Overview of the Cooperative Research Centre in Construction Innovation

Objectives of the Centre

The objective of the Cooperative Research Centre for Construction Innovation is to create and commercially exploit tools, technologies and management systems to deliver innovative constructed assets to further the financial, environmental and social benefit to the construction industry and the community. This will be achieved through effective management of the value chain for the whole-of-life: from business need, design and construction through to ownership, asset management and reuse.

Our vision is to increase national prosperity through more effective and innovative construction and management of sustainable built assets. Historically, innovation in the industry tends to be slow because of the fragmented nature of construction and development, as well as the high costs and risks involved. However, the building and construction industry is a key element of national competitiveness and this Cooperative Research Centre will ensure the industry better uses its resources and raises its efficiency and effectiveness, meaning Australian industry as a whole will be more competitive.

Economic and Social Benefits

The construction industry is a vital part of the Australian economy. As well as its own output, it has a significant impact on the efficiency and productivity of other industries. It promotes investment through its own activities and generates further investment in the broader economy. It provides both the physical infrastructure that underpins the economy and the built environment that more directly influences the quality of our lives. Some 95% of people work in the built environment and 90% of Australia’s Gross Domestic Product (GDP) is generated there. The Commonwealth Government’s Action Agenda for the Building and Construction Industry identified that in 1996-97, the construction industry contributed 14.4% of Australia’s GDP and employed a total of 729,400 people. Analysis by Stoeckel and Quirke has estimated that because of the size and linked nature of the building and construction industry, a 10% lift in efficiency could boost GDP by 2.5% over five years.

The building and construction industry is undergoing dramatic change around the world. Challenges facing the industry include globalisation, advances in technology, environmental issues and changes in the structure of the Australian economy. Most advanced industries have moved to an integrated mass production model. The building and construction industry is set to follow the same path. As public and private sector clients increasingly seek single-source solutions, there is a need for sectors of the industry to cooperate as seamless providers of finance, design, construction and maintenance services. This will mean redefining the underlying supply chains and business systems within the industry and moving from the current short-term project-to-project culture to one that is more strategic, long-term and enduring. This will include developing a better understanding of the increasingly complex financial arrangements for projects and links with manufacturers, construction service providers, facility managers and research organisations.
As part of the Commonwealth Government’s *Action Agenda* process, the National Building and Construction Committee (NatBACC) was formed to provide advice to Government on all sectors of the construction industry. Research was commissioned into the following key priority areas identified by NatBACC as confronting the Australian building and construction industry:

- The utilisation of Information Technology (IT) tools
- Innovation and research and development
- Environmental issues
- Innovative procurement and project delivery mechanisms
- Managing the supply chain
- The role of regulation
- The challenges of ‘going global’.

The CRC for Construction Innovation is designed to address challenges identified by the *Action Agenda* and has been developed with the assistance of the Department for Industry Science and Resources in consultation with the building and construction industry at a national level.

**Quality and Relevance of the Research Program**

A series of research committee meetings has taken place from May through July 2001 to ensure the focus of the selected research projects best reflects the blend of industry needs and priorities, capabilities of the researchers, and short and long term goals of the CRC. It should be noted that the diverse partnerships represented in this CRC span the life cycle of the constructed product and includes a mix of private and public organisations. The projects selected therefore present an opportunity for developing a blend of public and private good outcomes.

The research undertakings of the CRC for Construction Innovation will occur in one of five subprograms. The CRC subprograms represent an administrative division of activity but there is a strong interrelationship and interdependency between the subprograms, which are as follows:

1. Virtual environments for lifecycle design and construction
2. Construction project delivery strategies
3. Environmental sustainability
4. Integrated design and construction support systems
5. Management and adaptability of built assets.

