Part 1
Clients Driving Construction Innovation

CHAPTER 1

Introduction: Mapping the Terrain

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INTRODUCING THE TERRAIN

The construction industry currently provides 14 per cent of Australia's wealth, employs around 730,000 people and has a significant impact on many other industries such as banking and finance, the services sector and resource-based industries. However, challenges from globalisation, advances in technology, environmental factors and changes in the structure of economies are pressuring industry participants and stakeholders to reconsider their traditional ways of operating. These broader issues alert to the critical concern that there is a need for establishing and adopting alternative approaches to planning and undertaking construction and allied activities if the construction industry is to remain competitive and capture new opportunities. Importantly, there is an identified need to consolidate the broad range of diverse research effort and practice applications to provide a coherent map of the activities in the construction sector.

While the construction industry is a major driver of Australia's economy, it is argued there is an imperative to operate more effectively and productively. Through research and development that creates smarter construction operations, processes, techniques and adopts good policy and practice principles, those participating in the construction industry will have the tools to establish a more competitive industry. In turn, they will be in a superior position to take advantage of the insights, innovation and better practice that may flow from relevant, informed and robust research.

Innovation has been defined through the applicability of four related conditions: newness, evidence of change or discontinuity, the relation to invention and being understood both as a process and an outcome (Osborne and Brown, 2005). Within the construction arena, innovation has been determined according to a notion of significant change to a process, a product or at the system level that is novel and results in improvement (Slaughter, 1998). These definitions point to the importance of not only determining novel applications of practice and processes but ensuring that advancement of knowledge and practical application are captured and harnessed.

Clients Driving Construction Innovation: Mapping the Terrain seeks to bring together cutting-edge research, resources, frameworks and case studies to focus on the role of the client in the construction innovation process. This book offers insights into the ability of clients to drive innovation through their knowledge, purchasing power, by establishing documentation standards and developing regulations, legislation and codes by which construction industry policy and practice is implemented and carried out. The importance of exchanging ideas and exploring and sharing the latest research on the role of clients in the construction innovation is an important aspect of disseminating new thinking and initiatives and exposing research results and practice examples to wider review and scrutiny.

AIMS

The book aims to provide its readers with a comprehensive set of frameworks and practical methods and applications for understanding the drivers, enablers and barriers to innovation in the construction industry and to develop new and effective ways to capture the benefits of innovation.

The ability to engage clients in the innovation process is an important step in establishing processes to ensure that the significant investment in the construction industry is consolidated and value-added. Without appropriate systems of innovation and methods for diffusion of that innovation there is a risk that potentially valuable research remains underutilised or unused and will then become obsolete before benefits can be realised. The incorporation of a client perspective into innovation offers the prospect of delivering a range of benefits including improved performance across the sector, achieving productivity and growth and capitalising on the considerable synergies of working collaboratively with a range of stakeholders.

In this edited volume, leading built environment, engineering and construction practitioners and researchers explore issues such as understanding client requirements, client involvement in the construction innovation process, health and safety, electronic simulation, innovative asset management, procurement, firm-level innovation and international innovation. Together, these contributions can add significantly to creating the tools, technologies and practice-based initiatives needed for innovative competitiveness, more sustainable construction projects and deploying successful research and development in the construction sector.

STRUCTURE OF THE BOOK

The book is divided into four major parts. In the first part, the book introduces the topics covered in this volume and outlines the critical considerations in understanding the processes and practices by which clients drive innovation in the construction industry. The second part of the book identifies key concepts relating to client-driven innovation in the construction sector. The chapter covers areas of major concern across the industry and gives insights into the ways in which clients are driving innovation and areas that may enhance innovation from the client's perspective.

The third part of the book expands on these key concepts and examines the theory, frameworks and practice through which clients affect and are affected by innovation in the construction industry. The final part explores case studies of innovation in the construction sector and analyses key lessons for developing and establishing innovation through a better understanding of clients and their contribution to innovation processes and systems. It also sets out future directions for research in this area.

