OPTIMISING ENVIRONMENTALLY SUSTAINABLE DESIGN (ESD) OF MULTI-STOREY BUILDINGS

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Abstract
Modern building practice frequently seeks to utilise the benefits of private finance initiatives to incorporate a whole of life philosophy that drives innovation and efficient functional and financial outcomes through the application of Environmentally Sustainable Design (ESD) concepts.

Major Privately Finance Initiative (PFI) building proponents seek market advantage through the application of ESD concepts to optimise the overall project costs by considering both capital cost and whole of life operating and maintenance expenditure.

This paper discusses how a large international building proponent is integrating new technologies into its designs for medium and large scale projects to meet ESD concepts and is also influencing internal policies and practice to capture real benefits from ESD. It considers current expected ESD considerations in tender submissions and the drive for so called ‘green’ star ratings. Specific case examples, drawn from the UK and Australia, are used to reflect on the current application of ESD concepts and expectations into building practice and the potential for these concepts to be standardised.

The paper concludes that there is further scope for consideration of ‘Whole of Life costs’ and the development of improved outcomes for clients through the use of new design concepts.

Keywords
ESD, Energy, Procurement, Design, Multi-Storey
THE BUILDING INDUSTRY’S NEED FOR SUSTAINABLE PRACTICES

This paper discusses how a large international building company is integrating new technologies into its designs for medium and large projects to meet Environmentally Sustainable Design (ESD) concepts and how these approaches are influencing internal policies and practices to capture real benefits from ESD. The paper critiques the current status of ESD application and discusses its application to the Wembley Stadium project in the UK, along with Federation Square and Southern Cross Developments in Australia. A discussion of the potential for adding value through ESD concepts is followed by supposition on the future direction of industry.

The drive for ESD implementation is premised on achieving a sustainable living environment that encourages buildings to have improved levels of amenity whilst reducing the overall cost to operate, maintain and refurbish the building from a whole of life perspective. The breadth of potential for ESD, (eg. energy efficiency, reduced whole of life material costs, fabrication cost, minimisation of waste) has proven difficult for building regulators to encourage and mandate sufficiently to capture the full philosophical advantages sought. Some of the measures introduced, via ratings, have encouraged building orientation on sites to optimise the relationship between prevailing weather conditions and energy use. They have also instilled a mentality of choosing energy rated building components. By themselves these rating controls have not stimulated industry to capture benefits from building systems and quality construction.

Privately Financed Initiative (PFI) led projects have demonstrated a genuine attempt by proponents to evaluate and optimize a whole of life outcome for facilities as the proponent focuses on service outcomes over the whole period of a long term concession agreement rather than simply optimising for the efficient provision of a building. This objective has stimulated the optimization between construction, operation and maintenance costs. Broader environmental aspects such as the energy used for material production and the cost to refurbish buildings are, in truth, still in their infancy. Changing regulators focus for ratings to a systems approach may create opportunity for proponents to creatively deliver truly better outcomes.

To achieve such improved outcomes both proponents and owners will need to identify tangible benefits by way of improved utility and reduced costs. A negative alternative approach would be to impose penalties on non compliance with ESD concepts; whereas a more creative approach is to stimulate integration of ESD through an understanding of the benefits in terms of sustainable community savings.

ENVIRONMENTALLY SUSTAINABLE DESIGN: THE CURRENT SITUATION

Hicks and Francis (2003) found that there were many factors that determined whether large construction contractors adopted an Environmental Management System and whether they were proactive to implement measures to protect the environment. All large construction contractors in their study developed and implemented an Environmental Management Plan with the majority of contractors achieving accreditation to the international standard AS/NZS ISO 14001 (Hicks and Francis 2003). Currently in Australia there are no legislative measures, only voluntary framework for building construction organizations to manage their environmental issues. The United Kingdom has only recently adopted EU legislative requirements and such requirements are now being introduced into practice.

