

**Post Occupancy
Evaluation**

**- Carnegie College
Functional Performance
Review Condensed Report**

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Executive Summary

The Scottish Funding Council (SFC) commissioned BRE to undertake Post Occupancy Evaluations (POE) of a sample of four new Higher and Further Education buildings in Scotland. Carnegie College on the outskirts of Dunfermline, Fife was one of the Colleges visited by BRE to undertake this study. This report focuses on the assessment of functional, technical and operational performance through occupant consultation a sustainability audit, audits of energy and water usage and running costs and the DQM, an expert rating system. It is a condensed version of the full Functional Performance Review report that has been provided to the college and the SFC. These reports should be regarded as work in progress as they will be reviewed in the light of further information that is yet to be obtained, such as energy data and a post-construction BREEAM rating.

Carnegie College's new EcoSpace facility was designed to an ambitious brief which stressed environmental sustainability. These ranged from the sustainable Scottish timber used for its construction, to the provision of workshops to train vocational students in traditional construction crafts such as joinery and furniture restoration. The new building was traditionally procured (with contractor's design element), for a price of nearly £5 million (including some refurbishment of the existing building), to accommodate over two hundred staff and students in the new-build area, operational in September 2006. The new build extension houses the workshops, a central corridor incorporating a café area and the ASPIRE facility for independent living.

A complete Design and Procurement BREEAM Assessment was carried out on the Ecospace building and the overall rating the project received was a 71% BREEAM Excellent. A post construction review was not undertaken on the building by the original BREEAM Assessor, as it was not requested by the College nor was it mandatory at that time. From the plans, drawings, material selection and information available from the consultants and architects involved in the design of the new Carnegie College building, an indicative BREEAM Assessment score is being calculated using the BREEAM Post Construction Review criteria. More information is required from the Design Team to complete the indicative BREEAM Post Construction Review assessment, once this has been received the result will be calculated and this report will be updated.

Carnegie College was keen to establish environmentally sustainable credentials within the building design and operation, for which it should be commended. The College has aimed to set a high benchmark for others to aspire to and hopefully reflect on some of the lessons learned from this ambitious brief and innovative building.

A number of sustainable design features are evident throughout the building;

- There is a mix of mechanical and natural ventilation;
- The building has been designed to optimise the use of natural day lighting in all areas;
- There is an FSC approved, timber slat, brise-soleil solar shading system secured to the building;
- Solar thermal panels and high efficiency condensing gas boilers help to provide heat and hot water to the new building and are controlled through the Building Management System.

A Design Quality Method (DQM) assessment was carried out on the new EcoSpace building. The DQM consists of six matrices, over-arched by a summary matrix. The results from the DQM assessment found that the EcoSpace building appears successful in general space planning terms, but appears to have some detailed design problems which have led to a retention sum of 2.5% of the construction cost being retained at the time of this report (about £100k). The main problems, where independent reports were commissioned, seem to be in the areas of the timber structural frame; acoustics; and a leaking roof. The building boasts many sustainable features, however some features which could have helped to boost the overall operational efficiency levels of this building have been omitted during the construction phase e.g. there are no day lighting sensors present on any of the light fittings meaning large areas such as the main corridor are unnecessarily artificially lit for most of the day. There is also a sizable rain water harvesting system in place to supply water for flushing the WCs in the new build, but not all WCs & fittings are water efficient, therefore water consumption levels are increased in these areas.

Occupant questionnaires and focus groups found that occupants in the ASPIRE area were generally very happy with this area of the building. They described it as having good levels of daylight and ventilation, little noise transference and good sized teaching spaces. Users of the construction workshops were less satisfied particularly with the daylight and ventilation levels, high levels of noise and lack of user control especially with regards to artificial lighting and ventilation levels in the workshop areas where lights are not zoned for switching off areas not in use and windows cannot be manually opened. The general feeling from occupants using this building is that the quality of workmanship and finishing and some aspects of the environmental conditions such as the ventilation and acoustics were not as good as would be expected - again these comments were mainly directed at the workshop areas - although the majority felt the facilities were much better than they had previously..

The next stage of the Post Occupancy Evaluation will involve a Strategic Review of the building in the Autumn of 2009, after three years of occupation to assess its performance in the longer term and inform any future estates planning decisions.

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1 Introduction

1.1 College background

Carnegie College is situated on the outskirts of Dunfermline, Fife. The original College building was opened in the 1960's and has recently undergone a major transformation with extensive refurbishment work and the addition of a substantial extension known as EcoSpace. The new single-storey extension has a total floor area of 1,500m² and accommodates 190 students in construction workshops and in the ASPIRE (Additional Support Programmes in a Real Environment) area. This work was completed in September 2006 and both students and staff have been taking advantage of the extra teaching and workshop areas for the past year and a half. Normal hours of use are between 8.30am and 9pm Monday to Thursday, 8.30am and 6pm Friday.

