of Bath. These projects serve as a good comparison as both were originally constructed using the CLASP[10] system. Based upon this comparison, a typical refurbishment has approximately 30% of the environmental impact relative to a new build. See Appendix 3 for further detail of this study.

6.7.3. However, embodied environmental impact only relates to one stage in the life of the building. During the operation of the building the selection of materials and building services systems, along with the position and orientation of the building, will lead to ongoing consequences for the building and its occupants for many years. The Envest study has shown that the operational life of the building has a greater environmental impact than the embodied environmental impact.

6.7.4. The embodied environmental impact of the Bath 4 West new build represents 28% of the total environmental impact assuming a 30 year operational life.

6.7.5. The embodied environmental impact of the Vanbrugh block refurbishment represents 22% of the total environmental impact assuming a 15 year operational life.

6.7.6. Material choice has a very significant impact on embodied environmental impact irrespective of whether the project is a rebuild or a refurbishment.

6.7.7. All building and refurbishment projects need to be assessed in terms of life cycle costs and impacts, embracing operation and maintenance over the building's life, and not solely related to the construction / refurbishment phase.

6.7.7.1. In promoting environmental sustainability, a project should:

- Reduce demand for energy.
- Supply energy efficiently and reduce waste energy.
- Maximise the use of sustainable energy sources.
- Reduce the requirement for treated water.
- Maximise the use of rain water / grey water or other on-site sources.
- Reduce the amount of virgin materials used and construction waste.
- Use locally sourced materials to minimise transport.
- Make optimum use of land.
- Improve site biodiversity and habitat value.
- Create a high quality environment which people enjoy.
- Address safety and security issues.
- Promote the use of 'green' transport options.

9 the Building Research Establishment
10 the Consortium of Local Authorities Special Programme

6. Sustainability – its many faces

6.8. Functionality

6.8.1. At the time of original design and construction, buildings should be ideally suited to their intended use. However over time, user requirements generally change for any of a variety of reasons which may include:

- Change in teaching, research or administrative practices.
- Change in teaching, research or administrative volumes of work
- Changes in the 'market place' making adaptations necessary in order to compete with others.
- Social and legislative change.

6.8.2. For these and other reasons, buildings tend to become less functionally suitable and assessments are often made against the following criteria:

Effectiveness for use
Space utilisation
Use mix efficiency
Quality suitability
Internal circulation
Facilities for people with disabilities
Amenities and facilities
Environmental adequacy
Tenure arrangements
Building character
Location suitability

6.8.3. Features which allow overall functionality to be maintained as needs change, are worth identifying and assessing in value terms.

6.9. Long-term adaptability

6. Sustainability – its many faces

6.9.1. While all buildings offer some degree of adaptability there are marked differences between the 'good' and the 'bad' performers.

6.9.2. At the 'good' end of the spectrum buildings will have a generous floor to soffit height perhaps of 4.0 m while, poor performers may have only 2.4 m. Restricted ceiling heights limit the extent to which services can be routed or concealed, influence the scope to avoid mechanical ventilation and the depth of room for which natural daylight is adequate.

6.9.3. Steel and concrete framed buildings offer far more flexibility in changing space configuration than those relying on load bearing walls. Examples of projects in which a building has been capable of being stripped back to either the shell or the frame have proved highly successful.

6.9.4. The size of building and the scope of potential refurbishment will dictate whether or not work can be undertaken while the building remains in some degree of occupation and use. Refurbishment which involves the remodelling of space and extensive strip-out will be noisy and disruptive for anyone remaining in or even close to the building. On the other hand, less intrusive work within a large building may significantly reduce the impact of work in progress but is unlikely to avoid complaints from those trying to work normally elsewhere in the building. Health and Safety issues also require early and detailed consideration to avoid issues arising late in the day and possibly having a major impact on the practicality of continuing construction work while the building is partially occupied.

6.10. Aesthetics and Brand

6.10.1. These issues are now of major importance to almost every institution and project. The external appearance of a building makes a statement to all who see it and can say much about the ethos of its occupiers and its owners. Examples are readily recognised and include:

- Jubilee Campus – University of Nottingham.
- Portland Building – University of Portsmouth
- Oxtalls Campus – University of Gloucestershire
- Duke of Kent Building – University of Surrey

6.10.2. Putting a value on the appearance of a building is not easy and will always be open to debate, but there is now a widely accepted view that well designed buildings can influence recruitment, retention and performance of both staff and students. External stakeholders and potential stakeholders will also receive whatever message a building portrays.

6.10.3. While the external appearance will also speak to those who are merely passing by and have no current link with an institution, internal design will communicate with those who use a building, in many cases on a regular basis. While a strikingly good external appearance may impress the passer-by, the internal design needs to continue to impress and inspire on an often daily basis.

6.10.4. Older buildings may not address current requirements to reinforce or enhance the aesthetics or branding of an institution. While providing a replacement building creates the opportunity to address such shortcomings, refurbishment can also be successful if such mattes are addressed at the outset. The case study relating to the Muirhead Towers is a good example of creating what is anticipated to be a new 'icon'.

6.11. Legislative compliance and risks

6.11.1. Compliance requirements are seldom static for long as new legislation and Building Regulations are introduced. Sometimes new requirements are retrospective in application and on other occasions only apply to new constructions or when alterations are undertaken. When compliance is mandatory an institution has no alternative but to comply and the financial implications; implications for occupiers; age, condition and remaining life of the building; all need to be assessed.

6.11.2. When new requirements offer a degree of flexibility in adoption, an institution needs to consider the costs and advantages of undertaking the work against the risks of not doing so.

7. What are other sectors doing?

7.1. Public Institutions

7.1.1. Local Government and Public Institutions have parallels with the higher education sector in the provision of administration space, and information services such as public libraries. Similarly with the university sector, there was a local government estate building boom in the 1960's and 70's leaving a legacy in need of urgent attention.

7.1.2. Local government development projects tend to be funded from local taxes rather than from a central government pot. The critical driver in the decision making process on this kind of project tends to be keeping capital outlay to a minimum, and thus refurbishment tends to be the preferred route. Often this is the most economic and simplest route as there is not the same need for converting from one building use to another i.e. office space will usually remain as office space.

7.1.3. Arts and Culture estate across the country contains many iconic and heritage protected buildings that are driven towards refurbishment as a solution due to their heritage status. Also, as with local government projects, minimising capital expenditure also tends to be a driving force as there is generally a scarcity of budget for redevelopment in this sector, where many organisations are competing for lottery funding. Over the next few years this will particularly be the case as much funding has been directed towards the 2012 Olympics.

7.1.4. In the Arts and Leisure sector, refurbishment is also favoured as a solution as risk poses a major barrier to a new-build project. Unlike a university, an arts and culture institution may only own and manage a single building, and the estate management team will be small and have little skills and experience of managing the procurement of a new building project. This leap into the 'unknown' is a big risk for a small organisation to undertake and consequently refurbishment of existing Arts and Leisure is often the favoured solution.

7.1.5. BDP experience of refurbishment of Listed buildings in this sector shows that it is possible to deliver exactly what the client wants, despite the heritage restraints. It is therefore even easier to do this in an un-Listed building where there is more design freedom. The approach to making the best out of what already exists is key within this sector, where capital funds are tight. If the financial constraints were not there in the same way, then it is likely that most local government or arts / leisure clients would prefer to have a new building.

