

**A Triple Helix Approach:
*An inter-disciplinary approach to research into sustainability in outer-suburban housing estates***

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Abstract

Outer-suburban housing estates dominate new house constructions in Australia, and are a major contributor current and future environmental impacts such as water, waste and greenhouse gas emissions (Blair et al. 2003). Typically houses in these estates are built without an in-depth consideration of ecological sustainability factors. Program interventions aimed at promoting more sustainable practices have typically involved the dissemination of information materials, such as the 'Your Home' design guide, or the development of demonstration 'eco-homes', the most notable example being the ACF Greenhome completed in 1993. There is little evidence to suggest that these programs have had any substantive impact on mainstream housing developments (Okraglik 1995).

EcoHome is a three-year cross-disciplinary research study into what sustainability outcomes are possible for the industry using existing design methods and technologies, including design, technical and sociological research. Each research stream, and its strategy have been selected to address specific barriers to the mainstreaming of more sustainable homebuilding practices in Australia. The research is based around a new demonstration eco-house at the Estate of Cairnlea in Melbourne's outer west. Outcomes of the research will assist the housing and land development industry achieve more sustainable outcomes at the forthcoming 8500 home Aurora Estate to be constructed on the northern fringe of metropolitan Melbourne. This paper outlines the rationale and core methodologies of the project, focussing on the need for inter-disciplinary research both in the context of the outer-urban housing industry and sustainability more generally.

Introduction

What kind of information does society need to move towards ecological sustainability? What research methodologies can best generate that information, and under what conditions? How can different disciplines effectively collaborate to provide accessible, useful and confluent research outcomes? The ongoing unravelling of these questions is integral to the development of an effective sustainability research agenda. In this paper, it will be shown how they are also central to the ongoing

development and implementation of a new program being developed by the Centre for Design at RMIT University in Melbourne Australia, called EcoHome.

EcoHome is a three-year multidisciplinary research project investigating the sustainability outcomes that are possible in Melbourne’s suburban housing estates using current building and design technologies. It has sponsorship from a broad range of participants in the Victorian housing industry (see Table 1) and is supported by an Australian Research Council research grant. The research project is built around a demonstration home currently being constructed at the Cairnlea Estate in Melbourne’s outer west. The home, known as the ‘Cairnlea Eco-House’, demonstrates key principles of ecologically sustainable house design. It has been designed to appeal to new homebuyers and to maintain a high degree of affordability relative to other houses on the estate.

Table 1: EcoHome Project Sponsors

| Sponsor | Role within Industry | Primary role in the project |
|--|--|--|
| Building Commission of Victoria | Administration of regulated building controls for the State of Victoria | Financial sponsor of research project |
| City West Water | One of three government-owned water retailers in Melbourne. | Financial sponsor of research project |
| Hassell | Australian-based multinational architectural design firm | Developed landscaping plan and supporting marketing materials |
| Melbourne Water | Government-owned water wholesaler for Metropolitan Melbourne. | Financial sponsor of research project |
| Metricon Homes | Medium sized home-building firm operating primarily in Melbourne’s outer-urban market. | Construction and management of the Cairnlea demonstration home |
| Origin Energy (Solar Energy Division) | Division of Origin Energy, a private electricity retailer. Sells and installs Photovoltaic panels. | Donated PV panels for the Cairnlea demonstration home |
| Sustainable Energy Authority Victoria | Victorian Government agency responsible for promoting sustainable energy production and use | Financial sponsor of research project |
| VicUrban (formally the Urban and Regional Land Corporation - URLC) | Victorian Government residential property development corporation. | Financial sponsor of research project, management of the Cairnlea estate |

New housing developments are a substantial contributor to the impact of Australian society on the environment (Blair et al. 2003). These include direct impacts such as resource consumption and impacts to local habitats during their construction, as well

as locking in potential lifecycle impacts, such as those related to energy and water use in the home, and indoor air-quality. By the time the building designs are completed, most of their lifecycle economic and ecological costs have been made inevitable.