Carnegie College's new EcoSpace facility was designed to an ambitious brief which stressed environmental sustainability and it achieved an Excellent BREEAM rating at the design stage. The College was keen to establish environmentally sustainable credentials within the building design and operation. This ranged from the sustainable Scottish timber used for its construction, to the provision of workshops to train vocational students in traditional construction crafts such as joinery and furniture restoration.

1.2 Building form

A main corridor runs the length of the new build and with the craft workshops opening off along the far side. External access to and from the new build can be achieved from the east and west ends of this corridor and an internal link joins the corridor to the existing building. The entrance to the APSIRE centre is located to the east end of this corridor, adjacent to a small café area. The APSIRE centre comprises of a living area, laundry room and a series of learning classrooms.

The specific environmentally sustainable aspects of the new facility include the green timber frame and external cladding; porous paving to external works; organic paint; rainwater harvesting system; sedum roof; linoleum flooring; solar panels; and the use of a brownfield site (which contained existing accommodation in very poor condition, such as an old modular building and huts). The new building is largely naturally ventilated and naturally lit.

1.3 Methodology

A variety of assessment methods were used to carry out the POE in order to provide a holistic picture of the performance of the new building:

- Observational walk rounds were carried out to gather initial information on the performance of the new building. These observations have been captured and analysed within sections 2, 3 and 4 of this report;
- An indicative BREEAM Post Construction Review rating was calculated using information provided by the college and their consultants;
- An audit of energy, water and financial data was carried out subject to availability of that data;
- An assessment of the building was carried out using the DQM, an expert method used by auditing bodies throughout the UK; and
- Consultation with all staff and students who use the EcoSpace building via a paper based questionnaire and focus groups.

2 Energy, water usage and sustainability audit

2.1 Building Fabric

Carnegie College's new building has been developed on a brownfield site as an extension to the existing building, with surrounding farming land to the west and a housing estate to the east. The new build is sympathetic to its existing surrounding with its external larch cladding, solar shading brise soleil timber slats and green roof.

The new EcoSpace building boasts numerous sustainable features including the Sedum green roof, which appears to be functioning well, is visually attractive and has improved the building's rainwater management. Porous paving also surrounds the new building also helps to minimise the negative effects of water build up from surface run off and rainfall. All internal timber frame work in the new build is Douglas Fir and has been responsibly sourced, with all timber bearing the FSC trademark and more environmentally friendly, organic paint has been used to decorate the main corridor and areas within the ASPIRE centre. Furthermore, fixed, timber, solar shading panels have been fitted to the exterior of the new build on the glazed top half of the main corridor, offering protection from solar glare and over heating whilst still allowing an adequate level of natural light to enter the building at the seated café area.

However, some of the features which could have helped to boost the overall operational efficiency levels, quality and performance of this building have either been overlooked, the quality of installation has been poor or they have been left out during the construction phase. For instance, the internal timber frames showed signs of strain and were noticeably split and twisted. Such distortion caused the automatic door exit/entry systems that are secured to these frames within the main corridor of the new build, to sit out of line and not operate efficiently. BRE suggested that further investigation here and stress reports would be recommended. Since BRE's visit, the timber frame has been fully checked and the engineers have confirmed that the movement is as anticipated and the frame is operating within design tolerances.

Also, poor quality of finishes is evident in the workshop areas where the rubber shadow gap sealing between these panels has become loose in places and has been left hanging and concrete access floor panels have not been lipped at the edges and are beginning to chip. The College was also advised that the organic paint would be 'scrutable' and easy to clean, however this has proven not to be the case.

Additionally, the solar shading present on the high level windows on the main corridor at Carnegie's new building has made maintenance and cleaning of these windows rather difficult. Whilst the idea behind the use of this brise-soleil solar shading system on a new building is to be commended, this area could have been cooled and naturally ventilated by effectively controlling the openable, high level windows. This would also have helped to alleviate access, cleaning and maintenance issues associated with the high level windows above this corridor. Furthermore, as there was no Building Users Guide left for building occupants, not all staff were aware that these windows were in fact openable.

2.2 Ventilation

Mechanical ventilation is present in the craft workshops in the new build and has been integrated into the roof of each of these spaces, all controlled through the Building

Management System (BMS). Providing the BMS is programmed and operated correctly, the mechanical ventilation system in the craft workshops should be run efficiently when required, offering occupants maximum comfort levels.

By ensuring the high level windows running the full length of the main corridor are effectively controlled and are operable through the BMS or by occupants, a fresh flow of air could be encouraged through this area and could help to release some of the hot air, reducing temperatures during sunny periods.

The whole of the APSIRE centre is naturally ventilated with low-level, openable windows present along two of the external walls. The remains cool and comfortable for users even when occupancy numbers are high. In contrast to other areas within the ASPIRE centre, the ventilation levels in the laundry room of the ASPIRE centre are less than adequate, especially when the machinery is in operation. The one, small, openable window located to the rear of the room is not sufficient in circulating adequate levels of fresh air into a room of this size.