7.2. Secondary Schools

7.2.1. The schools post-war building boom began a little earlier to that of the university sector, in order to meet with the demand for secondary education of the baby-boomer generation. Therefore a lot of schools were built in the 1950's and 1960's typically with lightweight construction and system-build methods.

7.2.2. Building Schools for the Future is a current major £7bn building programme with improvements pledged to most secondary schools across the country. This is commonly being procured as framework packages through either PFI or Design and Build routes.

7.2.3. The procurement route has a significant impact on whether a school is likely to be refurbished or re-built. PFI projects require the contracting organisation to be responsible for management and operation of the building over a 25 year contract period. In this instance the contractor does not want to be liable for any structural or fabric defects inherent in an existing building and will therefore commonly only undertake a PFI project where there is a maximum of 5% retained building stock. The PFI route also promotes consideration of best Whole Life Cost, where operation and maintenance costs over the 25 year cycle become much more important to the decision making process.

7.2.4. This procurement route is therefore tending towards 'light touch' refurbishment, where existing buildings are of sufficient quality, at one end of the spectrum, and wholesale replacement at the other.

7.3. Healthcare Sector

7.3.1. During the early evolution of the NHS in the 1950's and early 1960's only a handful of hospitals were built, with the majority of the healthcare building boom occurring following a report by Enoch Powell in 1962 and continuing up until the late 1970's. The report set out an aspiration to provide a new District General Hospital in every local authority ward, and this growth was further fuelled by the public spending policy of the early 70's known as the 'Barber' boom' after the Chancellor, Anthony Barber.

7.3.2. This legacy of healthcare estate has generally suffered from a lack of maintenance over its lifetime, particularly with regard to mechanical and electrical services which are also now at the end of their 25 year design life.

7. What are other sectors doing?

7.3.3. There were aspirations for hospital buildings of the 60's and 70's to be designed with future flexibility and adaptability in mind. A notable approach was the 'Nuffield System' which allowed for interstitial plant floors at every other level. In general though, most of the legacy building stock is found to be quite tight in terms of services space provision.

7.3.4. When it comes to considering the refurbishment of a hospital, replacement of services is a very significant factor as it generally accounts for around 50% of the capital cost. Since all the hospitals of this era generally require mechanical and electrical services replacement, this adds a significant sum to the base cost of any project. It is of course possible to retain and refurbish much of the services distribution in hospitals, but this route is not commonly taken due to the difficulty in surveying and understanding the existing systems and being able to ensure their long term performance. This is an 'intellectual risk' that many consultants and clients do not wish to take.

7.3.5. Generally, as with other public sectors there are two funding streams for NHS Estate redevelopment. Central government funding is generally given to large, whole hospital redevelopment projects, where the key driver behind decision making has been a value judgement of the relationship between capital expenditure and quality of care provision. Around 10 years or so ago, there was a generally held unofficial rule within the NHS, that if the cost of a refurbishment was 70% or more of the cost of a new building then it would be preferable to demolish and rebuild.

7.3.6. Refurbishment projects on the other hand tend to have been carried out from local government or local trust block grant funding and are directed towards a more block –by-block approach to regeneration. In this instance it can be possible to decant from the hospital wing whilst the refurbishment work is undertaken.

7.3.7. PFI came in as the main contractual delivery vehicle for hospital estate around 15 years ago. The very first large PFI project at Swindon hospital considered all the options available but refurbishment was perhaps seen as too high an 'intellectual risk' and so an all new hospital was preferred instead, To a large extent this has been the pattern of all the major PFI renewal projects.

7.3.8. A classic case of where the risks associated with working within the constraints of refurbishing an existing CLASP building added significantly to the cost were at Greenwich PFI where the final cost ended up being significantly higher that that of a new-build.

7.3.9. Relative to the university sector, healthcare has also had relatively few Listed 60's and 70's buildings. It seems that the signature architects of the day did not enter into this sector so much, therefore there tends to be less heritage constraints placed upon hospital redevelopment projects.

7.4. Commercial Offices Sector

7.4.1. The 1960's and 70's legacy within the commercial offices sector obviously has many parallels to the general administration and some teaching areas within the University sector. Broadly speaking there are some differences between approaches to office design within the 1960's and 1970's.

7.4.2. The earlier designed office estate tended to be designed for natural ventilation and daylight and therefore had a relatively narrow plan and highly glazed façade, but was designed with a low floor to soffit height relative to today's standards, as there was not the need to incorporate mechanical ventilation or cooling distribution plant.

7.4.3. Strategy for office environmental design in the 70's moved more towards the comfort-controlled box, with a deeper plan space and much greater reliance on artificial lighting and mechanical ventilation. The facades of 70's buildings tend to have a greater proportion of heavyweight cladding and less glazing, as the design became more focused on a uniform artificial lighting environment.

7.4.4. In general the commercial buildings of the 60's and 70's are constructed from heavyweight in-situ concrete frame and were designed with the traditional office organisation of cellular spaces in mind. Consideration of future flexibility to allow ease of opening up the floor plate to open plan was not necessarily allowed for.

7.4.5. Perhaps the biggest changes in office design since this era have been changes in the organisation of the office working environment and practice, the big shift towards energy efficiency and the increase in the use of IT.

7. What are other sectors doing?

7.4.6. The ability to provide a high quality, flexible and inspirational work environment to all employees has become a key factor in the decision making process behind office redevelopment projects. Staff happiness, motivation and retention are now recognised as a key part of business success. A good illustration of how this may be achieved is shown in the BDP case studies for the BBC Mailbox project.

7.5. Conclusions

7.5.1. The drive towards improved energy efficiency and the condition of existing 1960's and 1970's facades means that provided the structural fabric remains sound, complete over-cladding with a secondary skin or replacement of the building façade is required on most refurbishment projects, additionally significant remodeling of lift and circulation cores is nearly always required to meet current legislative requirements.

7.5.2. Internally, the key factor on whether a refurbishment can meet the client's needs is the floor to soffit height available. The drive towards more sustainable, healthier internal environments requires good floor to soffit heights for improved natural daylight and more passive ventilation solutions. As shown in the BSkyB project, it was possible to remove an existing suspended ceiling and expose the thermal mass of the soffits.

7.5.3. In the university sector this can be achieved through the conversion of a former laboratory space into administration space, but may not be adequately achieved in the commercial sector where restrictive floor to soffit heights do not allow.

7.5.4. In addition, the increase in the use of IT has, in general, led to an increase in the requirement for mechanical ventilation and active cooling equipment at high levels and/or a raised floor at low level to allow flood wiring. This puts even greater pressure on the floor to soffit height and further discourages consideration of refurbishment as the preferred option.

7.5.5. With capital cost also being the other main driver for decision making, the decision to refurbish or rebuild often hinges on being able to provide quality and flexibility in the internal environment to meet modern working and sustainability aspirations, for a project cost benefit relative to a new-build equivalent.

8. Conclusions – Lessons Learnt

8.1. Refurbishment can provide good aesthetic and brand enhancement opportunities. An approach that embraces the original designer's aims and objectives will aid this process.