Many authors have argued that sustainable building projects cannot be seen as traditional building projects with 'green stuff' added on at the end. Rather, they require new development models and a multidisciplinary, risk sharing, cooperative and long-term perspective (Boden 1996; Rohracher 1999; Hewitt and Wilkinson 2002). The causes of these environmental impacts cannot however be seen as a concern solely for the design profession. While many of the technological and design solutions are in fact currently available to the industry, they are not being implemented. For example, despite the many demonstration 'eco-home' projects that have been completed in Australia over the past decade, there is little evidence to suggest the widespread penetration of even basic and cost-effective measures such as passive solar design and rainwater tanks at new estates. This suggests broader structural and cultural factors are at play, providing an inertia that resists environmental abatement despite the proximity of such specific technical solutions.

The EcoHome research project has the goal of stimulating the widespread uptake of sustainability promoting designs through targeted multidisciplinary research, involving design, engineering and social research methodologies. The multidisciplinary approach has been developed to match the multifaceted nature of the challenge as observed by industry participants and as drawn from the Centre for Design's experience in managing other green building projects.

While the three-stream 'triple-helix' approach has been positively received by project sponsors, significant challenges exist in managing the project towards integrated research outputs. This paper traces out the development of the EcoHome research project, in the early stages of its development with a view to generating a critical response from the housing research community that can be used to strengthen its processes toward the more efficient attainment of its objective.

Key Features of Australia's Housing Industry

In 2003 the Australian housing industry is booming due to low interest rates, a buoyant economy, steady population growth resulting from a substantial immigration program, and an overall thinning in household sizes related to the increase in the number of single parent families and 'empty nesters' (Tennant 2002). The industry currently builds an estimated 140,000 brand new homes every year (HIA 2002) to accommodate this growing and thinning process. Most of these homes are constructed on the east coast of Australia, and on the fringes of our largest state capital cities (ABS 1996).

New residential developments have until recently taken one of two forms; high-density inner city apartments, and low-density outer-urban housing estates. While there has been some shift towards apartment living and a more sophisticated multi-unit building sector is developing (Burke and Hayward 2000) outer-suburban detached housings developments still account for the majority of new home constructions (ABS 1996). In the words of Graham Jahn, national president of the Royal Australian Institute of Architects: 'at the moment there is a dichotomy where

the suburbs are seen as a place for a scaled down mansion and the city as a place for high rise apartments. The transition between the two is not happening' (Blundell 2003).

Australia has generally adopted a laissez-faire approach to urban planning. In recent times this has been seen to reflect an embrace of 'neo-liberal' over 'managerial' doctrines in planning and economic policy discourse as seen in the implementation of the National Competition Policy and the privatisation of many State Government planning functions (Gleeson and Low 2000). In the 'traditional regulatory subdivision', individual house lots are sold to building firms without additional controls on building design (Blair et al. 2003). In the general sense, lack of planning controls has been the subject of scorn from Architectural critics, such as the late Robin Boyd, since at least the 1950's (Greig 1995). The focus of this critique was 'a forsaken modernity', unable to command the suburban form above the chattering of the individual expressions of homebuilders.

The poor environmental performance of existing outer-urban housing stock, the rate and nature of new developments, and the lack of prescriptive (sustainability-promoting) design controls are major obstacles to Australia achieving some semblance of ecological sustainability in the domestic property sector. In the competitive housing market, builders and developers need to be highly attuned to customer preferences and expectations. In the outer-suburban mass-housing market this has led to the prioritisation of factors such as size, comfort and affordability over sustainability outcomes. A recent survey of the building industry (BIS-Shrapnel 2002) for example found that while most home builders are 'sympathetic' to the concept of the 'green home', the perception of higher construction costs was a major deterrent. Similarly, regulated minimum performance standards will move at a checked pace because of the sensitivity to possible adverse impacts on housing affordability. These factors underpin a common perception by industry observers that the sustainability performance gap between 'case study' architect designed environmental housing demonstration projects (both locally and internationally) and the mass-housing developments of Australia's suburban fringes is widening.

