



**DIRECTIONS FOR IT IN THE CONSTRUCTION
INDUSTRY**



Directions for IT in the Construction Industry

FOREWORD

Information technology (IT) is fundamentally changing the way we conduct business. The building and construction industry is no exception, although broad take up of technology is slow.

While some industry participants are well advanced in their use of IT, most are not. The achievement of widespread change will take time as participants learn the potential of IT and are willing to embrace it.

Nevertheless IT is driving change across many business sectors at a rapid pace and against this background it is important not to be left behind.

By setting directions, governments can assist in facilitating the wide and effective adoption of IT in construction procurement and facilities management. Major government clients can do this through setting requirements for doing business with government which include the use of IT. Specific encouragement to use IT can improve value for clients, while maintaining profitability and viability for suppliers.

To maximise the benefits from the wide take up of IT, directions and requirements need to be agreed to by all participants. Directions which are critical to the successful take up of IT in the construction industry have been identified by the Australian Procurement and Construction Council Inc. (APCC).

The APCC expects that the directions outlined in this paper will need to be implemented progressively over the next two to three years. While these directions are outlined individually, it is acknowledged that they collectively form an overall vision for IT take up that all industry stakeholders can pursue.

Pursuit of this collective vision will assist in facilitating improved outcomes for all stakeholders through the increased use of IT.

The APCC has consulted with industry to validate the directions outlined in this paper. Industry have confirmed that there is benefit for all industry stakeholders from governments pursuing these directions.

The Australian Procurement and Construction Ministerial Council releases this paper to stimulate, encourage and accelerate the use of IT in the construction industry.

The Hon Morris Iemma MP
Chair
Australian Procurement and Construction Ministerial Council

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WHAT IS HAPPENING NOW.....

All APCC jurisdictions have well developed capability in electronic tendering and are starting to provide tender documents that can be viewed, obtained and responded to in an electronic form.

The NSW, Queensland and Victorian governments are utilising tools which enable access to all project documents through a web browser. South Australia is investigating the use of such tools. These tools enable collaboration between designers, clients, authorities, suppliers and the community. They can also assist in providing a more accurate understanding of design and construction requirements.

Queensland is piloting a short course tailored to the building and construction industry to improve IT planning and implementation. This course assists consultants, contractors and subcontractors to develop a strategic approach to the application of IT in their business processes.

All APCC jurisdictions have implemented or are implementing electronic marketplaces for procurement of their goods and services. These marketplaces will allow government buyers to locate goods and services from contracted suppliers, preferred suppliers or on the open market. Government buyers will be able to place and track orders, make electronic payments and monitor performance. These marketplaces will provide a model for electronic procurement by the building and construction industry.

These ongoing developments will assist to increase the awareness of the potential of IT to achieve tangible benefits and facilitate change throughout the building and construction industry.

Some examples of projects that have incorporated IT integrated systems throughout the design, documentation and construction processes that reflect governments' adoption of IT include:

- The National Museum of Australia - ACT
- Extension of the Eastern Freeway - Victoria
- Online Remote Construction Management project – Queensland
- Second Primary School at Glenmore Park - NSW
- Christensens Road State School – Queensland
- Tweed Heads Hospital Redevelopment - NSW
- Electronic plan room facilities-Project Services – Queensland
- Camden High School - NSW
- Princess Alexandra Hospital - Queensland

WHAT IS POSSIBLE NOW

as a client
walking through a realistic model of your building before a sod is turned on site



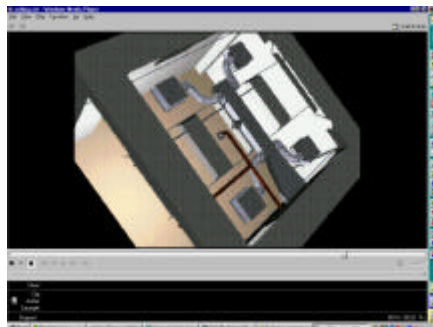
as a member of the community
looking at options for a school and voting on your preferred option



as the Planning Authority
examining sun shadow patterns in reviewing a Building Application



as a subcontractor
installing ductwork in sequence which fits in with the programme of the plumber working in the same space



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BACKGROUND

In 1997 the Australian Procurement and Construction Ministerial Council endorsed the vision statement '*Construct Australia – Building a Better Construction Industry in Australia*'.

