`Closing the loop`: exploring the link between the
design brief and post occupancy evaluation to
improve sustainable design

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ABSTRACT: The aim of the paper is to examine the linkages between the design brief and the environmental outcomes of a project that uses POE methodology. A case study method will be used to examine to what extent the design brief plays a role in creating positive environmental outcomes. This case study approach will promote a new briefing model that links all stages in the design process, from pre-design consultation to the post-occupancy evaluation of the final building. Briefing is a pre-design documentation process for building design, which at present mostly ignores environmental issues. This paper examines the process used to analyse and develop the framework for the Environmental Brief for an innovative environmentally sustainable building in the Lark Quarry Museum. Such a framework can assist the transformation of the building industry to Ecologically Sustainable Design practice. The paper presents discussions with the designers and clients of Lark Quarry Museum, Winton, Queensland, concerning the design intent of the building, together with an evaluation of the extent to which the building process has addressed this intent.

Conference theme: Building Case Studies
Keywords: Environmental Briefing, Post-occupancy Evaluations

INTRODUCTION

Briefing is a pre-design process for building design that, at present, mostly ignores environmental issues (Moore and Hyde 2006). However, as Australia’s current water crisis shows, good environmental management is necessary to ensure better future use of Australia’s natural resources. The architecture profession is not exempt from this national imperative. This paper argues the importance of a pre-design environmental briefing process linked to a post occupancy evaluation (POE) system, which has the potential to achieve better environmental management in future built environments in Australia. The research that underpins this argument involves examining the application of an integrated briefing and POE process to the Lark Quarry ‘Trackway’ building, Queensland. This is an innovative building, using an environmentally sustainable design, meant to provide a museum and tourism facility. The first part of the paper examines the theory underlying the integrated approach, which draws on concepts of ‘Environmental Briefing’ (Hyde 2006, forthcoming) and POE models for the design process. The second part presents the initial findings of a post-occupancy evaluation (POE) of the Lark Quarry ‘Trackway’ building in Central Western Queensland, which evaluate the operational performance and overall effectiveness of the museum’s environmental features. The third and final part includes recommendations for theoretical improvements to the integrated approach and illustrates the importance of environmental briefing procedures in the realisation of public and commercially-driven buildings in Australia.

1. THE DESIGN PROCESS: ENVIRONMENTAL BRIEF AND POE THEORY

1.1. Environmental briefing (EB)

Architects are coming to see the project brief developed by the client as the most crucial part of the entire design process, in terms of achieving high-quality buildings. It is argued that a brief that clearly articulates environmental issues is likely to be extremely effective in driving the building design and producing good environmental performance. It is further argued that the briefing stage should be used to the full, to set out environmental criteria that will allow assessment of the building’s performance throughout the various stages of the design process. This approach can effectively ensure that environmental design strategies are not compromised. For these reasons the implementation of the environmental brief is seen as an important step on the path to achieving a high level of performance of the overall environmental design strategies. The EB system has been developed from the theoretical work (Watson et al 2000) and practical testing involved in a number of pilot projects (Hyde 2006, forthcoming). The components of the system, shown in Figure 1.1, are set out in a series of stages, in a general-to-specific framework. Stage 1 involves starting with goals and objectives; Stage 2 consists of parameters; Stage 3 concerns strategies; and, finally, Stage 4 provides recommendations for their application. Stages 1 and 2 are largely descriptive, mapping the issues in the project. It is in Stage 3, strategizing, that the usefulness of the tool is most apparent, since its analytical framework supports design decision-making.
The implementation of the EB system requires the adaptation of existing design and procurement processes. Table 1 shows an example of how the process, as used in Australia, can be adapted to emphasize the use of the brief as a tool for environmental design.