There was no ventilation for the pump room located adjacent to the ladies showering area in the new build in the original design. This caused temperatures to sore to over 40°C, warping the access door to this area. Two roof vents and a louvre window have since been added to the design of this room to help rectify this problem of overheating.

2.3 Heating

Heating is supplied to the new build through a combination of high efficiency, condensing Regency 2 gas boilers and a series of solar thermal panels erected on the roof of the new build, helping to reduce the new buildings CO₂ and NO_x emissions. On inspection, all pipe work within the boiler house appeared to have adequate insulation and flow and return indicators were clearly marked on the pipes feeding to and from the system. The south-facing solar thermal panels located on the roof of the new build are estimated to generate 30,000 kWh annually. During BRE's visit, the primary solar system electric pump appeared to be consuming considerably less energy than anticipated. Further investigation found that the pump was accidentally switched off for a period of time. Some members of the Facilities Team require further training to understand how this system should operate and what visual checks they should be carrying out to ensure the system is operating to its maximum efficiency. All readings should continue to be monitored over the course of the summer months and the performance of the solar thermal panels should be noted.

The BMS controls an under-floor heating system present in all areas of the new build, with the exception of the workshop areas where radiator panels are present and are mounted around the high ceiling spaces of the workshop areas in the new build. However, the radiator panels themselves have been secured using thin wiring and are already showing a sign of strain as some of the wiring has snapped.

2.4 Cooling

The use of fresh air to provide clean, healthy, natural ventilation throughout the new build has been maximised throughout the new build. The craft workshop areas are mechanically ventilated using fresh air, the system is controlled through the BMS and there are no air conditioning units present within the new build. The ASPIRE centre makes full use of natural ventilation through openable low level windows covering two of the main walls.

2.5 Lighting

Low energy fluorescent lighting is the common type of lighting fitted throughout the new building, allowing Carnegie College to enjoy both financial and carbon savings compared with other types of energy intensive, less efficient lighting. There are a few sunken spot lights

present in the reception area outside the APSIRE centre and in one of the toilet areas; they appear to be serving more of an aesthetical rather than practical purpose. This type of lighting is energy intensive, requires to be replaced much more frequently than the fluorescent strip lighting and is very delicate, often having difficulty withstanding vibration.

Motion sensors control most of the lighting in the new build and are linked to the BMS rather than allowing local occupant control. The use of motion sensors is to be commended and can help to reduce lighting costs and increase the building's operating efficiency levels by ensuring unoccupied areas are not unnecessarily lit. However, on the day of the visit lights were on in two of the unoccupied workshop areas. This suggests that the time delay for switching off these lights may need to be shortened. Some areas with motion sensors fitted do not have manual control override. Further energy savings can be made when motion sensors are fitted with manual light switches. Occupants also prefer this as they have more control over their environment.

Daylight sensors can help to control lighting levels; however none are present within the new build at Carnegie College. Efficiency levels and running costs could greatly be improved by ensuring that this lighting in the main corridor is linked to daylight sensors. The level of artificial lighting could be reduced and natural light maximised in the main corridor, workshop areas and the ASPIRE centre if daylight sensors were in place.

2.6 Electrical equipment and white goods

A dust control extraction system is in place in the workshop areas and is one of the College's most energy intensive pieces of equipment within the new build. Care should therefore be taken to operate this system efficiently and only when required. Although it is commendable to have a dust control extraction system in place, the operating noise levels of this type of machinery may need to be investigated.

During the design stages, it was planned that all white goods installed in the new building would achieve a high-efficiency 'A+ rating' under the EU Energy Efficiency Labelling scheme. However, the washing and drying products present in the ASPIRE laundry room bare no mark of the EU Energy Efficiency Labelling scheme.

2.7 Controls

The BMS system controls the lighting, temperature and heating for the areas within the new building. These areas are zoned and represented on the system by room types. Output display panels showing a breakdown of electricity consumption, including lighting and pumps, are present in the estate team's control room within the old building. Since the visit, the team at Carnegie College have been monitoring and logging these output display panels in more detail. This will help to provide an accurate breakdown of electricity consumption for the new building and may help to identify any areas that are consuming more energy than expected.

2.8 Additional observations

There was no Building User's Guide passed to staff for this new building, only an O&M manual which the estates staff had to go through themselves without training or guidance. This meant that initially the BMS proved difficult to operate and manipulate.

Good use of rainwater harvesting is being demonstrated at Carnegie College where two large collector tanks are in place to collect rain water and provide water for flushing in the new build. Dual flush and aerated spray taps have been specified for use in one of the toilet areas within the new build and help to minimise the water consumption here. However, not all WC and wash hand basin fittings, as evident within the APSIRE centre, are dual flush or have aerated/energy efficient taps.