Griffith et al (2000) summarise the benefits to be gained by a better corporate focus, improvements in efficiency, enhanced marketability, reduced liability and improved
commercial competitive advantage. However, Hicks and Francis (2003, pg 680) highlighted that “building construction companies perceive themselves as ‘good’ corporate citizens, but are still ‘profit motivated’ and focused on environmental protection as a source of competitive advantage”. Their study revealed that, in general, “the Environmental Management Systems were immature unable to measure, specify or quantify the benefits to progress to the next level of continual improvement”. AS/NZS ISO 14001 has procedures to measure the performance of the systems, however due to the integrated nature of EMS’s with quality assurance and occupational, health and safety there were a lack of tangible benefits attained (Hicks and Francis 2003).

In addition, the research undertaken by Hicks and Francis (2003) discovered that it was the construction organizations themselves that undermined the implementation of their Environmental Management System due to the lack of effective training of their staff.

Yip (2000) and Griffith et al (2000) comment that the Environmental Management System (EMS) should be implemented through the whole construction process from project evaluation, through design, procurement and contract administration, into use and maintenance of the building. Hicks and Francis (2003) found this to be ‘idealistic’ with construction contractors revealing that their respective environmental management systems are implemented “where they can”. They highlight that due to “the inherent fragmented nature of the building construction industry, and the segregation of the design and construction functions in the majority of projects impose impediments to the achievement of environmental management implementation success (Hicks and Francis 2003 Pg 681)”. Adopting strategic procurement strategies that integrate the design and construction functions such as partnering and alliancing will improve the industry’s adversarial culture, increase profit margins of organizations, and mend the fragmented nature of the industry and its processes (Hicks and Francis, 2003; Kenley and London, 2002). In turn, we would have a better chance of developing and constructing projects with less impact on the environment and capturing real benefits from developing and implementing environmental initiatives.

The Building Research Establishment Environmental Assessment Method (BREEAM) was developed in the United Kingdom by the Building Research Establishment in 1990 and is the current national benchmark for what constitutes a ‘green building’. It assesses “the performance of building management, energy use, health and well being, pollution land use, ecology, materials and water” (Department of Sustainability and Environment, 2003 Pg 32). Since 1990 the assessment method has been further developed for several applications such as new offices, superstores, homes and industrial buildings and existing offices.

In recent years in Australia the environmental success benchmark of multiple storey buildings has been the ‘Green Star’ environmental rating system. The Green Building Council of Australia developed the scheme in conjunction with Sinclair Knight Merz in 2003 (Sinclair Knight Merz, 2003). It was fashioned on the existing overseas rating tools such as BREEAM and the Leadership in Energy and Environmental Design (LEED) systems from the United Kingdom and North America respectively (Department of Sustainability and Environment, 2003). The Green Star system is defined as “a pre-assessment tool intended for use by commercial office building project stakeholders as a guide for green and sustainable performance” (GBCA, 2005). It envelopes a number of criteria including: energy and water efficiency, quality of indoor and environmental and resource conservation. The Green Star rating system uses (6) stars to measure performance. Four (4) stars recognises and rewards best practice in building environmental initiatives; five (5) stars recognises and rewards Australian excellence; and six (6) stars recognises and rewards
international leadership. This tool is now used widely in Australia benchmarking the environmental impact of newly built office buildings, and one could say as market opportunity seeking new tenants, yet the Green Building Council of Australia disclaims that this tool is “no substitute for professional advice” (GBCA, 2005).

UK CONTEXT

In 1990, BREEAM was introduced, aimed at providing guidance for minimizing any adverse effects of buildings on the global and local environment whilst promoting healthier indoor environs.

In the UK it is now widely recognized as best practice and the scheme awards certificates to individual buildings on the basis of "credits" for a set of performance criteria. This is assessed by independent assessors and encompasses:

- Management (policies and environmental practice)
- Health and comfort (lighting level, thermal controls, wind effects, external noise, glare, lighting levels, air quality and intake etc)
- Energy (consumption and CO2 emissions)
- Transport (public availability and CO2 impacts from site selection and related transport issues)
- Water (consumption, water saving fittings, monitoring etc)
- Materials (life cycle assessments, timber treatments, paints, timber sourcing and certification, recycling etc)
- Land use (green or brown field site issues)
- Site ecology (ecological diversity changes, protection/enhancement of key site features)
- Pollution (refrigerants, insulants, recycling etc)

The assessment is differentiated between BREEAM for offices/commercial buildings and residential homes through the EcoHomes program. The Building Research Establishment (BRE) run training courses to training and qualify assessors, as the market opportunities are huge in the UK and Europe and it is an area recognized as having good market advantage potential.

