RMIT UNIVERSITY

CENTRE FOR DESIGN

2008—2009 Review

SUSTAINABILITY RESEARCH SOLUTIONS

WELCOME

Welcome to the Review 2008-9 for the Centre for Design at RMIT University in Melbourne, Australia. The Centre for Design is dedicated to research for sustainable design and related policy and practice.

Originally established in 1988, the Centre is recognised internationally for its sustainable systems research, innovative design methods and tools to support sustainable design. It has an established reputation as the Australasian region's key node of activity in Life Cycle Assessment. Following the RMIT University Centres Policy review completed in 2007, the Centre for Design has been centrally located within the College of Design and Social Context since January 2008.

Research is concentrated into four main research groups; Climate Change and Social Context; Sustainable Built Environments; Life Cycle Assessment and Sustainable Products and Packaging.

The last two years have brought rapid growth and diversification in the research activity at the Centre within this framework. New projects include multidisciplinary enquiry into housing design and performance and into the social context of household practices and technologies. These particularly relate to energy and water use and the need to reduce greenhouse gas emissions. Other areas of growth in research activity include tools for Life Cycle Assessment and decision support for sustainable design.

Our research partners span a considerable range, from the Australian Research Council, through all tiers of government, to large and small commercial organisations across sectors such as heavy industry, building, services and hospitality. We also work with non-government organisations and advocacy groups – our research partners for 2008-9 are listed in Appendix 1.

Currently, the Centre for Design comprises 40 core research staff and higher degree research students, administration staff and additional staff, volunteers, visiting researchers and associates. Volunteers and visitors are attracted to a vibrant, active and involved research environment which is strongly connected to the 'real' world, in an atmosphere of purposeful engagement with the transition to a more sustainable future.

The last financial year has seen Centre staff in demand in the media (print, television and radio) for reports and commentary on current affairs relating to our research across households, life cycle assessment, consumption, sustainability and climate change. Senior staff have also been invited to participate on judging panels for a variety of sustainability awards. We have also participated regularly, as invited experts, in policy discussions with state and federal governments. Examples of our involvement with these activities are contained in Appendix 2.

One result of having undertaken over 100 projects in the past year is that we have produced a wide range of publications, examples of which are included in Appendix 3. Notably, three of us have had a new book published recently by CSIRO Publishing. The book signals our direction in Life Cycle Assessment research by undertaking a critical examination of theory, methodologies and applications of Life Cycle Assessment. Key developments, challenges and opportunities are also illustrated with case studies, as indicated in the short summary within these pages.

Our scholarly activities also include both review roles for international journals and for key reports such as the 'State of the Environment' produced by the Office of the Commissioner for Sustainability (Victoria). Our involvement on the new 23-member Built Environment Industry Innovation Council (2008-11), makes RMIT one of only three universities represented in this initiative of the Australian Commonwealth Government to champion innovation in the industry.

As part of its outreach and knowledge communication strategy, the Centre has held a range of conferences, training events and discussions. We have provided courses, teaching and input to training and workshops, both locally and across the region, including in China, India, Japan, New Zealand, Singapore, South Korea and Vietnam, in subjects such as sustainability in the built environment, eco-design, Life Cycle Assessment and the provision of green buildings.

The Centre's main activity is research, which it undertakes in three ways:

- Exploratory projects – often seed projects, the development of ideas and pilot research as extensions or additions to existing research capacity;
- Applied Research projects – often client-funded, these result in specific research outputs and may involve research from three to twelve months;
- Depth and discovery projects – significant research, for one to four years, which leads to new knowledge and discovery through sustained effort across a research team. This often involves higher degree and post-doctoral scholars in addition to our senior investigators.

A selection of these three project types is reported in this review. I hope you enjoy reading about our activities.

Ralph Horne, Director
Centre for Design

HOUSEHOLD SUSTAINABILITY ASSESSMENT TOOL FOR GREEN LOANS PROGRAM

Karen Rosenberg and Dr Usha Iyer-Raniga

For many people, sustainability measures such as using solar energy, water saving and energy efficient products are home improvements that are just out of reach. The Australian Government has developed a new program for providing assistance to households (home owners and renters) which came into effect with the new financial year (1 July 2009). The program provides a free Home Sustainability Assessment and report, the outcomes of which determine eligibility for a government loan subsidy, covering the interest on borrowing up to $10 000 for four years from participating financial institutions.

The Centre for Design team, led by Adjunct Professor Alan Pears, Associate Professor Ralph Horne, Dr Usha Iyer Raniga and Karen Rosenberg conducted a significant research and development program to produce the Household Sustainability Assessment tool, an integral part of the Green Loans Program.

The Household Sustainability Assessment Tool is an online WEB 2.0 tool developed in conjunction with software partners WSP Environmental. The tool is central to the Household Sustainability Assessments, 200 000 of which will be undertaken in homes across Australia by trained expert assessors. The assessment will involve the physical inspection of major energy and water systems relating to thermal comfort, water heating, lighting, refrigeration, cooking, entertainment, water efficiency, outdoor consumption, and waste management. The assessment tool provides environmental impact calculations for energy, water and greenhouse gas emissions, and automated recommended actions and advice from the smallest behavior change to major investments such as a solar hot water system or photovoltaic panels. From this assessment, householders will get a tailored, expert report listing the most effective changes for their home.

In creating the Household Sustainability Assessment tool for the Australian government Green Loans program we set out to develop a detailed yet accessible online environment tool. The tool provides a report on the best ways to improve a home to save energy and water. Assessors can quickly key in data from their home inspection and generate a report on how sustainable the home is currently and what can be done to improve the home.

The program will enable households to implement sustainability measures with a reduced financial commitment, giving them and the environment the direct benefits of savings on water and energy.

As part of monitoring and assessing the outcomes of this program as it evolves, the Centre for Design has been leading a research consortium to inform an understanding of key actors – householders, financers, retrofitters and other stakeholders – as well as markets and practices involved. The project, for the Department of the Environment, Water, Heritage and the Arts, sees the Centre for Design working with the Institute for Sustainable Futures at UTS, Queensland University of Technology, University of Tasmania, University of South Australia and Murdoch University.

For more information, visit: www.environment.gov.au/greenloans
contact: ralph.horne@rmit.edu.au

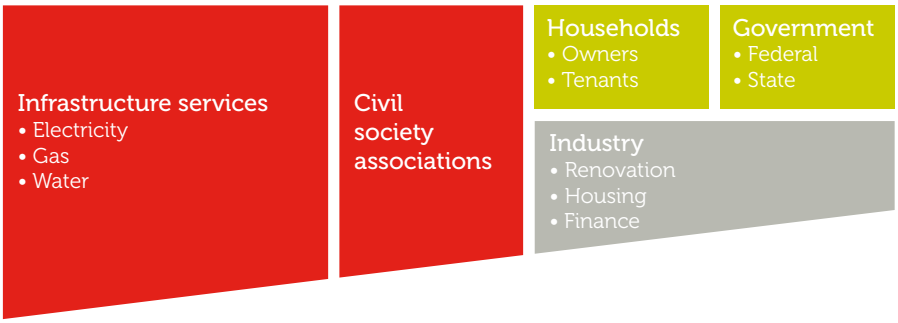
REMAKING SUBURBIA: PROSPECTS FOR SUSTAINABLE HOME IMPROVEMENT

When people set out to improve their homes they are increasingly likely to consider the environmental impact of their decision to extend or renovate. Their focus is also on increased comfort, perhaps the status associated with a better home and the market value. How can all these factors be reconciled?

At an aggregate level home improvements contribute to rising environmental impacts in the form of domestic water consumption and greenhouse gas emissions. Typically dwelling size increases and more appliances are installed. The common government response is to provide cost incentives to encourage householders to opt for more efficient technologies. The alternative is to simply wait for energy price increases that will encourage households to reduce consumption. However, both these approaches are inadequate on their own, and ignore the importance of the social dimensions of home improvement.

What might encourage people to add technical options such as insulation, solar energy, combined heat and power to their home improvement plans, especially when the expected savings from these may be difficult to identify?

What is involved



Remaking Suburbia is a three-year project by the Centre for Design and Global Cities Research Institute. The project aims to fill the gap in research seeking to explain the institutional, political, social and cultural dimensions of home improvements. It focuses on three themes: households undertaking home improvements; housing industry home improvement services and government policy and program development.

Led by Chief Investigators Professor Tony Dalton and Associate Professor Ralph Horne, with post-doctoral fellow Cecily Maller, this project is providing original knowledge about home renovator experiences and practices. Results can be used by government agencies, industry groups and civil society organisations to shape policy and programs to decrease the environmental impact of Australian suburbs.

Starting with the exception rather than the rule, a pilot study of Melbourne home owners who had recently chosen to undertake a 'green' renovation used qualitative research methods to reveal the experiences of homeowners who embark on 'sustainable' renovations.

What is their understanding of sustainability? What motivated them to opt for a 'green' renovation?

Perceptions of sustainability varied. Some thought of it as a means to maintain comfort and wellbeing; others saw 'green' as a new standard to be met, or believed living sustainably is an ethical duty. Impetus included the desire to improve the thermal comfort of their home, to minimise energy and water consumption and just to engage with sustainable technologies.

The next stage of the research explores these findings further by interviewing a larger sample of homeowners and introducing a second theme – the role of builders and other building industry service providers. Findings will provide a better understanding of triggers, perceived rewards and other influences, such as sources of information and advice on sustainable home improvement.

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REMAKING SUBURBIA: RESEARCH AND POLICY DIRECTIONS FOR SUSTAINABLE HOME IMPROVEMENTS

This one-day conference hosted by Centre for Design and the Global Cities Research Institute was held at the State Library in Melbourne in March. The Conference Convenor, Centre Director, Ralph Horne said: "This conference provided a forum for academics and policy makers to jointly consider how we might achieve widespread reductions in energy and water use across Australian households. It was deliberately challenging and multi-disciplinary, involving experts from both the UK and Australia presenting and leading conversations in a critical, reflective and comparative context".

The conference opening address was made by the Hon Gavin Jennings, Minister for Environment, Climate Change and Innovation in the State Government of Victoria. Keynote addresses covered practical and policy considerations and enabled researchers, policy makers, program makers, consultants and stakeholders to access UK experts involved in urban transitions for sustainable home improvements.

- Suburban transitions; a policy framework, Professor Tony Dalton (RMIT University)
- Social practices in the home, Professor Elizabeth Shove (Lancaster University, UK)
- Green loans and more; federal initiatives in housing retrofitting
  Stephen Berry (Director, Green Loans program,
  Australian Government Department of Environment, Water, Heritage and the Arts)
- Prospects for low-carbon housing industries, Gavin Killip
  (Environmental Change Institute, Oxford University, UK)
- Old Home Superhomes; UK experiences in retrofitting, John Doggart
  (Chairman, Sustainable Energy Academy, UK)

Speakers from across Australia presented topics relating to improving our housing stock to reduce impacts on water use and climate change. These covered socio-technical studies; home improvement industry and innovation; design and economics of home improvements; consumption, communication and behaviour change; international comparisons and regulatory mechanisms and modes of governance.

The Australian Government supported the conference and a subsequent one-day workshop of experts to consider comparisons between UK and Australia and the developments in programs in Australia. The government in the UK has instituted various relevant policies, schemes and programs.

The invited experts shed light on the strengths and weaknesses of these initiatives, including the extent to which they may be relevant (or not) in the Australian context.

Participants valued, "the variety of approaches to the issues; forum for questions; good spread of local and international speakers and issues – and the networking opportunities".