Construct Australia drew on the views, opinions and directions of key industry stakeholders. It identified what is expected of the construction industry, including its required future attributes and proposed a range of strategies to support industry development.

Common to many of these attributes and strategies was the use of information technology (IT). *Construct Australia* recognises that effective adoption of IT will contribute to a more integrated and innovative industry leading to increased efficiency and improved delivery of projects for clients.

When used effectively, IT enables improved decision making that contributes to higher quality and lower cost outcomes through access to relevant and timely information.

The APCC recognises that in the dynamically changing world of IT, the sharing of ideas between industry stakeholders will lead to improvements across the construction industry as a whole.

The key directions identified in this paper are supported by worldwide trends in the application of IT in the construction process.

These trends include:

- a focus on project specific applications including the use of object oriented project databases;
- integration of IT into the capital works procurement process commencing at the briefing stage and continuing through to facilities management and disposal;
- integration of IT throughout the entire supply chain, including subcontractors and suppliers; and
- recognition of the need to share learning both within the construction industry and with other industries.

Industry have been widely consulted with over 400 copies of the *Directions for IT in the Construction Industry* paper despatched together with a response form encouraging comment.

Feedback from industry supports the directions and governments' role to develop initiatives which facilitate the take up of IT in the construction industry.

KEY DIRECTIONS

The following key directions have been identified by the APCC as being critical to the successful take up of IT in the construction industry:

- maximising access to shared learning across the construction industry and using knowledge from other industries;
- requiring information from suppliers in electronic form;
- expecting electronic procurement to be used in all phases of project procurement and facilities management;
- using advanced tendering systems which provide real time accessible information to all interested parties thereby facilitating speedier interaction;
- driving process re-engineering through structural changes in procurement processes of governments;
- working with industry to integrate IT throughout the entire supply chain;
- facilitating the use of project web sites;
- managing the use of 'as built'¹ information;
- capturing and sharing information to better understand life cycle costing;
- adopting systems that share information in a useable form; and
- resolving issues including design copyright, intellectual property rights, confidentiality and commercial advantage.

¹“as built” refers to documentation/plans that show the final layout and detail of a structure upon completion of construction. Often plans handed to clients upon completion do not capture the “as built” detail due to the plans not being updated after modifications during the construction process.

IMPLEMENTING THE WIDER APPLICATION OF IT

Objectives of the Framework

Clear government leadership will raise the awareness of both industry and clients and encourage a more rapid take up of IT than would otherwise occur.

This paper has been developed to:

- Provide a coordinated policy approach for the effective integration of IT into the construction procurement and facility management processes of government building and construction projects.
- Provide a consistent approach in the use and adoption of IT by government agencies. This will assist enterprises in their resource investment planning and also achieve enhanced and simplified partnerships between government and industry.
- Influence, encourage and support the effective take up of IT in both the public and private sectors of the building and construction industry with the objective of optimising project outcomes.

Critical Issues

In considering how these objectives might best be achieved, the APCC identified a number of issues impacting on the success or failure of any strategies adopted.

These issues include:

- a limited awareness and understanding of IT and its potential benefits which has led to the patchy take up and application of IT across industry to date, despite the general availability of enabling technologies to all industry stakeholders;
- the availability of projects which demonstrate the use of IT and show potential benefits, to increase awareness and understanding;
- the traditional “paper based” approach of the industry;
- the requirements of the GST for better record keeping systems (likely to be computer based) may provide a significant opportunity to extend the use of IT;
- legal and contractual issues such as intellectual property and lack of precedents; and
- the significant goodwill and cooperative spirit which exists in the industry.

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USING IT

The paper proposes that the use of existing information technologies within the construction industry be extended. It also seeks to encourage participants to adopt innovative technology as it develops.

Existing technologies that are most relevant to the construction industry include:

- project databases:

A project database contains all the information about a project such as project models and physical attributes, as well as financial and project management data. The project database provides a central pool of information which can be accessed by any project participant, at any time, from any place, and in a form most suited to the participant. Tools such as design and scheduling software can be integrated with the database providing increased functionality as well as saving time and eliminating data re-entry.

