ENVIRONMENT DESIGN GUIDE

MONASH SCIENCE CENTRE, VICTORIA

Graham Crist

The project located on the Monash University Clayton campus in Victoria, employs a range of active ESD principles and techniques, within a relatively conventional construction method and budget. Significant architectural presence is achieved through articulation of form and materials, in particular a monumental timber clad wing. The client's active role and the early involvement of the environmental specialist was critical to the architectural success. The techniques used and decisions made within an ESD agenda provide lessons for a broad range of buildings.

1.0 INTRODUCTION AND PROJECT BACKGROUND

This paper discusses the Monash Science Centre from an architectural perspective in relationship to its environmental sustainability. It foregrounds general principles which are integrated into a building program, rather than specific performance data or measured targets.

It should be noted that although performance data is not yet available, this does not necessarily prevent the measuring of the building's success under the terms of the project design.

The project is located on the Monash University Campus, accessed from Normanby Road, Clayton, in the eastern suburbs of Melbourne. The building houses a Science Centre, which is an interactive learning facility providing a public interface with the University, and contains display halls, classrooms and offices. It is a small traditional museum, with six permanent staff, and capacity of around 100 visitors or students, in a gross building area of 1350m².

The architects began work on the project in 1996 and work was completed in June 2002. The facility opened shortly thereafter.

The project has a relatively long history with Williams & Boag's involvement including a master plan for another site off the main campus, and schematics for a much larger facility on that site. This included several large gallery spaces and an IMAX theatre. The project as built represents a scaled back version of that original vision.

The architects did not have previous background or particular focus on ESD issues, and were not selected for the project on this basis. From the first engagement however, the client expressed a concern for issues related to resources and energy. Similarly, the architect's had not previously worked with Caimin McCabe at Scott Wilson, and his involvement was instrumental in propelling issues of environmental design.

1.1 The design intent of the project

The design is intended to reflect the Science Centre's aspirations of building a wider understanding of science within the community. The sound application of ESD principles was seen as in keeping with an intelligent scientist's understanding of the earth as a complex and finite system. Similarly it was hoped that the construction form participated in the education process. It was intended that building services, material and structure be exposed and readable in a didactic sense, and thus form part of the learning process.

At the same time the project was seen as aspiring to architectural quality quite independently of environmental or energy concerns.

Figure 1. Entry to Monash Science Centre

2.0 PROJECT OUTLINE

Gross Building Area 1350m²

Construction Budget $4.0 million

Client

Monash University – interactive learning facility containing display halls, classroom and offices

Year of completion

June 2002

Architect

Williams & Boag Pty Ltd

Project team

Peter Williams, David Tweedie, Tim Lang, Andrew Croxon, Phillip Brady and Trang Vu

Structural and civil engineer

Kuter Consulting Engineers Pty Ltd

Andre Kuter, Harry Ukkola

Project manager

Monash University Projects & Planning

Bruce Davis

Environmental consultant

Scott Wilson Johnson Pty Ltd

Caimin McCabe

Services consultant

Bassett Kuttner Collins

Andrew Tull (electrical), Dr Gary Rosengarten (mechanical)

Hydraulic consultant

CR Knight & Associates

Barry Merlin

Quantity consultant

Donald Cant Watts Corke Pty Ltd

Jason Flentjar

Landscape consultant

Plant Design Pty Ltd

Paul Thompson

Building surveyor

Peter Luzinat & Partners Pty Ltd

Euan Morrison

Builder

Kane Constructions Pty Ltd

Photographer

Archiphoto Pty Ltd

Tony Millar

3.0 THE BRIEF AND THE PROGRAM

3.1 The resolution of the functional program

The building's program is articulated formally into its three main components: an exhibition hall, a teaching wing, and a lobby link and circulation space. These are expressed in the plan arrangement as two rectangular wings offset and connected by a third wing. This wing forms a transverse axis begun at the entry and terminating in a mezzanine over the main exhibition hall.