The main business advantages of pursuing this line of building (other than the obvious environmental benefits) are:

- Financial (achieving higher rental incomes, increasing energy efficiency and higher productivity)
- Marketing potential (Positive selling point)
- Benchmarking (Ensuring best practice and comparing buildings and practices to guide for improvement)
- Staff/user benefits - (creating more productivity through interior comfort)
- Environmental Improvement

From the outset, if major constructors can offer clients sound, cost effective alternatives to traditional designs and systems, then they can establish and promote a forward thinking reputation and wider client base that adds genuine cost effective ESD value and outcomes for clients.

**CASE EXAMPLES**

The practicality of the above points has been critiqued through the investigation of recent projects constructed in Australia and the UK. Wembley Stadium, Federation Square and the Southern Cross project have been selected as case examples on the basis of their creative ESD components and on the basis of the clients ESD expectations.

**Wembley Stadium, UK**

Wembley Stadium is a 100,000 seat multi-purpose sporting venue on the outskirts of London, UK.

Wembley has been a good test case regarding site control, suppliers and recycling in the UK. Most sites in the UK have not implemented sediment fences/textiles and the contractor pushed the plasterboard industry to investigate recycling opportunities. The resulting initiative has successfully diverted waste from landfills and is considered a forerunner to pending government initiatives.

The client, Wembley National Stadium Limited (WNSL), specified all lighting fixtures and pitch lighting levels for FA matches is to be 800 lux at TV broadcast level, whereas FIFA require 3000 lux for European matches held in England. The contractor, Multiplex, sourced the best priced comparable fittings and lamps which can reduce energy consumption.

With regards to timber sourcing, Forestry Stewardship Council (FSC) timbers were used in construction and operation of the stadium (including furnishings). A good comparison is the next most recent UK stadium “Millennium Stadium” in Cardiff, Wales; which was rated as poor by environmental groups. This was largely due to its use of uncertified timber that came from West Africa’s Forest of the Great Apes, where illegal logging is widespread and forest biodiversity is threatened. In contrast, Multiplex has received praise for their timber selection (Greenpeace 2005).

**Federation Square, Victoria, Australia**

The development of Federation Square is one of the most ambitious and complex construction projects in Australia.

The project consisted of redeveloping a 3.8-hectare site with a 30,000m² deck spanning fully operational railway tracks with limited construction windows, followed by a civic plaza and cultural centre including the Museum of Australian Art, the Cinemedia Centre, public atrium spaces, galleries, restaurants, commercial buildings and car park connecting the Melbourne CBD to the Yarra River (Multiplex Limited, 2005).
Prior to the era of energy efficient star ratings, Federation Square incorporated some of the best environmentally sustainable design features. Of note are the Atrium and its passive cooling system known as ‘The Labyrinth’. The Atrium is an irregular framed glazing system with internal and external glazing, and the Labyrinth a passage of zigzagging corrugated concrete walls, which is located between the deck over the railway yard and the square above (Panorama, 2003).

The labyrinth works by pumping cool night air through its cells from an intake facing the Yarra River, which in turn cools in the concrete zigzag-like cells. By day air is again drawn through the cells where it is cooled before entering the Atrium. After being cooled the air is drawn from the Labyrinth via fans, before entering the Atrium at floor level. With its external and internal glazing the Atrium acts as a thermal chimney extracting the build up of hot air by low velocity displacement. With cold air coming in at a low level, the existing warmer air is naturally pushed upwards maintaining an ideal climate within the first three to five metres of the Atrium space.

The labyrinth compares favourably to conventional air conditioning systems, with the advantage of substantially better energy consumption using one-tenth the energy of conventional systems, and consequently generating one-tenth the CO2 emissions (Panorama, 2003).

**Southern Cross Development, Melbourne, Australia**

As one of Multiplex’s first major developments in Melbourne it has endeavoured to develop and implement environmental initiatives into the Southern Cross building. It is one of the first buildings in Melbourne to achieve a 4.5 green star rating.