Outer-urban developers are now beginning to move away from the 'carve and sell' traditional subdivisions towards master planned communities (MPCs) that allow for a more integrated approach to design, community development and sustainability. The Property Council of Australia has recently reported that these kinds of developments are increasingly more popular as they provide a more appealing environment for young families and other market segments, and better protect the investment of new homebuyers (Ryder 2003). The VicUrban *Aurora* estate is an example of how MPCs can facilitate improved ecological sustainability outcomes. For example, its distance from existing urban sewerage infrastructure will require Aurora to manage its liquid waste internally. Integrated planning will for the first time allow a major residential development to orient all houses for improved passive solar heating and ventilation. Greater controls over individual house designs will allow for more environmentally sensitive selection of building materials. Integration with neighbouring commercial districts, and the inclusion of mixed-use town centres will allow for a reduced reliance on private motorised transportation (VicUrban 2003).

In both the traditional subdivisions and the MPC development models, builders sit between the consumers and the developer. Building firms working on new developments such as Aurora, are being led towards more sustainable designs and construction places by developers such as VicUrban, by having to work to developer-imposed design controls such as minimum building energy performance levels or material specifications. There is a general acceptance by building companies working on the outer-suburban housing estates that sustainability is increasingly going to be a driver in the industry. However, how builders are going to meet these challenges and what sense consumers in the outer-suburban housing market will make of these transformations are questions that are largely yet to be answered. The dominance of small businesses in the homebuilding sector, its strength and flexibility when assessing industry competition outcomes is also seen as limiting the industries capacity to respond proactively to the challenge of more sustainable urban developments: small firms lack the overall economies of scale to invest in research and development. Also, as sustainability requires the adoption of new value systems (Tibbs 2000) and organisational processes (Pears 2000), the small-firm fragmented nature of the industry acts as a barrier to sustainability promoting cultural change and knowledge diffusion across the industry.

The EcoHome Research Project

The early history of EcoHome illustrates the Centre for Design's approach to sustainability based around partnerships, hands-on cross-disciplinary research and consultancy. It also reflects the way in which institutional factors and experiences influence problem definition in the development of a research agenda.

The EcoHome Research Project can be seen as the research component, and an extension of the demonstration Eco-House being constructed at the VicUrban Estate of Cairnlea. The Centre for Design was initially engaged by the Cairnlea Eco-House project founders – Melbourne Water, Metricon Homes, Hassell Architects and VicUrban in a consultancy capacity – to provide advice on how to apply key principles of sustainable housing in a design/technical capacity. In 2001, the objectives of the Cairnlea demonstration eco-house were defined as:

- To construct a marketable sustainable display house that can be reproduced easily across the Cairnlea Estate with minor adaptations
- To inspire visitors who will eventually buy new houses or retrofit existing houses to incorporate more environmentally responsible features
- Act as a marketing device to showcase the many readily available sustainable building products, appliances and landscape elements, and to associate the project partners with good environmental practice in the built environment.

A fourth and implicit objective the project was for VicUrban and builders such as Metricon to develop their in-house experience on sustainable house design and construction in preparation for future estates such as Aurora. The original timeframe for the Cairnlea home would have seen it completed in November 2002 well before the commencement of works at Aurora in 2003. The house is now due for completion in September 2003.

The research dimension to the project principally resulted from the Centre for Design actively promoting research as an enabling activity for industry stakeholders. This

was motivated firstly by the Centre's experience with green building projects that demonstrated that a low degree of understanding and confidence existed for industry participants regarding the specific means by which housing firms would take-up sustainability principles at future estates such as Aurora. Secondly, goals established at the institutional level by RMIT University were encouraging the Centre to engage in more funded academic research and greater cross-faculty collaboration in research. These needs came together in 2002 as a proposal by the Centre for Design for funding under the Australian Research Council Linkage Grants Program, which was subsequently approved.