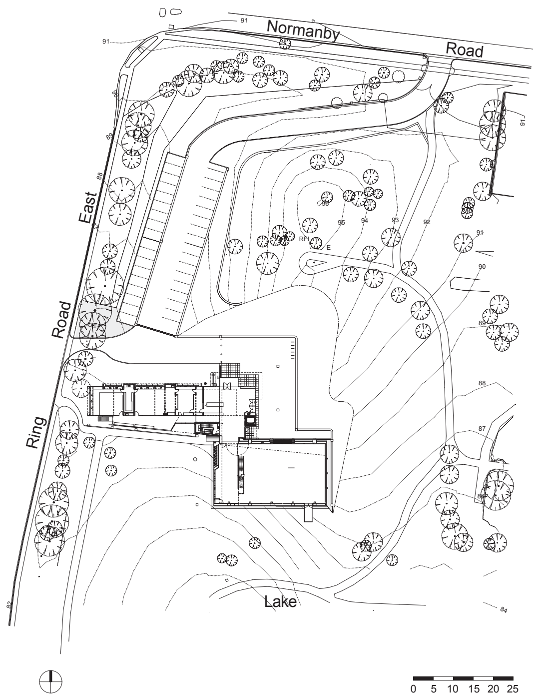

Figure 2. Site and floor plan

The entry is relatively informal and opens via a glazed airlock directly onto a lobby space which contains a reception as well as a small shop and café. The circulation is designed to orient the user in a non-institutional way, and this space provides a view down to the exhibits, as well as to the corridor running along the classroom wing. The lobby also links to an open exhibition court which handles larger group arrivals and provides break-out facilities from the main hall.

The classroom wing is a single level, single-loaded corridor, containing a pair of classrooms and support offices. The generous corridor creates an informal exhibition and gathering space outside the classrooms.

The main exhibition hall is resolved as a tall rectangular volume, with a mezzanine gallery at one end, accessed by a linear stair. This main volume contains large dinosaur exhibits, and in the lower areas is broken up by a range of display cases and interactive booths.

The change in level is resolved programmatically by the lobby wing splitting into three levels, the entry forming the middle level. One descends to a floor with amenities, plant and a workroom forming the bottom corner of the exhibition box. The top level is taken up by the exhibition mezzanine, with five exhibition spaces designated in total.

A lift connects these levels, and its location at a plan junction which opens to an outdoor space allows it to be used as a loading service lift at this point.

The rational, clear planning does produce an ambience of informality and modesty. At the same time, the clear articulation of the gallery wing contributes to its monumental expression, and facilitates the application of straightforward approaches to environmental qualities.

3.2 The siting of the project

The building is located to the north of an existing storm water retention lake. The building sits on an existing mound of fill, creating a site which slopes down to this body of water. The front approach and its relationship with the mound created around it, effectively separates the entry from the car park.

The separate car park and dedicated access road for the building respond to the agenda for an identity separate from the campus, and directly linked to the street. The forecourt is defined and contained by rock banks which negotiate between the hill and the flat paved area. The creation of these banks and forecourt was the only significant area of excavation required to site the project.

Figure 3. View from the north east

Figure 4. View from the south west

The two building wings run across the site from this approach. The solid presence of the timber-clad hall cut slightly into the hill contrasts with the lightweight metal classroom wing sitting off the ground. The approach from the lakeside is dominated by the drama of the timber exhibition box at its full height. The court formed at the junction of this and the elevated teaching wing provides the project's most monumental moment. Currently, it begs an active entry point onto it in order for the outdoor space to interact with these forms.

4.0 THE CLIENT'S ROLE

The project is intended as a meeting point between scientific researchers and the wider community, promoting an interaction with issues in scientific culture. The building is open to the public seven days a week, is accessed independently, and aspires to have a public and open presence. This presence is focused particularly toward school students.

