CICSTART - 2010

Project Title: Embedding Simplified Post Occupancy Evaluation within the Design Process.

Project Partners

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Introduction

The UK Construction Industry consists of approximately 250 000 firms employing approximately 2.0 million people. Unfortunately it is a significant contributor to CO_2 emissions, waste and pollution with the building sector alone accounting for 30% of global annual green house gas emissions. Buildings also consume of up to 40% of all energy.

A recent study on energy efficiency in buildings (EEB) indicated that the global building sector must cut energy consumption in buildings by 60% by 2050 to help meet global climate change targets and so the UK government has set ambitious targets in the last few years to work towards these goals. The specific legislative devices introduced to drive these changes forward are the new Part L of the Building Regulations in England and the Sullivan Report in Scotland. There are also numerous documents for information such as the Code for Sustainable Home Technical Guide and the Sullivan Report in Scotland. All these documents require designers today to implement low carbon features and technologies within their buildings.

It is hoped that the new legislation in England will bring about a step change in the industry's delivery of low and zero carbon buildings so that by 2018 all new public buildings including education buildings will be deemed zero carbon and similarly by 2019 all new commercial buildings will be classified as carbon neutral

Post Occupancy Evaluation

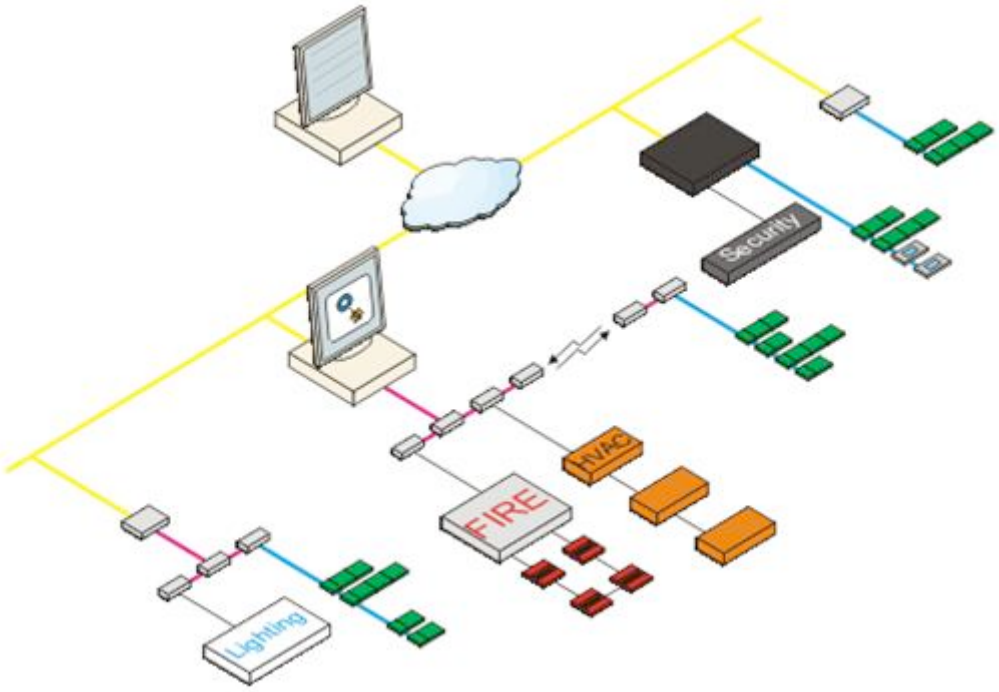
"Post occupancy evaluation (POE) is an umbrella term that includes a review of the process of planning, delivering and completing a project, as well as a review of the technical and functional performance of the building during occupation. This includes user views and experience." (Scottish Funding Council, 2007)

Although POE was an identified process included in the RIBA Outline Plan of Work as early as 1962, formal feedback was not routinely included as part of the design process and stage M which identified a form of POE was subsequently removed in 1972. In 2003 a form of feedback review was reintroduced and identified as stage L, but it has been in recent years due to the legislative changes occurring in the construction industry that interest has been renewed in carrying out formalised POE analyses of buildings.