Where the project database is object oriented, the information describes real objects such as walls, doors or windows, and abstract objects such as decisions. The real objects have attributes or properties including dimensional information, material requirements, fire, thermal or noise ratings and authorship. Abstract objects have attributes including date of creation, authorship and dependence on related objects.

- communication networks:

Communication networks allow access to a single project database, rather than multiple data sets held by each project participant. These networks may be the Internet or dedicated networks (Intranets and Extranets). The increasing use of the Internet and web browser technology provides access for project participants to a range of databases including the project database, client databases with generic information about their requirements and historic data, and product databases for manufacturers and suppliers.

- electronic commerce and electronic procurement:

Electronic commerce processes can be used for procurement activities including internal and external communication, business transactions and management of supply chains and alliances.

With the aim of promoting the wider use of such technologies within the industry, the APCC has identified two primary areas of action:

- knowledge development across the industry as a whole
- improved project delivery through the use of IT tools within individual projects.

APCC acknowledges that the transition from current paper based project delivery processes to an IT enabled delivery process will take time. The journey will involve both incremental changes and major changes involving process re-engineering.

This transition can be assisted by Clients and large contractors initially providing their smaller suppliers and subcontractors with access to information through simple technology such as web browsers, with applications provided by the Client or contractor on a web site. Routine communication can occur through electronic mail or facsimile, with the Client or contractor



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converting the facsimile to an electronic document for communication to others in the supply chain.

This process will allow SMEs to understand the potential of IT and how it might best suit their business needs. The cost of purchasing hardware and software, running both paper based and electronic systems, the training of people and adapting business processes can be matched to business outcomes which improve efficiency and viability of the enterprise.

The tables under each element show the steps from the present to an exciting future. The first line is a general statement about the industry, the second *in italics* gives examples.

Knowledge development across the industry

Shared learning

The exchange of knowledge which can be used to build on and learn from the experience and knowledge of others.

APCC members:

- will share practical knowledge gained from real projects;
- acknowledge the need for industry participants to maintain their competitiveness without compromising competitive advantage; and
- will use learning from other industries to accelerate learning within the construction industry and to minimise the concerns of direct, intra-industry competition.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Limited shared learning between enterprises	Shared learning about achievable outcomes	Shared learning about methods as well as achievable outcomes
Example	<i>Learning shared at conferences and seminars</i>	<i>Performance indicator data shared across industry</i>	<i>Learning shared about use of bar coding for delivery of site materials and placement of components during construction</i>

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Knowledge management

The capture and reuse of process, product and technical knowledge.

APCC members:

- will facilitate the capture of knowledge gained from project experiences that are often lost through discontinuity of project personnel;
- will expect industry participants, including clients, to re-use the knowledge gained from previous projects; and
- endorse the work of Construction Information Systems Australia in its development of the national building specification (NATSPEC) as a platform for the integration and dissemination of the industry's collective technical knowledge.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Knowledge restricted to single projects and phases	Knowledge captured and applied across multiple project phases but restricted to single project types	Knowledge captured and applied across multiple projects
Example	<i>Knowledge gained by design team for one school not always recorded or passed on to designers for other schools</i>	<i>Knowledge gained on design and construction of government schools shared with private school system</i>	<i>Knowledge gained on design and construction on government schools shared with housing industry</i>

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Supplier information

The availability of information about product and service suppliers, detailing their capability and products.

APCC members:

- consider that suppliers can increase their market share by providing electronic information that is easily used and updated. Electronic catalogues allow the open exchange of supplier information between project participants and support electronic procurement;
- will increasingly require information from suppliers in electronic form to ensure the accuracy, timeliness and completeness of information and avoid data re-entry; and
- endorse the work of the International Organisation for Standardisation in its development of a new standard framework for object-oriented information exchange in the construction industry.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Limited availability of information in electronic form	Searches by supplier rather than by product	Up to date information available electronically and searchable by performance characteristics
Example	<i>Catalogue information available as "scanned document" of product brochure</i>	<i>Supplier's catalogue can be downloaded directly into project documents and include video of typical operation</i>	<i>Search of supplier catalogues for wall with two hour fire rating and load bearing capacity</i>

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Intellectual property

Legal ownership of a unique product or service created by an identifiable source.