8.2. Refurbishment, if intended to create a quality environment and meet current aspirations, will not be a be a 'cheap option' and costs are likely to approach 80% of the cost of a new-build solution, but the environmental benefits compared against new-build, are potentially significant.

8.3. The Listing of some buildings results in consideration of their demolition not being a realistic option, or potentially causing an unacceptable risk and delay while planning approval is sought.

8.4. Similarly, where planning restrictions are unlikely to allow an increased footprint area or restrict the height of a new development, it can result in there being no net gain in accommodation space (or even a reduction) if demolition and re-building are considered.

8.5. Considering the potential to redevelop a particular building, is of secondary importance to wider university masterplan considerations and on-going projects, therefore this decision cannot be taken in isolation.

8.6. The potential for improvement to occupant comfort within an aging 1960-1970's building, is largely dependent upon the existing building fabric, particularly whether it is a lightweight or heavyweight building, room-depths and floor to soffit heights. Some internal structures may offer poor internal acoustic performance and may not be suitable for conversion to teaching space.

8.7. Buildings with a sound structural frame, of reasonable bay-widths, that are free from significant ties or bracing between columns, offer good scope for refurbishment and remodelling of space.

8.8. Cellular concrete structures have limited capacity to provide flexibility in remodelling space.

8.9. CLASP buildings offer limited options for successful remodelling

8.10. Ensuring that building access provision is compliant with current legislation and health and safety requirements, often requires that significant remodelling of the access core is required. This problem may be addressed as part of a new building extension to the existing.

8.11. Residential projects are capable of generating a robust financial business case which is likely to support replacement, rather than refurbishment. Income to fund a project is generated from student rents and use for supporting conference and other vacation use. Income from various standards of provision can be fairly accurately assessed.

8.12. Projects linked to academic and administrative facilities are likely to encounter greater difficulty in demonstrating income streams and as a result, preference tends to be towards lower cost refurbishment solutions.

8.13. An initial 'enabling works' contract can be used to eliminate areas of uncertainty and 'unknowns', minimising the areas of risk which a refurbishment contractor may otherwise be unwilling to include within the tender. This principle was followed for the Muirhead Towers and Proudman Institute projects while, for a residential refurbishment project, Surrey University decided to undertake a pilot project on a single house before arranging the contract to refurbish 55 others.

8.14. Some elements of risk are difficult to eliminate entirely through investigative survey work.

8.15. For refurbishment projects, asbestos related risks not only affect the construction area but other floors of the same building, as vibration work can cause fibres to dislodge and release.

8.16. Site specifics such as proximity to neighbouring buildings and access, may pose severe constraints to constructability of the project. Refurbishment rather than demolition may be favourable in such circumstances.

8.17. Refurbishment projects can be phased to accommodate the staged availability of funding or to minimise the need for decanting space.

8.18. In buildings constructed using systems such as CLASP, floor to soffit height, depth of original floor plate and thermal mass are also key factors in achieving a successful and energy efficient refurbishment.

8. Conclusions – Lessons Learnt

8.19. Thermal mass, whether introduced into new construction or retained or exposed in refurbishment, has significant potential benefits for thermal performance.

8.20. Building Management Systems offer scope to maximise the benefits of thermal mass.

8.21. Refurbishment generally has around 20% of the embodied environmental impact of an equivalent new building.

8.22. Refurbishment needs to address shortcomings in original designs, ongoing maintenance issues and reflect current legislative requirements.

8.23. Adaptation of 'embedded' space may impose restrictions on the scope of work which can be undertaken and may also result in higher than normal costs. [11]In such circumstances, the tenant has no real control over external fabric or incoming services such as heating and electricity supply. Additionally there may be noise and disturbance constraints which limit what alterations can be done, or when they can be done.

8.24. Refurbishment may not be a solution for one purpose but may offer a totally acceptable solution for alternative uses.

8.25. Environmental sustainability issues are often not considered or quantified in a structured manner at options appraisal stage.

11 In this context, 'embedded' refers to space occupied by the tenant within a larger area occupied and managed by others.

9. Introduction to Toolkit

The toolkit has been developed as an output from the case study research and with reference to other relevant publications. The purpose of the toolkit is to provide assistance to Directors of Estates and their teams in identifying the key issues that will need to be considered in making informed decisions and recommendations regarding the future of 1960-1970's university estate.

It is intended to provide support at two different strategic levels and stages within the decision-making process have been identified.

9.1. The first component of the toolkit has been developed as a 'filter' that assesses the potential for refurbishment of an existing building based upon the need to meet an accommodation brief. It is envisaged that this tool will be used by Estates Directors and key decision makers within the university.

9.2. The second component of the toolkit has been developed as an options appraisal matrix to be used to compare different option proposals for refurbishment intervention (including consideration of a demolition and rebuild option if appropriate). It is envisaged that this tool will be primarily completed by design team consultants on behalf of the Estates director during a more detailed options appraisal stage.

9.3. Both the 'filter' tool and options appraisal 'matrix' have been developed based upon the key issues concerning 1960's and 1970's estate relating to social, economic and environmental sustainability. In addition a further category entitled 'vision' has been incorporated in order to allow for assessment of how a proposed refurbishment or rebuild development would fit the university identity, growth and masterplan aspirations. The key criteria that have been identified are as shown opposite:

9.4. The 'Filter' Tool

9.4.1. The 'filter' tool (see Appendix 6) has been developed as a pre-feasibility study workshop facilitator. It is envisaged that the tool will be used by the University estates team for an internal meeting during the initial stages of considering the suitability of a required accommodation brief to fit potential existing accommodation. It is a tool that encourages consideration of re-use of the existing building stock and helps to identify the potential for this.

9.4.2. The purpose of the 'filter' tool is to ensure that the estates team are engaging with the key practicality and sustainability considerations during the workshop and clearly guided towards an understanding of the refurbishment potential for the building.

9.4.3. The tool is comprised of a series of questions relating to university's 'vision' and the social, economic and environmental sustainability of the proposed refurbishment – the same issues as listed above. For some of the questions, the university estates team may not have all the required information, but it is assumed that an informed selection can be made. The questions are simply 'yes' or 'no' answers in order to simplify the process.

9.4.4. It is envisaged that the tool will be used as a paper copy at the 'workshop' meetings. The 'filter' tool sheets have flow charts that are designed to be drawn over to plot the potential for a sustainable refurbishment. The sheets may then be kept as a record of the review workshop and will inform the next stage of project by providing a clear steer towards either a refurbishment or re-build solution. Where there is no clear steer towards either end of this scale it may be that a hybrid solution of part-refurbishment/ part-re-build or varying levels of intervention might be considered.

9.4.5. A steer such as this will be valuable to the estates team in planning the next steps of project development, e.g. initial project programming, refinement of the brief or selecting design consultants with appropriate experience for the likely intervention type.

9.5. The Options Appraisal Matrix Tool

9.5.1. The second component of the toolkit, the options appraisal matrix (see Appendix 7), is designed to be used as a briefing pack to consultants that sets out a best practice framework for carrying out an options appraisal. It is envisaged that following the use of the 'filter' tool, the estates team will have been guided towards investigating the feasibility of some different development options that may range from a minimal refurbishment to a full re-build solution. The options appraisal matrix offers a framework for scoring the sustainability of the different development options using a list of key criteria, some of which are qualitative and some quantitative. The options appraisal matrix comes complete with guidance notes (included in Appendix 5) on how to score against these criteria.