The underlying rationale for the grant application was the need for the industry to move beyond one-off demonstration homes towards the mainstreaming of more ecologically sustainable design practices. Demonstration homes are a standard mode through which the mass-housing industry promotes new housing products to the market. A demonstration 'eco-home' in this context can be reduced to a simple series of design innovations not requiring specific additional attention other than the customisation of marketing materials. When a demonstration home approach is taken to environmental initiatives however it is impossible to ensure that demonstrated technologies and design elements will in fact be taken up by consumers at other houses, and that they will not remain on the margins of mainstream thinking. A vivid demonstration of this risk is the Australian Conservation Foundation's (ACF) demonstration Greenhome completed in 1993 at URLC estate of Roxburgh Park, a successful demonstration of best practice technology and design, but a near complete failure in terms of influencing the mainstream housing market. In his evaluation of the ACF Greenhome for the Centre for Design, (Okraglik 1995) attributed the failure of the home to live up to expectations to a range of factors:

- Confusion as to who the likely purchasers would be (research indicated they would be environmentally conscious consumers, even though this did not typify the profile of Roxburgh Park home purchasers),
- No market research to determine market needs and little effort to identify the characteristics and segmentation of the prospective buyers, especially as it related to appearance and cost,
- Lack of an integrated marketing plan that involved all players,
- Failure to separate the ideals and ideology of environmental housing from the ultimate market offering,
- Failure to recognise the price-sensitive nature of the market segment, and
- Insufficient funds to support the continued demonstration role after launch.

The outcomes of the ACF Greenhome project mirror numerous local demonstration projects in Australia and internationally. In the Netherlands for example, Kortman and Uitzinger et al. (2001) found that while demonstration projects can be useful in developing skills and experience among participating parties, they consistently failed to address 'the user' (or consumer), who more than any stakeholder determines the ecological impacts of the builder's designs. Thus far the focus for most research in Australia into sustainable housing has been on the supply side; as Blair et al (2003) describe; 'there is a growing desire to *provide* housing which offers a comfortable standard of living, reduces environmental impacts and which simultaneously achieves a degree of affordability'. Implicitly, consumers are expected to passively absorb the aesthetic, cost or lifestyle implications of sustainable living, and share the project's vision for more sustainable housing and allocate their resources accordingly. What

has been to a large extent missing from the body of research is a developed understanding of real market dynamics, consumer preferences and expectations and the way in which they will impact on the uptake of future environmental housing offerings. If customers are not driving the ‘greening’ process, there is an underlying incentive for builders to meet only minimum regulatory requirements, as is currently the case (see for example Kortman and Uitzinger 2001). Understanding and mobilising the green consumer may in fact be the shift that is required to imbed sustainability in the mainstream (Cooper 1992; Williamson et al. 2003).

If consumers did in fact begin to drive improvements in sustainability outcomes, that is, if the features demonstrated at the Cairnlea home achieved some currency in the market, there would be a greater need for data that could link design-phase decisions to actual ecological outcomes, and documentation to facilitate the transfer of experience and knowledge from case studies to other building firms so as to make possible the replication of these outcomes at future sites. A research component to the project was thus seen as necessary to generate the knowledge and systems to shift the project’s focus from that of demonstration to catalysis. Stakeholder workshops held throughout 2002 confirmed this as being a valid research agenda.

The EcoHome research agenda was subsequently configured into three distinct research streams, linked to three respective barriers to the mainstreaming of more sustainable housing (see Table 2). Each of these was seen as leading to a specific research outputs that would be useful to the industry.