APCC members will:

- respect pre-existing intellectual property rights in the application of IT; and
- work with industry to resolve issues including design copyright, database ownership, confidentiality and commercial advantage.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Disciplines guard their own intellectual property	Intellectual property of a commercial nature closely guarded by the originator	Intellectual property seen as property of the team or virtual organisation as a whole
Example	<i>Shared documents provided as scanned images to limit alteration and reuse</i>	<i>Intelligent files shared with non originating party who is licensed to extract information and create new information</i>	<i>Virtual organisations sharing risks and rewards from development of intellectual property</i>

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Innovation and Research

The allocation of resources to develop improved innovative processes, products and service delivery methods.

APCC members will:

- encourage innovation through the use of IT;
- support coordinated research programs relating to the use of IT in the construction industry; and
- encourage the use of the Internet as a fast and inexpensive method of accessing global knowledge.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Innovation isolated and occurs within enterprises	Incremental innovation across supply chain.	Innovation expected and actively pursued
Example	<i>Three dimensional model used on site to assist construction process</i>	<i>Three dimensional modelling used across multiple disciplines to maximise innovative design solutions</i>	<i>Four dimensional ²modelling achieves improved construction processes</i>

	CURRENT	INTERMEDIATE	FUTURE
Statement	Research largely carried out by academic institutions, large client or contracting organisations.	Commitment by individual organisations and industry associations to conduct meaningful research and development.	Research shared across the industry with significant input from all stakeholders.
Example	<i>Large contracting organisation developing use of project web sites</i>	<i>Research on project web sites conducted with team comprising all major stake- holders aiming to change design processes</i>	<i>Industry collaborates on research projects as a norm with regular forums for exchange of research results</i>

² The use of the time dimension as well as physical dimensions such as height, width and depth. Objects in the model will be built at different times due to the sequence of construction and four dimensional modelling will allow the process of construction to be simulated, understood and optimised. At a more advanced level, moving objects such as plant being hoisted into place or moved into a room can also be simulated to check clearances.

Project Process Development

Electronic procurement

Using electronic commerce processes for procurement of goods, materials and services, including internal and external communication, transactions and supply chain and contract management.

APCC members:

- have developed and adopted a *National Framework for Cooperation for Electronic Commerce in Government Procurement*;
- believe that electronic procurement can be used in all stages of project procurement and facilities management, regardless of the delivery method used;
- will work with industry associations to provide greater confidence amongst stakeholders in the security of document and information sharing;
- are working with government agencies and the IT industry in the continuing development of technology standards, contract administration and a legislative framework to ensure confidentiality and security are maintained; and
- will progressively adopt systems that allow the complete tender process to be undertaken electronically.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Stakeholders aware of concept but not realising full potential	Stakeholders becoming aware of potential and applications for electronic procurement	Electronic commerce is the norm
Example	<i>Electronic Funds Transfer for payments</i>	<i>Orders for goods and services placed electronically</i>	<i>Electronic project and contract management from tendering to contract finalisation</i>

	CURRENT	INTERMEDIATE	FUTURE
Statement	Electronic documents printed for use	Value obtained from using documents electronically	Information has added value by being in electronic form
Example	<i>Tender documents downloaded and printed for estimating purposes</i>	<i>Client able to evaluate tenders electronically</i>	<i>Information contained in project database used to quantify products, services and providers and place orders electronically</i>

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Project process re-engineering

Changing project processes to better achieve project outcomes.

APCC members:

- acknowledge that the alignment of processes with IT strategies will assist project members to identify and eliminate non value adding steps;
- acknowledge that improved information transfer and communication will assist in understanding current processes and directions to fundamentally change them;
- recognise that process re-engineering needs to extend across all project processes and needs to be adopted by all project participants (including clients, consultants, contractors and suppliers) to achieve the full benefits; and
- will provide a catalyst for process re-engineering through structural changes in procurement processes of governments.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Paper based processes are being automated	Non value adding steps removed from existing processes	Processes re-engineered to maximise business outcomes
Examples	<i>CAD design as electronic pencil, electronic transfer of documents reducing the need for printing documents</i>	<i>Quantities extracted electronically from database rather than via a manual count from documents</i>	<i>Design process occurs concurrently through collaboration rather than sequentially</i>

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Supply chain management

Management of the relationships between all project participants.