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MORE THAN A ROOF OVERHEAD

"If people live in third world conditions in overcrowded, poorly built and maintained houses, then it is not surprising that they suffer the same health and social problems as people in developing countries"

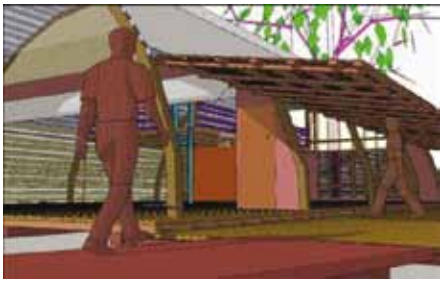
(Paul Pholeros, Director, Healthabitat).

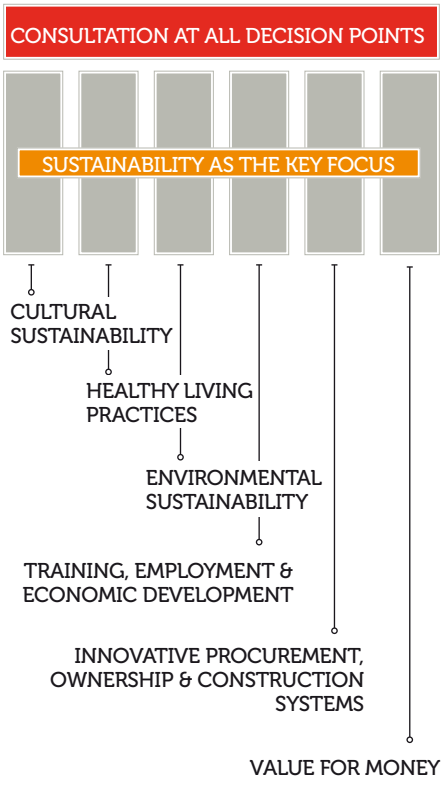
Crowded and poorly maintained housing is both a symptom and an ongoing cause of severe social disadvantage. Just under a third of the resident Indigenous population of Australia live in what is classified as remote and very remote parts of the country. Here they experience health, life-expectancy, education and living conditions far below those of the majority of Australians.

The Australian Research Council funded three-year project, "More than a Roof Overhead: Meeting the Need for a Sustainable Housing System in Remote Indigenous Communities" builds upon previous related research at RMIT funded by the Australian Housing and Urban Research Institute and Northern Territory Housing.

In the past much research on Indigenous housing has concentrated on individual elements of housing provision (such as health, culture, design, repairs, etc). This project takes a broad, whole-of-system and interdisciplinary approach in researching the delivery and management of remote Indigenous housing –where the key challenge is to design, build and manage housing as an integrated and sustainable system.

The aim of the research is to ensure that current and future investments in housing can maximise housing outcomes, in terms of increased numbers and improved functionality and longevity, as well as the non-housing outcomes associated with improved housing. These include improvements in family wellbeing, health, education and economic development.





The project is producing:

- Guidelines for appropriate and effective consultation with, and Indigenous participation in, housing decisions
- Strategies for leveraging investments in housing as a driver of employment, entrepreneurship, and regional and community development in and around remote Indigenous settlements
- Guidelines and protocols for developing and enhancing education, training and workforce development programs for remote Indigenous Australians to support housing-related employment
- Decision tools to support the development of innovative approaches to the procurement, design, construction and management of houses to maximise shelter and non-shelter outcomes for families, and
- Recommendations for the review and development of policy goals and programs through the life of the project.

Chief Investigators are RMIT's Professor John Fien, Dr Esther Charlesworth, Associate Professor Ralph Horne, Professor Ron Wakefield, Professor John Altman (Australian National University) and Associate Professor Michael Christie (Charles Darwin University), who are accompanied by a team of PhD scholars and a post-doctoral fellow.

At the Centre for Design, Research Fellow Andrew Martel is coordinating the project, due for final delivery in 2011. In addition to the Universities involved, partners include Bawinanga Aboriginal Corporation (Arnhem Land); the Centre for Appropriate Technology; Indigenous Business Australia; the Northern Territory Department of Local Government and Housing and the Western Australia Department of Housing and Works. The partner organisations are assisting the Centre by facilitating field work, allowing access to their data and research on Indigenous housing and actively participating in quarterly meetings of the research team.

The integrated 'whole-of-system' approach to housing aims to utilise the procurement process for new housing to improve community development. Improved outcomes throughout the housing life cycle sought through consultation, education and skills training. Looking in the other direction, the procurement process can also be used to inform and challenge the practices of government authorities responsible for the provision of remote Indigenous housing.

The first series of discussion papers from the project to be presented to the "More Than a Roof Overhead" partner organisations details the objectives of each part of the project and provides the groundwork for the initial fieldwork.

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LIFETIME AFFORDABLE HOUSING IN AUSTRALIA: INTEGRATING ENVIRONMENTAL PERFORMANCE AND AFFORDABILITY

Dr John Morrissey

The significance of climate change, and its implications, means that it is crucial to make a major effort to improve the energy and water performance of housing. At the same time, there is broad agreement that providing quality, affordable housing for Australian families and individuals is a policy imperative.

There is a perceived trade-off between residential building (environmental) performance and cost. There are also perceived trade-offs between the supply of lower cost land (and therefore housing) on the outer periphery and the increases in private transport, with more use of fuel and more greenhouse gas emissions that distance from key employment centres means. Trade-offs extend to wider social and economic costs, particularly for lower income, vulnerable households. These trade-offs are encompassed in the term 'Lifetime Affordable Housing', coined by the chief investigators for this project; Associate Professor Ralph Horne, Professor Mike Berry (RMIT AHURI), Associate Professor Jon Kellett and Professor Stephen Hamnett (both from the University of South Australia).

The industry partners, the Victorian Building Commission and VicUrban and South Australia's Land Management Corporation, joined the project in order to make the affordability and sustainability aspects of the housing debate explicit by collaborating on a wide-ranging empirical analysis. This will in turn provide an evidence base for future planning and policy mechanisms, enabling the delivery of optimal environmental performance and affordability.

The project staff: Dr John Morrisey (co-ordinator, post-doctoral fellow) and three PhD scholars (Sue Irvine, Bronwyn Merrick and Trivess Moore) are funded through an Australian Research Council Linkage Grant (2007-10), within which parallel studies of environmental and cost benefits of (a) improved housing design and specification, and (b) utilisation of urban land for affordable housing are being undertaken.

In addressing the following four research questions, the team is exploring the key themes of life cycle costs and locational efficiencies:

1. What are the through-life costs and benefits of predominant housing forms in Australia's major cities?
2. What are the real through-life costs and benefits of utilising urban brownfield and greyfield sites to supply more affordable housing around employment centres to enhance locational efficiency?
3. How do the costs and benefits identified in questions 1 and 2 impact on housing affordability over the short and long terms?
4. How can the perceived trade-off between affordability and housing performance be overcome by market and regulatory mechanisms including:
    - financial incentives and disincentives (private and public) to encourage environmental performance in housing
    - regulatory and planning reform, including policies to encourage denser residential redevelopment on existing brownfield and greyfield urban sites, and
    - refining affordability policy mechanisms to ensure long term as well as short term positive outcomes?

The research to date has already established case studies for analysis, looking at three housing scenarios in particular; baseline (5-star to current building codes); enhanced (7-star to enhanced performance parameters) and world class (approximately 9 star, approaching carbon neutral). Life Cycle Assessment and costs data are being applied to each scenario to calculate capital, payback and lifetime costs of each, with emphasis on three key parameters; $, CO2 equivalent and litres of water used.

The Lifetime Affordable Housing team has engaged with stakeholders in the housing industry who have relevant expertise in these areas. Early indications are that, perhaps surprisingly, under typical expectations of future energy and water prices, cheaper houses are generally those with significantly higher specifications than existing building codes require.

Over the next year, the project team will be exploring – through further modelling and analysis – the relative costs and benefits of different design innovations. This will provide further examples of how the study is providing essential research knowledge to inform policy, enabling Australia to provide higher performance urban housing, within current and future economic and environmental limits.

As part of our brief to engage with key stakeholders across Australia we have established links with developers such as Hamton Property Developers, builders such as Jan Brandjes (Victoria), Rossdale Homes and Charterhouse by Hickinbotham (Adelaide), architects such as Peter Lees and Zen architects (Victoria) and other industry players such as Canberra Investment Corporation. The Centre aims to establish more partnerships so that expertise and data can be transferred from industry to academia and visa-versa.

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YOUR HOME BUYERS GUIDE AND RENOVATORS GUIDE

'Your Home' is an Australian Government initiative to provide a suite of information and assistance sources to households. Your Home Buyer's Guide is an innovative publication (co-authored by Centre for Design) which takes new home buyers through the house purchase process, while presenting ways in which they can choose or build a more comfortable, sustainable home. It is available to any builder, developer or consumer.

The guide is a major initiative to promote sustainable and affordable housing. It encourages project home buyers to consider issues such as orientation and ventilation and options such as solar hot water systems and energy-efficient lighting. The guide was initiated by Clarendon Homes and funded by commonwealth and state governments to promote sustainable and affordable housing. For a .pdf copy of Your Home Buyer's Guide, go to www.yourhome.gov.au or www.clarendon.com.au.

The Centre for Design was also separately commissioned to develop the step-by-step resources for Your Home Renovator's Guide. The Buyer Guide and Renovator's Guide provide buyers and renovators with strategies to reduce both the environmental impact and running costs of their home.

Our project partners included the Institute for Sustainable Futures at University of Technology Sydney, Department of the Environment, Water, Heritage and the Arts, the Building Commission (Vic), Sustainability Victoria, Department of Housing Works (WA), Queensland Environmental Protection Agency in the Department of Environment and Climate Change the ACT Planning and Land Authority and Moreland Energy Foundation.

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YOUR BUILDING WORKSHOPS AND WEBSITE

'Your Building' is an initiative of the Australian Cooperative Research Centre for Construction Innovation, in partnership with the Australian Sustainable Built Environment Council and the Australian Greenhouse Office. It promotes sustainable building and building management practices in Australia's commercial buildings. The Centre for Design collaborated with other partners in this major project and played a role in providing ongoing support through the provision and review of new articles and information for the website. A workshop series was launched in late 2007, with the first module "Developing the business case for sustainable commercial buildings" in Melbourne, Sydney and Brisbane. More workshops were launched in 2008, including 'Valuation', 'Life Cycle Costing' and 'Developing a Brief' for the business case.

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CARBON NEUTRAL COMMUNITIES: MAKING THE TRANSITION

How can a coal- and oil-powered economy meet the challenge of reducing its carbon/greenhouse-induced contribution to climate change?

Our current high per capita greenhouse gas emissions present two significant problems. First, to meet global community obligations to mitigate global climate effects we need to reduce significantly the high emissions of fossil fuel use. Second, heavy energy users are more vulnerable to a future where greenhouse gas emissions will have a high cost. In order to build resilience, Australian communities can anticipate, and adapt to, climate change by reducing their need for fossil-fuel based energy resources and looking to make sustainable energy resources the norm. 'Carbon Neutral Communities: Making the Transition' is an Australian Research Council funded project that applies innovative research methods in assessing and enhancing progress towards achieving carbon neutrality in communities.

Our team is multi-disciplinary with expertise ranging from education to geography and from environmental science to planning. We originally met in 2005 and matched expertise and knowledge gaps for research together across our two states – Victoria and South Australia – the team includes researchers from the University of South Australia and RMIT University Centre for Design. The research team is Professors John Fien and Stephen Hamnett; Associate Professor Jon Kellett; Dr Susie Moloney; Annette Kroen; Anna Strempel; Catherine Hamilton and project leader Associate Professor Ralph Horne.