Table 2: Three Component Research Projects

| <i>Research Stream</i> | <i>Barrier to Sustainability</i> | <i>Research Outputs</i> |
|------------------------|---|---|
| Social Research | Perceived consumer disinterest in environmentally innovative housing products by building firms | <ul style="list-style-type: none"> • Identify the relationship between current consumer preferences and the uptake sustainability enhancing design features and technologies • Consumer typologies to allow more effective targeting of new housing products • Identify ‘best chance of success’ strategies for the housing industry |
| Technical Research | The lack of quantitative data that can firmly relate design phase decisions to actual lifecycle environmental performance | <ul style="list-style-type: none"> • A monitoring strategy for the EcoHome based on best-practice • A long-term performance prediction model for housing sustainability performance • A strategy to evaluate whole-of-life sustainability as an index |

| | | |
|-----------------|---|---|
| Design Research | The lack of knowledge and capability among builders and developers to engage in more environmentally friendly design and construction practices | <ul style="list-style-type: none"> • Documents the process from the builder perspective, identifying critical information needs • Develop a 'decision support tool' based on all research outputs for developers and builders to help match performance objectives to specific actions (such as design elements or product selection) • Provides overall coordination for the research project |
|-----------------|---|---|

The approval of the Australian Research Council Linkage Grant and the finalisation of a sponsorship agreement with industry stakeholders (see Table 1.) allowed the centre to recruit two staff to undertake the social and technical research and appropriate the existing manager of the EcoHome consultancy project to the design research stream. All researchers are using the project as primary research towards a PhD degree.

The Eco-House will be available to the researchers for 12 months as a display home and for an additional 12 months once occupied. Research outputs will be finalised and presented to industry sponsors in 2005.

Social Research

The social research component of the project is being undertaken through the RMIT School of Social Science and Planning. Social research on the project can support and shape supply side strategies by developing new models of consumer preference and behaviour, to expose current and potential barriers to the uptake of new housing offerings and, to assess what future policies and programs will be most efficient and effective in stimulating changes in market outcomes.

In particular, social research will seek to answer the following questions:

- How can consumers in Melbourne's mass-housing market be engaged as drivers of ecological sustainability rather than barriers?
 - How have consumers been constructed as agents of environmental change in the current policies and strategies of industry participants?
 - What are the major drivers of consumer behaviour in Melbourne's outer suburban housing market, and how do they currently affect sustainability outcomes?
 - What new products, policies or programs would have the best chance of satisfying and/or moulding consumer preferences while driving innovation and improved environmental performance over time?

Four principal social research methods will be used:

1. Literature review – The literature review will primarily identify the analytical tools that can be applied to make sense of the relationships between ecological sustainability and market behaviour. It will also help to contextualise the research within the current body of knowledge developed around theories of environmental consumerism and politics, and ecological and industry economics.

2. Discourse analysis - ‘Discourse analysis’ in the social sciences is based on the assumption that social action, policy development and market behaviour are a product of the ‘currents of communication’ both in the public sphere and the ‘lifeworld’ of social actors (Habermas 1996). Communication, and therefore social action, is framed by the dominant discourse: the networks of meaning that delineate objects and issues and define their interrelationships. In a highly complex and differentiated society based on a plurality of industry, cultural and political conditions, we can expect the industry discourse to be marked by both consensus and conflict. Understanding both the unifying principles and tensions within the industry is required to assess underlying drivers of behaviour and industry conditions. This will be presented both as a narrative outlining the relevant historical contingencies of Melbourne’s mass-housing industry, and used to develop a dynamic model illustrating the current industry conditions as they contextualise the views and behaviour of industry participants. This study will focus specifically on identifying the various ways consumer behaviour is constructed in industry policy and strategies of market participants as it relates to the failure of the housing market to achieve acceptable levels of environmental performance. Understanding how stakeholder networks operate and how they define ‘market failure’ is critical to determining how new approaches can complement or add value to the current systems, and to identify issues related to their uptake.