APCC members:

- consider that efficiency gains can be achieved through accessibility to more accurate real time information by all project participants and across all project phases;
- recognise that improved supply chain management can be achieved using IT to provide greater integration of off-site and on-site offices; and
- will work with industry to maximise the benefits of using integrated IT systems across the entire supply chain.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Fragmented, limited communication between disciplines within a phase and between phases	Cooperative team working. Relationship between primary supplier (contractor or consultant) and sub suppliers based on pre-established relationships and experiences. The intent is to continue a working relationship.	Virtual organisations which come together for the duration of a project but share learning from previous projects. Individual organisations maintain strategic alliances. Transparent, cooperative, open supply chain
Example	<i>“Silo mentality” leads to installation of services in ceiling space on a “first in best dressed” basis without concern for the effects on the installers of other services</i>	<i>Contractor locates and orders materials and services directly from contract documents linked to a database of regular suppliers</i>	<i>Participants in supply chain have worked together on previous projects and share knowledge on re-engineered processes</i>

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Project management systems

The management of resources, time and costs on projects.

APCC members:

- recognise that more effective management of projects can be enabled through a variety of IT systems and processes;
- will facilitate the use of project web sites to achieve savings in time and cost through improved communication and real time information; and
- recognise that in time the virtual project office³, established through the use of project databases, will facilitate a cooperative and more integrated industry.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Processes are paper based	Client and main supplier exchange information electronically	All project participants exchange information electronically
Example	<i>Majority of documentation prepared electronically with CAD and word processors but used as paper documents.</i>	<i>Electronic exchange of tender and contract management documents between client and main suppliers, information entered into database by contractor for minor suppliers</i>	<i>All project documents available through project web site and used by client, contractor, designers, sub-contractors, suppliers and community stakeholders</i>

³ The virtual project office combines organisations working together such that the client has a relationship with what they perceive to be a single organisation whereas in reality they are dealing with a group of separate organisations working together. The organisations can be in different locations operating within various time zones.

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Facility Management

The management of built assets throughout their life, including operation and maintenance, refurbishment and disposal.

APCC members:

- will seek improved access to timely, 'as built' documents and operational data to improve facility management performance;
- will require contractors to provide 'as built' information in electronic form; and
- will encourage clients to use 'as built' information in electronic form for improved maintenance decisions.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Limited availability of 'as built' information to facility manager	Increased availability of design and construction data to facility manager.	Comprehensive facility management information and knowledge available and used
Example	<i>'As built' information not readily accessible or able to be interpreted As built information not kept up to date during occupancy</i>	<i>The facilities manager orders replacement glass for a broken window by accessing the original supplier contact details, cut glass size and solar reflectivity properties</i>	<i>Maintenance contractor on site accessing linked information from a European manufacturer's exploded assembly diagram for a complex valve, including video and voice instructions and recent feedback from other maintenance contractors on operational problems</i>

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Life cycle considerations

The assessment during project planning of the effect of design proposals on the economic life and maintenance costs of an asset.

APCC members:

- acknowledge the benefits of electronic capture of comprehensive data that allows for accurate scenarios to be evaluated; and
- will require the capture of relevant data leading to improved life cycle considerations.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Fragmented life cycle information available due to separation between capital funding, recurrent expenditure, maintenance costs	Operation and maintenance costs evaluated during design development	Solutions chosen based on whole of life costs including environmental and social impacts
Example	<i>Procurement solutions largely based on construction costs due to lack of, and access to, reliable life cycle costing</i>	<i>Use of building and facilities simulation tools and modelling of a hospital ward to determine sight lines from nurse stations and staffing needs</i>	<i>A financier simulating and determining the most cost effective solution for options including full brick, brick veneer and reverse brick veneer, including construction and energy costs, leasing returns and demolition effects</i>

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Interoperability

Interoperability is the seamless electronic exchange and sharing of project information between participants and across the life of the project in a way that is software independent and operating in an open systems environment.