### 1. Virtual Environments for Lifecycle Design and Construction

**Objective:**

The activities of this subprogram build on research in object-oriented virtual worlds to develop a model for 3D immersive life cycle design, construction, and asset management. The construction industry needs to move from dependency on document transfer and word of mouth to distributed information systems for communication and modelling. The research will focus on a representation of the construction site, the design model and complementary areas in the early stages. The environments developed as part of this research program will be used for communication and modelling in the other research programs. Outcomes will promote elimination of paper based construction documentation; increased speed of communication between participants in various locations; and improved data capture, knowledge capture
**Strategy (research projects approved to date):**

- **Modelling Viable Mixed Use Developments Through Virtual Environments**
  This project will lead to the development of viable innovative designs that respond to market demands. While we can approach masterplanning as mixed use development, much of the development and financing remains in fixed bundles of 'commercial', 'industrial', 'residential' and so on. This project involves the consideration of new strategies for mixed use development that take into account and make direct use of virtual communities and their role in physical communities. This will be achieved through the parallel development of a 3D multi-user virtual environment which allows community feedback be incorporated into an urban design process in order to support planning and conceptual design. The Northlakes town centre development will be used as a case study. The 3D model will be available to the developers and designers for modification and to the community for walkthroughs and feedback. The project will trial new strategies for innovative mixed use development and collect data on how these strategies are developed, applied, and implemented within a virtual environment.

- **Life Cycle Modelling and Design Knowledge Development in Virtual Environments**
  This project looks at the development of a modelling tool within a 3D virtual environment that will enable facility planners and managers to visually simulate and make future projections of the facility or building in terms of its life cycle needs (maintenance, refurbishment, extension and major replacements) and its response to management action to meet those needs. The project will use existing data on facilities like schools, hospitals and correctional centres and develop specialised data mining techniques to demonstrate data mining of historical databases. Designers can also use the modelling tool to visualise the impact of design decisions on the future life cycle of buildings and facilities in order to minimise life cycle costs.

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2. **Construction Project Delivery Strategies**

**Objective:**

The research activities of this subprogram will analyse the complexity of construction delivery processes. This will enable re-engineering to eliminate non-value adding activities and improved integration and management of construction supply chains. Significant developments in information and communications technology, knowledge management, and computer language interoperability pave the way for the creation of a virtual project team and new collaborations between project participants. A previous study has shown that up to 85% of activities in typical construction processes are non-value adding giving scope for substantial reengineering. The research and application will be focussed on putting new strategies into practice with industry partners and monitoring and refining them.

**Strategy (research projects approved to date):**

- **Value Alignment Process for Project Delivery**
  - Value alignment process for project delivery is a decision tool to assist clients and others to optimise the project delivery system meeting the needs of the stakeholders. The research project will focus upon how to best capitalise upon existing re-engineering and value chain studies undertaken on the construction procurement chain. It will make re-engineering the process possible by providing a decision tool based on principles rather than using existing off the shelf delivery methods.

- **Delivering Improved Knowledge Management and Innovation Diffusion**
  - If the construction industry (CI) is to become innovative and take advantage of innovation it must improve both the way it generates and manages knowledge through an effective knowledge innovation diffusion strategy that provides added value to its paying customers and other stakeholders. There are two theoretical elements to this research project-studying how knowledge creation and management (KM) is best pursued and studying how innovation diffusion (ID), particularly supporting IT infrastructure, is best achieved. Becoming more effective in applying innovation will facilitate the CI to manage any required change process involving knowledge generation and knowledge management. This project also provides a focus on a tangible KM outcome through a risk appraisal task sheet planning application.

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3. **Environmental Sustainability**

**Objective:**

This subprogram is driven by the broad environmental sustainability objectives from forums such as Habitat II and Rio (Agenda 21) and National Environmental Agenda into key projects. This will generate new knowledge and computer-based techniques for improved planning, design and management of the built environment that delivers both environmental and efficiency outcomes. The aim is to reduce greenhouse emissions and energy usage, increase the efficiency of water and energy use in buildings and cities, increase recycling and improve the design, health and comfort of our indoor environments—where Australian’s spend over 90% of their time.

