

CRC Construction Innovation

SINCE 2001 THE CRC CONSTRUCTION INNOVATION HAS PROVIDED THE FRAMEWORK FOR RESEARCH INTO BUILDING PRACTICE AND TECHNIQUES

The Cooperative Research Centre (CRC) for Construction Innovation is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors.

Established in 2001 and headquartered at Queensland University of Technology (QUT) as an unincorporated joint venture under the Australian Government's Cooperative Research Centre Programme, Construction Innovation is developing key technologies, tools and management systems to improve the effectiveness of the construction industry.

Underpinning it is the most significant commitment ever made to construction research in Australia – a seven year AUD\$14 million Commonwealth Government grant and AUD\$50 million in industry, research and other government funding. More than three hundred individuals are participating and an impressive alliance of nineteen leading partner organisations are involved in, and supporting the activities of, Construction Innovation.

By facilitating collaboration between researchers, industry and government, Construction Innovation supports research that creates the tools to support the design, construction and maintenance of buildings including residential housing, commercial premises and industrial facilities in addition to infrastructure.

The primary partners provide management advice and significant funding to support the centre's

work. Partners include construction firms, engineering practices, government agencies, universities and the Australian Building Codes Board (ABCB).

Construction Innovation is an unincorporated joint venture governed by a Board of ten nominees from the nineteen participants and an independent Chair from the building and construction industry.

Four committees provide direction to Construction Innovation's work, with a particular emphasis on good governance. These committees are the research

committee, the remuneration committee (to assess the remuneration levels for senior staff), the Board performance committee and finally the audit and compliance committee.

RESEARCH PROGRAMS

PROGRAM A — Business and industry development
To improve the long-term effectiveness, competitiveness and dynamics of a viable construction industry in the Australian and international contexts through:

- > Greater innovation in business processes
- > Strengthened human relations and ethical practice
- > More effective interactions between industry and its clients

PROGRAM B — Sustainable built assets
To drive healthy and sustainable constructed assets and optimise the environmental impact of built facilities through:

- > Sound conceptual basis for economic, social and environmental accounting of the built environment
- > Virtual building technology to examine design performance prior to documentation, construction and use
- > Assessing human health and productivity benefits of smart indoor environments

PROGRAM C — Delivery and management of built assets
To deliver project value for stakeholders for the whole-of-life, from business need, design and construction through to ownership, asset management and reuse through:

- > Improved communication and use of knowledge
- > Increased productivity and value
- > Effective delivery and management of whole-of-life assets



Commercialising Innovation Conference

**A RECENT CONFERENCE DEMONSTRATED HOW CRC
CONSTRUCTION INNOVATION RESEARCH IS BEING USED
BY INDUSTRY**

The task of translating research from the CRC Construction Innovation into practical tools for building professionals was the focus of a conference held over 12-14 March 2006 in Queensland. The conference Clients Driving Innovation: Moving Ideas into Practice was attended by builders, researchers and government representatives.

Over ninety speakers from eleven countries addressed the conference's key themes of sustainable construction, industry development, performance-based building, facility management, industry and technology diffusion, procurement and risk management, and construction health and safety. The many Australian speakers demonstrated how innovative professional builders are becoming.

Award-winning architect David Baggs from Natural Integrated Living discussed how innovation is making significant inroads. As an experienced sustainability consultant, David was well placed to discuss the significant impact life-cycle analysis tools such as Ecospecifier and LCADesign have had on the structures that professional builders are responsible for constructing.

Dr Peter Newton of the CSIRO is another specialist in building sustainability and his work focuses on making existing buildings 'green' after renovation. Dr Newton's paper was of interest to builders responsible for refurbishment of the existing building stock.

Significantly, of the 240 people who attend the conference 56% represented from industry and public sector construction interests, the latter from local, state and commonwealth authorities. A/Professor Graham Miller FAIB, an AIB Councillor, and AIB's General Manager, Troy Williams attended at the Conference. This reflects the renewed emphasis that AIB has placed on its relationship with the CRC Construction Innovation.

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The Hampson Interview

KEITH HAMPSON, CEO OF THE CRC FOR CONSTRUCTION INNOVATION, AND TROY WILLIAMS, GENERAL MANAGER OF THE AUSTRALIAN INSTITUTE OF BUILDING REVIEW THE ACHIEVEMENTS AND FUTURE OF THE CRC

TW: The funding arrangements for the CRC for Construction Innovation are currently under review, with a funding renewal bid due in 2006. What factors are likely to influence the Government's decision to renew Construction Innovation funding and how confident is Construction Innovation's Board of success?