APCC members:

- endorse the International Alliance for Interoperability – Australasia Chapter⁴;
- recognise that sharing information in electronic form, particularly from a single source and in a form that suits the user, provides significant benefits. These benefits include improved understanding, reduced face-to-face meetings, improved document control, and elimination of re-keying errors and resources;
- will progressively adopt systems that share information in a useable electronic form and to advance interoperability between applications; and
- endorse the work of the International Organisation for Standardisation (through Standards Australia), the International Alliance for Interoperability (through the Australasian Chapter) and the International Construction Information Society (through Construction Information Systems Australia) in their development of new standards for information management, exchange and sharing.

	CURRENT	INTERMEDIATE	FUTURE
Statement	Data re-entered for different software applications	Software applications generally restricted to those which can communicate with each other	Any software application can communicate with any other application
Example	<i>Dimensions and thermal properties of walls entered into thermal calculation software</i>	<i>Thermal calculation software able to extract data from dimensional and materials model</i>	<i>Fire compartments determined with Fire Commissioners, interacting with Code requirements, doors and door hardware altered in digital model as walls made fire rated</i>

⁴ The objectives of the IAI-AC include:

- the development of Industry Foundation Classes for exchange of information between multiple applications, such as architectural planning, thermal load calculation and taking off quantities.
- Demonstrating the potential of technology through electronic projects

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ADVANTAGES AND BENEFITS OF DIRECTIONS FOR IT

The paper provides directions for fundamental change that will contribute to greater integration in the building and construction industry. Realisable benefits are likely to be accrued only after relatively long periods. While some industry participants are well advanced in their use of IT, many are not. The achievement of widespread change will take time but provide incremental benefits as it is implemented.

For long term gains to be achieved there will be some short term pain in implementing IT such as double handling of information (paper to electronic) and time to learn new systems. This short term pain can be minimised through information and knowledge sharing.

The benefits flowing from the wide take up of IT are difficult to quantify, but the following table lists some advantages and benefits to all participants in the construction industry in a generic sense.

ACTION AREA FEATURES	ADVANTAGES	BENEFITS
Knowledge Development	<ul style="list-style-type: none"> • develops a smarter industry • promotes cultural change • improves industry integration and capability • promotes innovation • increases innovation take up through whole supply chain • provides better access to project and industry information • avoids repetition of mistakes from project to project • improves regional development 	<ul style="list-style-type: none"> • improved profitability • improved long term viability • better application of innovation • greater certainty of outcomes • reduced cost of projects • reduced social costs (fewer mistakes and accidents) • increased market share • improved world competitiveness • increased opportunities for SMEs and regional enterprises

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ACTION AREA FEATURES	ADVANTAGES	BENEFITS
Project process Development	<ul style="list-style-type: none"> • focuses on value adding steps • assists culture change • improves industry integration • improves project outcomes • allows more efficient management of assets • gives broader access to project details • assists decision making through better quality information matched to need • helps control project costs • minimises data re-entry • provides ability to record and access reasons behind decisions leading to improved understanding of decision making process • provides ability to re-examine decisions with full knowledge of background • provides greater choice of suppliers • provides local sourcing of maintenance 	<ul style="list-style-type: none"> • greater certainty of project outcomes • reduced costs for service providers and contractors • reduced project costs • better project time delivery • reduced design and documentation rework • reduced construction rework • reduced materials wastage • reduced response times • better decision making • increased flexibility in decision making if circumstances change • better communication, less stress • better working environment • greater empowerment of project personnel • better acceptance of decisions • reduced maintenance costs and faster delivery

APPENDIX A

A construction project progresses over a number of distinct phases. These range from determining the needs of the client through brief development, design, construction and operation to disposal. The phases are identified by the headings in each of the ellipses.

The figure gives examples of how IT can be applied within and between the various phases of project delivery.

The more effective and integrated use of information technology, such as electronic communication (eg email or web based technology), integrated information exchange, project data accessibility (project databases) and three and four dimensional modelling, can improve communication and productivity within construction projects. These IT enablers are available with current and evolving technology.