The client's commitment to an ESD agenda is instrumental to the architectural outcomes. The client's role should be clarified at this point. Pat Vickers Rich is a paleontologist and Head of Earth Sciences at Monash. Her motivations promoted the project initially, and continued a pursuit of the environmental issues throughout the course of the project. Her involvement continued as client/user. The architects were directly engaged by Monash Projects and Planning, the body responsible for the building procurement. This group acted as the conventional client/project manager, and prioritized typical issues of budget and building standards.

The combined design involvement of the architect, the client/user, and the environmental designer produced environmental outcomes in the context of a client/manager which aimed at achieving conventional building outcomes, traditional modes of conditioning the space, and conventional institutional materials.

Vickers Rich remained closely involved with the architects' design process during all stages. This included, for example, a close monitoring of materials, their contents, and toxic properties.

Commitment from the client was important in establishing appropriate expectations for the internal environment. Users were briefed at an early stage on issues that would affect the use of the spaces, for example, that indoor temperatures would fluctuate significantly, and that air temperatures similar to the outdoor ambient temperature were expected internally during warm periods. The building use would need to plan for this. It was agreed for example, not to program large events in February.

4.1 The impact of the budget on the design process

The project attempted an extensive ESD program of features within a typical institutional/commercial budget, and construction type. The final cost of construction was $4 million dollars, approximately eight per cent over the initial university budget. This final construction cost equates to a little below $3000/m^2. Consequently techniques needed to be relatively simple, and were assessed against conventional equivalents.

An example of the client making a conscious choice for an environmental feature with a cost was the use of the water basin for geothermal heating. This was considered an extra cost of around $60,000, but was considered integral to the building's relation to the site.

Conversely, the absence of water recycling systems is an example of the budget prohibiting such features. This will be discussed further in this paper.

5.0 THE CONSULTANTS' ROLE

Critical to the environmental outcomes of the project was the very early involvement of the Environmental Consultant, Caimin McCabe from Scott Wilson. His input fed into the sketch design process and provided a brief to more traditional services design undertaken by Bassett.

McCabe brought two related approaches to the project: firstly, that the energy features should be integrated into the design concept at a very early stage, and secondly that these features need not be used to `badge' the project as an ESD building. Indeed the success of the project may be measured to the extent to which it may be viewed architecturally, outside the concerns of its ESD focus. There was a strong belief from both McCabe and Williams and Boag, that ESD issues should be mainstreamed and not sit outside of other architectural issues.

Scott Wilson was thus involved with the architects on the project before any other consultants, and their work provided a brief to the later services design. The Services Engineering consultancy was awarded to Bassett Kuttner Collins. The initial work of the environmental consultant was followed through with success in the services design and the occasional consultation with McCabe.

Figure 5. View of the exhibition hall interior

6.0 MATERIALS

6.1 Construction system overview

The building structure consists primarily of steel frame with timber stud infill. Precast concrete panels are structural at lower levels of the exhibition hall. The building then is predominantly a lightweight skin on a frame, with a range of external finishes articulating forms, these being rough sawn timber, galvanized steel, and painted fibre cement sheet. It was considered that a full mass wall system was not viable from a budgetary point of view on this project.

6.2 Exterior finishes

The main exhibition hall is clad in kiln dried yellow stringy bark timber boards. The timber cladding provides a rain screen only with open joints. A membrane of Tyvek sarking sits behind the timber and over the framing, providing moisture-proofing to the insulation and structure. The open joints allow air to circulate behind the timber, helping to maintain constant moisture content. The boards are rough sawn and laid horizontally with a splayed top edge and a gap of around 10mm.The appearance from a distance is somewhat like red brick, giving a sense of mass to this form.

The classroom wing is clad in zincalume pans cladding, providing a contrast to the hall, and a finish that was durable as pre-finished, and would not require coatings.

Internally, a range of conventional finishes are used including perforated Gyprock, Vitrepanel, Interface carpet tiles, granite floors and linoleum. The main exhibition floors are finished Black Butt Armourply over a structural ply layer, with a tung oil finish.

Breezeway louvres of glass and Western Red Cedar are featured in several areas.