KH: CRC funding is a highly competitive process. Typically, the Federal Government receives 100 expressions of interest and only 15 are successful. We have put together a very strong renewal bid. Through consultation with industry we have identified the key areas to focus our future work on and we've assembled an impressive partner group. The majority of our existing partners are returning, which is very pleasing, but we've also had some new and exciting partners come onboard.

As far as influencing factors go, this will revolve around two points: firstly, the commercial, industrial and economic growth opportunities arising out of the new CRC; and, secondly, engagement with industry. In each of these respects Construction Innovation's renewal bid is very strong.

For example, our proposal to improve the interoperability of information modelling to allow more seamless transfer of information and communication between the property, design, construction and facility management sectors is estimated to improve national productivity growth by 0.3 per cent per annum. That's AUD\$5 billion dollars over the extended life of the modelling.

We also take our involvement with industry very seriously. We have a strong relationship with Australian Construction Industry Forum (ACIF) and its member organisations like AIB. This provides us with the traction and engagement with almost 200,000 members – particularly the SMEs – across Australia.

TW: Construction Innovation has undertaken a number of research projects that look at construction techniques, cost management, procurement and regulatory compliance. What steps are being taken to 'commercialise' this

research – to provide products that are usable by building professionals?

KH: We've already had success in this area. Our research with the Australian Building Codes Board (ABCB) has formed a foundation for the increased uptake of sustainability principles in the future Building Code of Australia.

In addition, we have three other commercialisation streams that we are currently developing. Our ICT suite (AutoEstimator, AutoScheduler, DesignCheck and LCADesign) works with 3D CAD facility models to provide automated estimating, scheduling, design checking and eco-assessment of buildings at the design stage. We're currently talking with potential commercialisation partners from the ICT world both in Australia and overseas.

Project Diagnostics is a software tool that identifies areas of poor project health, then establishes probable root causes and provides suggested remedies. We're delighted to say it has been licensed to Arup Australasia for further development. The third area is our noise management project, which we've been running with the Queensland Department of Main Roads. One of the outcomes from this project has been a set of prototype software tools for designers to minimise noise levels from transport corridors for homes and building occupants. At this stage, these tools are still being refined.

TW: Of all the projects you are undertaking, which is your personal favourite and why?

KH: I don't play favourites, generally, but I do think the Construction Site Safety Taskforce is a breath of fresh air for the industry. Chaired by Bill Wild, former Managing Director of John Holland, it brings together all areas of the construction industry – owners, designers and constructors – to reduce deaths and injuries on construction sites. Construction Innovation is conducting research for the taskforce to help deliver safer industry practices.

The Sydney Opera House Facility Management Exemplar project is another project I am particularly

excited about. This project is benchmarking facility management practices, addressing procurement issues and introducing a building information model. I believe very much that the integration of digital information modelling is fundamental to the future of the facility management sector. In this sense, Australia has an opportunity to really make a mark on a global level.

TW: What opportunities exist for construction firms and individual building professionals to support and participate in Construction Innovation research?

KH: Larger industry firms are welcome to participate as a collaborating partner in Construction Innovation, particularly in our current renewal bid. Smaller firms can participate through industry organisations like the AIB and ACIF. We encourage SMEs and smaller firms to come along to any of our industry information sessions or workshops. During those sessions there is scope to provide input to our research and development work. We look forward to working with the AIB and its members in fulfilling that mutually beneficial role.

TW: Some observers have criticised Construction Innovation, probably unfairly, for being too reliant upon QUT and the construction industry in south-east Queensland. Is this a fair assessment and how are you working to address this perception?

KH: You're right. We've been wonderfully supported in south-east Queensland by all our industry, government and research partners over the last five years: the Queensland Government, QUT, Brisbane City Council and many of our industry partners – John Holland, Bovis Lend Lease, Arup Australasia and Brookwater – have also been strong supporters through their regional offices.

Of course, there's a reason for this focus in south-east Queensland. Most people know it's the fastest growing area in Australia, but I heard the other day it's also the second-fastest growing region in the world (after Phoenix in the USA). So it's logical we are strongly involved in the region. Having said that, the majority of Construction Innovation's partners are based in Victoria, New South Wales and the ACT. And we are also on the verge of announcing a major initiative with the Western Australian Government. Once that is bedded-down, our research activity will be spread pretty evenly across the country.