Our project partners are also from both states: Manningham City Council (Vic,) the City of Playford (SA), Moreland Energy Foundation (MEFL), Community Power and Consumer Affairs Victoria and Northern Alliance for Greenhouse Action (NAGA) as well as the International Council for Local Environmental Initiatives (ICLEI).

The project focuses on the role of 'behaviour change' initiatives and other non-technical interventions. By evaluating these and undertaking action-based research at the local government and household level the project is identifying the necessary mechanisms required to assist transition to carbon neutral communities.

In exploring the nexus between the social practices around household energy use and the infrastructures and institutions of energy provision, the project began by examining greenhouse gas emissions arising from transport, housing and industry across a local government area.

In our quantitative analyses of resources and technical opportunities we conducted renewable energy opportunity assessments for the municipalities of Manningham in Victoria and Playford in South Australia. The project then evolved into an exploration of social practices, looking 'beyond barriers' to understand the broader systemic and social factors that shape the ways we currently use energy at a household level.

A desktop analysis of sustainability behaviour change programs around the country was followed by a qualitative analysis of selected initiatives. Through in-depth interviews with behaviour change program designers this stage of the Carbon Neutral Communities project sought to build an understanding of how past and current programs have tried to influence householder behaviour, and the extent to which they have been successful in achieving energy usage reductions.

Out of this research we developed a framework for analysis to use as a tool in the scoping, design and evaluation of sustainability behaviour change programs. The framework will be applied and tested during the next stage of the project.

By working with selected organisations the final Action Research phase will test the function and utility of the framework for analysis. It is intended that this phase will provide opportunities for organisations working in the space to share experiences, knowledge and skills as well as providing the project team with valuable data.

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GREEN BUILDING AND DESIGN CONFERENCE

Over the last seven years, this annual professional training conference, hosted by the Centre for Design, has continued to grow. The Green Building and Design Conference (GB08) also brought together more architects and designers, policy makers, government practitioners, energy consultants, building owners and building industry representatives.

With its breadth of speakers and the practical emphasis of the program, the conference has gained a reputation as the most comprehensive and informative in this field. Reflecting the importance of such an event for government and industry partners, sponsors for GB08 included the Department of the Environment, Water, Heritage and the Arts (commonwealth), Department of Planning and Community Development (Victoria) – Heritage Victoria, VicUrban, Brisbane City Council, Land Management Corporation, Department for Planning and Infrastructure (Western Australia), Cedar Woods Properties Limited and LandCorp.

The event has been delivered across several Australian cities, with a focus across a range of topics including:

- Proposed emissions trading and its effect on building materials in Australia
- Building materials and liability
- Life Cycle Assessment
- Third Party Certification of environmental performance
- Alternative building materials
- Innovative insulation materials.

In 2009, the Conference is offered in three formats:

- As a two-day conference in Melbourne (9-10th September, at the new world-leading 6 Star Green Star rated Melbourne Convention Centre);
- As an international webinar (people can access the conference in real time on their computer), and
- As a post-graduate study module at RMIT, in conjunction with the School of Property, Construction and Project Management.

The focus in 2009 is on materials. The selection of materials in buildings has an impact on the environment, on human health and on construction costs. Regulatory requirements have to be complied with, consumer demand for ‘healthy’ buildings needs to be met and liability claims will need to be deflected when choosing products and materials for the built environment.

Designers, manufacturers and regulators have been called upon to explore various options for green materials: be it those produced from renewable or recycled materials or from innovative high-tech products – evaluating the alternatives can be a real challenge for all concerned. The conference provides practical guidance on how to assess building materials. Site visits and the presentation of case studies illustrate how theory has been put into practice and how practice can be used to refine theory.

In 2008 participant feedback indicates the balance of theory and practice; “Factual edge as well as the theoretical framework”; and the combination of presentations and discussion; “particularly good discussion and currency of information”.

Register online at www.shortcourses.rmit.edu.au or telephone Short Courses on 03 9925 8111.

Register online for BUIL 1225 ‘Sustainability in the built environment: A focus on building and design’ at www.singlecourses.rmit.edu.au or telephone Single Courses on 03 9925 8111.

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SUSTAINABILITY AND HERITAGE BUILDINGS

The environmental assessment of existing residential and commercial buildings in Australia and New Zealand has clear benefits, especially for those with heritage values.

The Heritage Council of Victoria, the Building Commission, the Victorian State Architect's Office, Building Policy (Department of Planning and Community Development), Department of Sustainability and Environment and Heritage Chairs and Officials of Australia and New Zealand (HCOANZ) have commissioned the Centre for Design to develop environmental assessment of a range of existing residential and commercial buildings in Australia and New Zealand that have heritage values.

The project will provide empirical research evidence in the form of a comparison between life cycle embodied and operational energy performance, greenhouse gas, water and other environmental impacts of a range of heritage building designs compared to 'improved' retrofitted designs where heritage values are preserved.

Residential and institutional heritage building types in different construction era spanning from 1880s to 1990s will be selected to provide empirical research evidence in the form of a comparison between life cycle energy, greenhouse gas, water and other environmental impacts.

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EXHIBITIONS AND SUSTAINABILITY

"What we received was a competent consultation on a holistic approach to sustainable interior design and event architecture. The cooperation with the Centre for Design was the tipping point for our company policy on sustainability."

Kristian Willand, Managing Director - ESG Group

Research for the Expo Solutions Group (ESG), one of Australia's leading service providers in the exhibition and interior design market, was designed to assist in addressing the problem that 'green' options are not widely available in the industry.

Using a national showroom fit-out project as a case study, the Centre for Design was asked to conduct research and assessment to investigate how its environmental impact could be reduced. As an example, the selection of paints used by ESG was analysed and a choice of lower environmental impact alternatives identified, including a shift from solvent-based to water- based paints. The new factory layout has since been revised to incorporate the new painting processes.

Following the study, ESG has introduced certificates which are supplied with all furniture items manufactured inhouse. These guarantee that the product may be returned to ESG at its end of life. ESG will then partly re-use and partly recycle the product.

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ECO-UPDATE: THE NEW LOOK (INSIDE) MAGAZINE COLUMN

The Centre for Design has long enjoyed a successful partnership with Niche Media, regularly contributing to the popular interior design publication (inside) magazine and periodically researching building and interior materials and products.

A new format for the column in 2008 meant reporting on the latest developments in realising sustainable outcomes in design. The column presents up to date environmental performance information plus simple advice on how designers can make more sustainable choices. (Inside) magazine is published five times per year.

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ACCELERATING SUSTAINABLE BUILDING FOR LOCAL GOVERNMENT

Local government manages substantial built assets – both newly commissioned and existing buildings on behalf of their communities. New research in institutional capacity development will contribute to the development of a local government sustainable building program for improved asset management in Victoria.

The Centre for Design was awarded a Sustainability Accord competitive grant as part of a consortium of local councils in Victoria. The Accelerating Sustainable Buildings in Local Government project provides the first step in developing leading practice for local government to integrate ecologically sustainable development (ESD) into council asset management programs.

Led by Faye Adams of Manningham City Council and Associate Professor Ralph Horne and Dr Usha Iyer-Raniga from Centre for Design, project partners include the Building Commission, Department of Sustainability and Environment, Sustainability Victoria, International Council for Local Environmental Initiatives, Municipal Association of Victoria and Darebin, Moreland, Yarra and Manningham City Councils.

Accelerating Sustainable Buildings in Local Government is a participatory action research project. It will explore barriers to sustainable building outcomes and identify ways practitioners can improve sustainable outcomes for built environment in their own municipality.

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CREED'S FARM AT VICURBAN'S AURORA

The Creed's Farm project sees the Centre for Design building on over five years as a research partner with VicUrban studying their flagship Aurora development. Taking on board sustainability considerations at the design stage facilitated a successful partnership between thermal performance assessors (Centre for Design) and the architects (Tandem design studios) to ensure a new Learning Centre will perform thermally in a sustainable and energy-saving way.

The Hornery Institute has assembled several partners to establish a Learning Centre for a new community of 25,000 people. The 'Creeds Farm Living and Learning' Neighbourhood Centre is to be built at the Aurora development in Melbourne's northern suburbs.

One of the key design objectives of this building project is to demonstrate sustainable design practices. The thermal performance benchmark has therefore been set as reaching an equivalent of a residential 7 star energy rating, rather than the current regulatory requirement of 5 stars.

Using thermal modelling techniques, the Centre for Design team established a baseline model of the building from the original architectural plans and specifications. Adjunct Professor Alan Pears, Dr Usha Iyer-Raniga and Karen Rosenberg adopted an iterative optimisation approach to modify the building design to help reach its performance target.

Architects at Tandem Design Studio were consulted throughout the process to ensure that construction and design options being investigated were feasible and their advice was sought in the final configurations. The results of the analysis were then adopted into the building design.

The success of this project highlights the importance of incorporating environmental sustainability and thermal performance considerations into the development process at the earliest possible stages. The Creeds Farm Living and Learning' Neighbourhood Centre's final design is expected to result in a building with relatively low bills and high efficiency.

For more information, contact: usha.iyer-raniga@rmit.edu.au

BUILDING ASSEMBLY AND MATERIALS SCORECARD (BAMS)

A design support tool to enable informed choices regarding the environmental impacts of building products and assemblies will score well with policy makers and building industry suppliers and practitioners.

With a Sustainability Fund grant from the Victorian Government, the Centre for Design developed the Building Assemblies and Materials Scorecard (BAMS). This design support tool will address current shortcomings and enable government and industry to assess the environmental impact not only of individual building components, but also of assemblies – such as a timber frame plus plasterboard for use in a wall.

Manufacturers and industry representatives have the opportunity to have their products and building systems assessed to differentiate high-performing products and assemblies with a standardised and transparent method.

Building on initiatives such as the Green Guide in the UK and MRPI in the Netherlands, BAMS uses Life Cycle Assessment (LCA) to ensure consistent and science-based evaluation of construction options. It will also be useful for other rating tools, including Green Star.

For more information, contact: usha.iyer-raniga@rmit.edu.au

GREEN BUILDING GUIDELINES FOR SCHOOLS

The Association of Independent Schools of Victoria received guidelines from the Centre for Design for the design and development of low environmental impact, educationally productive school buildings.

Led by Associate Professor Ralph Horne with Ian Jones and Karen Rosenberg, the project builds on the following ideas:

- a green school building can act as a 'living laboratory' for student exploration of green issues;
- a green indoor school environment should introduce more fresh air, lower levels of toxic compounds and more natural light, and thus promote better physical conditions for learning;
- a green indoor school environment is also better for teachers, whether psychologically or physically (or both) and will lead to higher productivity;
- a green school building is an example to the community, providing ethical leadership and various 'green halo' effects in terms of enhanced interest from high quality students and new staff, awards and recognition.

In realising the multiple benefits of green school building initiatives the project examines school buildings internationally as well as in Australia. It uses in-house ecologically sustainable development (ESD) expertise to develop case studies and principles for sustainable schools stakeholders.

For more information, contact: ralph.horne@rmit.edu.au

PILOT COURSE FOR BUILDING ENERGY ANALYSIS PROFESSIONALS

A Graduate qualification in building energy principles and energy modelling techniques for professionals in the building and construction industry is an important component in improving environmental performance of our homes and buildings.

The Centre for Design, the Clean Energy Council and the National Centre for Sustainability at Swinburne University were commissioned to collaboratively develop a new course for a Graduate Certificate for Building Energy Analysis Professionals (BEAP) by National Framework for Energy Efficiency (NFEE).

The objectives of the course are to increase the uptake of energy efficient technologies and processes across Australia by developing skills and knowledge in energy analysis.