The main glazing system consists of hardwood frames with Capral St Lucia glazing adaptors fixed to the outside. This provides the insulating properties of the timber and an externally durable and low maintenance aluminium skin.

The general approach to materials in this building has been to select from a relatively conventional palette, with a number of sustainability issues in mind. No experimental or recycled materials have been employed. Instead they are chosen for their durability and lack of toxicity. Particular attention has been paid to emissions from interior coatings, with the client/user directly approving any interior coatings.

The extensive use of timber in the project raises some common building dilemmas. No recycled timber products are used, and new, native non-plantation timbers are employed. These were selected on the basis of durability, recyclability and the general soundness of the source. Like many managed timber sources, its ecological responsibility is open to debate. State forests in New South Wales claim best practices available for such timbers.

The two primary areas are the Black Butt Armourply flooring, and the stringy bark cladding. The ply was supplied by Big River timbers which sources from New South Wales state forests, as does North Eden timber which supplied the stringy bark. In each case, the timber is highly visible, and needed to meet aesthetic and surface durability specifications. The Armourply flooring had additionally rigorous requirements to meet over the floor heating system, and the stringy bark as a stable exterior wall cladding.

The use of hardwood frames represents a compromise to achieve a durable thermal barrier for window frames. The cedar louvre blades may be seen as a case where a proprietary item was selected with little consideration of its source.

7.0 ENVIRONMENTAL CONTROLS

Measures for controlling indoor air quality were largely carried out by Caimin McCabe at the early design stages. Simulations of performance were carried out which essentially formed a brief to the services engineer, and which form the basis of the main environmental features.

A direct digital control (DDC) system aims to automate these systems through a range of sensors. This system controls the range of vents and louvres, as well as photo controller panels measuring ambient light, and is connected to an automatic dimming system.

7.1 Thermal comfort and air quality – natural ventilation systems

7.1.1 Thermal chimneys

These elements assist in circulating air and in particular drawing hot air up and out of the exhibition hall. Located on the north facade, they are expressed as a series of four black steel towers on the timber box. The tops of these extend past the main roof and are louvred on both sides. In summer, this creates an updraft and draws warm air out of the main space through low level louvres in the wall. This movement is assisted by automated louvres on the south facade creating a cross air movement toward the chimneys, and also by fans located within the chimney shafts. In winter an operable damper locks off the louvred top section. By reversing the fan within the shaft, warm air from within the exhibition space is drawn into the chimney at high level through louvre panels, and is forced downwards to discharge through the louvre panels at low level.

These louvred elements, along with more conventional natural openings and roof vents, are used in a general night purging strategy for expelling warmed air accumulated over the day.

7.1.2 Geothermal heating system

The project was fortunate to make use of a nearby lake on the site, and employed this as a heat sink. The water is a storm water retard basin (a well landscaped drain) and the architects were careful not to label it a lake in order to avoid it being misunderstood as employing a natural landscape feature for this purpose. The pipes for heating and cooling systems are passed through this body of water to stabilise their temperature, providing pre-heating and pre-chilling to conditioned air.

The system is significant in terms of the promotion of ESD values by the University, since it was retained after budgeting showed that it was not cost-effective: it was clearly less expensive to use a conventional condenser. Nevertheless, the client valued its presence in the overall budget, and accepted it as an extra cost.

7.1.3 Thermal mass

Precast concrete panels are employed in the base of the exhibition hall to provide thermal mass to this envelope. Its resolution is a negotiation between the optimum area of mass wall under thermal models, and constructional (therefore budgetary) constraints. These panels thus extend three metres from the ground, providing the benefit at low level, and conforming to the constructional advantages of the three metre wide panel.

Masonry work benches are located on the north side of the classrooms and offices to receive solar radiation from the glazing adjacent, and provide a subtle effect in their relatively modest scale.