At the time of the visit no insulation was present on the hot or cold water pipes feeding the sink in the ASPIRE centre laundry room. Not only is this inefficient in terms of heat loss, it is also presents a hazard to occupants as temperatures running through these pipes can become very hot.

2.9 BREEAM Assessment

2.9.1 Introduction to BREEAM

BREEAM (BRE's Environmental Assessment Method) is the first available environmental assessment tool for buildings.

It can be used to assess the environmental performance of both new and existing buildings. BREEAM is highly regarded by the UK's construction and property sectors as the measure for best practice in environmental design and management. BREEAM's success can be attributed to its ability to cover a wide range of environmental issues within one assessment.

2.9.2 Carnegie College and the BREEAM Assessment

A complete Design and Procurement BREEAM Assessment was carried out on the Carnegie College new EcoSpace building. Cyril Sweett was the appointed BREEAM Assessor and the overall rating the project received was a 71% BREEAM Excellent. The project was a Bespoke BREEAM 2005 Assessment.

A post construction review was not undertaken on the building by the original BREEAM Assessor, as this was not mandatory at that time. From the plans, drawings, material selection and information available from the consultants and architects involved in the design of the building, an indicative BREEAM Post Construction Review rating has been calculated. This was done using the same BREEAM 2005 criteria used in the Design & Procurement BREEAM Assessment developed for the Carnegie College EcoSpace building.

2.9.3 Overall indicative score

The Post Construction Review score, based on evidence received so far is 49.38% which is a 'Good' rating. If further evidence can be provided then a maximum rating of 'Very Good' can be achieved.

The reason that this score is lower than the original Design & Procurement score is due to the following:

- Evidence was not kept or could not be provided (probably because the design team were not expecting to do a Post Construction Review).
- A commitment for some credits was made at the design stage but this was not carried through into construction either through changes to the design or oversight (e.g. no building user's guide produced, daylight sensors not installed, levels of day lighting in workshops.).

2.9.4 BREEAM Synopsis

Management

Evidence for Commissioning and Considerate Constructor's Scheme has been provided. Evidence of construction site impacts is still to be provided. Although a commitment was made at design stages to provide a Building User Guide, this has not been carried out. Stakeholder consultation credits have been awarded as this was carried out throughout the Design & Procurement stage.

Health & Well-being

Credits relating to the avoidance of legionella have been achieved. Although achieved at design stages, the credit for internal air pollution could not be awarded at PCR stage because the rooflights which are used to supply natural ventilation to the workshops are too close to the mechanical extract for the painting room. The rooflights in many areas also meant that the credit for providing a view out was not achieved. Other credits which were achieved at D&P but not at PCR were lighting credits as lux levels were too high in places and daylight sensors hadn't been installed. Also credits for thermal zoning and thermal comfort modelling couldn't be achieved as radiators with thermostatic controls were no longer part of the heating strategy.

A number of credits in this section require more evidence to be submitted.

Energy

Substantial sub-metering has been installed in the building to cover all major electricity uses. A credit has been awarded for this as well as the tenancy sub-metering credit which has been awarded by default. The centre has Solar Thermal Panels for hot water supply and thus has gained credits for the carbon intensity of the heating source and also for undertaking a feasibility study at design stages.

Internal Lighting controls credits could not be achieved as no daylight sensors were fitted internally and some areas in the building had presence detection lighting but with no manual override facility. The appliances in the laundry room were not A-rated appliances and another credit was lost in this area.

A number of credits in this section require more evidence to be submitted.

Transport

Carnegie College is well situated for public transport links and has maintained all the credits which were awarded at the D & P stages for public transport, pedestrian/cycle paths and access to local amenities. Credits which were lost for PCR were the cyclist facilities credits (incorrect type and number of cycle racks) and the Travel Information Space credit (there was no dedicated area in the building to display local transport information).

Water

Credits achieved in this section were the rainwater harvesting credits and the major leak detection credit. Credits for water efficient tap fittings and low flush toilets were lost at the PCR stage as they are only present in some of the toilets in the building and not throughout as intended in the D&P BREEAM Assessment.

Materials

Most of the credits in this section have still to be confirmed.

Land Use and Ecology

The land use and ecology credits for PCR are all identical to the credits achieved in the D&P assessment. An ecologist was not consulted in the design of the landscaping so a number of credits were not achieved at D&P or PCR stages. The land however was on a site of low ecological value, thus the overall ecological impact of the building was minimal.

Pollution

Although a local air conditioning system was specified for the IT room in the new building, it hasn't been installed. This actually has a positive effect on the BREEAM Assessment as refrigerants are generally discouraged and 3 credits can be achieved by default by not having any refrigerants. Credits for NOx emissions, external light pollution and water run-off have all been achieved. Some credits require more information before a decision is made on whether they have been achieved.

The credit for the zero emission energy source, in this case solar thermal, was not awarded as there was no way of monitoring how much energy the solar panels had contributed the building's heat load.