Two course modules have been piloted by the Centre for Design to a group of fourteen participant professionals from a range of backgrounds; including large consulting firms working in the field of energy efficiency, smaller businesses interested in expanding into this area and local government.

For more information, contact: usha.iyer-raniga@rmit.edu.au

CLIMATE CHANGE ADAPTATION IN VIETNAM LIFE CYCLE APPLICATIONS

Using a case study in one of the world's most vulnerable cities to sea level rise, Ho Chi Minh City, we set out to test the feasibility of developing a simple aid for planners and developers to assess the possible impacts of building and development options under possible climate change scenarios.

Development of models to inform climate change adaptation planning technologies and projects tend to focus on vulnerability mapping and 'hard' infrastructure adaptation responses, such as proposed erections of sea walls in response to sea level rise. However, the greenhouse gas implications of these adaptation strategies have generally been neglected. In response to this, the Global Cities Research Institute at RMIT University commissioned the Centre for Design to develop a simple aid for planners and developers to assess the possible impacts of building and development options under possible climate change scenarios. This research project has led to the development of the Built Environment Life Cycle Assessment Decision Support (BELCADS) tool for Climate Change Adaptation (CCA) projects.

Using Life Cycle Assessment (LCA) methodology, the tool allows analyses of development designs under both present and future conditions.

Two scenarios were chosen in the tool in a pilot study in Australia to reflect possible climate change outcomes: rise in temperature and the increased prevalence of severe weather events. By studying the life cycle performance of a suburb under both the current and the expected climatic conditions, BELCADS helps to identify the implications of both adaptation and mitigation.

For example, initial testing of the tool on a residential suburb in the Melbourne climate zone indicated that the adaptation strategy of increasing the thermal performance of buildings, such as raising mandatory star ratings, might not deliver significant benefits under expected future climate conditions.

The next phase of development is centred on application of the tool in developing countries, with a case study in Ho Chi Minh City, Viet Nam. Associate Professor Ralph Horne, Dr Usha Iyer-Raniga, Andrew Carre and Dr Ifte Ahmed are collaborating on the project. In 2009 data collection and tool enhancement, including vulnerability mapping data, will be incorporated.

For more information, contact: usha.iyer-raniga@rmit.edu.au

GREEN BUILDINGS INDIA: RATING TOOL IMPLEMENTATION CLUES SHARED

The Victorian Building Commission commissioned the Centre for Design to research and document the implementation of the Green Star suite of environmental rating tools in Australia, as a contribution to knowledge that developing countries can draw upon in their own sustainable building rating processes. The resultant report has been provided to Green Building-related organisations in India, under the auspices of the Confederation of Indian Industries, and also to other developing countries that are investigating how to establish building sustainability rating tools.

For more information, contact: usha.iyer-raniga@rmit.edu.au

CIIA

Sustainability of the built environment will hinge on the need for a reduction of natural resource consumption and the reduction of the impact of buildings on climate change. These important factors are driving the need for buildings to be more adaptable to change. The Construction Industry Institute Australia (CIIA) commissioned the Centre for Design to investigate the environmental performance of building materials within the context of climate change and adaptation for existing residential and commercial buildings. The outcome of the project is a framework to assess the performance of building materials to lower their environmental impact.

For more information, contact: usha.iyer-raniga@rmit.edu.au

UNDERGRADUATE ELECTIVE: 'INTRODUCTION TO LIFE CYCLE ASSESSMENT'

As sustainability awareness has grown in the community, so too has employer demand for 'sustainability aware' graduates. The Centre for Design has developed an undergraduate elective teaching the essentials of Life Cycle Assessment (LCA). This supports the curriculum incorporation of contemporary sustainability techniques at RMIT University. An elective for second and third year engineers, it will be delivered through the School of Chemical Engineering.

An understanding of the life cycle impacts associated with materials, products and services is critical to designing and developing sustainable systems. Life Cycle Assessment is an objective method of quantifying the environmental impacts of product systems over their entire life cycles; from raw material extraction and manufacture, through to use and disposal.

As sustainability concerns become drivers for business and policy decision makers, LCA has become recognised as a scientifically valid and robust tool to evaluate environmental impacts across a diverse range of subject areas, such as architecture, product design, packaging solutions, recycling and waste disposal.

The course provides knowledge and develops the skills required to undertake an LCA study in accordance with the internationally recognised standard ISO 14040. Content addresses key components of the LCA framework and draws connections to contemporary areas of interest such as environmental product claims and carbon footprinting.

Course graduates will be able to:

- Model and determine the life cycle impacts of a material, product or service as per ISO 14040 series of standards
- Define goal, scope and system boundary for a LCA project
- Understand how to gather suitable information for building a life cycle inventory, including the role of uncertainty
- Understand the differences between attributional and consequential perspectives within LCA, and be able to use either approach in an LCA
- Understand the environmental impact categories used in an LCA, including the underlying assessment models
- Interpret the results obtained from all stages of an LCA
- Undertake an LCA using SimaPro software
- Write a report to meet ISO 14040 standards

By providing access to sustainability electives such as 'An introduction to LCA' students will graduate with skills that can be directly applied to solving sustainability problems.

PROFESSIONAL EDUCATION: LIFE CYCLE ASSESSMENT

Growing sustainability awareness and requirements across private sector industry and government have driven a demand for Life Cycle Assessment (LCA) expertise. The Centre for Design has developed an intensive LCA course for professionals to support the creation of LCA skills.

Throughout the year, the Centre for Design runs LCA courses which introduce methods and provide grounding in key underlying concepts. The courses are run quarterly and provide an opportunity for 'time poor' professionals to quickly come to terms with LCA methodology and its appropriate application.

The course is designed to cover a lot of ground in a short period so is delivered in an intensive fashion over two days. In addition to methodological aspects, participants are given exposure to LCA case studies which help bring the subject to life and illustrate its potential. On the second day participants are invited to develop their own LCA project and are given support to achieve directional conclusions that can be further refined. Contextualisation of LCA with other tools such as Risk Assessment, Life Cycle Costing, and Environmental Impact Assessment are also addressed.

Courses have been delivered both across Australia and overseas, with regular courses held in Melbourne. Organisations interested in the Centre developing a life cycle program for their staff can find more information at our website.

For more information, contact: andrew.carre@rmit.edu.au

LIFE CYCLE ASSESSMENT MASTERCLASS

The Centre for Design held a Life Cycle Assessment (LCA) Masterclass with Professor Bo Weidema at the Rockford, Darling Harbour Sydney in August 2008. The course attracted a group of life cycle assessment practitioners who were eager to expand on the basic principles and concepts of LCA.

Bo Weidema is one of the world's leading LCA practitioners and was instrumental in the development of the SPOLD LCI data format and database network from 1995 to 2001. He is executive manager of the ecoinvent database, Associate Professor at Aalborg University and member of the UNEP/SETAC Life Cycle Initiative task forces on social aspects (co-chair) and natural resources and land use. He is also expert delegate to the ISO TC207 / SC5 on life cycle assessment.

The masterclass addressed two of the most challenging aspects of LCA; the use and practice of consequential LCA and the integration of process and input output LCA.

LIFE CYCLE THINKING

Life Cycle Thinking is the newest training approach to holistic design and development.

While the centre is very active in providing training on Life Cycle Assessment (LCA), we have also responded to requests to provide training on life cycle thinking.

Life Cycle Thinking (LCT) provides a framework for holistic design and decision making by incorporating sustainability into design and development. LCT allows researchers from different disciplines to work alongside practitioners and decision makers in developing concepts and ideas for considering whole of life implications of products and/or services, and thus make appropriate designs to minimise impacts.

For more information, contact: andrew.carre@rmit.edu.au
Visit: www.shortcourses.rmit.edu.au

REUSABLE AND DISPOSABLE LAUNDERED PRODUCTS

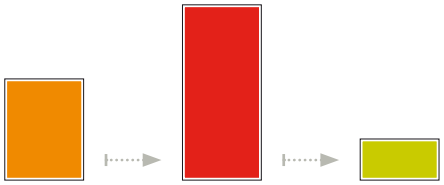
Disposable laundered products generate material waste although a reusable laundered product generates washing loads, with detergent, disposal, and energy implications. Andrew Carre has conducted an LCA study of different options in order to measure environmental impacts and assess points of difference. Included in the study were all relevant aspects of manufacturing, use and disposal phases. In the reusable case, particular attention was paid to the laundering process and its associated impacts.

The study was conducted for the Australian Industry Group and the Textile Rental and Laundry Association. It was intended to help guide the industry toward process aspects that can be enhanced to further reduce environmental impacts. Areas considered to be of particular importance were water consumption throughout both processes - and greenhouse gas emissions. Other impact categories were also to be investigated to provide a broad overview of environmental impacts.

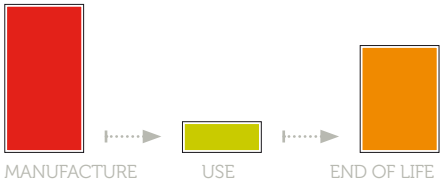
For more information, contact: andrew.carre@rmit.edu.au

ECO-BUY SUSTAINABLE PROCUREMENT STUDY

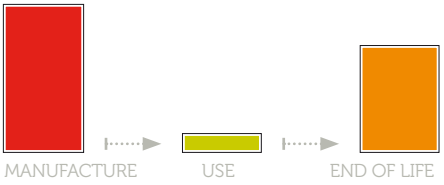
LIFE CYCLE OF LARGE ELECTRICAL APPLIANCES



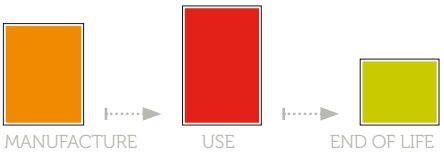
LIFE CYCLE OF PACKAGING



LIFE CYCLE IMPACTS OF FURNITURE



LIFE CYCLE IMPACTS OF SMALL ELECTRONIC APPLIANCES



ECO-Buy is a not for profit organisation with a mandate to encourage the purchase by both public and private organisations of environmentally preferable products and materials. In 2006, the State Government in Victoria accepted, in principle, a recommendation by the Commissioner for Environmental Sustainability that ECO-Buy be engaged to help departments and government develop greener procurement resources. This initiative included recommendations to develop life cycle assessment (LCA) and life cycle costing (LCC) tools to support departmental purchasing decisions. Consequently, the Victorian Government Sustainability Action Statement "Our Environment Our Future" and Election Policy Commitment "Tackling Climate Change – Helping Families Play Their Part" contain specific commitments to adopt purchasing strategies to minimise environmental impacts.

As part of this strategy, ECO-Buy engaged the Centre for Design to conduct an integrative research project investigating environmental LCS and economic LCC, with a view to developing a standard model by which green procurement options can be assessed simultaneously, using environment and economic criteria. The research project is developing an integrated approach to LCA and LCC to provide both environmental and financial decision making data for procurement. It addresses the methodological and data issues associated with the measurement of the environmental benefits of ECO-Buy purchases. This will lead ECO-Buy and members towards the capacity to accurately and transparently report the greenhouse and other environmental benefits of eco-purchasing.

While there is no standard methodological framework for LCC, there have been moves towards creating one. A general LCC method was first developed by Blanchard and was further refined by Blanchard and Fabrycky (Blanchard and Fabrycky, 1998). This has been further developed in a series of standards including ISO 15663 (International Standards Organisation (ISO), 2000-2001), IEC 60300-3-3 (International Electrotechnical Commission (IEC), 2004), and AS/NZS 4536 (Standards Australia and Standards New Zealand (AS/NZS), 1999). However, methods and standards do not provide a definitive methodology on how to perform a LCC study. Rather, they present LCC in terms of life cycle thinking (Hunkeler et al., 2008).