9. Introduction to Toolkit

Categories	Sub-Categories	Notes
Vision		
	Space Accommodation	A measure of how well a brief may be accommodated.
	Branding	A measure of how a development suits the university 'brand' or identity.
	Listing / Heritage	A measure of the impact that Listed status places upon redevelopment options.
	Masterplan	A measure of how well a development proposal will integrate with the wider university masterplan.
	Development Restrictions	A measure of the impact that planning restrictions will impose upon the development options.
Social		
	Occupant Comfort Satisfaction	A measure of likely occupant comfort satisfaction.
	Flexibility	A measure of how flexible the building is in terms of adaptability to future change of use and education needs.
	Good Building Design	A measure of how much users like the building.
	Accessibility	A measure of the buildings accessibility to all users.
Econimic		
	Whole Life Costs	A measure of the project WLC including NPV capital and operational costs.
	Benefit	A measure of the project financial benefits including fee income, rental income, research income and residual value.
	Risk	A measure of the risk posed by uncertainties such as existing structural condition.
	Funding Potential	A measure of the capital funding potential available for development options.
	Asbestos Management and Legislative Compliance	A measure of the success of proposed development strategies to mitigate against outstanding health and safety issues including asbestos and legislative compliance.
	Constructability	A measure of the ease of constructability, including consideration of ease of deconstruction if considered.
	Programme and Phasing	A measure of the ease with which development can be delivered according to shortest programme and ease of phasing and associated decant.
Environment		
	Environmental Servicing	A measure of how easily a solution for low-energy consumption, practical environmental servicing solutions can be implemented.
	Lifecycle	A measure of the future building life.
	Best Practice Environmental Performance	A measure of how well the development can perform in relation to current best practice environmental standards.
	Carbon Emissions	A measure of how well the building will perform with relation to carbon emissions.
	Embodied Environmental Impact	A measure of how well the building will perform in terms of the embodied environmental impact.
	Water Consumption	A measure of how well the building will perform in terms of water consumption.

9. Introduction to Toolkit

9.5.2. The purpose of this component of the tool is to promote a balanced approach to sustainability thinking, when considering options for the redevelopment of 1960-1970's university estate buildings and allow an accurate reflection of the benefits and dis-benefits of each option to be compared.

9.5.3. The matrix ensures that the university takes a balanced approach to sustainability as each of the 'Vision', Social, Economic and Environment categories are incorporated into the assessment and each category has a minimum weighting value of 20%. This gives some flexibility to the user to rate the importance of certain categories more highly than others but not to the extent where others can be entirely ignored.

9.5.4. Each sub-category within the matrix has also been given a weighting ranging from 1 to 10; it is recommended that these weightings remain at the default values provided as these figures represent the relative importance of each of the sub-categories. Further explanation of the recommended default weightings is provided within the supporting guidance notes included in the appendix.

9.5.5. Finally, there is also the field for scoring how each development option performs under each sub-category, ranging from 1 to 5; these are the fields that are to be used for options appraisal scoring by members of the project team.

9.5.6. Guidance notes have been developed to provide background information that will assist in completing this appraisal. Some notes explaining the key considerations for each category and the method of benchmarking the category have been outlined. The notes also provide a method of score calibration so that a maximum score of '5' relates to optimum performance; while a score of '1' relates to lowest performance under that category.

9.6. It is envisaged that this tool will be used as an Excel spreadsheet by the design team that are undertaking the options appraisal study and could be used as the basis for a workshop event, involving Estates Directorate, architect, building services engineer, and cost consultant. The suggested team member responsible for scoring each category is as follows:

- Vision – Estates Director, supported by planning, strategy and marketing team members.
- Social – Architect,
- Economic – Cost Consultant, supported by facilities management and finance team members.
- Environment – Building Services / Environmental Engineer.

9.6.1. The spreadsheet is designed to be completed and included within the options appraisal study report together with the resultant radar diagrams demonstrating the sustainable potential of each option against the 'vision', social, economic, environment categories.

Appendix 1 – Checklist of measures which improve environmental performance

Item	Measure	Potential for Each Measure to be Integrated into Development Type		
		Refurbishment	Remodelling	Demolish / Rebuild
	PASSIVE MEASURES			
1	Improve insulation	Low	Medium (for façade replacement options)	High
2	Improve air-tightness	Low	Medium (for façade replacement options)	High
3	High structural thermal mass	Dependent on original structure	Dependent on original structure	High
4	Phase change materials to enhance thermal capacity	High	High	High
5	Façade optimisation – high performance glazing, solar shading	Low	Medium (for façade replacement options)	High
6	Maximise use of daylight	Dependent on original room depths / floor to soffit heights	Dependent on original floor to soffit heights	High
7	Natural ventilation	Dependent on original room depths / floor to soffit heights	Medium. Dependent on original floor to soffit heights	High
8	Night ventilation to cool the structure	Dependent on original structure	Dependent on original structure	High
9	Living roofs to provide passive cooling, rainwater attenuation and enhance site biodiversity.	Low	Medium (for roof replacement options). Dependent on original structure	Medium. Dependent on proposed structure
	EFFICIENCY MEASURES			
10	Local lighting controls	High	High	High
11	Daylight or occupancy linked lighting control	High	High	High
12	Maximise the use of Building Management Systems for environmental control	High	High	High
13	Regenerative lifts	Low	High	High
14	CO2 controls for ventilation	High	High	High
15	Energy efficient low temperature heating systems for condensing boiler application	Low	Medium (for façade replacement options)	High
16	Variable speed pumps and fans	High	High	High
17	Improve control strategies for existing air conditioning	Medium		
18	Heat recovery from e.g. server rooms	High	High	High
19	CHP / tri-generation	Dependent on site wide energy strategy	Dependent on site wide energy strategy	Dependent on site wide energy strategy
20	Water efficient appliances	High	High	High
21	Leak detection and water management control systems	High	High	High

Appendix 1 – Checklist of measures which improve environmental performance

Item	Measure	Potential for Each Measure to be Integrated into Development Type		
		Refurbishment	Remodelling	Demolish / Rebuild
	SUSTAINABLE TECHNOLOGIES			
22	Solar collectors for water heating	High	High	High
23	Photo voltaic panels	High	High	High
24	Wind turbines	Recommended as site wide rather than building integrated	Recommended as site wide rather than building integrated	Recommended as site wide rather than building integrated
25	Ground source heating / cooling	Medium	Medium	High
26	Biomass Boilers / CHP	Dependent on site wide energy strategy	Dependent on site wide energy strategy	Dependent on site wide energy strategy
27	Rain water harvesting / use of grey water	Medium	Medium	High
	EMBODIED IMPACT ISSUES			
28	Design for ease of deconstruction – to aid reuse	Medium. Dependent on original structure	Medium. Dependent on original structure	High
29	Re-use of existing structure	High	High	Low
30	Reuse of materials following demolition		Medium. Dependent on deconstruction method and existing materials	Medium. Dependent on deconstruction method and existing materials
31	Low environmental impact materials specification	High	Medium	Medium