7.1.4 Air conditioning

Air conditioning in the building is limited to the staff office areas. The decision to mechanically condition this space was partly made due to the heat generated in that space (a concentration of photocopiers, printers, computers etc.) The system employs the geothermal

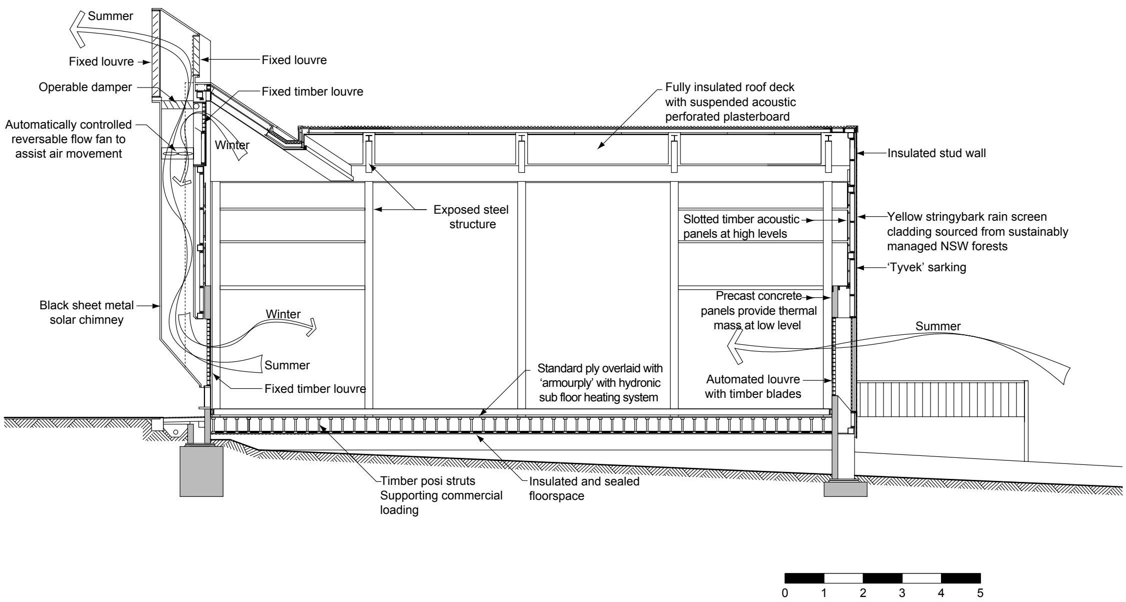

Figure 6. Section through the exhibition hall

system for the provision of chilled water. It is noteworthy and not surprising that the director of the Centre chose not to air condition her office.

7.1.5 Hydronic floor heating

The exhibition and office spaces feature a hydronically heated timber floor system, one of the more innovative systems in the building. The decision to use such a system was made early in the design process, and involved overcoming reservations from the architects, relating to the impact of the heat on the timber and its excessive movement. Caimin McCabe was committed to the system, which he had experienced in the USA and Europe. The builders had similar concerns, seeing it as a potential risk.

While unconventional in Australia, the system is relatively straightforward. The floor space created by the posi-strut structure is laid with aluminium pans which hold polyethylene pipes carrying the heated water. Below this, the floor space is fully sealed and insulated. The floor deck on the posi-joists consists of Armourply finish panels laid over a structural ply deck. The bottom ply deck was introduced to protect the timber floor from variable heat and to distribute the radiated heat more evenly across the panels. This allowed more conventional timber boards to be laid on top, despite ply being used as the final finish.

The result is a system which has the advantages of radiant floor heating and is more responsive than a slab due to its lower thermal mass. It enables temperatures to be dropped down during empty periods and re-heated more efficiently than a concrete floor.

7.1.6 Passive solar control

The building design carries out straightforward and well known methods to control solar gain. Exterior shading fins are employed over classroom areas, orientation maximizes solar control, and single clear glazing is maintained below 40 per cent of building envelope area to control building heat loss.

7.2 Daylighting

The aim of the daylighting design to produce glare-free, good quality working daylight in office and teaching areas, was achieved through an even distribution of glazing, including high lights, as well as light shelves, to provide north light reflected from the horizontal blades to the ceiling.