Keith
Hampson

TW: In 20 years time, what do you hope will be Construction Innovation's legacy to the nation? And what contribution do you see yourself as having made to this legacy?

KH: I think our greatest contribution has been to bring together industry, government and research organisations in a more nationally coordinated way – adding value to each others business. In the past, this collaboration has been patchy at best. We have worked hard at building the levels of mutual respect across these groups and identified 'champions' in some of this country's leading organisations. Through this we have created a real focus for applied research for the industry and that work has led to significant industrial, commercial and economic benefits already. I've been honoured to have been in a position to lead the Construction Innovation team over this critical formative period. The future possibilities are very exciting should we secure a further seven years of CRC funding.

TW: How do you view the relationship between Construction Innovation and AIB evolving over the next few years?

KH: AIB occupies a key role in the industry, providing professional accreditation and recognition of skills across Australia. It has a strong and active membership and, as a result, is a vital organisation for us to engage with for our research and to assist us deliver the information from our applied research to AIB's members. We look forward to working with the AIB in the future and hope that your members will support our renewal bid.

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Construction Site Safety Research

CONSTRUCTION INNOVATION PROJECT: REVIEWING DIFFERENT APPROACHES TO CONSTRUCTION SITE SAFETY

It is not uncommon to see two construction projects / sites which have robust safety management systems in place, which have similar scopes of work, technology and employ similar trades, but which have vastly differing safety performance. The reason for this performance is being researched by the CRC for Construction Innovation in a project supported by Bovis Lend Lease and John Holland Constructions.

The difference in safety performance between two building sites are often the skills, knowledge competencies, understanding, attitudes, behaviours, norms and ultimate commitment of line management and Supervision to site / project safety. Another element is that much of the critical skills and 'know-how' are lost because of the transient nature of the construction labour process and the workforce including the reliance on sub contractors. Over the past two years a CRC for Construction Innovation project team has conducted research in three key areas of safety these being:

- ❧ Which management and supervisory positions within a construction company / project are critical to safety performance (safety critical positions);
- ❧ What types of competencies / skills / knowledge / behaviours are required to shape the understanding, attitudes, behavioural competencies, norms and ultimate commitment of line management and supervision to site / project safety and safety culture; and
- ❧ What type of training packages and learning tools are in place and to link their effectiveness to individual site and industry OHS outcomes and safety performance?

In order to ensure validity of the data collected the project team has been sampling, by random selection, at least two large and two medium sized construction organisations / principal contractors and two small to medium organisations. These are typically sub contractors who employ five to thirty workers. In addition, the team has obtained data from at least two government OHS Field Officers or Team Leaders in each jurisdiction and representation from the Building Employees Redundancy Trust (BERT).

On the basis of the data obtained by structured interviews on site, it is proposed to develop and administer a survey instrument throughout the industry on representative sampling frames. A reference group of five people was established for this project which meets quarterly. ❧

Mixed use development design tools

CONSTRUCTION INNOVATION PROJECT: REDEFINING CONSTRUCTION, ARCHITECTURE AND ENGINEERING CAD SYSTEMS

This CRC for Construction Innovation research project entitled Parametric building development during early design investigated leading edge software tools and developed interfaces to promote the rapid optimising of architectural layout and structure based on parametric models. The term "parametric", in this context, refers to the relationships among and between all elements of the model which will enable the coordination that is desired by building professionals.

Model relationships were based on parameters such as 'building usage mix', 'respective floor areas', etc. which are key features in the architectural domain, while structural parameters such as structure type (reinforced or pre-cast concrete, steel, etc.) and minimum column centres are all crucial to the early design phase. In a similar way, the standard of HVAC and the forms of vertical transportation are vital mechanical parameters, while lighting levels, and type of metering are key electrical parameters.

Many of the important environmental factors were also implicitly considered as relationships or combinations of parameters normally represented across these traditional descriptions of architectural, structural, mechanical and electrical systems. Beginning with a relatively simple rectangular building, and with architecture and engineering knowledge of various empirical approaches already in use by industry partners, the research team worked with parametric descriptions of building projects during the early sketch design stage to determine how a wide range of user requirements can be assessed from this simple outline. It examined the methods for defining parametric models within the three major architecture, engineering and construction CAD systems (AutoCAD Architectural Desktop - ADT, ArchiCAD and Microstation Triforma) plus Catia (a leading parametric modeller), and a popular category of mixed use commercial / residential multi-storey developments was chosen for analysis and implementation.