Appendix 2 – Literature and Web Search

Title	Publisher	Author
Tall Buildings and Sustainability	The Corporation of London	Will Pank, Herbert Girardet & Greg Cox
Sustainable Prescription	FM in Healthcare, February 2007, pages 15-16	Jane Fenwick
Designing Quality Buildings – a BRE Guide	BRE	Contributions from all parts of BRE
Space Management Project	UK Higher Education Space Management Group	
Nimrod Building Refurbishment	Defence Estates	DE Directorate of Estate Strategy & Policy
Building-in Sustainability	Durham County Council www.onenortheast.co.uk	
County Council puts Sustainability at Core of Office Development	Hampshire County Council	
Office Refurbishments – cost model, February 1996	Building Magazine	Davis Langdon & Everest
Vetro - Liverpool	NCH Architects	
Solaris Newsletter	Blackpool Council	
Sustainable Offices and Workplaces	http://scom.hud.ac.uk	
Renewables and the London Plan	British Council for Offices, March 2007	Foreman Roberts
Guide to Occupier Handover	British Council for Offices	
Conservation Plan	University of Sussex, January 2006	Architects Design Partnership
Making Europe's existing buildings sustainable	Revival-eu Faber Maunsell Project Co-ordinator www.revival-eu.net	www.revival-eu.net
Our Dark Materials	Building Magazine, 9 November 2007	Thomas lane
Sustainability-Embodied Carbon	Building Magazine, 12 October 2007	Simon Rawlison and David Weight of Davis Langdon
High Performance Buildings 1 & 2	HEEPI and SUST	
Refurbishment of Concrete Buildings	BSRIA, Guidance Note GN 8/99	CA Gold and AJ Martin
Re:view	British Association of Reinforcement annual review - 2007	
London Borough of Lambeth – Fairfax House	Sustainable Homes www.sustainablehomes.co.uk	
London Borough of Lambeth – Holles House, Angell town Brixton	Sustainable Homes www.sustainablehomes.co.uk	
London Borough of Southwark – Reedham street, Bellenden Renewal Area	Sustainable Homes www.sustainablehomes.co.uk	
Refurbishment or redevelopment of office buildings? Code IP9/02	Building Research Establishment J Anderson and K Mills	

Appendix 3 – Review of Envest Environmental Impact Assessment Tool

What is Envest?

Envest 2 is the latest version of the software tool developed by the BRE (Building Research Establishment) that can be used to evaluate the environmental benefits or disadvantages of design decisions.

Basic information about the building (height, number of storeys, window area, etc) and choices of elements (external wall, roof covering, etc) is entered into the software. Envest 2 identifies those elements with the most influence on the building's environmental impact and shows the effects of selecting different materials. It also predicts the environmental impact of various strategies for heating, cooling and operating a building over a stated operational life.

Within the software there are twelve types of environmental impact ranging from climate change to toxicity impacts of the construction and materials selections. To standardise this range of data the environmental impact is measured in Ecopoints.

As a guide, one UK Ecopoint is the equivalent to any the following:

- Traveling 65 miles by articulated truck
- Manufacturing ¾ tonne of brick (250 bricks)
- Consigning 1.3 tonnes of waste to landfill
- Using 320 kWh electricity
- Using 83m3 of water

How was Envest used?

This research project has used the Envest 2 software to compare the embodied and operational impacts of two AUDE case study projects. The two projects are the refurbishment of the Vanbrugh block at York University and the rebuilding of Building 4 West at Bath University. These projects serve as a good comparison as both were originally constructed using the CLASP system (Consortium of Local Authorities Special Programme).

CLASP was founded in 1957 for the purpose of improving the construction and delivery of schools and addressed issues of skill and material shortage together with a high demand. It turned to a systematic form of construction, which relied on a high proportion of prefabricated elements. CLASP buildings also tend to be steel framed with lightweight concrete cladding and low suspended ceilings.

Building 4 West at Bath Rebuild

The existing CLASP building had reasonably good adaptability with high floor-to-ceiling heights but the deep floor plan limited daylighting and ventilation opportunities. The architectural quality of the building was unremarkable and the building had poor environmental performance and high running costs. The building was also partly vacant, provided no financial benefit and had limited life. The requirements to meet with current building standards would also have been prohibitive. This building was a typical case for rebuilding. Figures 1 and 2 show Building 4 West before and during demolition.

Figure 1: Building 4 West at Bath University Campus before demolition

Figure 2: Building 4 West at Bath University Campus during demolition

Appendix 3 – Review of Envest Environmental Impact Assessment Tool

The new building has been designed to allow further development phases to connect within the extent of the site created and has been developed to give both flexible and efficient floor space at all levels suitable for academic use.

The new 4 West building has also been designed and constructed along current best practice standards to meet the BREEAM 'Excellent' Rating.

Vanbrugh block at York University Refurbishment

This project was the refurbishment of existing student residential accommodation into new administration and teaching space. The bedrooms did not meet with modern accommodation aspirations and the buildings in general are bland and appear aged.

The steel framed structure of the building made it difficult to remodel or adapt, with a high number of columns and wind-bracing elements. As a consequence, a cellular configuration was the only suitable solution.

The existing residential buildings perform poorly with regards to internal environmental conditions and energy use. Built for low cost they have outlived their original design life with relatively low failure rate of panel system. Single glazing and poor thermal fabric has resulted in high energy bills and reduced thermal comfort. Within the building there is extensive use of asbestos for fire protection and building access was non DDA compliant.

Superficially there is little evidence that a refurbishment has taken place. Changing the external appearance of the college blocks had previously been a consideration of the university in a separate feasibility study. This would have been difficult and costly to achieve due to constraints of the CLASP system.

Externally, the elements of refurbishment that can be seen are the remodelled stair cores for improved access and the replacement windows to meet with modern thermal standards.

Internally, the block was stripped back to the structural frame, with the new partitions, suspended ceilings and floor finishes added.

Envest Data

The Envest 2 calculator has been used to compare the environmental impact of the two projects on the 'Ecopoints' scale. For Bath, building details relating to the proposed new-build project have been entered into the calculator. However, for the York refurbishment, although all the building details have been entered into the calculator, only the elements relating to the refurbishment have been included in the 'Ecopoint' analysis. For example, the environmental impact of the structural frame and foundation has been ignored as these are already existing elements.

Table 1 shows the basic information that was entered into the Envest 2 calculator. It should be noted that a realistic operational life of 30 and 15 years was assumed for Bath and York University respectively.

Once sufficient information had been entered into the calculator, it was used to produce reports displaying key figures in tabular and graphical form. The data from multiple buildings was also compared in a report.

Results

The results that the Envest 2 calculator produced have been used as a comparison tool to demonstrate the differences between a refurbishment and a complete new-build project (Table 2).