**Figure 1: Components of the Environmental Brief**

### 1.2. Environmental briefing and the design process

Research has identified two further pathways for designers, in addition to that for environmental briefing. An important pathway includes not only environmental assessment systems (incorporating environmental management principles) but also the use of tools such as rating and benchmarking systems. An additional pathway that has been identified involves the use of blueprinting systems to feed forward information from existing buildings into the design process. A unified approach in the design process that links these pathways may assist with improving the environmental performance of buildings. Research into POE theory has supported this idea of making better use of the last step in the design phase.

**Table 1: Steps in the design process related to the pathways for green design**

<table>
<thead>
<tr>
<th>Steps</th>
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<th>Step 2: Sketch design</th>
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### 1.3. POE Theory

“Post-occupancy evaluation (POE) is a review technique for systematically assessing the appropriateness of facilities. It involves the study of the quality of a facility once it has been occupied and is in full use. In general, a POE does not examine the project delivery or construction process but concentrates primarily on the performance of a completed and occupied facility.” (Bycroft and McGregor 2002: 1.)

The theoretical framework for post-occupancy evaluation is grounded in people-environment theory, which assumes a two-way interaction between people and their built environments — i.e. the impact of the facility on people and the impact of people on the facility. Environmental impacts on people are those described as cultural, social, behavioural and physiological, while the impacts of people on buildings are economic — the cost of maintenance, and operational costs, and technical — the failure or deterioration of building components.
The forty-year history of POE displays four main theoretical shifts since the initial development of the practice in the early 1960s. POE was originally developed in the United Kingdom as a performance evaluation of particular buildings, but has since expanded, starting with a first shift in theory toward being more people-focused. A second shift in theory saw the integration of a ‘business-outcome model’ that made the approach more relevant to the economic objectives of projects (Bycroft and McGregor 2002: 2). Yet the importance of POE in terms of its relevance for design professionals was being questioned; in 1981, Law published the findings of a survey into the use of post occupancy evaluation by Australian architects. They showed that ‘only 10% of architects return to consciously and voluntarily learn from the experience of their buildings in everyday use’ (Leslie 1987). This apparent lack of use in the architectural profession was seen as a symptom of the lack of theoretical development of POE itself. In spite of it maintaining a cross-disciplinary focus and drawing from non-architectural fields, such as environmental psychology, sociology, and economics, it is still not widely practiced. This failing promoted a third shift in theory to a focus on the needs of the practitioner. Preiser (1995) has identified three ‘levels’ or types of POE – indicative, investigative, and diagnostic – and explains that each level is related to the effort a practitioner must expend in undertaking a particular evaluation.

1. Indicative POEs are quick, walk-through evaluations, involving structured interviews with key personnel...as well as inspections in which both positive and negative aspects of building performance are documented photographically...
2. Investigative POEs are more in-depth and they utilize interviews and survey questionnaires, in addition to photographic...and physical measurements...
3. Diagnostic POEs are focused, longitudinal and cross-sectional evaluation studies of such performance aspects as...safety, orientation...lighting, privacy, overcrowding, etc. (Preiser 1995: 22.)

Building on Preiser’s (1995) work, Bycroft and McGregor (2002: 5) explain the differences in each type of POE. They show that the indicative POE has a broad scope, which gives immediate feedback to the evaluator, whereas the investigative POE "involves a more detailed analysis," and builds on the indicative approach by focusing on the technical aspects of the building’s performance. The diagnostic type of POE is a comprehensive assessment, which incorporates aspects of the indicative and investigative approaches, and adds other evaluative components, such as economic and community (cultural) characteristics (Bycroft and McGregor 2002: 5). According to Bycroft and McGregor (2002: 6), the purpose of a POE investigation is firstly to ‘feed-back’ or fine-tune an existing project, which generates a brief for proposed alterations, and may establish a management programme for the building; and secondly, to ‘feed-forward’, which involves providing a draft brief and general information for use with future projects of a similar nature.