3 Design Quality Method

3.1 The Design Quality Method (DQM)

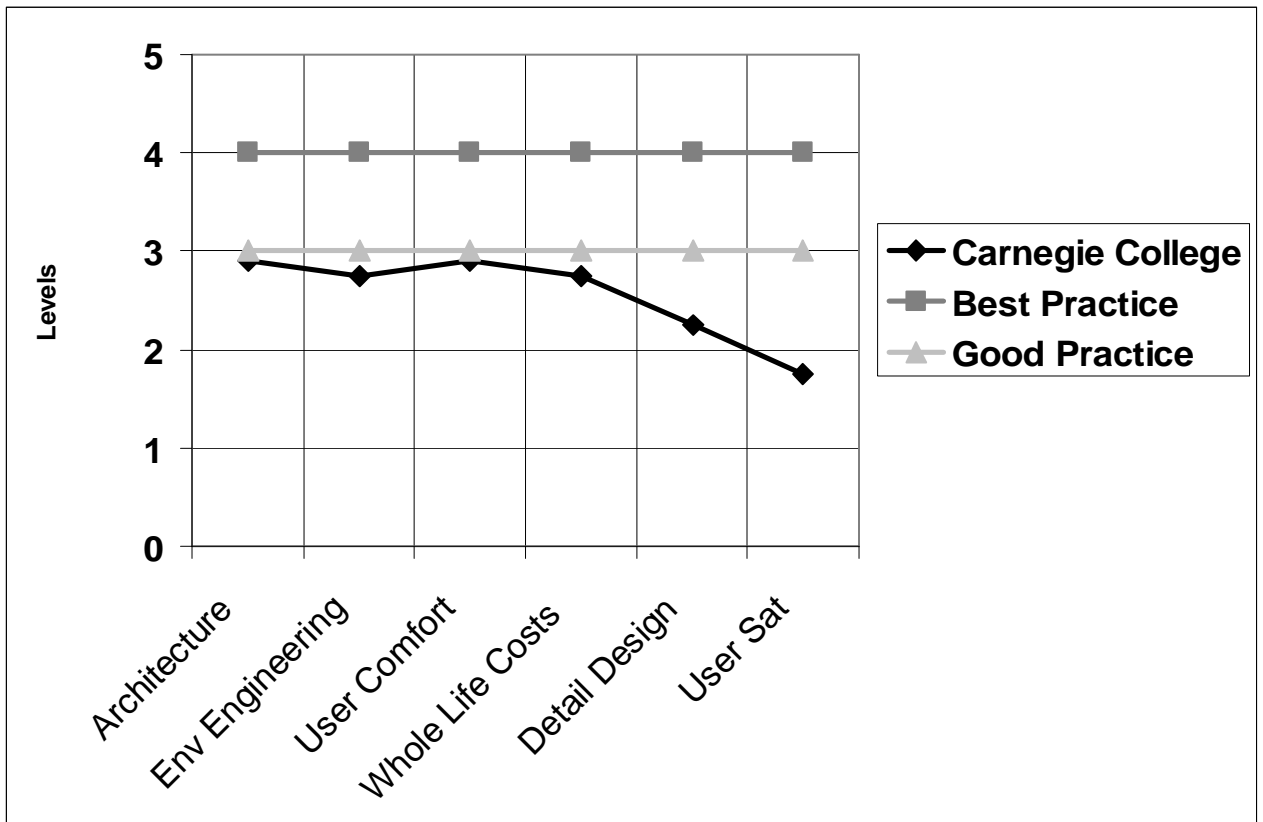
The Design Quality Method (DQM) is a tried and tested methodology for the post occupancy evaluation (POE) of educational buildings and is used by all auditing bodies in the UK. It consists of visual surveys of premises by a small team of expert architects and engineers, preceded by a semi-structured interview with key users and/or facilities managers.

The DQM was used to evaluate the new EcoSpace building at Carnegie College by using a series of exercises and mapping results onto a 'balanced scorecard' that measures the whole performance of building. The Method relies on expert opinion, professional judgement, user opinion, and scientific measurement (eg lighting levels, air quality and acoustics etc). The DQM consists of the following six matrices, over-arched by a summary matrix.

3.2 Findings

The matrices used in the DQM identify levels ranging from 0 to 5. Level 5 is exemplar; Level 4 is Best Practice; Level 3 is Good Practice; Level 2 is Standard; Level 1 is Poor; and Level 0 is Unacceptable.

3.2.1 Matrix 0 – Summary matrix



3.2.2 Matrix 0 – Summary matrix commentary

The above matrix is the summary of the six matrices and gives an overview of the results. It shows that environmental engineering, whole life costs, detail design, and user satisfaction

are below Good Practice. User satisfaction scores are inevitably subjective and we treat these interviews as anecdotal evidence – a more widespread rating of user satisfaction has been provided through the occupant consultation. The 6 individual matrices, provided in the main report show more detail, particularly aspects of the matrices which influence the median scores in the summary matrix. It should be noted that this is an interim rating that will be reviewed in the light of further information, such as energy data and a post-construction BREEAM rating.