**Strategy (research projects approved to date):**

- **Indoor Environments: Design, Productivity and Health**
  The productivity and health of building occupants are influenced by conditions of the indoor environment, particularly the indoor air quality (IAQ), thermal comfort and lighting. In the USA and Europe, it has been estimated that poor IAQ affects 30-40% of office occupants and can cost up to 2% of GDP. While there are specifications for thermal comfort, lighting and some IAQ factors in Australia, there is a general lack of information about whether they are appropriate to deliver optimum human outcomes (in terms of health and productivity), and whether they are achieved. This project will determine the availability of Australian and international data for thermal comfort, lighting and IAQ; the populations and buildings affected; and procedures by which this information can be used to estimate real costs to productivity and health of Australian office workers.
  This scoping study will form the basis for a full study in which procedures for determining the impact of these factors will be established, followed by development of methods for estimating the economic impact of poor quality indoor environments. Design knowledge will be ultimately integrated into building design tools. Part of the scoping study will involve developing a detailed research brief for Engineering Solutions to Legionella Control in Cooling Towers.

- **Environmental Rating Systems for the Built Environment**
  The principal drivers for building design in Australia continue to be cost related – not lifetime environmental factors. Most developed countries have now initiated voluntary environmental rating schemes for building design. Australia is falling behind in best practice in this area.
  This project combines life cycle assessment, whole of life costing and whole of life performance assessment in development of a suite of CAD-integrated environmental assessment tools for buildings (and subsequently individual building products) that can enhance the decision-making process among AEC professionals and deliver superior built environment outcomes.
  Benchmark data derived from this project will be applied initially in Industry Partner projects.
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**Indoor Environments: Design, Productivity and Health**
- Engineering concepts for Legionella elimination
- Literature surveys; project plan; w/shop
- Demographic analysis of exposure to pollutants
- Cost impact analysis; proposals and methodologies

**Environmental Rating Systems for the Built Environment**
- Evaluation report; business plan; environmental rating systems framework report; environmental analysis system report; environmental priorities; report on CAD-based tool for environmental rating; dimensioning building element databases report
- Populating building element databases report; eco-point multi-criteria environmental analysis system
- CAD-based tool for environmental rating of buildings; environmental weightings report

**4. Integrated Design and Construction Support Systems**

**Objective:**

This research program will focus on the need to reduce design and construction 'errors' which typically account for 10% of construction cost. The research will integrate fragmented knowledge bases and reduce inaccuracies and incompatibilities in information flows; raise labour and equipment operational efficiency in construction; and reduce material wastage. The research will develop modular integrated decision support systems including: knowledge based systems to assist constructors and other participants to optimise selection of construction inputs and resources (materials, sub-systems, plant and labour components from various networked databases). It will also include simulation, scheduling and optimisation algorithms for the construction process to improve productivity with interfaces to design software for CAD, building regulations, standards, and databases for products, labour and equipment.

**Strategy (research projects approved to date):**

- **Managing Information Flows with Models and Virtual Environments**
  This project examines information flows using models and virtual environments to support design and construction planning for buildings and civil works. The innovation in this project is to employ object models throughout the information flow process. This enables tracking of the development of information through the design process (through virtual environments) leading into the “pre-construction” process (through estimating and scheduling software). “Intelligent” objects within AEC industry software allow significant improvements in productivity in the design and construction of buildings and civil works. Virtual environments provide a basis for both visualisation and interface to the object model representation. The initial focus of the post-design processes for building projects is on the building core and structure. This will be expanded in the later stages according to the interests of the industry partners. The initial focus for civil projects is on the support for e-commerce and e-projects for less sophisticated models. Harmonisation of building and civil models will be undertaken for architectural, structural, hydraulic and site works models.
- **Project Team Integration: Communication, Coordination and Decision Support:**
  - (a) Scoping Studies
  - (b) Internet-based Construction Project Management (ICPM)
  This project investigates the potential for information and communication technology to integrate construction project teams. The first component consists of scoping studies to facilitate communication, coordination and decision support. The second component benchmarks and evaluates the use of internet-based construction project management (ICPM), and investigates wireless technologies to enhance ICPM.