Accurate predictive testing was carried out to ensure even light. This was modeled and simulated by Scott Wilson using *Radiance* software, producing a rendered visual image of the projected lighting effects. Predictions showed well distributed daylight in the office and teaching areas: this in turn became a brief for the services engineers in designing artificial lighting. An example is one area which showed a lower level of daylight due to lack of glazing. This was then able to be boosted by selective location and switching of fittings.

7.2.1 Artificial lighting

Low voltage dimmable and automated lighting aims to minimize the use of artificial light and supplement daylighting.

7.3 Energy generation – photovoltaics

One 4kw array of photovoltaic cells has been installed on the roof of the teaching wing, funded in part by the Commonwealth Government's rebate program, with the intention of future expansion. This might be seen as *badging* the ESD agenda on the building. While they contribute a relatively small proportion of power to the building, the cells mark an aspiration toward alternative energy sources. It is perhaps for this reason that the array is located prominently near the entry. It was noted also that placement of photovoltaics on the roof was preferable to the intended location on window sills, to prevent theft.

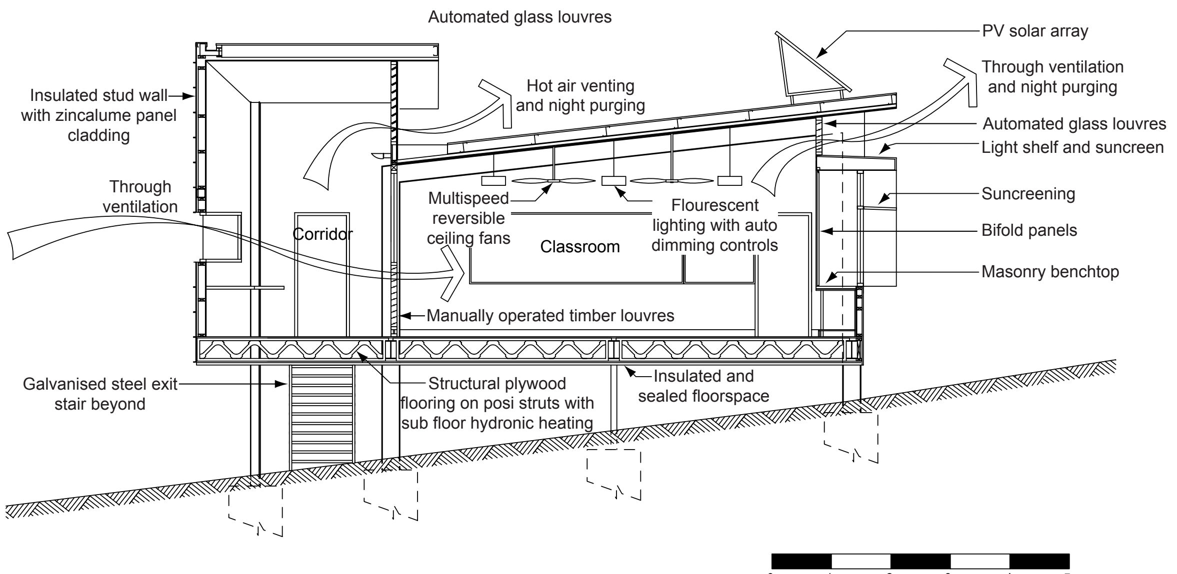

Figure 7. Section through the classroom wing

7.4 Water management

In this project, no water collection or re-use is employed. The handling of water within the building is conventional, without collection of storm water, or grey water. This reflects decisions made within budget constraints, and is the most notable omission within the project's sustainability agenda. Caimin McCabe points to the lack of economic incentives available to employ such techniques. Water rates are measured on numbers of fixtures with no rebate on water development charges available for recycling systems.

Figure 8. North approach

At sketch design stage, the project contained storm water collection tanks and the beginnings of a grey water recycling system. In its final built form the roof has been designed to be capable of collecting storm water at a later date.