Building Management Systems

Building Management Systems (BMS's) are common nowadays in most modern buildings and have the ability to control, monitor and optimise Building Service systems BMS's including HVACs, lighting, security and heating systems. BMS's should be ideally suited to support sustainable building design and there are various different systems usually pre-programmed, calibrated and controlled from a central computer.

A schematic of a typical BMS is shown below, with a central computer and its various areas of control:



The precise nature of their control should mean that heating, lighting and ventilation systems are run efficiently and utility budgeting is optimised ie environmental control is managed efficiently. A number of case studies over recent years have indicated however that there can be problems with their use.

Designers must be confident in the performance of automised Building Management Systems due to their increasing use in the UK construction industry as an erroneously programmed or faulty building management system will have a detrimental impact on not only comfort conditions but also electrical or heating usage and therefore relative CO_2 output. This automisation of environmental control in many buildings makes the establishment of simple POE procedures even more important and this project is therefore very timely.

Page and Park Architects

Page & Park Architects have built up an excellent reputation over the last twenty years for designing high quality "sustainable" buildings and have taken progressive steps to demonstrate innovative technologies and embody novel features within their designs in order to reduce energy consumption and therefore CO_2 emissions.

Within the new context of zero carbon targets and as a result of the practice's acquired experience in many different forms of building designs, there has been a realisation that there is a need to extend company activity into Post Occupancy Evaluation (POE) in order to ensure that design intent is being realised in completed buildings. As the company has recently acquired BREEAM excellent ratings on several of their buildings, it is particularly keen to gather numerical and anecdotal evidence to demonstrate that these buildings are indeed performing better than typical good practice benchmarks.

The practice is fortunate to have several recurring clients, as well as long established relationships with both structural and environmental engineering practices in Glasgow and Edinburgh. This provides them with a unique opportunity to gain feedback on building performance as well as a detailed insight into building management issues.

Although these long-term contacts give the firm access to detailed knowledge of completed buildings and an immense opportunity to carry out POE, it can be a time consuming process. This presents a significant challenge to the company given the cost and time constraints associated with most projects and the complexities associated with various types of assessments of building performance.

The intention of this CICSTART project was therefore to build on the knowledge gained from previous POE activities in the UK, and devise a simple, user friendly process or tool to support POE assessment within the practice that could be routinely employed in all P\P projects. Because it was crucial that the method be both cost-effective and time efficient, it was envisaged that it would be implemented as an extension to current post completion reviews.

A further anticipated benefit of utilising this tool was that it would provide a documented Quality Assurance trail for the completion and commissioning stage of the design process, that would provide evidence of compliance with QC procedures and feedback loops.

Project Description

The project involved the team looking at POE analysis from a number of perspectives. The team studied:

1. Information relating to existing POE methodologies
2. Current Building Industry benchmarks to determine industry best practice and compare appropriate figures against P\P best practice.
3. Various existing questionnaires in order to devise a simple questionnaire that Clients would feel was user-friendly and quick to fill in.
4. The range of formats in which clients/companies receive energy data so that a meaningful POE process could be devised that would cope with a wide range of data.

It was decided that the most effective way to deliver a simplified POE process, to complement the existing work practices of Page & Park, was to design a software tool, named POET. This tool was developed over the period of the project and underwent a number of revisions to deal with issues such as:

- compatability with a Mac interface
- the ability to draw multiple graphs
- the ability to export graphs
- the ability to include monthly energy benchmark figures

Energy Benchmarks

A key deliverable on the project was to use POE as a method of guaging any differences between design intent and use in practice so that information could be fed back into future P\P projects. It was also crucial that the Architects would be able to compare P\P designs with best practice guidelines. The benchmark figures chosen for this project were extracted from CIBSE Benchmarks TM46 (2008). This document gives a range of good practice benchmark annual figures for 29 categories of buildings but for the purposes of this project we chose the following four categories:

Category 1 general office
Category 10 cultural activities
Category 17 schools and seasonal public buildings
Category 22 General Accomodation (to cover domestic buildings)

During the project it became clear that although there are a number of different guides giving various annual benchmarks for various building types there is little or no information provided with regards to monthly figures. Although CIBSE Guide TM46: Energy Benchmarks contains 29 different categories of buildings each with a different energy benchmark, it has no method for proportioning annual figures into meaningful monthly figures.