3. Consumer research - The display home phase of the Cairnlea demonstration eco-house provides an opportunity to undertake primary survey research into consumer views and intentions. The total number of people visiting the home depends on the marketing and promotional strategies of Metricon and VicUrban. Over 12 months it is hoped that at least 1000 people will tour the home and participate in the survey research. A short questionnaire is being developed for visitors to the home being administered by Metricon and VicUrban sales staff. It will collect information related to the following issues:
 - Consumer environmental literacy
 - Demographics (age, income, entry level, income, owner-occupancy, family structure, pets, ethnicity-language, special needs/issues, gender, postcode)
 - Reasons for and interest in environmental features (perceived benefits)
 - Reasons for and disinterest in environmental features (perceived costs)
 - Changes in attitude, preferences and their perception of environmental features
 - Perception of time, effort, skill and upfront cost requirements of the new housing features, such as composting, gardening, hot-house
 - Perception of value of ‘centralised vs. decentralised’ features (eg. community amenity/‘body corporate’ vs. individual management of water recycling)
 - Perceived relationship between house size and lifestyle and environmental factors
 - Receptiveness to alternative financing options such as upfront/outright ownership of features versus leaseback arrangements, or finance by utilities or builders.
 - Feedback on the cost premium of new features

- The trade-offs between environment and other drivers such as comfort, space and security?

The questionnaire will seek to determine the real reasons behind consumer interest or disinterest in specific environmental housing elements and ascertain their 'willingness to buy'. Data can be used to develop consumer typologies based on their level of interest, or nominal categories related to demographic or other determining factors. If the sample size is large enough, regression analysis can be used to quantify the relationship between consumer typologies and propensity to take-up environmental housing options. This will assist the industry stakeholders to better market eco-housing initiatives in the future and in this particular segment of the housing market. The findings of the survey research will be augmented by interviews and focus groups with visitors to the demonstration home. Qualitative research can provide 'narratives' or 'case studies' that ground quantitative data in real life examples. It also exposes the research to the indeterminate and fluid dynamic of conversation, which can identify issues and opportunities not considered in the initial design of the research, and be used to cross-check assumptions and ideas taken into, or developed through the research process. In this way in-depth qualitative research is required to provide the research with 'credibility' and 'authenticity' (Bryman 2001).

4. Action workshops with industry participants – The direct involvement of project sponsors is required to ensure that they are engaged and supportive of research directions and 'buy in' to its findings. As they are also industry participants, it also provides an opportunity to engage them as subjects of the research in an action research context. Action research aims to "contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science ..." (Rapoport 1970). It involves parallel and interacting systems of research and stakeholder dialogue. Action workshops in this project will be used to present the findings of both the literature reviews and consumer research to the project stakeholders, with the objective of capturing their interpretation of the findings and to develop strategies for further research or action at an industry level. This will include using the outcomes of literature reviews and consumer research to workshop new products, such as those related to the financing of premium design elements and technologies by industry bodies to breakthrough the upfront cost barrier at the point of sale. These new 'products' can then be re-introduced into the consumer research process to ascertain their market potential.

Critiquing the way consumers are constructed in the discourse of industry participants is an opportunity to question long-held assumptions related to mainstream consumer disinterest in environmental housing products. The Cairnlea demonstration home provides an opportunity for primary research with consumers that can be used as a basis and justification for this critique. This in turn creates a platform on which new 'best chance of success' policies programs and products can be developed and tested.

Entering the life-world of prospective homebuyers through focus groups and survey research, and exploring their motivations, preferences, assumptions, and opinions can open-up consumer decision-making so that it can be analysed more deeply with regard to its implications for sociological theory and sustainable development. From a sociological perspective, there is an opportunity to investigate the phenomenon of ecological modernisation as it relates to the cultural transforation and inertia, and the

ecological rationalisation of the social-technical system and the life-worlds of consumers, families and citizens (see: Beck 1992, 1996; Spaargaren 1998; Giddens 1999). Specifically, there is an opportunity to investigate the various modes of action and rationalisation expressed by consumers through their purchasing intentions. It is anticipated that these modes will vary (from the traditional, the altruistic, the economic rational) and this will have implications for the theoretical problem of individualisation and its capacity to account for counter-individualist emergent rationalities such as altruistic environmental abatement (Berking 1996).