The project leader was Mr John Crawford from CSIRO and team members included senior staff from Arup, Woods Bagot, CSIRO, RMIT University and Stanford University (USA). ❧

New Tool For Construction Schedules

**CONSTRUCTION INNOVATION PROJECT:
NEW TOOL PROVIDES AUTOMATIC PREPARATION OF
CONSTRUCTION PROJECTS AND 4D MODELS**

Builders will benefit from a new tool, developed as a result of the CRC for Construction Innovation's research, that automatically prepares construction schedules together with a four-dimensional (4D) simulation of the construction process. The four-dimensional model is simply prepared from using three-dimensional (3D) CAD model, and provides an interface to Common Point Project 4D to provide a 4D (3D + time) visual representation of the building process.

Information contained in the 3D CAD building information model is simply exported to a database. The automatic scheduler uses this data together with a set of knowledge rules to determine construction sequences, relationships, resources and timing to generate a building plan.

The information about classes of building elements can be combined in order to plan activities. For example, there are 64 in-situ reinforced concrete columns on a floor in a building. Each of these columns contains reinforced concrete of a particular grade and reinforcing steel. The volume of concrete and amount of reinforcing steel can be calculated from the geometry of the building elements. We know that the sequence of operations for concrete columns is first to place reinforcing bars, then erect the formwork and then propping it, pour the concrete and finally waiting for the concrete to reach an appropriate strength before stripping the formwork. We also know the resources (personnel and plant) required to construct these elements. A simple plan for the erection of these columns can be built up using this available information. We also know that these columns will normally be erected after the floor below is completed and before the beams and slab above are started. The plans for the various groups of elements can be assembled into a cohesive whole for the entire project using this relatively simple reasoning process. The construction plan for the entire project can then be presented to a human operator to allow them to analyse and improve the suggested schedule.

The scope of the project, in the initial phase, was limited to the structural elements i.e. beams, columns, slabs, walls and footing systems. However once the viability of the deliverables is proven the project will be extended to cover a wider range of building elements. ∞

Research predicts life of building materials

**CONSTRUCTION INNOVATION PROJECT:
NEW TOOL TO FACILITATE BUILDING MATERIALS
SELECTION BASED UPON LIFE EXPECTANCY**

A two year CRC for Construction Innovation project entitled Case-based reasoning in construction and infrastructure projects, conducted over 2003 to 2005 has developed a tool to assist in the selection of building products by assessing the life of these products.

The project had two major objectives being to: develop an "engine" that uses Case Based Logic (CBL) to link together process modules to form tailored models for specific applications; and to apply this approach to estimate the life of components in construction and infrastructure projects.

Studies have demonstrated that statistical models of component life, though useful, are extremely limited in their application and cannot predict outside the data sets used to generate the models. Process-based models are much more flexible, however such models are very costly to develop as they need to be developed for each material.

This project focused on predicting the life of the key metallic construction materials and components and assessing the viability of the technique to a wider range of materials such as concrete (including reinforced) and timber. This project, in its specific application to life prediction of construction materials, will provide for the first time a modelling framework that is flexible and comprehensive. This permits accurate inputs into environmental impact, damage risk and like models.

The research has provided professional builders with a unique tool that can be used for modelling a wide variety of complex systems. The Queensland Government spends AUD\$1.2 million each year on replacing metal components within the state's schools. The use of the tool developed through this research will reduce this cost and will allow a similar assessment to be made of the timber and concrete components.

The project was headed by Ivan Cole from CSIRO and supported by representatives from the University of Sydney, the Queensland Department of Public Works (QDPW) and the Queensland Department of Main Roads (QDMR).

The database has been made available to QDPW and QDMR throughout 2005 and 2006 for evaluation and testing. ∞

Project delivery research to assist builders

CONSTRUCTION INNOVATION PROJECT: STUDY OF EFFECTIVENESS OF CONSTRUCTION PROCESSES ON CONSTRUCTION TECHNIQUES

The building and construction industry will directly benefit from a CRC-CI project that is investigating the characteristics of re-life projects that impact upon the effective management of the construction process. Such characteristics include the identification and mitigation of risks, issues of decanting and existing tenants, identification of existing structure and services, work scheduling, occupational health and safety issues for construction personnel and tenants, demolition, waste and recycling, issues of quality and workmanship, cost planning and cost modelling methodologies.