The project team have therefore devised their own unique methodology for splitting annual figures into monthly figures, by using a factor based on degree days.

A degree day is a term which is based on the premise that the indoor temperature of an unheated building in the UK is on average higher than the outdoor. In the UK, using traditional British construction the difference is notionally taken to be 3 degrees. (This means that if say a building internal design temperature of 18 degrees needed to be maintained, the building would only require heating when the temperature outside dropped below 15 degrees.)

This "base temperature" is used as a reference for counting the number of degrees that the outside temperature is below the reference and the number of days in which this temperature drop occurs. The total accumulated temperature difference for a location and region is therefore a measure of the climatic severity during a particular season. A typical degree day value for Scotland is between 2400 and 2600.

As the calculation of degree days is weather dependent and therefore location dependent we have split each TM46 benchmark into four locations: North-East Scotland, North-West Scotland, East Scotland and West Scotland.

POET

POET is displayed in Figure 1. The main interface has a number of functions designed to achieve the stated aim of the project; to produce a simplified tool to carry out POE analysis.

For a given building, energy use data is recorded and stored in POET over a one to two year period following occupancy. This data can be inputted as either monthly or annual electricity, gas or other utility figures. These figures can then be displayed in the form of graphs and compared with the benchmark performance data within the program which are presently CIBSE TM46, but could be say other P\P exemplar projects.

After approximately 6 - 12 months of occupancy, a questionnaire-based building performance evaluation is undertaken by the facility manager (or equivalent) and the outcomes stored in POET. The intention of these evaluations is to capture the building users' consensus view of performance and record how this changes over time. The questionnaire produces quantitative and qualitative data from the building users on various aspects of the building including design, comfort and sustainability – see Appendix 1 for Questionnaire example.

Observational walkthroughs can also be used to corroborate evidence gained. They can be used to record whether people are using the building as intended; where they relax, how they use quiet spaces and what they do to counteract negative environmental features e.g. moving to alternative desks to avoid sunlight, having fans/ heaters beside their desks.

At the year's end the energy data and building performance evaluations are scrutinised by a nominated P\P representative and, where deficiencies are evident, one of several possible actions may be initiated:

- further investigation of energy consumption, environmental conditions or building management;