Technical Research

Technical research is being carried out through the RMIT Faculty of Engineering, and in collaboration with the Built Environment Research Group at Deakin University. This research stream will quantify the degree to which sustainable design features translate into actual performance improvements through empirical testing of the EcoHome's performance compared against targets and objectives established in the design phase. Specifically, the objectives of the technical research stream are:

- To develop a monitoring strategy, including instrumentation, to capture reliable, functional, behavioural and incidental data through a remote data logging system
- To develop long-term performance prediction models, which are capable of whole-of-life forecasting using the data acquired during the EcoHome study
- To devise strategies and numerical methods to adapt performance prediction models to incorporate occupants' behavioural patterns and life styles
- To develop a new Whole-of-Life Sustainability Index (WLSI) as a resource for industry outlining the scope of measures to determine the sustainability of housing projects

As Blair et al (2003) state: 'sustainable development has been defined in literally thousands of ways, none of which materially help to operationalise the concept or to reduce the complexity of its measurement'. Consequently, it is difficult to decide how to monitor a house's sustainability performance. This research will provide some guidance for industry in Australia about methodologies for doing this. It is also critical for the marketing of the Cairnlea Eco-House that all performance benefits can be quantified, and linked to specific decisions throughout the design and construction process. This research stream will quantify the degree to which sustainable design features translate into actual performance improvements through empirical testing of the EcoHome's performance compared against targets and objectives established in the design phase.

A monitoring strategy has been developed to obtain data relating to water and energy consumption, building envelope performance, indoor air quality, thermal comfort and greywater quality. The performance of equipment utilised such as the photovoltaic cells and solar hot water system will also be assessed. This will include continuous or periodic monitoring of a wide range of environmental indicators. Data obtained from this monitoring will be compared to water and energy consumption in comparable but conventional project homes in the region, as well as to 'average' industry data.

Monitoring will be conducted both during the first twelve months after construction, when the house will be used as a display home, and for an at least 12 months following occupation by residents. Interviews of the EcoHome occupants will be carried out to establish the impact of occupant behaviour on the EcoHome's lifecycle environmental performance. The next phase of the research is to attempt to predict future performance of the EcoHome by developing long-term performance prediction models. A probabilistic approach using stochastic modelling and performance prediction techniques will be used. Other tools, which will be applied for this purpose, include lifecycle assessment and lifecycle costing methodologies. Data obtained from this house will be used to calibrate the model as a potential tool for industry.

The case-study nature of this approach is a limiting factor in terms of generating findings that can be generalised to all new housing stock. Rather than providing definitive data however, the focus will be on the development of new models and methodologies that can then be cross-tested and refined with a larger sample of houses at a later time. This detailed and holistic approach will also enable a critical review of a range of environmental ratings tools for the housing sector used both within Australia and internationally and the appropriateness of 'sustainability criteria' used to assess new environmental housing initiatives taking into account local factors and the idiosyncrasies that arise from complex interactions within the house as a socio-technical system. These outcomes will feed into development of a methodology for the development of a Whole-of-Life Sustainability Index for use in the broader housing industry.

Design Research

Australia's mass-market building industry has traditionally had little experience in managing projects for environmental performance improvements resulting in an overall lack of internal organisational capability. Where initiatives have occurred, they remain peripheral to the mainstream phenomena of large-scale and relentless housing development. Recent theoretical accounts of 'green building' projects support the notion that sustainability requires a culture shift, new organisational processes, systems, relationships, as much as it requires the implementation of design and technological innovations (Hewitt and Wilkinson 2002; Williamson et al. 2003). Boden (1996) relates the complexity of the required shift to a 'paradigm change' where even fundamental and implicit assumptions and approaches need to be questioned.

The challenge from the perspective of the design profession can be seen as two-fold. Firstly there is a need to determine the specific conditions (knowledges, systems, networks and technologies etc) for sustainability in the industry. Secondly, there is a need to develop a program for strategic intervention that can facilitate the actualisation of these conditions through the development of resources to both promote and support change in the industry, be it through the delivery of tools, training etc.