Building on this methodological work, Scott McAlister and Associate Professor Ralph Horne have developed purchasing data and decision making scenarios through the ECO-Buy Sustainable Procurement Study. These include comparative items commonly purchased by ECO-Buy members: different lighting systems; notebook and desktop computers; moleskin and cotton drill uniforms; office chairs; recycled and virgin office paper; toner cartridges, vehicle tyres and workstation panel. The results provide both a 'proof of concept' for the method and are readily useable by the project partner organisations when making procurement decisions by incorporating the combined cost and environmental information provided.

For more information, contact: ralph.horne@rmit.edu.au
Visit: www.ecobuy.org.au

SMART ALTERNATIVE WATER RESOURCE USE IN NEW NON-RESIDENTIAL DEVELOPMENTS

The Centre for Design was awarded this Smart Water Grant funded research project which aims to facilitate efficient, effective and optimal reticulated water consumption in new non-residential developments. Through the project, a team working with Andrew Carre is developing a decision support process for use by the development community, owners, and operators.

Achieving beneficial water use practices across a diverse range of industries requires application of broad principles as well as tools that accommodate the many ways water is used in an industrial setting – including treatment, recycling and reuse. This project involves research and development to address these needs and enable a wide range of water use alternatives to be adopted. Focusing on waste water re-use as a key strategy to achieving water savings, the research will cover not only enabling technologies that reduce and re-use water, but also drivers of behavioural change such as regulatory, social and business motivators.

Different case studies are directed towards each of the main target groups and development types. Examples are used to illustrate how calculations can be completed and criteria integrated.

For more information, contact: andrew.carre@rmit.edu.au

LIFE CYCLE ASSESSMENT FOR WANNON WATER

The Environmental Protection Authority (EPA) in Victoria has introduced guidelines for the management of biosolids (treated sewage sludges). These guidelines are, in turn, prompting research and development opportunities.

The Centre for Design is working on a Life Cycle Assessment (LCA) based research project with Wannon Water and the EPA to investigate potential environmental impacts of different licensing scenarios and augmentation options for a water reclamation plant.

The goal of the LCA was to model the current treatments and the 18 proposed licensing options by investigating energy use, raw material use, waste and any emissions to the air, soil and water. The functional unit used was the operation of the potable water supply and the construction and operation of the wastewater treatment options over a 25 year period.

Given the number of potential options, the ‘best’ option was dependent on which criteria was considered most important. Included in the outcomes are the major impacts across all scenarios and findings based on water extractions and greenhouse gas emissions, providing Wannon Water and other researchers with a useful guide for further research and future projects.

For more information, contact: andrew.carre@rmit.edu.au

ECOLOGICAL FOOTPRINTS

In creating a 'green' residential development, a leading property developer approached the Centre for Design to provide information on the ecological footprint of its house plans.

The study focussed on the construction and maintenance related aspects of the designs over their lifetime, with operational impacts being assessed by Greenmode. Outcomes indicated the relative footprint of different phases of the life cycle of each of the designs.

For more information, contact: andrew.carre@rmit.edu.au

ASSESSING THE ECOLOGICAL FOOTPRINT OF HOUSING DEVELOPMENTS

Creating a housing development that reduces environmental impacts can be a difficult proposition, especially if houses are to remain affordable. The Centre for Design has been conducting ecological footprint-based research and assessment of low impact housing designs and forms.

In South Australia, the Land Management Corporation commissioned research leading to the development of a new eco-footprint calculator, allowing users to carry out simulations of different housing forms and designs..

Led by Associate Professor Horne and Dr John Morrissey, this project connects to other work on the topic undertaken at the Centre. For example, see the Lifetime Affordable Housing page in this review.

For more information, contact: ralph.horne@rmit.edu.au

GLOBAL FOOTPRINT NETWORK PARTNERSHIP

An ecological footprint is a measure of the demand that the human population has on the Earth's ecosystems. It compares human demand with the planet's ecological capacity to regenerate.

The footprint value will represent the amount of productive land and sea area that is needed to regenerate those resources that a human population will consume, and to absorb and render harmless the waste that is generated.

Global Footprint Network engages in projects that serve to advance its mission of harmonising applications and bringing the concept of its Ecological Footprint into new areas to affect change. Through these projects the Network also provides training to practitioners and develops new tools that benefit the entire sustainability community.

The Centre for Design is a participating partner of Global Footprint Network with the intention of developing a future series of smaller projects. The Centre's contribution as a research partner lies in strengthening the Ecological Footprint tool, enhancing the National Footprint Accounts Program, coordinating research among partners, standardising methodologies and extending the Ecological Footprint into new domains. These activities align with the Ecological Footprint community and strengthen the credibility and visibility of the tool.

For more information, contact: andrew.carre@rmit.edu.au
Visit www.footprintnetwork.org

SHOPPING BAGS: ENVIRONMENTAL FOOTPRINTS

In conjunction with the Sustainable Packaging Alliance, the Centre for Design completed a research project focusing on use and environmental implications of shopping bags for the Woolworths organisation. A life cycle approach was used and considered the environmental impacts of a shopping bag from 'cradle to grave,' rather than at a single point in the supply chain.

A streamlined assessment was undertaken for different shopping bags. The seven shopping bags analysed were:

- High density polyethylene (HDPE) plastic with 100 per cent virgin material
- HDPE plastic with recycled material
- Compostable bag
- Oxo-degradable bag
- Paper bag
- Reusable polyethylene terephthalate (PET) bag with recycled material and
- Reusable polypropylene (PP) bags.

Factors such as composition, trip rate and bag volume were explored. The outcomes provide an impact comparison of each bag across a selection of environmental indicators and sensitivity analysis to variables that are important for achieving the environmental benefits for a particular bag. The study also reviewed end-of-life scenarios and related issues for each bag type.

The life cycle assessment (LCA) modelling used the SimaPro® software based on the unit defined as the amount of shopping bags consumed by a household to carry 70 separate grocery items home from the supermarket each week for 52 weeks.

The system boundaries were the growing and processing of the corn-starch material, manufacturing and thermoforming of the polymer, material extraction and production of HDPE, growth of tree and paper processing, manufacturing process, manufacture of bags from those raw materials, transport, use and waste management of the product. The production of PET and PP fibres was also included.

The post-consumer waste management scenarios considered landfill, recycling and commercial composting for the applicable materials and the reuse of bags as bin liners (only applicable for single use polymer bags).

The disposal and recovery options for the different bags vary and are dependent upon at least three factors:

- the design of the bag, including the primary material used and its durability
- the available infrastructure for collection and recovery of this type of bag and
- the behaviour of individual consumers.

Key findings from the study were:

1. The reusable bags (PET and PP) generally have lower environmental impacts than all of the single use bags
2. The benefits of a reusable bag are highly sensitive to the number of occasions each bag is used during its life
3. The single-use paper bag has the highest environmental impact as a result of pulp and paper production and the weight of material required per bag
4. Global warming impacts are driven by material resource consumption and energy use across the life cycle
5. The water use impacts are driven by water consumption in material consumption
6. Raw materials sourced from land-based operations have higher impacts for eutrophication (the release of nutrients into waterways) and land use (the occupation of land to grow crops and timber)
7. Paper bags have the lowest impact on litter. HDPE bags and paper bags make up a small percentage of littered items but HDPE bags tend to have a higher impact as they are more visible and take longer to break down
8. All bags have the potential to be recovered after they are used. How this happens depends on the material the bag is made of, the infrastructure available for collection and reprocessing and the willingness of consumers to dispose of the bag through an available recovery system

In summary it was found that single-use paper bags have the highest environmental impact of all the options, but reusable bags need to be used as many times as possible to gain the full benefit available.

For more information, contact: andrew.carre@rmit.edu.au

QUANTIFYING THE BENEFITS OF RECYCLED CONCRETE AGGREGATES

Does the recycling of concrete aggregates in building products reduce environmental impact?

The Centre for Design sought the answer by completing a detailed inventory of the concrete recycling process and carrying out an assessment of associated benefits, such as solid waste avoidance and metals recovery.

We found that generally the impacts associated with crushed concrete aggregate were driven by transport to and from the plant, machinery use within the plant and electricity use. These impacts were more than offset by the benefits associated with steel recovery and landfill avoidance.

With respect to quarried stone, impacts were driven by transport from the plant to the building site, machinery use within the plant and electricity use.

Sensitivity analysis was conducted to test the impacts of key study parameters. This analysis showed no change in study conclusions under the parameters considered, but did show that transport distances play a significant role in determining total environmental impacts.

For more information, contact: andrew.carre@rmit.edu.au

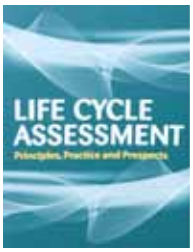
RETURNABLE VERSUS DISPOSABLE PACKAGING

The decision to adopt a returnable packaging system rather than a disposable one can be difficult from a sustainability perspective. To help a leading food product manufacturer make this decision objectively, the Centre for Design undertook a Life Cycle Assessment (LCA) of the systems proposed.

Two packaging systems were considered – a single-use corrugated cardboard box (lined with a plastic film) and a reusable injection moulded plastic crate with a plastic liner.

The LCA of both packaging systems aimed to identify a range of potential environmental outcomes associated with each system and was intended to better understand the environmental pros and cons of each by comparing the environmental performance of each system.

NEW BOOK ON LIFE CYCLE ASSESSMENT



The role of environmental data in design is constantly evolving. Intuition is not a sufficient basis for design decision making, and 'natural' is not necessarily environmentally benign.

Life Cycle Assessment (LCA) has now been offering a view of 'the world behind the product' for several decades. However, results have not always been accepted uncritically - often, with good reason. As the applications for LCA gather pace – and interest in carbon accounts and system/ company environmental impacts rightfully receives rapidly increased attention, it is an opportune time to examine its limits and possibilities.

A new book, from Centre for Design staff Associate Professor Ralph Horne, Dr Karli Verghese and Adjunct Professor Tim Grant, provides scholars and professionals across a range of disciplines a critical perspective on the practice of LCA and its possible future directions.

It is not intended as a guide or handbook, of which there are several already. Instead, theory, methodologies and applications of LCA are critically examined. Key developments, challenges and opportunities are illustrated with case studies. Across 12 chapters, the authors critique LCA practice and a range of connected issues, provide case studies of LCA practice across infrastructure, the built environment, agriculture, waste, packaging and products, describe the rise of so-called 'quick LCA' and Life Cycle Management (LCM) tools, and develop a prospective discussion of future trends in LCA to 2020.

Horne, R., Grant, T., Verghese, K., (2009) Life cycle assessment: Principles, practice and prospects, CSIRO Publishing, Collingwood.

LIFE CYCLE INVENTORY OF FOREST AND WOOD PRODUCTS IN AUSTRALIA

Commissioned by the timber industry (Forest and Wood Products Australia) to undertake a detailed Life Cycle Inventory (LCI) of forest and wood products, the Centre for Design partnered with a consortium, led by CSIRO Sustainable Ecosystems.

This LCI project is intended to establish a credible, quantitative basis for the assessment of the environmental impacts of timber products. The resulting LCI database will cover five categories of forest and wood products:

- softwood plantation and hardwood native forests;
- softwood framing and hardwood timbers;
- veneer, plywood and LVL (laminated veneer lumber)
- particleboard and MDF (medium density fibreboard)
- glulam (glue-laminated solid timber) and engineered I-beams.

The Centre for Design is undertaking the LCI for the particleboard and MDF products.

For more information, contact: andrew.carre@rmit.edu.au

GREENFLY DESIGN DECISION SUPPORT TOOL

An online design decision support tool enables product designers to obtain information about the life cycle environmental performance of their products quickly. Greenfly calculates in real-time. The user instantly sees the potential environmental impacts of their design and can quickly trial options to maximise environmental benefit.