- a discussion with the client, M&E consultant or in-house QM team; or an

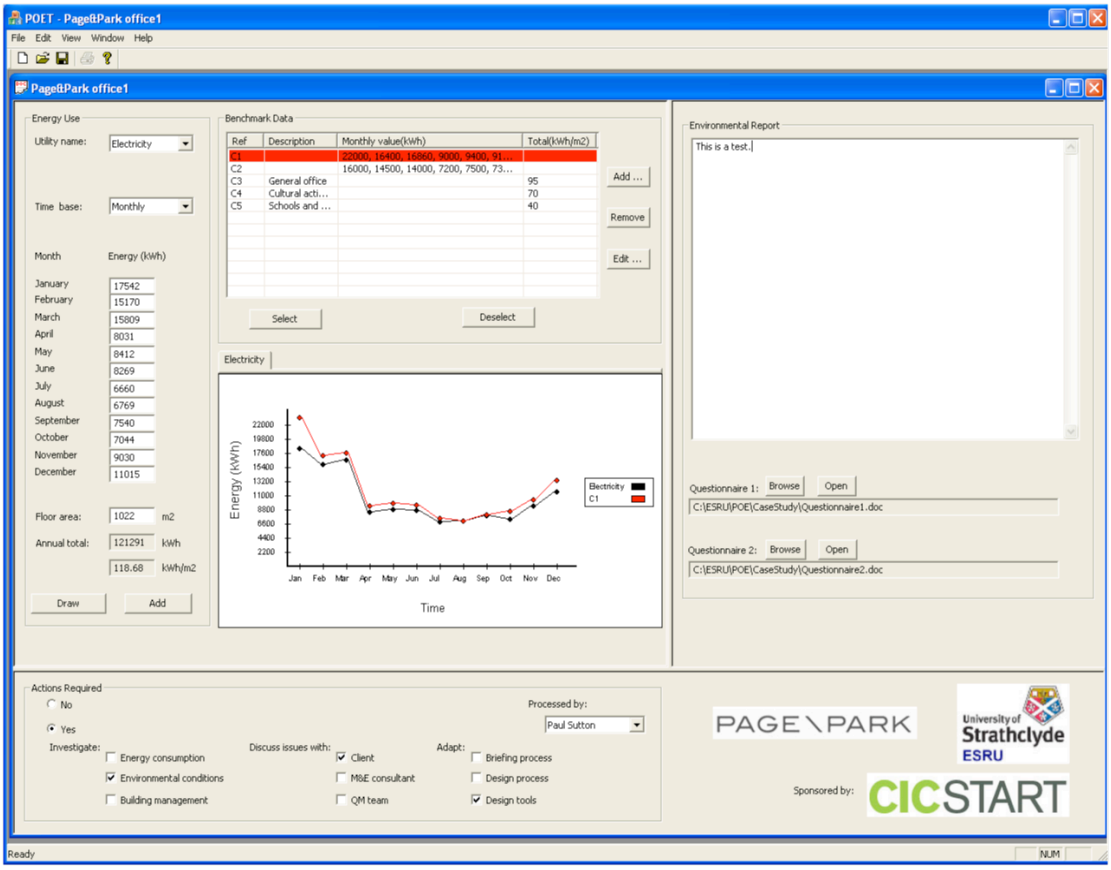


Figure 1: Interface of the Post Occupancy Evaluation Tool (POET).

- adaption of the briefing process or design process.

In this way problems are made explicit and linked to ongoing remedial action within P\P.

Where issues arise that require a more detailed investigation of a particular performance aspect (e.g. glare or overheating) company personnel will be trained in the use of physical environmental performance measurement devices. (ESRU will carry out this training during summer 2010.) This approach will allow the company to systematically evaluate the objective and subjective aspects of the building's design performance (including possibly BMS performance) and identify ways to improve the design process to align design intent with user satisfaction.

Case Studies

P\P are now starting to utilise POET on two recent building designs. Questionnaires have been issued to users of both buildings but to date the response rate has been quite low. This is a perennial problem with trying to carry out questionnaire surveys and will be a challenge for P\P being able to gather sufficient information to give a representative sample of user opinions. A sample questionnaire is included in Appendix 1.

The firm has utility bill information for one of the buildings which will be inputed into POET and they are awaiting information from the other building. P\P have also accessed utility information from two other recently completed buildings that they will use to populate POET and start building up their POE database.

Conclusion

This CIC start project has been an interesting and informative project for all the team members. It has started a fruitful collaboration between P\P and the University and hopefully provided P\P with a useful tool that will allow them to carry out POE on all their future buildings.

It will give the practice a detailed knowledge both statistically and subjectively of how their building designs perform in use, as well as an ability to benchmark their designs against best practice sustainability indicators. POET will also importantly allow the practice to review their design strategies in future buildings by providing information and feedback on various design issues such as the performance of innovative technologies, the efficiency of BMS systems and the comfort of users with regards to issues such as glare, overheating, draughts etc.

In the medium to longer term it is hoped that this project will be the start of long lasting research collaboration between the two institutions that will facilitate practice baced research, innovation and knowledge exchange.