1.4 Advancing POE theory: linking the design brief to improved sustainability in building performance

A fourth shift in theory is emerging, with the grounding of POE methodology within the sustainability research paradigm (Roaf 2004). As it embraces the ‘four pillars for sustainability’ theory, which focuses on four main areas for sustainable building practice: ethical and cultural values; social and community values; environmental values; and economic values, additional relevance to building design professionals and clients may ensue. In light of this, we (the authors of this paper) have devised a practice-based method, combining both qualitative and quantitative approaches for the POE, in order to test the environmental briefing objectives of the Lark Quarry Trackway building.

The Lark Quarry POE study is intended to provide both ‘feed-back’, suggesting improvements to be made to the building, as well as ‘feed-forward’, making suggestions for improvements to the environmental briefing process for all similar projects in the future.

The current research method is focused more on the diagnostic framework, as it incorporates aspects of both the indicative and investigative processes outlined above. This framework sets up a longitudinal research methodology to study the museum’s technical performance over a six-month period, as well as investigating the cultural and community impacts of the Lark Quarry building.

This model specifies a number of areas for data collection and analysis concerning the environmental performance of the Lark Quarry Trackway building. The authors have focussed on such aspects as the technical performance of the building, recurrent operational costs, and human physiological impacts. The theoretical framework for this exercise is grounded in the Royal Australian Institute of Architect’s (RAIA) BDP Environment Design Guide (EDG). This RAIA EDG document has become the industry standard text and serves as an important resource for the Australian architectural profession. EDG covers post-occupancy theory in detail, due to its relevance to ecologically sustainable design.

2. CASE STUDY

2.1. Role of the Lark Quarry Brief
The Lark Quarry Trackway Building is in a remote desert area, 120 kilometres southwest of Winton in Central Queensland, and accommodates a set of dinosaur footprints that are unique to the area and have been acknowledged to be of significant archaeological value. The Lark Quarry Conservation Park protects these excavated dinosaur footprints, which are 93 million years old and are the world’s best-known record of a dinosaur stampede. The isolation and fragility of this natural resource requires special consideration with regard to access, conservation and presentation. The Lark Quarry project offers an ideal case study, due to its remote and highly fragile desert ecology (see Fig. 2).
2.2. Functional Requirements
A working group was established, with representatives from Tourism Queensland, the Queensland Parks and Wildlife Service, the Department of the Premier and Cabinet, the Queensland Heritage Trails Network and a number of consulting organizations, to produce a concept design and pre-feasibility study in order to progress the development funding for this project. The major issues considered by the working group in formulating this report were preservation of the Trackway surface; ongoing funding of site facilities; additional requirements brought about by increased site visitation; and defining the interpretation focus for the facility.

Further issues were promotion of the Trackway facility; accommodation at the facility; and the incorporation of ecologically sustainable design and technology, appropriate for the environment and the experience. The Queensland Museum advised that the Trackway could potentially extend further into the hill on which they are situated, and that other, as yet undiscovered, palaeontologic resources might be found on any or all of the surrounding ridges. This information resulted in the decision to locate the primary visitor facility, together with any camping accommodation, well away from the Trackway conservation building. The design objectives for the project encompassed the conservation of the dinosaur tracks; accommodation and access for visitors; and the interpretation to visitors of the meanings of the tracks and the surrounding landscape, focusing on the existing landscape and the history, theories, and information behind the dinosaur Trackway. This was to be accomplished through ‘best practice’ ESD (Ecologically Sustainable Development) principles.