The research will identify and document the issues that impact on re-life projects, design, engineering and procurement, and issues of decanting and sustainability. With this information it will develop methodologies for assessing the condition of the existing building structure, the residual service life, and modelling of operating and maintenance costs, and the utility and productivity expected from the refurbished building. This will include the investigation of potential applications for new remediation processes such as fibre reinforced composites (FRC).

The *Value Alignment Decision Support* tool will be enhanced through the development of an additional paper based module that will provide specific advice for re-life projects, and appropriate pre qualification criteria for consultants and contractors.

In the area of reducing costs the research will identify the opportunities for designing out waste, waste avoidance, reduction, reuse and recycling, and construction programming to minimise waste generation. In the coming years this project will develop new processes used by professional builders to deliver projects in a more cost-effective and timely manner. ■■■

BRANZ's environmental research focus

ASSISTING AUSTRALIAN BUILDING PROFESSIONALS COMPLY WITH ENVIRONMENTAL REGULATIONS IS A PRIMARY FOCUS OF BRANZ RESEARCH

BRANZ was conceived in the late 60's as the result of the need for the New Zealand building industry to be able to access practical building technology appropriate for New Zealand's unique environmental conditions. These include earth tremors and conditions that include high UV, high humidity and as no where is very far from the sea, high levels of wind blown chlorides. These climatic conditions focus research on the practical areas of building product durability and innovative construction techniques.

The manager of BRANZ Australia, Mr David Sharp MAIB, says there are construction companies that greatly value the benefits of applied research and indeed undertake significant amounts in their own right. He cites Bovis Lend Lease as one such company who use research to support its platform of 'Certainty in Delivery'. However a great deal of research is also being undertaken to assist the building industry in regulatory compliance matters.

Building professionals are assisted by BRANZ research to support the development of building codes and standards. For example BRANZ developed the Greenhouse Rating Tool for Office Buildings for the Sustainable Energy Development Authority (SEDA) in New South Wales. A recent research project completed for the Australian Government has identified how climate change may impact on the built environment.

BRANZ first employed an environmental scientist in 1993, in response to signals which were coming from Europe regarding what is now known as "sustainable building". This capability has grown substantially over the intervening years, and now encompasses projects on carbon-neutral buildings, means of identifying risks and mitigation measures in response to climate change, and a recently completed four-year study into the resource efficient use of materials in buildings. Very closely related is the energy efficiency work which BRANZ

has undertaken during past ten years. This research includes the HEEP study, which is the world's only national residential energy end-use project, and ZALEH - the Zero and Low Energy House Project, which has uncovered some interesting views on what low-energy features (like double glazing or high levels of insulation) really mean to people who live with them.

Over the next decade at least two immediate research priorities are apparent for BRANZ and the Australian construction industry says Mr Sharp. Firstly is the need to understand how to deliver buildings which offer great flexibility of use over their lives. This addresses sustainability imperatives (remodeling is more sustainable than rebuilding if the building is built to be adapted). It is important to recognise that buildings represent an extremely long-term investment, thus the design needs to be flexible to suit changing purposes of use. Prolonging the continued usability of these buildings is common sense, provided that they are durable and flexible from the outset.

He says the second priority is that we need to learn how to create buildings which support the health and wellbeing of their occupants. For offices, this usually equates to greater productivity from the occupants, whilst at home it means fewer sniffles, cuts or falls for children and elderly alike. The Victorian Building Commission's publication *Welcome* was developed from a BRANZ publication *Homes Without Barriers*. These publications recognise the importance of accessibility to people with disabilities of different sorts. An extension of this is the increasing importance of ageing in place – growing old in a home that you own is both more pleasant for the individuals, and less expensive for society.

BRANZ considers itself to be an Australasian company, with a significant presence in Australia and New Zealand. In many areas BRANZ research is focused on ensuring that it can be demonstrated that the delivered project is able to comply with codes, standards and any additional local regulations, for example BASIX in NSW.

Mr Sharp says this focus on research is significant because BRANZ it is owned by the New Zealand building industry and has successfully separated its public good activities from its commercial activities through the establishment of two entities. Building Research Inc, is the parent company which identifies research needs for the New Zealand building industry and BRANZ Ltd is the commercial entity with a separate board.

How important is BRANZ engagement with organisations like the Australian Institute of Building (AIB)? It's essential when you consider BRANZ Core Purpose - to improve people's lives through our research and our drive to inform, educate and motivate those who shape the sustainable built environment. ∞