The closest attempt thus far to this kind of strategic intervention has been the Commonwealth Government's 'Your Home' project, which has developed generic design guidelines and delivered extensive training through design profession and building profession industry associations. Despite the popularity and quality of the

resources that have been developed there is little evidence to indicate tangible outcomes resulting from the program. One limiting factor may be the programs focus on design and technology fixes, rather than the processes that support and drive sustainability from concept development through construction and marketing.

The design researcher on the EcoHome project will take a fresh look at the challenge faced by building firms and investigate the information needs of relevant industry participants through the design and construction process. The focus will be on 'improving' the design process and identifying the need for specific decision support tools. Specifically, the study will answer the following specific research questions:

- What design and procurement process was followed in developing the EcoHome?
- How does this process need to be re-engineered to improve sustainability in the broader outer-suburban housing industry?

Guy and Farmer (2000) have developed a social constructionist framework for examining the 'assumptions, values and normative commitments involved in the process of design and their resulting embodiment in built form'. This framework will be used to interpret the perspectives of the different actors involved in the suburban housing industry in Melbourne. Principle research methods will be interviews and focus groups with industry participants, leading to the development of a case study of the Cairnlea demonstration eco-house and recommendations for designers and builders for the optimisation of the design and construction process for improved environmental performance.

The design researcher has also played the role of a hands-on coordinator of environmental initiatives at Cairnlea. As this is not replicable for all future projects from a cost perspective, alternative systems need to be developed that can stand-alone and reliably deliver the same level of environmental performance without the design researcher's direct involvement.

A 'triple helix' approach

The history of the EcoHome project, and the inclusion of a substantial research component represent a substantive shift from a simple demonstration-home/design-fix approach to sustainability, to one that recognises the profound implications of sustainability for all levels of industry activity and actively extends itself across disciplinary boundaries to identify critical information needs, and meet those needs through targeted research.

The concept of the triple helix represents the way the three research streams have been developed as autonomous research projects, within a framework of collaboration, cross consultation and support. In particular it emphasises the way in which the ultimate impact of each stream, its potential to effect positive change in the industry, is contingent on the outcomes of the other two. In this way the three disciplines are entwined in a *singular operational paradigm* regarding the dynamics of the industry and its receptiveness to strategic intervention that crosses traditional disciplinary and faculty boundaries. This kind of structure reflects perhaps a fundamental demand of sustainability research; to move beyond traditional academic silos; to move in networks that reflect the interaction between the field of study and

the system in which it operates; to move against intellectual reductionism. The emerging unifying paradigm, if in fact there is one, may be the emerging and increasingly professional discourse of ecological sustainability itself.

Rather than a solution, cross-disciplinary engagement is still an ongoing challenge for sustainability practitioners. For example on one green commercial building project, architects deliberately fostered cross-functional collaboration (Hes 2003). Engineers participated in design workshops integrating lighting, heating, cooling and natural ventilation with the results of the thermal modelling to achieve an optimum product. This kind of collaboration however needs to be actively managed and supported to resist the tendency for people to retreat back into disciplinary comfort zones or 'silos' (Inkson and Kolb 1998).

The architects on the RCC Green project purposely tried to make the project more 'multidisciplinary and interagency' (...). The engineers were invited to workshops, targets set and issues discussed with them at length. They all understood the 'green' agenda. The problem was, that (...) they would go back to their office and treat the project as any other, applying the same technologies, tools, set of beliefs and values (Hes 2003:33).

In the EcoHome research project collaboration is forcedly implemented through a regime of fortnightly meetings (usually teleconferences) so that each researcher experiences the development of the other project streams, its key methodological challenges as well as practical, strategic and implementation issues. Quarterly stakeholder workshops also serve to consolidate research directions, especially when joint presentations need to be made. This serves to unify the three streams by forcing them each to address the entangled and multifaceted complex of ecological sustainability as a need for the housing industry, the underlying and original impetus for the research.

As the project is still in its first year, and the specifics of the research strategies are still being developed, there has not yet been a substantial opportunity to share primary research data and test the responsiveness of each stream to developments in the other. In this sense the articulation of each research stream in this paper, within the context of singular research program, is the first spoke of the helix.

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