The Centre for Design, WSP Environmental and the Design Institute of Australia have used a Victorian Sustainability Fund grant to develop Greenfly, an online design decision support tool which enables product designers to quickly obtain information about the life cycle environmental performance of their products during the initial concept design phase. Immediate and accessible impact quantification of impacts/emissions such as total greenhouse gas emissions, are available based on life cycle assessment (LCA) data and information regarding EoL (End of Life) options, such as reuse, recycling and disposal.

Importantly, the brief stipulated Greenfly was to be an easy to use, yet powerful, online tool. It had to enable the integration of environmental considerations into product design, using life cycle assessment data and eco design strategies.

The project team - Associate Professor Ralph Horne, John Gertsakis, John Cameron, Andrew Sweatman, Leyla Acaroglu and other international and Australian researchers - focussed on both algorithm development and interface development.

The result is a unique sustainable design tool that embodies research and knowledge from experts within the field of sustainable design in an online format with a beautifully crafted interface.

Light and fast to use, Greenfly thrives in the initial phase of product development where impact analysis will provide the most environmental benefit.

Greenfly guides the user quickly and simply through product life cycle stages and provides environmental assessment onscreen in real-time. Greenfly also provides the user with practical and assessable guides and tips on sustainable design. Greenfly employs the latest web technology allowing for the easy integration of extra features such as regulatory compliance in future versions.

In July 2008 Greenfly was made available online as a free trial of the alpha version. The trial was announced at the launch, and at several design events and conferences, although Greenfly appears to have spread “virally” with 875 people signing up across Australasia, North America and Europe for the trial. Following this successful trial of the beta version, bug fixes and further developments are in train in 2009, with more functionality and a full rollout in train. The intention is to bring Greenfly to a wider audience including the design and research communities, environmental managers and decision makers across government, commercial and non-governmental organisations.

For more information, contact: ralph.horne@rmit.edu.au
Visit: www.greenflyonline.org

CERES WASTE WISE SCHOOLS PROGRAM

CERES Environment Park in Melbourne has engaged the Centre for Design to participate in the three-year Resource Smart Schools Waste Program which engages 159 schools across Victoria in efficient resource management and use programs (2008-10). Centre for Design is providing an advisory role as well as conducting new research and developing content.

The focus of the waste wise school program is: waste reduction, effective resource management, sustainable consumption and individual actions to achieving a more sustainable future.

Resources developed to date include an evaluation of the recycling of school equipment and life cycle processes posters for computers, plastic bags and paper.

For more information, visit: www.sustainability.ceres.org.au/files/sei_itn_wastewise.htm
For more information, contact: ralph.horne@rmit.edu.au

ECO-DESIGN TRAINING, DEVELOPMENT AND RESOURCES

To assist practitioners in gaining eco-design skills, competencies and knowledge, the Centre for Design has organised and facilitated a range of initiatives. Some examples are included below.

National Eco-Design Curriculum

A curriculum resource kit for tertiary teachers and students in industrial design, the National Eco-Design Curriculum, was developed by Centre for Design with a grant from the Australian Government.

In order to provide for an improved understanding of Design for Environment (DfE) principles, strategies and resources we engaged with training providers and produced courseware.

Eleven sessions have been developed that can each be presented during a standard three hour studio. The curriculum has been piloted in industrial design programs at RMIT University (Victoria), University of South Australia and the University of Technology (Sydney) before production of the resource kit for wider use.

Tertiary institutions have been using the completed materials in teaching and project-based courses.

HeadStart – Design for Sustainability Masterclass

HeadStart was first run in 2005, as a masterclass for industrial designers to develop their skills in designing for sustainability.

Sustainability Victoria has engaged the Centre for Design to further develop the program in the form of inhouse professional development and training workshops for industrial design firms.

Masterclasses are run periodically every few months - for further details check the Centre for Design website.

Eco-design seminars and workshops

In July, international guest Professor Allan Chochinov (Core 77 and Pratt Institute of Art and Design, USA) and Centre for Design Director Ralph Horne presented an eco-design seminar in Melbourne Chaired by John Gertsakis (WSP Group), a Q&A panel shared ideas on eco-design, life cycle assessment, product innovation and design for the future, including active demonstrations from Andrew Carre and his shaving device!

In conjunction with Design Victoria the Centre for Design has also been running eco-design seminars and workshops for designers and SMEs in Victoria. Eight events were held in 2008, with more planned for 2009-10.

EcoDesign Guide for Graphic Designers

The EcoDesign Guide for graphic designers and desktop publishers gives information on how to reduce the environmental impacts of printed products. The Centre for Design was commissioned by the Victorian Government to produce the guide and materials, available for download from the Centre for Design website.

The guide provides easy-to-follow design considerations, based on each design stage. It is intended for use by designers and those commissioning design work associated with the wide range of government publications.

Online EcoDesign 'How to' kit for Design Victoria

An online EcoDesign resource for a range of designers has been developed by the Centre for Design. The website provides guidelines and information on some initial environmental issues and considerations for designers in the industrial, product, graphic, fashion and textile design industries. The 'how to' kit includes downloadable desktop quick guides so that EcoDesign strategies can be integrated throughout the design process. Access the resource at: www.designvic.com/knowledge/publications/whatisecodesign.aspx.

For more information, contact: andrew.carre@rmit.edu.au

EXTENDED ENVIRONMENTAL BENEFITS OF RECYCLING

Is recycling worth the trouble? Does the whole process actually deliver landfill space savings, or reduce greenhouse gas emissions?

A competitive tender process saw the Centre for Design engaged by the NSW Department of Environment & Climate Change (DECC) to find out.

In Australia there is strong public support for recycling which has been encouraged by governments and industry alike. This support has been based on the assertion that 'recycling is good' because it has a positive impact on the environment through the saving of resources and a reduction in the impacts resulting from landfill of this waste.

The belief that 'recycling is good' is founded upon the more obvious benefits of avoiding landfill processes and the notion that material is reused and therefore does not need to be extracted from the environment. These benefits are indeed present for many recycling processes, however recycling itself, almost always has an environmental impact of its own. This recycling impact is typically associated with collection methods, such as aluminium smelters or paper reprocessors. Once these impacts are considered, the statement 'recycling is good' becomes more difficult to validate.

In order for recycling to be environmentally advantageous, benefits such as avoided landfill and material recover need to offset recycling related impacts such as material collection and reprocessing. Only by objectively assessing the impacts associated with the various components of a recycling process and its alernative landfill process (landfill is the predominant waste disposal process in Australia) can it be concluded that a recycling process is environmentally beneficial.

Rather than accepting the assertion 'recycling is good', this study undertakes the assessment necessary to determine if recycling is environmentally preferable across a range of material types.

Materials considered

Metals 1a Aluminium cans 1b Aluminium (other than cans) 2 Copper 3a Packaging steel (steel cans) 3b Steel	**Organics** 12 Timber pallets/packaging 13 Mixed food & garden organics 14 Garden organics
Concrete, brick and asphalt 4 Asphalt 5 Brick (modelled as "Brick & Tile") 6 Concrete 7 Plasterboard	**Glass** 15 Glass containers 16 Sheet/laminated glass
Paper and cardboard 8 Cardboard/paper packaging 9 Newsprint/magazines 10 Liquid paper board 11 Office Paper	**Plastics** 17 PET #1 18 HDPE #2 19 PVC #3 20 Mixed plastics #7 21 Rubber Tyres

Results

In general, metals recycling provided the highest benefits per tonne, and concrete, brick and asphalt provided the lowest benefits per tonne. Although benefits for dense wastes such as brick and asphalt were low, these waste materials were generated in large quantities, making the statewide potential savings for these materials significant. For example, over 1.7 million tonnes of waste concrete was recycled in 2006/7 which is nearly 155 times the amount of aluminium over the same period.
Outcomes for composting and recycling of organic wastes, in general, provided positive outcomes across most indicators. From a greenhouse gases perspective, these outcomes were found to vary depending on assumptions made with respect to the degradation of waste of landfill and the storage of carbon in landfill.

For more information, contact: andrew.carre@rmit.edu.au

PACKAGING IMPACT QUICK EVALUATION TOOL (PIQET)

Packaging has long been identified as an iconic example of 'over-consumption' and waste in modern society. However, it is also necessary and provides essential protection and containment, in particular to food and beverages.

Although it is time consuming, Life Cycle Assessment (LCA) can be applied in order to compare different packaging options. Often this is only conducted when two packaging formats have been chosen and detailed.

A world-first project was developed by the Centre for Design back in 2004. It enabled decision-making – informed by quantified, modelled LCA data regarding likely environmental impacts of systems – at packaging design concept stage.

Through a partnership with the Sustainable Packaging Alliance, a not-for-profit organisation, Dr Karli Verghese, Associate Professor Ralph Horne and a team at Centre for Design developed the Packaging Impact Quick Evaluation Tool (PIQET). PIQET provides packaging designers, environmental managers and others who produce or use packaging with a quick and credible life cycle environmental assessment tool. Such a tool will assist them in making decisions on packaging development and innovation strategies.

PIQET is web-based and provides quantified environmental impacts of packaging systems throughout the packaging life-cycle. It includes both environmental indicators (e.g. greenhouse gas emissions) as well as packaging specific indicators (e.g. product to packaging ratio and recyclability).

PIQET has been financially supported by Australian Government competitive grants, as well as by Cadbury Schweppes, Lion Nathan, Masterfoods Australia New Zealand, Nestle Australia, Simplot Australia and Sustainability Victoria.

Organisations can subscribe to use PIQET. Enquiries can be directed to: enquiries@sustainablepack.org.

The first version of PIQET was designed for Australian industries, and an upgrade incorporating global datasets and functionality is underway this year. The underlying life cycle inventory databases of materials, converting processes, transport, and waste management embedded into PIQET are regularly updated.

PIQET also incorporates technical support and is supplemented with regular Sustainable Packaging Design workshops with the Sustainable Packaging Alliance.

For more information, contact: andrew.carre@rmit.edu.au

SUSTAINABLE PACKAGING ALLIANCE ROUND TABLES

Apart from licensing and operating PIQET, the Sustainable Packaging Alliance (SPA) undertakes a range of activities to engage and assist packaging stakeholders to improve the environmental performance of their packaging systems. Included among SPA services are regular round table discussions. For example, over 80 people attended the 15th SPA Roundtable, organised in association with the Plastics and Chemicals Industries Association (PACIA). The purpose of the roundtable was to explore the sustainability of degradable plastics used for packaging. It approached the topic from three perspectives:

- Sustainability and life cycle thinking;
- Product stewardship; and
- Infrastructure for end-of-life management

In fostering discussions among policy makers and packaging industry stakeholders, like previous SPA round tables, this event contributed to shaping the future direction of the packaging industry as it responds to sustainability challenges.

For more information, visit: www.sustainablepack.org

DESIGN AND SUSTAINABLE PACKAGING

Areli Avendano, PhD Scholar

Areli Avendano is an international PhD scholar at Centre for Design sponsored by the Mexican Government. She is investigating the role of design in sustainable packaging. The principle aim of her research is to contribute to the sustainability discourse to assist in delivering appropriate recommendations to industry towards sustainable packaging systems.

Recent work has allowed professionals from leading food packaging companies and design experts to enable an understanding of the specific roles and responsibilities of particular personnel involved in the procurement and design of packaging systems in the food and beverage sector. This enables the identification of the different issues faced by the packaging industry when considering sustainability in the product development process.