- **Benchmarking Information and Communication Technology Uptake and Integration in the Australian Construction Industry: Scoping Study**
  A six-month scoping study of historical and contemporary issues that relate to surveying and benchmarking of ICT uptake and integration with Construction Industry business processes. It is intended to inform the development of adaptive benchmarking tools to map industry sectors, regions and roles over the life of the CRC.

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5. **Management and Adaptability of Built Assets**

**Objective:**

The research will include: new decision-making processes/models for corporate property and asset management; improving understanding of building performance; building flexibility into commercial assets to accommodate changing demand to extend economic life and optimising function/utility; identifying and evaluating new ownership options for various components of commercial assets and infrastructure; and meeting changing needs of the workplace through uptake of IT allowing for flexible work arrangements. Outcomes will include new models and methodologies for demand analysis and supply options through the life of the asset; new concepts in shared asset ownership; best practice business strategies, strategic facility planning and property/facilities management and property management to accommodate the demands of the new economy; financial and other modelling to support decision making in the creation, as well as the use of and re-investment in built assets and infrastructure.

**Strategy (research projects approved to date):**

- **Investment Decision Framework for Infrastructure Asset Management**
  In the Australian road sector, over A$7 billion is spent on new construction and maintenance annually. The maintenance expenditure (nearly A$3 billion annual) is generally budgeted based on previous expenditure and ‘as seen’ performance of the roads. If the future performance of the road were taken into consideration in decision-making, the expenditure on maintenance would be better utilised. There is a need to have the ability to make effective investment choices at various levels and identify and implement an investment decision framework for infrastructure asset management. This study in the short term (2-3 years) will focus on the modification and adaptation of such a plan for the road sector, especially for the Department of Main Roads Queensland. In the long term, the framework will be applied to buildings, bridges and possibly railways.

- **The Evaluation of Functional Performance in Commercial Buildings (future alliance with Project 1.4)**
  This project examines the performance of commercial buildings as investment assets. It relates changes in the physical life-cycle of the structure to occupational productivity, and focuses specifically on future adaptability to changes in demand. Actual building records will be used to evaluate functional performance over time.

- **Innovation Potential, Directions and Implementation in the Building and Construction Product System**
  This project is a longitudinal and comprehensive study of innovation in Australia’s building and construction sector. The project will provide information on development and adoption of best practices and technological innovations by businesses in the sector. Information will be based on a national biennial survey of innovation and a biennial collection of innovation case studies.
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**STRATEGY FOR UTILISATION AND COMMERCIALISATION OF RESEARCH OUTPUTS**

The construction industry can be resistant to change – change often occurs informally and is generally driven top down. The industry is fragmented and has a multiplicity of industry associations, yet it is a major driver of the national economy. The purpose of this CRC is to develop novel solutions for the industry that will result in positive industry change. Despite this apparent contradiction, the strategy for utilisation and commercialisation of the research will work pragmatically through the participation of major players from the complementary sub-sectors in the construction industry as partners in the CRC. As leaders in the industry, they have carriage of the decision-making, the major projects and influence over the techniques and procedures that drive the adoption of new ideas by their clients and contractors. This infusion process will occur through contracted relationships and competitive pressure. Other industry participants will also benefit over time through observing the behaviour of the industry leaders involved in this CRC.

As solutions are developed with the industrial partners of the CRC, additional relationships will be established within *distribution channels*. This is because the present partners could generally be classed as end-users, albeit users who have substantial economic influence in the industry. The *distribution channels* will assist the CRC reach throughout the industry and overseas.