Figures 3 Vanbrugh block at York University before refurbishment

Figure 4: Vanbrugh block at York University after refurbishment

	York	Bath
	New build	**Refurbishment**
Gross floor area (m2)	3,946	1,862
Number of storeys	5	3
Storey height (m)	4	3
Glazing ratio (%)	35	30
Cellular Space (%) (i.e. not open plan)	80	90
Building Frame	Concrete	Steel (existing)
Foundation	Deep Strip	Shallow strip (existing)
External Wall	78% Concrete cladding 22% Glazed curtain walling	Concrete cladding (existing) and insulation (new)
Internal Wall	Plasterboard on metal studs	Fire resistant plasterboard (new)
Ground Floor	Insitu concrete with screed and nylon carpet	Insitu concrete with screed (existing) and nylon carpet (new)
Upper floors	Insitu concrete slab and nylon carpet	Timber and wool carpet (new)
Windows	uPVC	Aluminium (new)
Ceiling	Tiled suspended	Tiled suspended (new)
Roof	Flat insitu concrete	Timber (existing)
Heating	Gas condensing boilers	Conventional (new)
Lighting operation	Totally manual	Manual with some occupancy sensors
Water	7.5l toilets, regular water fittings	7.5l toilets, regular water fittings
Rainwater harvesting (% roof coverage)	50	0
Ventilation	Supply and extract	Natural
Air change rate	8l/s/person	8l/s/person
Cooling	Variable air volume	None

Table 1: Envest input data

	York	Bath
	New build	**Refurbishment**
Gross floor area (m2)	3,946	1,862
Operational Life (years)	30	15
Environmental Impact		
Total Environmental Impact (Ecopoints)	45,223	8,695
Embodied Environmental Impact of Construction / Refurbishment	12,834 (28%)	1,257 (22%)
Operational Environmental Impact	32,389 (72%)	4,552 (78%)
Embodied Environmental Impact relative to typical new build (%)	100	30
Fabric & Structure		
Initial Ecopoints	10,854	1,086
Life Cycle Ecopoints	1,651	147
Maintenance Ecopoints	190	0
Services		
Initial Ecopoints	330	24
Life Cycle Ecopoints	0	0
Maintenance Ecopoints	0 0	
Operational Ecopoints	32,127	4,552

Table 2: Envest output data

Appendix 3 – Review of Envest Environmental Impact Assessment Tool

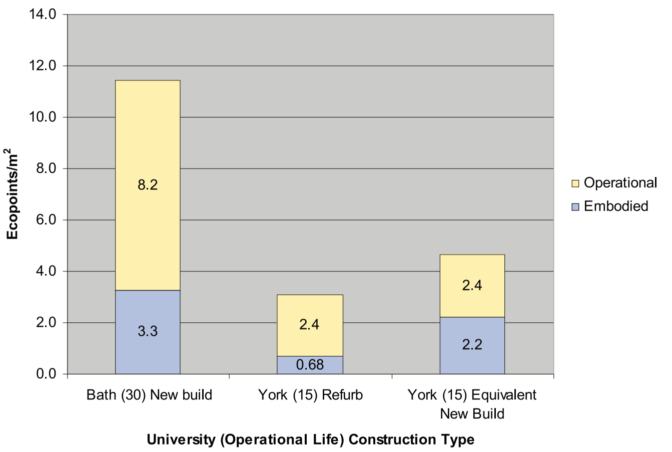


Figure 5: Operational and Embodied Ecopoints for Bath and York University buildings

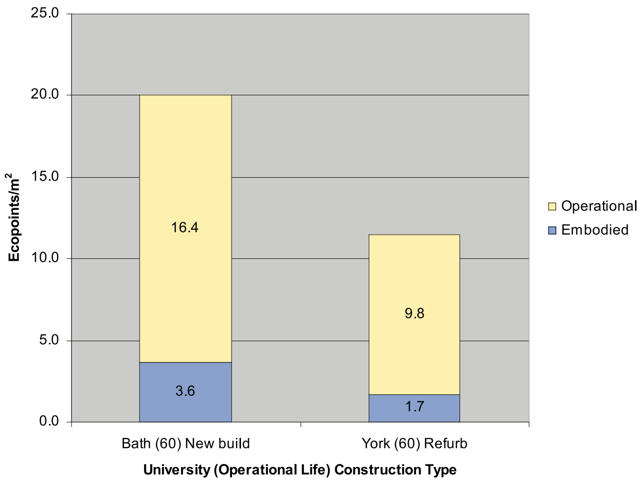


Figure 6: Operational and Embodied Ecopoints for Bath and York University buildings with an operational life of 60 years

The results from the Envest 2 calculator shown in Figure 5 illustrate a number of useful results:

- The embodied environmental impact of the Bath 4 West new build represents 28% of the total environmental impact assuming a 30 year operational life.
- The embodied environmental impact of the Vanbrugh block refurbishment represents 22% of the total environmental impact assuming a 15 year operational life.
- The embodied environmental impact of the Vanbrugh block refurbishment was calculated as having 30% the environmental impact relative to an equivalent new build.
- The operational environmental impact for both the Bath new build and York refurbishment was greater than the embodied impact, 2.5 and 3.5 times respectively.

There are some issues that must be taken into consideration when examining the results. The Bath 4 West building uses mechanical ventilation and the Vanbrugh block at York uses natural ventilation. This could account for the comparatively large operational impact of the Bath building, as well as the additional 15 years operational life.

60 year operational life

The Envest calculator was also used to show the environmental impact of the buildings assuming an operational life of 60 years.

The most noticeable difference between the graph in Figure 5 and Figure 6 is the increase in operational energy which increases for both buildings approximately proportionate to the length of the operational life. Another, more revealing result is that – compared to the realistic operational life of years – there is a small increase in the embodied environmental impact of the Bath new build (8%), but a larger increase in the embodied environmental impact of the York refurbishment (60%).

Timber vs. Concrete

To show the influence of material choice on the embodied environmental impact of a building some of the elements were changed from timber to concrete in the Envest calculator. The York University refurbishment with a 15 year operational life was used as a base example and the upper floors and roof were changed to concrete.

The difference in embodied environmental impact can be clearly seen in Figure 7. Looking specifically at the change in Ecopoints between the timber and concrete options (Table 3), it can be seen that the concrete elements have 4.9 times the embodied environmental impact of timber.

Appendix 3 – Review of Envest Environmental Impact Assessment Tool

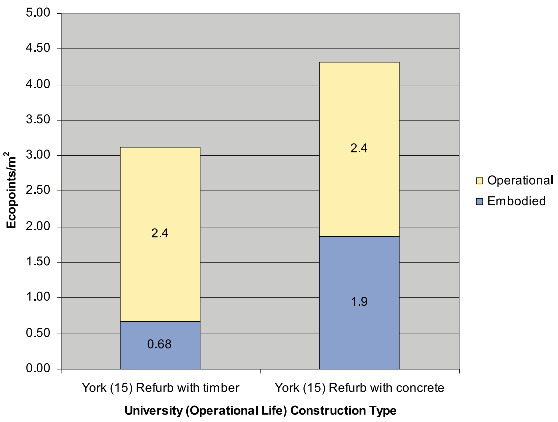


Figure 7: Operational and Embodied Ecopoints for Bath and York University buildings showing the influence of material choice

	Timber	Concrete	Difference	Factor
Upper floors	244	2166	1922	8.9
Roof	320	624	304	2.0
Total	**564**	**2790**	**2226**	**4.9**

Table 3: Ecopoints for timber and concrete elements

Conclusions

The Envest study has shown that the operational environmental impact of the building is greater than the embodied environmental impact. This has been based upon studies of buildings with operational lives of between 15 and 60 years. Embodied environmental impact only relates to one stage in the life of the building. During the operation of the building the selection of materials and building services systems, along with the position and orientation of the building, will have ongoing consequences for the building and its occupants for many years. Given that operational environmental impact is dominant it follows that careful consideration should be given to the methods of heating, ventilation and cooling for the life of the building. To reduce the energy demand during operation, natural ventilation and efficient services should be preferred. It is important to integrate sustainable design solutions that reduce the environmental impact over the life of the development such as high thermal mass to mitigate extremes in temperature, natural daylighting to reduce the need for artificial lighting and green roofs to reduce the need for cooling.