The Southern Cross project will be constructed in two stages. Stage one, currently under construction, comprises the construction of a five-level basement car park with parking for 951 cars, a substructure for the West Tower site and a 39-storey East Tower consisting of a regular floor plate with central service core allowing for the efficient and flexible use of accommodation (Multiplex Limited, 2005).

The building has been planned utilising the application of environmentally sustainable design. This will facilitate reduction in the long term operating costs for users and also substantially benefit the local environment.

A key environmental sustainable design feature of this building is the use of a double glazed façade. Unlike traditional sealed double glazed systems, this active system expels or traps hot air as required. It is located on the lower north and upper west facades. The system is made up of two sheets of glass creating an air pocket between them. The air in this pocket heats up in-between the two sheets of glass. In summer this air rises up and is extracted out of the building, and in winter dampers trap the air. As a result the air conditioning system will be used in over both winter and summer to heat and cool. This in turn reduces the overall energy consumption of the system and the CO2 emissions created from energy generation in turn providing a more comfortable climate for the occupant to work in.

Becoming standard within the construction of new multiple storey towers in Melbourne, The Southern Cross building also incorporates a blackwater treatment plant, an initiative to reduce the use of potable water. The black water is filtered and treated with a conventional biological process, UV disinfections, and a small amount of chlorine to maintain required residual levels. New multiple storey buildings aim to collect, treat and reuse 75% of the wastewater generated for the flushing of toilets.
Further to this many efforts have been made by Multiplex to incorporate recycled materials in the construction. For example, the 75,000m² of carpet underlay required for the project will consist of 70% recycled material, 30% wool with no PVC chemicals. Reconstituted stone will be used for bench tops and all timber will be recycled or from plantations.

The introduction of such green solutions in new office buildings has been encouraged by the ‘Commercial Office Building Energy Innovation Initiative’. This initiative has been developed by the Sustainable Energy Authority in conjunction with the Victorian Government and seeks partnership with developers, property owners and tenants. The Sustainable Energy Authority provides a predetermined financial contribution to interested parties who meet the Authority’s criteria to “integrate innovative sustainable energy design or technology into a commercial office building” (Sustainable Energy Authority, 2005).

POTENTIAL FOR ADDING VALUE THROUGH ESD

Ofori (1998, p. 143) calls for the need for radical change by stating “to achieve sustainable development, there should be changes in thinking, behaving, producing and consuming”. This paper demonstrates that in today’s society there has been change in thinking, behaving, producing and consuming via the implementation and development of environmental management systems, the adoption of environmental sustainable design practices and the benchmarking of these efforts. However, do these systems and measures we currently have in place to protect the environment truly achieve the most innovative, efficient and financial outcomes for the construction contractors and the environment at large?

It is evident from the foregoing examples that there are numerous creative techniques that add genuine value to specific building projects and also to the broader environment. The key to achieving such outcomes appears, at least from these case examples, to be the innovative, whole of life approach taken by the projects construction and development teams. The successful achievement of ESD outcomes has not directly resulted from any so called ‘star rating’ of the building as detailed in current government policies and legislation. Real value, efficiency and cost savings come from consideration of the overall building system and how this system interfaces with the broader environment.

It is suggested that regulators need to capture the intent of ESD and facilitate opportunities for creative, long term solutions that are not constrained by structured legislation that focuses on building components rather than overall outcomes. A lead in this respect has been provided by the project initiation structure of PFI/PPP projects where the key project driver is achievement of long term service outcomes that add value for money (VfM) to the community. Such VfM should of course include ESD principles. The challenge for ESD regulators is to foster, capture and facilitate such positive initiatives.

CONCLUDING REMARKS

The most progressive building and construction companies are actively seeking mechanisms to achieve positive ESD outcomes and the examples provided are an illustration of where real value, efficiency and long term environmental outcomes have been achieved.
Future building regulations need to capture and encourage long term system outcomes that achieve ESD principles. This will require a new paradigm of thinking that goes beyond simplistic ratings. This in turn will require new ways of quantifying ESD outcomes. Our collective outcome should be to foster creative options that facilitate and capture the many potential ESD benefits from innovative projects.

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