Overall this demonstrates the importance of involving complementary industry players as industrial partners – as we have secured in this CRC. Hence, each Program has several research projects that will involve industry partners and researchers from different academic partners. This is to ensure that collaboration and a national industry focus is maintained throughout the research and implementation phases.
Each industry partner will contribute their business problems for consideration as foci for CRC research projects. This means utilisation of CRC output will occur because of strong commercial imperatives from members intimately involved in the research. Commercialisation will also be encouraged by linking the principal CRC node and several of the projects to major development projects. The Brisbane node will form a key feature of the Lend Lease North Lakes development. This is a 15 year $2.2 billion project for 25,000 people with a full range of construction, infrastructure and supply chain requirements that form the focus of collaboratively developed research projects. New technologies and methodologies that are developed will be implemented on a continuous improvement basis as part of the project. North Lakes is a flagship project for the international Lend Lease Group so it provides technologies and a model that can be implemented on a global scale not only for the benefit of Lend Lease but also for other project partners. Other project implementation and commercialisation activities will occur through the following industry and government partners:

- **Lend Lease** in building and construction projects
- **Arup Australasia** – civil, environmental and building design and construction
- **Queensland Public Works** projects - building construction for major public facilities
- **Queensland Dept of Main Roads** - major road construction and maintenance
- **Rider Hunt** – data rich CAD and electronic media for costing and measurement
- **Australian Building Codes Board** - building regulations software systems
- **DEM Gillespies** - for design of major projects
- **Woods Bagot Architects** - design and documentation of major construction projects
- **Springfield Land Corporation** - housing development projects

The organisations we will consider for on-marketing include the computer industry, architectural and engineering consulting firms, project management groups and trade and professional education providers. This will provide access to the industry in Australia and substantial markets overseas. These organisations will also inform us about competitive alternatives from within Australia and overseas. We intend to involve them at the prototype stage of the R & DC stage of development so that their input can be incorporated during product development.

We also expect this to bring stimulating commercial ideas and approaches into the CRC. Taken together, this will be a particularly important long-term investment in the corporate attitudes for an industry that has been very slow at adopting new ideas.

Our Chairman, Jim Service, is highly regarded in the construction industry and is an influential member of a number of boards of industry associations. We see this will allow us to monitor the needs and capabilities of the construction sector in a very effective way. This also means that new products and services developed by the CRC will appear on the agenda of these peak bodies. Supporting partners such as the Construction Industry Institute of Australia and collaborating associations such as the Australian Contractors Association, the Master Builders Association and the Australian Construction Industry Forum have indicated their support for this CRC. Their involvement will substantially assist in the diffusion of research outputs.

**Exploitation of Intellectual Property**

This CRC will maintain an IP register which will identify pre-existing IP from partners and clients relevant to the CRC. It will also identify IP developed as a result of the activities of the CRC using resources contracted through the Commonwealth CRC agreement (called CRC IP). This will include generic and consortia IP. The fourth category of IP will arise as a result of contract research between the
It is anticipated that there will be a range of vehicles for exploitation of IP. These will include the joint ownership and operation by groups of partners, establishing spin off companies with shareholdings by CRC participants, licensing and patents, for example. The CRC will pay special care to protect the innovations it generates by copyright, patent or other methods.

Overall we can say that:

- This CRC has involved key industry players from a broad range of sub-sectors who have a vested interest in finding better solutions to their pressing commercial issues, who in turn through strategic partnering relationships and forcing competitive change encourage the use and commercialisation from the CRC.
- The individuals on the CRC Board are senior members of the industrial partners, per se, this brings individual networks of contacts and influence that will allow the CRC to receive market intelligence about the needs and capabilities of the whole sector.
- The industrial partners will expose their emerging managers to R&D projects at the CRC, this will bring two-way benefits to the CRC and the industry.
- The marketing relationships to be established once the CRC is up and running will allow the output of the CRC to be commercialised; by involving these organisations in the R&DC process will ensure the product development will meet the needs of the market.
- The researchers, the industry associations, the industrial partners and the marketing alliances will ensure the CRC will monitor competitive developments world-wide.