Material choice has a very significant impact on embodied environmental impact irrespective of whether the project is a rebuild or a refurbishment. This is shown in the results with a comparison between concrete and timber. More durable materials should also be specified to reduce the need for replacement. This will decrease the embodied environmental impact of the building throughout its life.

There are some processes that the Envest software does not account for but should still be considered. If the opportunities for refurbishment prove to be unfavourable, and rebuild is opted for, the prevention of environmental impact during demolition must be considered. Wherever possible, steps should be taken to reuse, recycle and segregate demolition waste through the use of pre-fabrication, standardised components, flexible design and implementation of a site environmental management plan (SEMP). Potential air quality and dust pollution risks should also be investigated.

Another way to reduce embodied energy that is not considered in detail within the Envest calculator is by specifying materials that are reused on site, reclaimed, or with high recycled content.

The main conclusion that can be drawn from this Envest study is that refurbished buildings have a smaller embodied environmental impact than buildings that are demolished and rebuilt. Operational environmental impact is largely dependent on the operational life span and efficiency of the building services.

Refurbished 1960's and 70's buildings may be brought up to best practice standards through investment in sustainable design solutions, and conversion of use to reflect current market requirements (i.e. previous laboratory buildings refurbished to office use) yet it is unlikely that these buildings will be able to achieve better operational environmental performance than exemplar new building projects.

References

http://www.clasp.gov.uk/NetBuildPro/process/6/History.html
http://www.northwestdemolition.co.uk/demolition_recycling.html
http://www.bioregional.com

Appendix 4 – Participating Institutions

The AUDE Executive and the project Steering Group, wish to express their appreciation to the estates staff of the following institutions who contributed this project by submitting information in respect of relevant refurbishment and replacement works undertaken. Those who provided the case study material deserve extra thanks for the added demands to which they all willingly responded.

1 City University
2 Kings College London
3 Loughborough University
4 Napier University
5 Open University
6 Royal College of Art
7 Royal Holloway University of London
8 Sheffield Hallam University
9 The Robert Gordon University
10 The University of Northampton
11 University College for the Creative Arts
12 University of Bath
13 University of Birmingham
14 University of Bournemouth
15 University of Brighton
16 University of East Anglia
17 University of Edinburgh
18 University of Liverpool
19 University of Plymouth
20 University of Portsmouth
21 University of Sheffield
22 University of Southampton
23 University of Surrey
24 University of Sussex
25 University of Wales Aberystwyth
26 University of York

Appendix 5 – Acknowledgements

The AUDE Executive and the project Steering Group, wish to express their appreciation to the following for their support in providing information and use of facilities in undertaking this project:

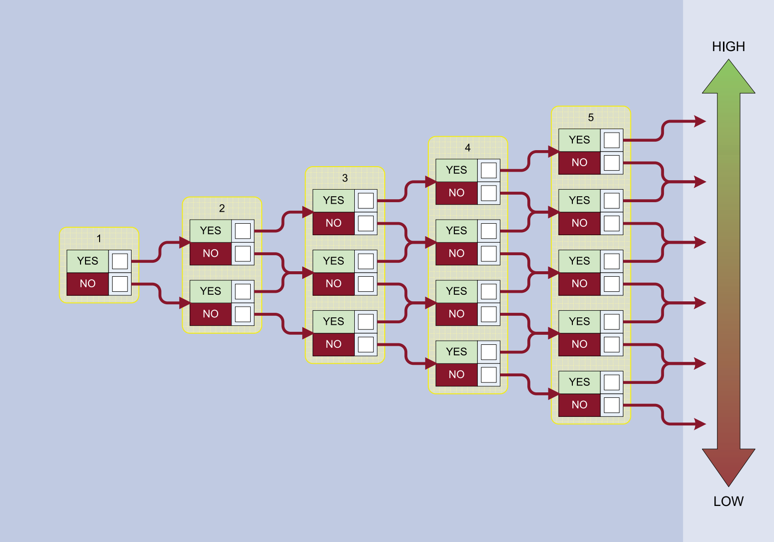
- ADP Architects – Alison McKerracher
- Atisreal – Tony Forbat
- HEEPI – Higher Education Environmental Performance Improvement – Professor Peter James
- Hefce – the Higher Education Funding Council for England

Appendix 6 – Filter

VISION

1. SPACE ACCOMMODATION	2. BRANDING	3. LISTING / HERITAGE	4. MASTERPLAN	5. DEVELOPMENT RESTRICTIONS
Can the assessed building fit the desired space accommodation, and is this in a desirable location as required by the proposed future tenant(s)?	Is the building of significant importance to the branding of the university, or could it be refurbished to meet branding aspirations?	Does the building have or is it likely to be awarded a listed status that will strongly support refurbishment or create a planning risk for a non-refurbishment option?	Does the assessed building and proposed brief have good potential to engage with and compliment the current University Masterplan?	Is there a planning (or other) restriction on increasing the footprint of the building or on increasing the overall built area of the campus? e.g. conservation area limitations.

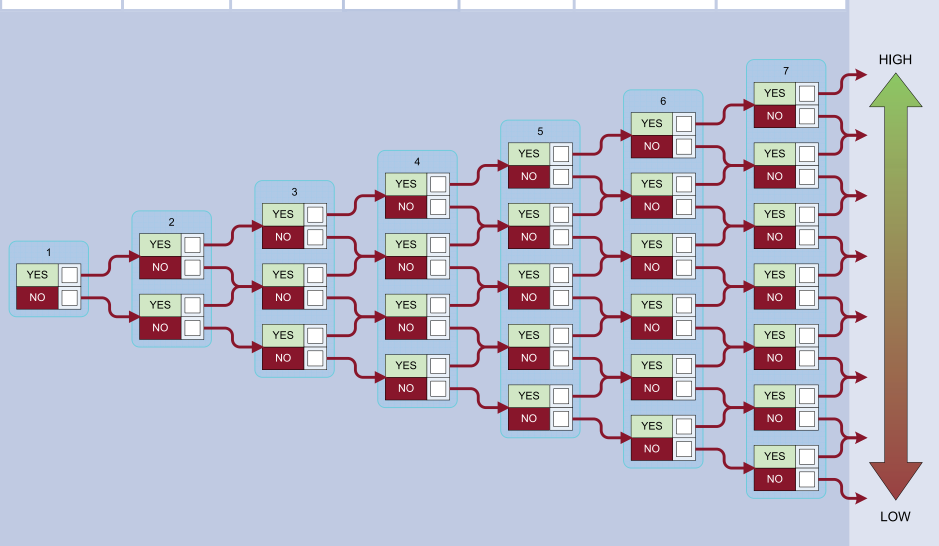
SUSTAINABLE REFURBISHMENT POTENTIAL



ECONOMIC

1. WHOLE LIFE COST	2. BENEFIT	3. RISK	4. FUNDING POTENTIAL	5. LEGISLATIVE COMPLIANCE AND ASBESTOS MANAGEMENT	6. DE-CONSTRUCTABILITY / EASE OF DELIVERY	7. PROGRAMME AND PHASING
Is refurbishment likely to offer the lowest Whole Life Cost?	Can a positive increase in revenue though fee, research or rental income be accrued?	Can contractor risk associated with refurbishment be mitigated through initial investigative survey work?	Does preferential funding exist (both internal and external) for a refurbishment of the building?	Can the building be made to comply with all current relevant legislation?	Does demolition of the building cause difficulties when considering the location and proximity of neighbouring buildings?	Can refurbishment of the building allow for a shorter programme of project delivery and minimal disruption to normal activities?