2.3. Design Approach & Environmental Goals
The sustainability goals and objectives of the Lark Quarry Museum were included in a pre-feasibility study carried out by Tourism Queensland. This has resulted in a comprehensive document that includes sketch design concepts. Sustainability objectives, although not in the brief, were integrated by way of this study. A design approach, integrated between designers, engineers and environmental managers, came about during this project. The complete team, with multidisciplinary members, had joint oversight of analytical work and testing, in an interdisciplinary and coordinated approach using design charrettes (brainstorming sessions) to facilitate better communication between the client body and the consultant team. There was evidence of the use of energy audits, benchmarks, targets and thermal modelling where energy concepts were dealt with in the energy consultant’s report, which included daylighting studies. The team also worked within an Environment Management System in operation at the Conservation Park, which included standards and energy audits specifies an operational statement for post construction project assessment, operational control and, where appropriate, continual improvement of environmental and local impacts through the Queensland Parks and Wildlife Service. ESD initiatives were included at the early cost planning stage of this project. The architects developed a policy to integrate the builder’s advice at an early sketch design stage of the project, so as to better mesh the environmental, construction and economic issues in the design. A valuable strategy in the exercise was to use a bill of rates for work for the project, giving a degree of transparency to the project costing process, allowing for variations during design development to be easily costed. An added benefit was that the builder was selected and engaged early in the process and provided input into the construction documentation of the building. This meant that the builder became a critical part of the design team for documentation. The builder’s advice on suitable construction methods was also critical, with the builder becoming directly involved with QPWS (Queensland Parks and Wildlife Service) in relation to minimizing impacts on the site through the Conservation Park EMS (Environmental Management Standard).

2.4. POE Research Methodology
The post occupancy evaluation of the Lark Quarry Museum involved discussions with designers, clients and users concerning the building’s design intent and its current operational and environmental performance. The purpose of the evaluation was to establish the extent to which the building had addressed this original intent, as well as focus on the design and construction process, and how this was assisting to reduce environmental impacts. The POE also considered the effectiveness of passive systems to adequately control comfort and provide a stable environment for the museum’s artefacts, as well as to measure the ongoing operational savings in water, energy, and waste that come from the design systems used in the building methodology. The POE also evaluated the operational performance of the building, acting through an environmental framework, and considered the relevance of this approach for use in practice for other public buildings of a similar nature. The main intention of the POE was to develop measures for a broader framework, while refining the Environmental Brief for wider use in architectural practice.
The POE research methodology involved an initial two-day site visit in June 2006, with plans for a follow-up visit in early December 2006. This initial field trip to Lark Quarry installed the measuring equipment, and gave researchers an opportunity to discuss the operational and environmental performance of the building with museum staff. The period for evaluation is the six months between July, the coolest time of the year, and February, the hottest. Portable and non-intrusive data loggers were set up to measure diurnal temperature and humidity changes at 30-minute intervals over that period. Lux meters were used to gauge the effectiveness of the building’s skylights. Airflow within the building is currently being measured with anemometers.

Ventilation flows around and through the building were also investigated and the night purging system, which currently deals with humidity levels, is being investigated. The effectiveness of the existing skylights for temperature control is also being investigated.

2.5. Design Strategies and Building Performance

The planning of the Trackway complex is based on a number of factors. A key influence on the position and the form of the Trackway building and its geometry is the nature of the dinosaur tracks. The excavation is approximately 22m by 22m and roughly triangular. The resulting building is a big ‘shed’ comprising a steel superstructure (on a six-metre grid) that spans across the tracks in providing the enclosure. The form has additional bays added to the roof structure, which extend the building into the hill to provide good shading and keep ground water away from the building. External cladding is lightweight, with insulated external walls and heavyweight rammed earth internal walls. The Trackway building is linked to the entrance building by a walkway that forms a bridge over the landscape. The entrance building is based on a three-metre grid, and contains seating and an information area. The building is heavy in weight, with timber batten screens and a louvre system to control ventilation. The main strategy for energy efficiency and conservation is the use of passive strategies, such as thermal mass and insulation.