3.2.3 Matrix 1 – Architecture matrix commentary

Interior design, space planning and sustainability are at Good Practice levels. Specification is at Level 2, an entire level below Good Practice, as the building has a number of detailed design and specification defects that are the subject of contractual dispute. The building was designed to an ambitious environmental sustainability brief and achieved an Excellent rating at design stage – this warrants a sustainability rating approaching Best Practice. However, this should be reviewed in the light of a post-construction BREEAM assessment.

Architecture and site planning are rated as approaching Good Practice. Architecture is let down by compromises to the detailed design, and site planning is constrained by the link to the existing building which has created some completely internal spaces with no external walls or windows.

3.2.4 Matrix 2 – Environmental engineering matrix commentary

Sustainability is at a similar level to the architecture matrix score for this aspect, as the building achieved an Excellent BREEAM rating at the design stage. However, this should be reviewed in the light of a post-construction BREEAM assessment. Other aspects are provisionally set at approaching Good Practice, apart from Mechanical and Electrical systems. Mechanical systems are rated as below Level 2 due to the problems with the mechanical extract system to the workshops, and Electrical systems are rated at between Level 2 and Level 3. The Electrical systems are rated below Good Practice due to some excessive light level readings in the ASPIRE facility (800-1200 Lux) and other controls problems (eg occupancy sensors in the corridor and a lack of external light sensors).

3.2.5 Matrix 3 – User comfort matrix commentary

Most aspects appear to approach Good Practice levels. Summertime overheating should be ameliorated by the louvres to the clerestory windows in the corridor, and the workshops are naturally-lit with north lights and have mechanical ventilation. However, the building fabric is predominately timber which means that it has quite a light thermal weight – but no significant complaints were recorded by the facilities manager over the first summer of occupation. It would be useful to monitor comfort conditions in the internal spaces where the new building joins the old – by placing temperature and humidity sensors over an entire year, and sporadically checking CO₂ levels. This area is, at least, surrounded by the heavyweight thermal mass of the existing building.

Audible intrusion and acoustics are rated at Level 2 due to the high noise levels from the mechanical extract ventilation system and machinery. This is probably exacerbated by the acoustically lightweight nature of the construction, such as the timber partitions between workshops. Although the partitioning system has seals, many of these appear to have come loose. Acoustic isolation generally needs mass, or heavy weight, to be effective.

3.2.6 Matrix 4 – Whole life costs matrix commentary

External materials and internal fabric and finishes generally approach Good Practice. However, there are some reservations concerning constructional details and the potentially adverse affect this could have on the service life of building fabric and building services

components. One example of this is the leaking roof, where the possible defect was recently identified as a missing compriband seal to the guttering system. This omission in the detailed design has caused leaks which have affected other components, such as a door closer beneath one of the leaks. Damp is generally a buildings worse enemy, particular one predominately made of timber.

Facilities management fitness is rated at Level 2 due to the outstanding, alleged defects that are still the subject of dispute between the architects and contractors and the client. Flexibility is also rated at Level 2, but this is largely due to the very specific brief and the constrained site for further expansion. Flexibility is less relevant due to the specific function of the building – it was not designed to be flexible. It was designed for the very specific function contained in the vocational workshops and the ASPIRE independent living facility.

3.2.7 Matrix 5 – Detailed design matrix commentary

External, internal and junction details are generally rated around Level 2 due to concerns over detailed design issues such as access for window cleaning to the clerestory windows in the corridor, and the alleged defects such as the leaking roof. These aspects need to be reviewed in the light of further maintenance experience. The appearance of the external cladding shows a lack of attention to detail due to dimensional discrepancies. Internally, windows and partitions have sealant strips hanging out.

Safety and security is marked at Level 2 due to the security compromises caused by the expansion and contraction of the timber superstructure/substructure according to weather conditions. The facilities manager recorded instances of being unable to close external doors and match magnetic catches so the alarm system could be switched on. This has led to a number of false alarms.

3.2.8 Matrix 6 – User satisfaction matrix commentary

We have to regard this matrix as largely subjective opinion, which provides invaluable anecdotal insights and evidence into how the building is perceived to perform. This is because it is usually garnering the lay opinion of building users during a semi-structured interview with, for example, the head teacher of a school. It also provides clues to areas that can be further investigated by the expert team. These scores represent the ratings response of the facilities manager of the college at the time, who was striving to rectify a number of alleged building performance failures – relating to such issues as the structural engineering; acoustics; and a leaking roof. A retention sum of 2.5% of the contract sum (about £100k) was withheld in the hope of sorting these issues out, and independent reports were commissioned to investigate the problems.