The architects cite a payback period of approximately 60 years for the water harvesting system. This concurs with anecdotal evidence on other projects, and reflects partly on water being an artificially under-priced resource, and partly on building priorities.

8.0 CONCLUSIONS

8.1 Evaluations – building management energy audits

No formal audit or post-completion assessment has been carried out to provide figures for the building's energy performance. This is an area of some concern to the consultants, and largely an issue of funding. The client is eager to carry out such a study, and is seeking University funds to do so.

Such audits will measure predictions made by Scott Wilson, rather than specific briefed targets.

In some ways these targets have been exceeded, since the client/manager set targets of a conventionally serviced facility. Instead, the building uses very limited air conditioning and a more passive heating system which is assisted by a geothermal water basin. The building's air quality and environmental ambience is significantly different to a comparable conventional building, which supports McCabe's foregrounding of qualitative issues.

It is expected that data will be collected within the next few months. For the moment, we rely on anecdotal response.

8.2 Client and user responses

Of the informal responses from users surveyed, the environmental quality is generally good and the building performs well. A number of the problems encountered relate to an institutional building which is very *openable*, in contrast to the usual hermetically sealed museum space.

Dust is a greater problem than usual, though apparently manageable. A dust-free environment is not apparently critical. Typically with naturally ventilated teaching spaces, papers tend to blow around when breeze is excessive.

It was reported that there is a reluctance to open the large doors which perform a ventilation role, due to the tendency of birds to fly in and become trapped in the building. The fact that the large doors were not designed as part of the ventilation system points to the need for thorough briefing and learning in the handover and use of the building.

It was also reported that the classrooms tend to get hot in summer when full of students. While the ventilation system operates well under normal circumstances, it does not tend to cope in warm weather when the room is full of people. This is well within the expectations of the environmental design, given that the parameters were to keep spaces close to ambient temperature at best. It is reasonable to suggest that such expectations are consistent with comparable classroom spaces in schools. Ironically in light of issues relating to opening the building, there are certain light wells which have fixed glass and a deep sill at their base. These provide excellent roosting areas for pigeons, and since the glass is fixed, cannot be readily accessed for cleaning.

The contribution of this project is in its mainstreaming of ESD and integrating it into an architectural approach. This is in keeping with the architects' and the environmental consultant's views that a building should not be branded by its ESD attributes. The building promotes ESD values best by striving for aesthetic excellence in its architecture.

A debate as to the measurement of merit in sustainability was opened up when the Monash Science Centre won the *Award for Sustainable Architecture* at RAIA's 2003 Victorian Architecture Awards. The building was unconventionally submitted without quantifying data supporting its energy efficient credentials.

The jury took a position that the future of sustainability was best served by acknowledging its relationship with a building of architectural merit. The issue of integration of sustainable techniques into an architectural program was seen as paramount.

> "*We were not convinced by submissions that have failed to establish a relationship or where sustainability criteria had been foregrounded at the apparent expense of architectural quality... the high level of the architectural integration of sustainability features indicates the architects' desire to consider sustainability within their overall strategy from an early stage.*" (Architect Victoria, Awards 2003, p.35-36)

This project is one which is dependent on its future user, to promote, accept and assist in the adoption of low-energy techniques. It was the commitment of the designers and consultants to fully integrate these techniques into the project from an early stage which made them a convincing part of their architectural environment. The project should be viewed in the context of promoting an agenda which has continuing difficulties in a broader sense. Compromises and small failures exist within the process of this project. However, a clear target was set to raise the profile of sustainability by placing it within conventional architectural and aesthetic concerns. It appears to have met this target.

Figure 9. View from entry at night

ACKNOWLEDGEMENT

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BIOGRAPHY

Graham Crist is a partner in the practice S-ARCHITECTURE in Melbourne and is a lecturer in architecture at RMIT University, where he coordinates the sustainable technology course. He writes regularly for *Architecture Australia* and *Monument*. He studied at the University of Western Australia.