2.6. Physiological factors: The use of passive and thermal mass strategies

Climate data for the site was taken to be the same as at Longreach, since there is currently no climate recording on the site. Longreach is the nearest official weather station to Lark Quarry. Situated at 23° 27' S latitude, and 144° 15' E longitude, Lark Quarry has a hot dry climate with average temperature levels mostly within the human comfort zone (22-27°C) throughout the year. From May to August, the average temperature levels are below the comfort zone; so heating may be required for these months. This can be achieved through passive solar heating. For the other months, temperature levels are mostly higher than the comfort zone and thus require cooling. For passive cooling, better ventilation is needed. One of the best methods in this situation would be to use the stack effect, where cold air enters the lower areas of the building during the night and displaces the lighter, hotter air exiting from the upper levels. Air will need to be filtered to prevent dust from entering the building. Thermal mass is a key to stabilizing the temperature for user comfort in this building. In addition to thermal mass, insulation and limits to the glazing area are also important for comfort issues as well as preserving the dinosaur footprints. The average relative humidity level ranges around 20 to 50 per cent during the year. In summary, with low humidity and a high diurnal temperature range, the bio-climatic strategies used to cool and heat the building naturally are mass effect – using the thermal flywheel effect of heavyweight materials, air effect – using the cooling effect of lower night-time temperatures, and evaporative effects – using water cooling (see Fig. 4).

Internal walls are made of rammed earth, 300 to 450mm thick, that provide thermal mass for the building. The envelope and line of enclosure use a lightweight cladding system comprising 100mm thick composite steel sheets with polystyrene cores (see Fig. 5). This gives a thermal resistance (R-value) of 1.5 in the wall structure. The roof is a lightweight galvanized iron cladding with rigid plastic insulation and felt sisalation (radiant barrier) providing an R-value of 2.5. The rammed earth walls and floor are the main elements of the thermal mass. These thermal resistance values are appropriate to deal with the average temperatures at Lark Quarry, however questions arise when they are required to deal with the extreme temperatures during summer and winter. The authors are unsure as to these values at the moment, since the investigation is ongoing.

Other questions have been raised, as to whether the insulated skin was necessary, or would the 450 mm thick pise adobe walls be sufficient, given that it has an R-value of only 0.5. Initial modelling and investigations reached a
number of conclusions, for example, in the pise adobe walls the energy required to maintain comfort between 23 and 28°C was 154MJ/m for cooling, and 46MJ/m for heating. With the external insulation, the walls, at R1.5, achieved 33MJ/m for cooling, and 23MJ/m for heating. This performance improvement, with external wall insulation, reduced cooling energy by eighty percent and heating energy by fifty percent. Positive effects on thermal comfort were also found with the insulated walls. The building was simulated under free running mode in summer (assuming a small degree of night-time ventilation) to assess comfort and the effects of insulation. Uninsulated walls kept the annual temperature range in the building to 14 degrees C or between 18 and 33°C for the whole year. Insulating the walls reduced the annual temperature range to 11 degrees C (19 - 30°C). This reduction of temperature range is crucial for the preservation of the Trackway building and modelling has shown the indicative range of temperatures that can be maintained. Further parametric studies were done to check the range of temperatures on hot days in summer and in winter and demonstrated similar results. The value of a hands-on POE investigation means that actual testing can now be done to prove whether or not these desired temperature ranges actually occur in the building now it is constructed.

![Psychrometric information for Longreach. The climate delivers significant under-heating in winter and over-heating in summer, the area being notorious for extreme variations in temperature. Low relative humidity dominates the yearly moisture cycle.](image)

**Figure 4:** Psychrometric information for Longreach. The climate delivers significant under-heating in winter and over-heating in summer, the area being notorious for extreme variations in temperature. Low relative humidity dominates the yearly moisture cycle.

![Lark Quarry Museum gallery area – role of thermal mass; interior view of sandwich panel construction; and display area – need for retrofitting ventilation.](image)

**Figure 5:** Lark Quarry Museum gallery area – role of thermal mass; interior view of sandwich panel construction; and display area – need for retrofitting ventilation.