**Collaborative Arrangements**

Collaboration will occur through the joint research programs involving the research staff of partners and research end-users. Partners to third party organisations such as other government agencies may manage some research under contract and construction-related companies who are not partners. Research results will be trialed on actual projects offered by the industrial and government partners.

Key Nodes of the CRC will be based in Brisbane (QUT), Melbourne (CSIRO/RMIT) and Sydney (U Sydney/CSIRO/U of Newcastle/UWS).

**Incubator Projects**

Industry partners will provide practical problems that will act as incubators for the generation of new ideas and prototyping new technologies. This will foster close collaboration between partners plus an industry focus throughout the research and implementation phases. The incubators will also be used to provide the industry with examples of the new technologies and publicised widely through seminars and workshops. These projects are a key step to commercialising research prototypes for the wider market. They also provide a mechanism for feedback from field testing of the prototype technologies back into refining the research program to more accurately reflecting the market needs. These incubator projects will be developed into demonstrator cases of best practice for the benefit of the SME sector, with leadership by the CRC participants.

One unique feature of the CRC is that part of the Brisbane node will form a key feature of the Lend Lease North Lakes development. This is a 15 year $2.2 billion project for 25,000 people with a full range of construction, infrastructure and supply chain requirements that can be researched in detail. New technologies that are developed will be implemented on a continuous improvement basis as part of the project. North Lakes is a flagship project for the international Lend Lease group so it provides unique opportunities for research and a model that can be implemented on a global scale not only for the benefit of Lend Lease but also for other project partners.
International collaboration to ensure world’s best practice in research methodologies and focus will form an integral component of this CRC. The Key Researcher group have existing close personal and professional relationships with leading peers in Europe, Scandinavia, North America and Asia. A well-developed series of linkages with national groupings also exists. International and national collaborative arrangements have been formalised with:

- Australian Contractors Association
- Australian Institute of Quantity Surveyors
- Carnegie Mellon University
- Centre for Building Research, Hong Kong Polytechnic University
- Centre for Integrated Facility Engineering, Stanford University
- Construct IT, Salford University, UK
- Construction Industry Institute, Australia
- Construction Industry Institute, United States
- Construction Training Queensland
- Danish Building Research Institute
- European Construction Institute
- Institution of Engineers Australia
- International Alliance for Interoperability
- Master Builders Association-Australia
- Royal Australian Institute of Architects
- VTT Technical Research Centre of Finland

Each research project also requires at least two industry partners and two research partners to secure funding. This ensures a high level of national collaboration and aids technology transfer across CRC partners. Each of the subprograms also has a Leader and Co-Leader from different institutions, this is intended to promote further cross-fertilisation of ideas and enhance collaboration.

**Education and Training**

**Objectives:**

The technology transfer module in the CRC underpins the programs and represents outcomes in education and training that will deliver a knowledge rich industry with enhanced graduate qualities and upskilling of the workforce. This will be achieved through a planned and integrated program spanning graduate research training, dissemination via industry media and enhanced curriculum managed by the professional and VET sector organisations responsible for course design and accreditation. There is already substantial collaboration in respect to education and training between the proponents of this CRC. CSIRO have a strategic Construction Research Alliance with QUT with their Building and Construction Engineering personnel located on campus within the Faculty of Built Environment. CSIRO staff are visiting Professors at a number of the University partners, as are academic colleagues.
The education and training and technology transfer component of the CRC will have the following components:

- Research training for graduate students, mentoring and knowledge management.
- Industry focussed research masters and doctoral students including a new professional doctorate.
- Dissemination and innovation diffusion through industry conferences workshops and short courses.
- Publications strategy - trade/professional journals and magazines, journals, books and best practice notes, making use of the Internet where appropriate.
- Input to undergraduate and postgraduate coursework programs.
- TAFE (technical and further education) and VET (vocational education training) course material will also be generated for wider industry use.

The education and training outcomes will closely parallel outcomes from the research programs. The major expenditure budgeted in the education and training area for the first two years is for PhD scholarships – to complement research projects at the various academic institutions. The research outcomes will provide partner focus and benefits in this early phase of CRC development. More elaborate industry-wide dissemination of research outcomes will substantially occur after the second year. The early phase of CRC management will focus on technology/business development more so than technology transfer, training or commercialisation activities.