Overall, it was felt that the spaces worked well for their very specific function (vocational workshops – hence the low flexibility score), particularly the ASPIRE space, but that persistent and quite significant functionality problems relating to detailing and failures to meet the performance specification were present. This is reflected in the fact that how the building is working is rated well below Good Practice (Level 1-2), while its ability to lift the spirits is rated above Good Practice (Level 3-4). The detailed occupant satisfaction investigation provides more in-depth feedback as to how the users feel about their new building. Security was compromised by structural movement and detailing issues with the external doors.

4 Occupant questionnaires and focus groups

4.1 Methodology

A paper questionnaire was distributed to all the staff and students who use the new EcoSpace building. In total 138 occupants completed the questionnaire. Following the collection and analysis of the questionnaire data a series of focus groups were conducted with occupants from the college buildings to verify, and obtain more detail on, the findings of the questionnaire.

4.2 Findings

4.2.1 Temperature

Overall, occupants were generally happy with the temperature and temperature stability in the EcoSpace. However, the Construction workshops and the café area were found to be uncomfortably cold, particularly in the winter months.

4.2.2 Lighting

The staff and students in the ASPIRE area were very happy with the lighting thanks to a good number of windows and amount of daylight. However, staff and students from the Construction workshops were less happy with the level of daylight, particularly considering the work carried out in these spaces. The workshops in the EcoSpace do not have windows only opening sky lights. Some staff felt that the lack of daylight and 'view out' was having an adverse effect on their health and wellbeing. Overall, a quarter of questionnaire respondents felt there was too little daylight. Almost one third of respondents felt there was too much electric light as many are on all the time regardless of daylight levels. There were very few issues with glare in the building.

4.2.3 Noise

Occupants from the ASPIRE area reported very few problems with noise transference either between rooms or from outside. However, for occupants from the Construction workshops noise was a major issue. Noise from the extraction system is the main cause of disturbance in all workshops, although, noises from the compression system and machine workshops were also found to be disturbing for surrounding rooms. General noise from surrounding classrooms and corridors was not found to be a problem.

4.2.4 Ventilation

Once again the majority of rooms in the ASPIRE area were described as having good ventilation and air quality thanks to the openable windows in these rooms. However, a lack of adequate ventilation was found to be an issue in the Construction workshops. This lack of ventilation is particularly problematic when it rains as the skylight windows automatically close and cannot be opened. Once again this is a concern given the nature of the work that happens in these spaces and the dust and fumes produced.

4.2.5 Control

The findings of the questionnaire revealed that approximately a quarter of respondents felt they had little or no control over the lighting, temperature, and ventilation. 41% felt they had little or no control over the amount of daylight, although this does not appear to be an issue for occupants as they experience very little glare and very rarely feel there is too much natural light. One thing that does frustrate occupants is the lack of any kind of manual control over the electric lights in the building (particularly in the workshops and main corridor). The movement sensitive lighting is perceived as wasteful and occasionally annoying.

4.2.6 Storage

One major issue raised by cleaners, staff, and students, was the lack of storage space in the building. 41% of questionnaire respondents described the storage space provided as poor or very poor. Storage is a particular problem in the Construction workshops as there is little room to store students' work. This means that some practical work has to be stored outside in metal containers or Portakabins. Occupants from the ASPIRE area have been able to retro fit adequate storage although they feel more space should have been allocated in the design for storage space.

4.2.7 Décor

Respondents from the ASPIRE area felt the décor was generally good. However Construction workshop occupants rated the décor as significantly poorer than those from the other areas of the EcoSpace. Construction staff and students were particularly unhappy with material and colour of the walls, saying this made the spaces look unfinished and was too dark. There were also concerns about the channels in the flooring for wiring / airline system as the covers bow under pressure and are described as a trip hazard. Staff and students feel these services should have been run overhead instead of in the flooring. Finally, almost all occupants felt that the paint used in the EcoSpace marked far too easily and was difficult to clean, spoiling the look of the building.

Many occupants were unhappy with the general finish of the buildings and felt the building looked scruffy and unfinished in places. Finally, occupants complained that the toilets occasionally had to be closed. Students understood the cause to be insufficient grey water collected to flush them.

4.2.8 Facilities and amenities

The main issue that emerged in relation to the facilities and amenities was the size of the teaching spaces. Overall, 41% of questionnaire respondents felt the teaching spaces were too small. However, respondents from the ASPIRE area reported being very happy with the space in the centre and rated the size of the teaching spaces as better than those from the other areas of the building. Once again occupants who use the Construction workshops were particularly unhappy with the size of these rooms. Student projects can be very large and often can not be moved until finished and marked, meaning large areas of the workshop can be taken up. Almost a quarter of questionnaire respondents rated the external areas as poor. The external decking space was well-liked although several staff and students suggested that benches and tables on the decking space would increase usage and provide a useful amenity..

4.2.9 Security and building management

The vast majority of questionnaire respondents and focus group participants said they felt safe when in or around the college. However, some concerns were raised that there were so many unmanned entrances and exits and that many of these were left open in the evenings (including the entrances into the EcoSpace).