The form of the building is not necessarily optimised for climate considerations (i.e. through its orientation) due to its function. Both the Trackway building, and the entry and display facilities building, are oriented along an east/west axis with orientation eight degrees west of north, with its longitudinal side facing North and South, thus minimizing exposure to West and East. The optimum orientation would have been to align the building east/west. This is a common situation with this type of building, where function is of primary importance, and it leads to a reliance on manipulating the envelope to achieve energy efficiency and occupant comfort and preservation of the site. Shading has been designed so as to exclude western sun exposure. The building has been designed with minimum window area to suit the preservation/interpretation function and to minimize heat gain in the building. The wall construction is heavyweight rammed earth, set well clear of the footprints. The external veneer is sandwich panel construction on the outside to act as insulation and for night purging. The building is designed to exclude breezes during the day in summer when the maximum external temperature is around 40 degrees C. Theoretically buildings of this type with thermal mass should perform better if the thermal mass can be cooled by the external night air. Desert locations such as this have a high diurnal temperature range and the heat sink effect of the thermal mass can be used to advantage. The simulations were carried out with night purging included. The comfort conditions inside the building were much better, then, but the diurnal temperature variation was also greater. This approach is better for human comfort but worse for preservation of the Trackway.

### 2.7. Daylighting

On a cold day in July in winter, the external temperature variation was from 4.0 to 21.9°. In the building with externally insulated walls this produced a temperature range between 19.4 and 21.5°. As to annual temperature variation throughout the year, every 6-7°C variation in external temperature produced about 1° variation inside the building when the walls were externally insulated (Wilrath, op. cit., p4). Daylighting is delivered into the building by ten angular selective 1.2 m square Skydome skylights (Skydome 2004). Modelling of daylighting in the Trackway building...
revealed that these provide adequate daylight all the year and for differing sky conditions (Wilrath op cit: 3). Light is admitted through the roof and a diffusing panel is placed at the ceiling to reduce glare.

2.8. Building envelope
An interesting outcome from our initial POE was that, in comparison to the theoretical Mahoney Analysis, which stated that no cross-ventilation was required, in practice cross-ventilation was required, with the building envelope failing to provide necessary access for cooling breezes during hotter, more extreme, periods of the year. Overall, a defensive building is recommended for Lark Quarry’s dry hot climate. A defensive building is defined as one that primarily uses the building envelope to mitigate heat gains or losses due to the exterior environment. The opposite of a defensive building is an interactive one, where the envelope works to accept favourable heat flux and reject unfavourable climate events. The Lark Quarry building can be both. In winter it is primarily closed to conserve heat whereas in summer it can be closed during the heat of the day and opened during the night, to ventilate the building and keep temperatures constant inside. The main objective of this project is not only to provide thermal comfort for visitors but to also avoid damage to the footprints through excessive expansion and contraction. This strategy of combining defensive with interactive capability in the envelope is appropriate.

2.9. Research Findings
The research team visited the site in July 2006 to set up the instrumentation. Initial spot measures were taken to address three main questions: 1) what variation in temperatures is found in and around the building? 2) what level of thermal comfort is provided in and around the building? 3) how was the building operating in terms of environmental criteria?

With regard to thermal comfort, spot temperatures taken recorded that the building functions well during winter as it stayed within the human comfort zone; however, small temperature variations were found in the internal gallery and adjacent veranda spaces. Variations were also found in the heat flow through walls, depending on the extent of shading to the external skin. Data on electricity and water usage could not be collected, due to a lack of available meters. Initial discussions with users of the building pointed to satisfaction with the building in winter, but areas of the building, such as the enclosed veranda and gallery spaces, were said to overheat in summer. As a result the building has a short visitation season in winter, but the use in summer could be extended if the thermal comfort issues could be resolved. The recommendations based on these observations are: 1) install electricity meters to record energy use and yield for a photovoltaic system; 2) install water meters to log water yield and consumption; and 3) implement a questionnaire regarding comfort levels for users and visitors. The POE study was extended to include the summer period, when the extent of the overheating problem could be investigated. In addition a questionnaire system is being developed for use in the building.