For more information, contact: areli.avendano@rmit.edu.au

2008 AIP CONFERENCE 'CLIMATE OF CHANGE'

In June 2008 the Australian Institute of Packaging National Conference, "Climate of Change" Towards a sustainable packaging industry saw more than 280 delegates and 46 speakers from the industry descend upon Sydney's Luna Park, a testimony to the successful packaging of fairground experiences.

Conference issues included climate change; life cycle assessment; the online design evaluation tool, PIQET; updates on the National Packaging Covenant; returnable packaging; waste and recycling and biopolymers. Three members of Centre for Design team presented at the conference:

- Dr Karli Verghese: the Sustainable Packaging Alliance definition of sustainable packaging
- Dr Juin Majumdar: the Packaging Impact Quick Evaluation Tool (PIQET) and
- Areli Avendano spoke about the role designe rs have in selecting sustainable packaging options and outcomes.

For more information, visit: www.aipack.com.au

NATIONAL PACKAGING COVENANT (NPC) REVIEW PROJECT

A random statistically valid sample of signatories ranging from brand owners to industry groups and raw material suppliers was analysed when the Centre for Design participated in a comprehensive industry review process commissioned by the National Packaging Covenant (NPC). The NPC is charged with managing the environmental impacts of consumer packaging in Australia.

The Centre for Design was engaged to independently review the progress of NPC signatories against its environmental goals, targets, key performance indicators and the Environmental Code of Practice for Packaging (ECoPP).

For more information, contact: karli.verghese@rmit.edu.au
Visit: www.packagingcovenant.org.au

Appendix one

Examples of our research partners, 2008-9

- Alex Fraser Group, Australia
- Aluminium Can Group
- Amcor
- Archicentre
- Association of Independent Schools of Victoria
- Australian Dental Association
- Bawinanga Aboriginal Corporation
- Building Commission, Victoria
- Cadbury Schweppes Pty Ltd
- Centre for Appropriate Technology
- Centre for Education & Research Environmental Strategies (CERES)
- City of Playford
- Coca-Cola Amatil Pty Ltd
- Coca-Cola South Pacific Pty Ltd
- Community Power
- Consumer Affairs Victoria
- CRC Construction Innovation (Research)
- CSIRO, Australia
- Department of Environment and Climate Change, NSW
- Department of Housing and Works, Western Australia
- Department of Local Government, Housing and Sport, Territory Housing, Northern Territory
- Department of Planning & Community Development,Victoria
- Department of Sustainability and Environment, Victoria
- Department of the Environment, Water, Heritage and the Arts, Commonwealth Government of Australia
- Dulux Australia
- ECO-BUY Pty
- EPA Victoria
- Forest & Wood Products Australia
- Godfrey Hirst Australia
- Inghams Enterprises
- International Council of Local Environmental Initiatives
- Indigenous Business Australia
- Inghams
- JTP Australia
- Land Management Corporation, South Australia
- Lion Nathan
- Local Governments for Sustainability - ICLEI
- MacDonald Johnston
- Manningham City Council, Victoria
- Maribyrnong City Council, Victoria
- Mars Snackfood Australia
- Melton Shire Council, Victoria
- Moreland Energy Foundation Limited
- Municipal Association of Victoria
- Murdoch University
- Museum Victoria
- Nestec
- Nestle Australia Ltd
- Northern Alliance for Greenhouse Action
- Pacific Brands Limited
- Plantic Technologies
- Provisor
- Queensland University of Technology
- Simplot Australia Pty Ltd
- Sustainability Fund, Victoria
- Sustainability Victoria
- Sustainable Packaging Alliance
- Target Australia
- Telstra
- Territory Housing, Northern Territory
- The Australian Industry Group
- The Clean Energy Council
- The Gaia Partnership
- The National Packaging Covenant Industry Association, Australia
- University of Melbourne
- University of South Australia
- University of Tasmania
- University of South Australia
- VicUrban
- Vietnam Green Building Council
- WSP Environmental Pty Ltd

Appendix two

Examples of our supplementary activities, 2008-9

Centre for Design Directors Ralph Horne, Usha Iyer-Raniga, Alan Pears, Andrew Carre and Karli Verghese have between them delivered invited international addresses in the UK, India, Singapore, Japan, Vietnam and South Korea in 2008-9. They have also served on international advisory committees in peer review roles for journals and conferences, and acted as judges for competitions involving packaging, product design and sustainable buildings. In September Ralph Horne was appointed to the 23-member Built Environment Industry Innovation Council (2008-11), making RMIT one of only three universities represented on this initiative of the Australian Commonwealth Government to champion innovation in the industry. In May 2009 Alan Pears was awarded the Order of Australia in recognition of his role in driving energy efficiency policies and practices in Australia.

Centre for Design directors and researchers are often called upon as the leading experts in their field. The following are some of the media where RMIT has been called upon for comment:

30 May 2008, ABC 774 Melbourne Red Symons Breakfast, Sustainable Cities

11 July 2008, Science Alert, Alan Pears, Thoughts on a broader national sustainability agenda

14 July 2008, Herald Sun, Alan Pears, Big Australia power generates won't give up

30 July 2008, Myrtleford Times, Alan Pears, Television Labels

11 August 2008, Cranbourne Journal, Alan Pears, Add more bite to energy rules

29 August 2008, Australian Financial Review, Alan Pears, BCA accused of double standards

36 September 2008, The Okala Guide, Centre for Design at RMIT, Learning Green Design

20 October 2008, Inside retailing, Leyla Acaroglu, POPAI Australian and NZ conference

30 October 2008, Australian Financial Review, RMIT Centre for Design, Building materials

8 November 2008, The Age, RMIT Centre for Design, Your Home Renovator's Guide

1 December 2009, Packaging, Dr Karli Verghese, Sustainable packaging

2 March 2009, Australian Associated Press General News, RMIT Centre for Design, Sustainable packaging

2 March 2009, AAP Bulletins, RMIT Centre for Design, Sustainable packaging

3 March 2009, The Age, RMIT Centre for Design, Sustainable packaging

21 April 2009, Progress Leader, Ralph Horne, Sustainable packaging

1 May 2009, The Age, Ralph Horne, New homes forced to go six stars

1 May 2009, The Age, Ralph Horne, Six-star energy rules for homes

9 June 2009, World Entertainment News, Adj Prof Alan Pears, Energy pioneer honoured by Queen

9 June 2009, Connected Australia, Adj Prof Alan Pears, Energy label innovator honoured

9 June 2009, Sustainable Melbourne, Assoc Prof Ralph Horne, Sustainable cities roundtable- the energy to change

14 June 2009, Science Blog, Alan Pears, Energy efficiency guru receives honour

18 June 2009, Sydney Morning Herald, Alan pears, Saving Energy

19 June 2009, Plasmas to get on energy rating

19 July 2009, G Magazine, Centre for Design, Plastic versus re-usable plastic bags

24 June 2009, Radio National (Canberra), interview; Ralph Horne, Co-authored book Life Cycle Assessment

24 June 2009, Radio National syndicated nationally, interview; Ralph Horne, Co-authored book Life Cycle Assessment

Associate Director Alan Pears

Appendix three

Examples of publications 2007-9

Books and book chapters

Carre, A S and Horne, R E (2009) Will the well run dry? Developments in water resource planning and impact assessment. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 8, pp 93-108 CSIRO Publishing, Melbourne, Australia

Ciroth, C, Gensch, C, Gunther, E, Hoppe, H, Hunkler, D, Huppes, G, Lichtenvort, K, Ludvig, K, Notarnicola, B, Pelzeter, A, Prox, M, Rebitzer, G, Rudenauer, I and Verghese, K (2008) Life cycle costing case studies. In *Environmental Life Cycle Costing*. Hunkler, D, Lichtenvort, K and Rebitzer, R (ed), the Society of Environmental Toxicology and Chemistry (SETAC) and CRC Press, Pensacola, Florida

Ciroth, A, Verghese, K, Trescher, C (2008) A survey of current life cycle costing studies, In *Environmental Life Cycle Costing*. Hunkler, D, Lichtenvort, K and Rebitzer, R (editors), the Society of Environmental Toxicology and Chemistry (SETAC) and CRC Press, Pensacola, Florida

Dalton, T, Horne, R E, Hafkamp, W. and Lee, M (2007) Retrofitting the Australian suburbs for sustainability. In: A Nelson (ed.) *Steering Sustainability in an Urbanising World; policy practice and performance*. Chapter 17, pp 215-225 Ashgate, London

Grant, T (2009) Life cycle assessment in practice. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 3, pp 23-32 CSIRO Publishing, Melbourne, Australia

Grant, T (2009) The Australian environment: Impact assessment in a sunburnt country. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 5, pp 43-50 CSIRO Publishing, Melbourne, Australia

Grant, T and MacDonald, F (2009) Life cycle assessment as decision support: A systemic critique. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 4, pp 33-42 CSIRO Publishing, Melbourne, Australia

Horne, R, Grant, T, Verghese, K, (2009) *Life cycle assessment: Principles, practice and prospects*, CSIRO Publishing, Collingwood

Horne, R E (2009) Life cycle assessment: Origins, principles and context. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 1, pp1-8 CSIRO Publishing, Melbourne, Australia

Horne, R E (2009) Life cycle assessment: Applications in the built environment. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 7, pp75-92 CSIRO Publishing, Melbourne, Australia

Horne, R E and Grant, T (2009) LCA and agriculture: Challenges and prospects. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 9, pp 107-124 CSIRO Publishing, Melbourne, Australia

McAlister, S and Horne, R E (2009) Climate change responses: Carbon offsets, biofuels and the life cycle assessment contribution. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 10, pp 125-140 CSIRO Publishing, Melbourne, Australia

Horne R E and Verghese K L (2009) Accelerating life cycle assessment uptake: Life cycle management and 'quick' LCA tools. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 11, pp 141-160. CSIRO Publishing, Melbourne, Australia

Horne, R E, Grant, T and Verghese K L (2009) Prospects for life cycle assessment development and practice in the quest for sustainable consumption. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 12, pp 161-172 CSIRO Publishing, Melbourne, Australia

Iyer-Raniga, U and Wasiluk, K. (2008). 'Sustainability and the built environment', *Australian Master OHS & Environment Guide*, 3rd Edition. CCH Publications, Sydney

'Sustainability and the built environment', *Australian Master OHS & Environment Guide*, 2nd Edition. CCH Publications, Sydney

Iyer-Raniga, U and Wasiluk, K (2007). 'Sustainability Rating Tools, A snapshot study'. *BDP Environment Design Guide*, DES 70

Lewis, H (2008) Eco-design of food packaging materials, in *Environmentally-compatible food packaging*, editor Emo Chiellini, Woodhead Publishing, UK

Pears, A (2007). 'Stationary Energy: A Critical Element of Sustainable Urban Metabolism' in *Steering Sustainability in an Urbanizing World: Policy, Practice, Performance*. Ashgate Publishing, England, 69 - 81, ISBN: 978-0-7546-7146-6

Verghese, K L, Grant, T and Horne, R E (2009) The development of life cycle assessment methods and applications. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 2, pp 9-20 CSIRO Publishing, Melbourne, Australia

Verghese, K, (2009) Life cycle assessment and waste management. In: Horne, R E, et al *Life Cycle Assessment: Principles, Practice and Prospects*. Chapter 6, pp 51-74 CSIRO Publishing, Melbourne, Australia

Verghese, K (2008) Environmental assessment of food packaging and advanced methods to choose the correct material, in *Environmentally-compatible food packaging*, editor Emo Chiellini, Woodhead Publishing, UK

Wasiluk, K and Horne, R E (2009) The business case for sustainable commercial buildings. In: Newton, P W, Hampson, K D and Drogemuller, R M. *Technology, design, and process innovation in the built environment* Chapter 27, pp 493-513 SPON Press, Taylor and Francis, London and New York