**Research Training, Mentoring and Knowledge Management**

The Karpin Report of the mid-1990s recognised the need for sound mentoring and development of organisational learning. The CRC provides a unique opportunity to bring together leading academic experts with industry and government participants within a formal research training regime. This aids in-company mentoring approaches because it introduces high level independent academic input. Moreover, with the coursework masters programs and professional doctorate and the level of exposure of independent ideas from cross-disciplinary sources is increased. Further, the Doctor of Project Management has subject area knowledge management as a core coursework theme, so that case study research will enhance in-house efforts to better manage the under-utilised knowledge resource.

**Research Degrees and Professional Doctorate**

The CRC will be a prime vehicle for providing scholarships and funded research projects linked to masters and doctoral student research. Generally, programs identified will extensively use research students under supervision of lead researchers drawn from the universities partnered with industry supervisors. In particular QUT and RMIT are jointly developing a professional doctorate, which will be an ideal vehicle for industry-based research. They expect to have their proposed professional doctorate programs operational in late 2001. This program, which combines 33% coursework with 67% case study practice research is an ideal mechanism for ensuring high-level high quality research dissemination from the CRC. The program that requires a coursework Masters Degree (such as Master of Project Management, Master of Property, Master of Engineering or MBA) for entry to the program will provide many opportunities for case study practice-related research by candidates. Moreover, the CRC will be able to influence industry and government to support the program through the close linkage opportunity between the CRC and QUT/RMIT.
The CRC for Construction Innovation has budgeted for up to 10 PhD students to be engaged on CRC related research at any one time. This will involve engaging 5 PhD candidates in the 2001-2002 (first) year of operation with another 5 PhD candidates engaged for the commencement of the 2002-2003 year. Each PhD candidate will normally be required to complete their course of research and present their thesis in a 3 year period. As the first group of 5 PhD candidates completes their course of study, the next group will be engaged as indicated below.

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Dissemination and Innovation Diffusion Workshops and Short Courses

The Construction Industry Institute, Australia has committed to using its annual industry conference and publications as one vehicle for dissemination of research results. The National Master Builders Association and Construction Training Queensland have also joined with industry professional bodies in agreeing to act as a conduit for dissemination of results. This will be applied at all levels in the industry from VET sector trade courses to professional level. A strategy for education and training activity will accompany all research projects to ensure that implementation is as seamless as possible, engaging people fully in a learning process to prepare and train them for adopting improved processes and other innovations.

It is expected that while the cost of this aspect will be built into programs, additional opportunities will exist for income generation through providing training for CRC partners and external organisations. Multimedia education and training materials will be developed with opportunities to provide on-line versions where appropriate. RMIT Online experience will be used to develop web-based products as well as collaborative efforts with the University of Newcastle's distance learning and problem-based learning expertise and the University of Sydney’s Virtual Campus.
Undergraduate and Postgraduate Coursework Programs

All research work will provide curriculum improvements for both undergraduate and postgraduate programs. Each of the research programs identified is linked to coursework programs so that provision of current content will add value to the educational experience of students. Content provided will include development of new theory, case studies and improved interaction with industry and government partners. Where development of short course materials fits into existing academic subjects offered and standards required, due credit towards degree award programs can be granted. Both QUT and RMIT offer a Master of Project Management, a Master of Facilities Management and a Master of Property Management. The University of Sydney offers a graduate program in Facilities Management with a Graduate Certificate and Graduate Diploma that articulate to the Master degree. These courses all require a research project component. The CRC will be able to tap into these students, most of whom are at middle-management level, to participate in research projects either as a structured part of a program or as an adjunct providing case study material or other forms of research validation exercises. The CRC research projects are most likely to feed best practice knowledge to the industry through curriculum improvements benefiting from CRC research.