4.2.10 Energy efficiency

Approximately half the questionnaire respondents said it was important or very important to them that the college buildings were energy and water efficient and were built in an environmentally friendly way. However, less than 40% rated the EcoSpace building as efficient or very efficient. Most occupants were aware that the building was designed to energy and water efficient, however some students were sceptical about whether the energy / water efficient systems used were actually working and contributing to the efficiency of the building. The students said they would like feedback on how much energy has actually been produced / saved. Occupants felt water and energy was being wasted by the lack of daylight, movement sensitive lighting with no manual override or daylight linking and wasteful water taps that do not turn off soon enough.

4.2.11 Overall

ASPIRE staff and students were generally very happy with their part of the building. There are a few features they would have designed differently with hindsight; however, the staff feel the space is a huge improvement on what they had before. Staff feel they had adequate input into the design and feel it is extremely positive that there is now a dedicated space for ASPIRE and that it is closely linked with the rest of the college.

However Construction students and staff who participated in the focus groups felt that the building was poor value for money. Construction staff felt that they were not consulted enough during the design process and that their professional opinion was not taken into account. As a result some users feel that the workshops are not fit for purpose as they are poorly lit, ventilated, and lack space. There are acoustic issues and many also feel the workmanship and finishing is poor overall.

5 Conclusions

The Ecospace building at Carnegie College was designed around an ambitious brief which centred on environmental sustainability and as a result it achieved an Excellent BREEAM rating at the design stage. The College was keen to establish environmentally sustainable credentials within the building design and operation, for which it should be commended. The College was brave enough to incorporate a host of sustainable features including the use of A-rated, sustainably sourced materials, the provision of on-site renewable energy generation, the installation of a sizeable rainwater harvesting systems, embracing the benefits of a Sedum green roof and many more. However, despite Carnegie College's best intentions to deliver an environmentally sustainable Ecospace building and as a result of being one of the first Colleges to be daring enough to pilot so many innovative and to incorporate numerous sustainably sound aspects into this new building, there have inevitably been a number of lessons to be learned from this project.

5.1 Lessons learned and future recommendations

A number of valuable lessons have been learned from this project:

- Ensure an independent BREEAM Assessor is appointed early in the design process to provide consultancy advice and conduct both a D&P and PCR assessment
 - This will ensure every team member will know exactly what evidence will be required from them in order to secure both a D&P and PCR BREEAM rating and will help to ensure that every commitment made at D&P stage is actually carried out.
- Consult future occupants of the building at early design stages and throughout the project
 - Ensure that end users (e.g. teaching staff, cleaning staff, facilities team, students) are properly consulted and their ideas and opinions are listened to and incorporated into the design. These are the people who will be making use of the new space and it is important that they do so in an efficient and effective way.
- Specify more detailed, higher standards of finishing
 - Quality of finishing and detailing is very important to the feel of a building and how it is subsequently looked after. On future projects ensure the finishing is of a high standard.
- Carefully consider the secondary effects of equipment such as extraction or compression systems for future projects
 - Noise pollution can prove to become a problem, consider using individual extraction systems for the rooms that need them and positioning the extraction / compression equipment outside the main building.

Future recommendations, to ensure the new Carnegie College building is being managed and is operating in the most efficient and effective way, include:

- Develop a Building Users Guide for staff
 - Despite being specified in the BREEAM report, this was not provided. This is simple a non-technical guide that allows maintenance and estate staff quickly and easily identify what systems are in place within the new building and how to monitor and operate them efficiently.
- Substantial sub-metering equipment is in place – ensure staff are monitoring and recording this information
 - Explain to estates/maintenance staff what is being monitored, how to take readings and record this information. This can help to monitor and lower energy consumption as well as ensuring that all systems within the building are operating efficiently and effectively.
- Distribute information to building occupants to ensure that they are aware of what systems are in place and how to correctly operate different building controls effectively
 - Highlight the sustainable features and feedback the results to the building occupants e.g. inform them that the rain water harvesting system collected so many litres of water to help feed the low flush toilets in the new build and that the solar thermal panel helped to produce so many kWh of energy helping to save so many kilograms of Carbon Dioxide.
- Deliver information on the EU energy labelling scheme and develop a College policy for replacing white and electric goods with 'A-rated' and Energy Star products
 - This is good practice and will help to reduce running costs and improve the College's carbon footprint.
- Develop a detailed maintenance schedule and ensure staff are aware of what their duties entail
 - In particular, clarify the responsibilities of the cleaning staff in relation to the construction workshops.
- Carry out Health and Safety checks around the building
 - Address trip hazards i.e. services covers on floors of workshops, address dust removal for all workshops, ensure all fire doors are able to open and close easily etc.

5.2 Future work

The next stage of the Post Occupancy Evaluation for Carnegie College will involve a Strategic Review of the building in the Autumn of 2009, after three years of occupation to assess its performance in the longer term and inform any future estates planning decisions.