Examples of journal articles and peer reviewed conference papers

Horne, R E (2009) Limits to labels: The role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. *International Journal of Consumer Studies*, 33, 175–182

Horne, R E, Wasiluk, K and Gertsakis, J (2007) Rapid life cycle assessment design tools and their role in DfE transitions in Australia. Proceedings, 5th International Conference on "Design and Manufacture for Sustainable Development" Loughborough, UK, 10-11 July 2007

Horne, R E, Bates and Fien, J (2008) Carbon Neutral Households: Making the transition through learning from experiences in community health. Solar Cities Congress, Adelaide, February

Horne, R E and Hayles, C (2008). Towards global benchmarking for sustainable homes: An international comparison of the energy performance of housing. *Journal of Housing and the Built Environment*, 23, pp119-130

Hurley, J, Horne R E and Grant, T (2007) Ecological Footprinting as a decision making tool in urban development. State of Australian Cities Conference, November, Adelaide

Hurley, J and Horne, R E (2008) Ecologically Sustainable Suburbs? Development of a framework to inform planning, design, delivery and evaluation. Proceedings, Sustainable Buildings '08

Iyer-Raniga, U, Stanley, H and Wasiluk, K (2007). 'Liveable Homes: A vehicle for facilitating the uptake of sustainability measures in new homes'. XXXV IAHS World Congress on Housing Science, Melbourne, 4-7 September, 2007

Iyer-Raniga, U, Rosenberg, K and Moore, T (2008) Excelling the uptake of LEED India: Integrating lessons learnt from the Development of Green Star, Sustainable Buildings Conference SB08, Melbourne, 21-25 September 2008

Iyer-Raniga, U and Moore, T (2008). Reducing the Environmental Footprint: Case study of the Mornington Peninsula Shire. Poster presented at the Sustainable Buildings Conference SB08, Melbourne, 21-25 September 2008

Iyer-Raniga, U, Rouwette, R, Carre, A and Grant T (2008) A framework for understanding the environmental impact for buildings in Australia, Sustainable Buildings Conference SB08, Melbourne, 21-25 September 2008

Lane R, Horne R E and Bicknell, J (2008) Routes of reuse of second hand goods in Melbourne households. *Australian Geographer*, 40, 2, pp 151-168

Majumdar, J, Verghese, K, and Fitzpatrick, L (2008) PIQET: A Life Cycle Management Tool for Sustainable Plastics Packaging. Peer reviewed paper presented at the 2008 Global Plastics Environmental Conference (GPEC), Society of Plastics Engineers, Plastic Environmental Division, 11-12 March, Orlando, Florida

Moloney, S, Maller, C, Horne, R (2008) "Housing and Sustainability: Bridging the Gap Between Technical Solutions and Householder Behaviour", Australasian Housing Researchers Conference, 18-20 June, RMIT University

Moloney, S, Horne, R E and Fien, J (2009) Transitioning to Low Carbon Communities – From Behaviour Change to Systemic Change: Lessons from Australia. *Energy Policy* doi:10.1016/j.enpol.2009.06.058

Pears, A (2007) 'Imagining Australia's energy services futures', *Futures*, 39, 253 - 271

Pears, A (2008) 'GHG emission reduction in buildings - how does emissions trading relate', *BEDP Environment Design Guide*, 80, 1 - 8

Pears, A (2008) 'GHG emission reduction in buildings - the need for further policy beyond emissions trading', *BEDP Environment Design Guide*, 81, 1 - 8

Verghese, K, Horne, R, and Carre, A (2008) PIQET: The design and development of an online 'quick' LCA tool for sustainable packaging design decision support, International Journal of Life Cycle Assessment (submitted October)

Verghese, K, Lewis, H and Burritt, Roger (2008) Sustainable Packaging and Sustainability Accounting: Exploring Links and Synergies Journal of the Asia Pacific Centre for Environmental Accountability, Vol 14, No. 3, September, School of Commerce, Division of Business, University of South Australia (ISSN 1442-1224)

Verghese, K, Jollands, M, and Allan, K (2008) The Litterability of Plastic Bags: Key Design Criteria, Peer reviewed paper presented at the 2008 Global Plastics Environmental Conference (GPEC), Society of Plastics Engineers, Plastic Environmental Division, 11-12 March, Orlando, Florida

Appendix three

Examples of reports and other publications

Acaroglu, L (2008) Greenfly promotion at Design Ex, Sydney, April

Acaroglu, L (2008) Greenfly promotion at State of Design, Melbourne, July

Acaroglu, L (2008) Greenfly presentation at POPAI Marketing Conference, Sydney, October

Acaroglu, L (2008) Greenfly presentation and sustainable design workshop at GreenTech, Sydney, November

Avendano, A (2008) The role of the designer in sustainable packaging presentation at Australian Institute of Packaging National Conference, Sydney, June

Avendano, A (2008) The role of the designer in sustainable packaging presentation at the Changing the Change conference, Torino, Italy

Bontinck, P-A and Verghese, K (2008) Analysis of plastic bags and alternatives for Target Australia

Carre, A (2008) Life cycle assessment comparing laundered surgical gowns with polypropylene based disposable gowns, Report prepared for the Australian Industry Group and the Textile Rental and Laundry Association (Victoria), November

Carre, A (2008) Comparative life cycle assessment of a returnable versus disposable crate system, report prepared for Ingham's Enterprises Pty Limited, September

Carre, A and Di-Mauro Hayes, G (2008) The assessment of a footprint of a Lend Lease residential development in Queensland for Greenmode, report prepared for Greenmode, September

Carre, A and Morrisey, J (2008) Development of an ecological footprint calculator for a residential housing development in South Australia, Excel tool for LMC

Carre, A and Rouwette, R (2008) Life cycle comparison of crushed concrete aggregate with traditionally quarried stone aggregate, report prepared for Alex Fraser Group, May

Carre, A, Jones, I, Horne, R and Iyer-Raniga, U (2008) GCI Built Environment Life Cycle Assessment and Design Support Tool for Climate Change Adaptation Projects, September

Centre for Design (2008) Print and Publication Environmental Design Guide, for the Department of Sustainability and Environment, September

Centre for Design (2008) HeadStart 2 - Design for Sustainability Masterclass - course material development for Sustainability Victoria

Collado Ruiz, D and Avendano, A (2008) Sustainable packaging and the design process presentation at Design 2008, Croatia

Dalton, T, Horne, R & Maller, C J (2008). The Practice of Going Green: Policy Drivers and Homeowners' Experiences of Improving Housing Environmental Performance in Victoria, Australia European Network for Housing Research 3rd Annual Conference 'Shrinking Cities, Sprawling Suburbs, Changing Countrysides', 6-9th July Dublin, Ireland

Di-Mauro Hayes, G and Verghese, K (2008) Numerous PIQET - Packaging Impact Quick Evaluation Tool - assessments for Brandowner companies and packaging manufacturers and suppliers

Di-Mauro Hayes, G, and Verghese, K, (2008) Life Cycle Assessment on Plantic Biodegradable plastic packaging systems compared with alternative polymers (updated 2008 streamlined report) for Plantic Technologies

DEWR (2007) Scoping Study to Investigate Measures for Improving The Environmental Sustainability of Building Materials

Horne, RE, Wasiluk, K and Lewis, H (2007) The roles of PELS for sound Life Cycle management of Product Environmental impacts. Sustainability Victoria

Horne, R E (2007) Towards carbon neutral communities: The role of carbon assessment in creating sustainable housing. Invited Plenary address, World Congress on Housing Science, 5-6 September, Melbourne

Horne, R E and Hayes, P (2007) Climate change and city futures. Urban 45 Summit: New Ideas for Australia's Cities, State Library of Victoria, Melbourne, August

Horne, R E, Dalton, T and Wakefield, R (2007) Greening housing in Australia: a question of institutional capacity. ENHR 2007 International Conference 'Sustainable Urban Areas', Rotterdam, Netherlands, June

Horne R E and Dalton, T (2009) Green jobs in remaking suburbia: a pilot study of innovation and skills in housing renovation and retrofitting. Australasian Housing Researchers Conference, Sydney, 5-7th August

Horne, R E, Dalton, T and Maller, C (2009) Remaking suburbia: Transition to low carbon, water-efficient households through home improvements? ESRC Workshop: Cities and Low Carbon Transitions, Manchester, UK, 8-9th May

Horne, R and Moore, T (2008) Hand over report to BRBA, report prepared for the Buy Recycled Business Alliance, March

Iyer-Raniga, U., and Carre, A. (2008) "Building Assemblies and Materials Scorecard - Final Report" for Sustainability Fund, Sustainability Victoria

Lane, R and Horne, R E (2007) From Junk to Greenhouse Savings. WasteQ 2007: Leadership in a Climate of Change, June 4-5, Gold Coast

Lewis, H., Fitzpatrick, L., Verghese, K., Sonneveld, K., Jordan, R (2007) Sustainable Packaging Redefined, Draft November, Sustainable Packaging Alliance

Lewis, H, Jordan, R, Buelow, S, Sonneveld, K, Verghese, K, Di-Mauro Hayes, G, Majumdar, J (2007) Packaging Review for Woolworths Private Label Products, Prepared for Woolworths Limited, Sustainable Packaging Alliance, Melbourne, November

Majumdar J, Verghese K, Carre A, Horne R E, Fitzpatrick L, Jordan R and Sonneveld K (2008) Packaging Impact Quick Evaluation Tool (PIQET): A tool for the packaging industry. Presentation at the Climate of Change - Towards a sustainable packaging industry. 2008 AIP National Conference, Australian Institute of Packaging, 12-13 June, Luna Park, Sydney

McAlister, S (2008) Life cycle assessment of Lead Acid Battery Recycling, Report prepared for EPA Victoria, Australian Refined Alloys and Zinifex, September

McAlister, S (2008) Greenhouse life cycle assessment Godfrey Hirst, report prepared for Godfrey Hirst, October

McAlister, S and Yamaguchi, D (2008) Life cycle assessment of Chlorine production, for Orica Australia Pty Ltd, April

McAlister, S (2008) Scoping study for ECO-Buy Quantification Project, report prepared for ECO-Buy, April

McAlister, S (2007) Life cycle assessment of Warrnambool Water Reclamation Plant Licensing Scenarios, for Wannon Water and EPA Victoria, September

McGee, C and Stanley, H (2008) Your Home Renovator's Guide User Testing, Findings and Recommendations for the Your Home Renovator's Guide Project Partners, Institute for Sustainable Futures and Centre for Design

Morrissey, J, Moore, T, Horne, R, Berry, M, Kellett, J, Meryick, B, Irvine, S (2009) How affordable is sustainable housing? Methods to assess the cost implications of higher energy efficiency for new Australian homes. Australasian Housing Researchers Conference, Sydney, 5-7th August

Rosenberg, K (2008) Sustainable Development Initiatives for Banbury Village, Report prepared for the City of Maribyrnong

Rosenberg, K (2008) Environmentally Sustainable Development on Crown Lands, Report prepared for the Department of Sustainability and Environment, July

Rosenberg, K, Morrissey, J and Iyer-Raniga, U (2008) Creeds Farm Neighbourhood Centre Thermal Performance Assessment, Report prepared for the Hornery Institute/Tandem Design Studio, Melbourne, August

Rouwette, R, McAlister, S and Grant, T (2008) Module E: Particleboard and MDF. LCI Forestry and Wood Products Project Report & for Forest and Wood Products Australia, FWPA Project Number PR07.1044, April

Rouwette, R and Carre, A (2008) Life cycle assessment for BP Service Station Outlets, for BP Australia

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