SUSTAINABLE REFURBISHMENT POTENTIAL

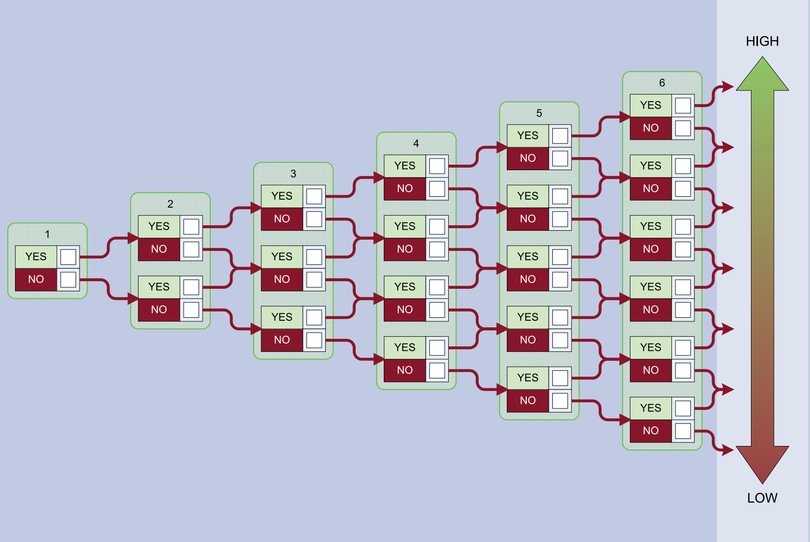


Appendix 6 – Filter

ENVIRONMENT

1. ENVIRONMENTAL SERVICING	2. LIFECYCLE	3. BEST PRACTICE ENVIRONMENTAL PERFORMANCE	4. CARBON EMISSIONS	5. EMBODIED ENVIRONMENTAL IMPACTS	6. WATER CONSUMPTION
Can the building provide the desired functionality in terms of depth of floor plan and floor to ceiling height to facilitate appropriate sustainable servicing solutions?	Does the predicted lifespan of the building structural frame meet with the project lifespan requirements?	Can the building be brought up to current best practice environmental performance standards (i.e. HEFCE recommended BREEAM targets)?	Can the building be brought up to current best practice carbon emissions standards?	Does the building have the potential for being refurbished with minimal embodied environmental impact?	Can the building be brought up to current best practice water consumption standards?

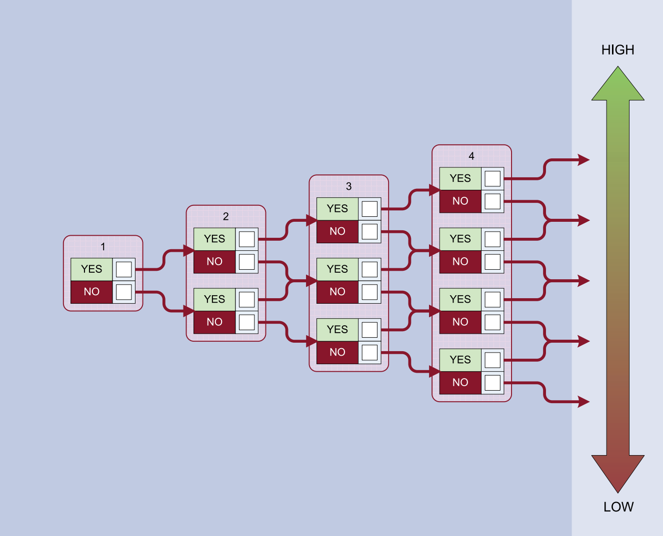
SUSTAINABLE REFURBISHMENT POTENTIAL



SOCIAL

1. OCCUPANT COMFORT SATISFACTION	2. FLEXIBILITY	3. GOOD BUILDING DESIGN	4. ACCESSIBILITY
Does the building have the potential to provide a high quality internal environment for building occupants?	Does the structural frame / grid of the assessed building allow the desired flexibility?	Do occupants enjoy using the building?	Can the building be brought up to current best practice in respect to accessibility, at minimum complying with all current accessibility legislation?

SUSTAINABLE REFURBISHMENT POTENTIAL



Appendix 7 – Matrix

AUDE 1960-70's Buildings Matrix Tool Version 1.0 Jan-08	
Name of Institution:	
Project Title:	
Assessment By:	
Date:	

Categories	Sub-Categories	For each Option, please enter a score between 1 and 5 for each field OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Vision						
	Space Accomodation	1	1	1	1	1
	Branding	1	1	1	1	1
	Listing/Heritage	1	1	1	1	1
	Masterplan	1	1	1	1	1
	Development Restrictions	1	1	1	1	1
Social						
	Occupant Comfort Satisfaction	1	1	1	1	1
	Flexibility	1	1	1	1	1
	Good Building Design	1	1	1	1	1
	Accessibility	1	1	1	1	1
Economic						
	Whole Life Costs	1	1	1	1	1
	Benefit	1	1	1	1	1
	Risk	1	1	1	1	1
	Funding Potential	1	1	1	1	1
	Legislative Compliance and Asebestos Management	1	1	1	1	1
	De-constructability / Ease of Delivery	1	1	1	1	1
	Programme and Phasing	1	1	1	1	1
Environment						
Please Note: Embodied environmental impact related issues ('Lifecycle' and 'Embodied Environmental Impact') have an in-built reduced weighting relative to the operational environmental impact related issues. For both refurbishment and new-build projects the average embodied environmental impact is approximated to 25% relative to operational impact over a 30 year lifecycle. See	Environmental Servicing	1	1	1	1	1
	Lifecycle	1	1	1	1	1
	Best Practice Environmental Performance	1	1	1	1	1
	Carbon Emissions	1	1	1	1	1
	Embodied Environmental Impact	1	1	1	1	1
	Water Consumption	1	1	1	1	1
Category Weightings						
Vision	**25%**	**5%**	**5%**	**5%**	**5%**	**5%**
Social	**25%**	**5%**	**5%**	**5%**	**5%**	**5%**
Economic	**25%**	**5%**	**5%**	**5%**	**5%**	**5%**
Environment	**25%**	**5%**	**5%**	**5%**	**5%**	**5%**
Overall Score	**100%**	**20%**	**20%**	**20%**	**20%**	**20%**