3. RETURN TO THEORY: LINKING THE BRIEF TO POST OCCUPANCY STUDIES

3.1 Creating an interactive environmental briefing process
Judging by the initial work at Lark Quarry, it may be advisable to include recommendations in the brief, for POE work to enhance environmental performance in the operational phase of the building. The POE process could involve additional activities, in an interactive manner with the design team and the client, which might assist with fine-tuning the building to improve its performance. Figure 6 below illustrates some of these activities.

The POE acts as a diagnostic activity to assist with commissioning the building’s passive and active systems, so that these can operate at their optimum. Users are not experts in this type of work, and require assistance to utilise the building at optimum.

3.2. Initial Findings
Initial findings from the study show the need to link the briefing process with the POE study. Discussions with the client and the architect revealed a need to use the POE as the basis for further design development work. Figure 6 shows the basis for this work, where the POE is included as part of a commissioning retrofit process of design development. In environmental terms, this allows for the adoption of important principles such as continued improvements and to reduce cost and environmental impacts. Implementation of environmental standards such as the Green Globe 21 could also be used to improve the briefing process and the subsequent building performance.

![Figure 6: Linking the brief to POE to improve environmental performance.](image-url)
DISCUSSION AND CONCLUSION

The ‘cultural’ and ‘information management’ impediments to the acceptance and utilisation of POE in the design profession have far-reaching implications in terms of wasted resources and sustainability. More importantly, there needs to be a significant change in the ‘arts paradigm’ that still predominates the architectural profession. There is growing evidence that the design professions are losing significant ground because of theseibilities. (Bycroft and McGregor 2002: 3.)

The project is an example of a remote tourism facility designed to work within the ecosystems that form its context. This includes the natural and man-made environments. Lessons learned from this project are as follows: 1) coordinated supervision of design and communication with sub-contractors is important in order to persuade them to use environmentally responsible construction processes. Because of the fragile nature of the Trackway, everything needs to be done either from above or outside during construction; 2) building systems and methods are specified to reduce energy consumption and waste during construction; 3) transportation energy is a key component of remote projects. Using locally sourced materials and labour minimizes this demand for energy. Minimization of waste during construction is achieved through extensive prefabrication, to avoid on-site cutting and minimize waste from off-cuts; 4) a low service intensity of the building has been achieved. Air-conditioning has been avoided, so it is possible to achieve a high degree of autonomy for the building. Service needs for energy and water are met from onsite harvesting; 4) the most important design lesson for the Lark Quarry project is to understand the interaction between all issues, which include: land impact, energy related issues, resources, construction methods, local economy, local approval, expertise and intervention, social issues, etc. As everything is interconnected, decisions need to be well thought out. Certain difficulties emerged at different times for the various parties involved, especially as the site has great historical importance and requires complex programming, budgeting and monitoring. Thus, conservation and minimal site disturbance during construction, and good communication among all parties are vital for the Lark Quarry project; and 5) cooperation with the builder was a key strategy in achieving the level of sustainable development in this project.

In conclusion, the Lark Quarry project has offered valuable design lessons for architects and designers. It is the preservation, accommodation and interpretation that make the project instructive and worth documenting for future reference. Further improvement can be achieved through implementing POE studies and operational environmental standards. It is seems important that at the initial part of the design phase, when briefing takes place, that post occupancy work will be needed to ‘fine tune’ the building performance through retrofitting and commissioning work. The lack of this type of activity at Lark Quarry is preventing optimum utilisation of the building in terms of providing comfort for users and also protecting the artefacts within the building. Use of POE to test the objectives of the brief in an iterative manner holds some further potential for ongoing improvement of the environmental performance of the building. The discussion to this point in the paper has focused on presenting initial findings, the authors are due to return to Lark Quarry, either later this year or in early 2007. While the research findings are limited at this point, preliminary results illustrate the necessity for good pre-design environmental briefing with a follow up post-design, post-occupancy evaluation.

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