Part 1: Clients driving construction innovation

Innovation is acknowledged as the key to impel more effective design, operations and management, and achieve greater productivity within the construction sector. The need for better and more informed understanding of innovation in the construction sector is evidenced in the inability to draw effectively on the innovation already occurring, disseminate to a broader constituency and capitalise on initiatives, potentially from other industries, that have the potential capacity to drive sector-wide change. Importantly, the conditions and environment under which innovation emerges and may be fostered are not well-understood in construction. However, innovation is occurring at many levels in the sector, and the need to capitalise on the gains is a critical component of the research outlined in this book.

The extensive number and scope of topics covered in this volume underscore the breadth of involvement of clients in the construction innovation process. The introductory section sets out the

key issues and details the research and practice implications of the chapters. It charts the frameworks and concepts used to understand and facilitate the client role in construction innovation.

Part 2: Key concepts in clients driving construction innovation

The major areas of interest in the role of clients in the construction industry are highlighted in this section. The broad themes address areas such as the client role in innovation across the construction sector, occupational health and safety and the role of the client, improving satisfaction through greater involvement of the client and international perspectives on sustainability and innovation.

A focus on the three C's of clients driving innovation through appropriate *concepts*, *collaboration* and *communication* in chapter three alerts to the potential of a new approach to doing business in the construction industry. The shift to relationship-oriented agreements rather than highly specified contractual obligations in order to undertake construction projects is reshaping the industry. The consequent move away from adversarial contractual approaches offers the prospect of greater involvement of clients and the possibility of an improved environment and infrastructure for innovation to occur.

The next chapter shifts our attention to the unintended consequences of innovation. Chapter four suggests the drive to innovate forces new choices that may not necessarily result in long-term beneficial effects. It is timely to review the innovation cycle and the long lead time for innovation to become accepted and diffused throughout an industry. Focusing on the three V's of *vectors, visions* and *values* indicates that it is the combination of factors that work to secure innovation and that these can be adjusted and interrogated to ensure that innovation improves not just processes but the social and community dimensions as well. The three V's establish a coherent framework that links social and economic values to ensure that construction innovation is integrated into questions of social values, sustainability and business processes.

Occupational Health and Safety is of central concern to the construction industry. Chapter five focuses on the role of the client in supporting a climate of care for promoting safe workplace practices. The statistics indicate that construction has higher rates of accidents and fatalities than other sectors and the persistence of this situation leads to the need for a different approach to safety. The notion of the caring client is not just about taking care, but driving a safety culture from the top of every organisation and ensuring that a commitment to safety is paramount. Clients have a critical role to play in driving innovation through initiatives that have focused on collecting better and more consistent information, their push for more involvement in research, and for approaches that reward those who perform consistently above the minimum.

Chapter six focuses on the role of the client in innovative ways of delivering improved satisfaction with services in the property industry. The focus on meeting client needs required a shift from concentrating solely on technical competency to a services–based approach. The recognition of the community of people housed as a central concern rather than property management transformed the business orientation and led the way for an innovative approach to facilities management. The quality assurance principles were expanded to included more sophisticated Information and Communication Technologies (ICT) to track client records and requests for service, an improved inspection regime, better communication between clients and directors, and change from a tick and flick customer satisfaction questionnaire to one that is paper or internet-based and captures clients' responses in both open and closed questions. The key change driving this innovation was to consider the role of property services as part of maintaining a viable community of people rather than merely the stock of properties.

Chapter seven focuses on an innovative 4D CAD application that promises significant productivity improvements for large-scale projects. The chapter investigates the possibilities and problems for collaboration between industry and academia in this area. It explains how and why cutting edge technology can be adopted and implemented to achieve gains in planning and production in these large projects.

Chapter eight considers international innovation and focuses on the city and the built environment. It is argued in the chapter that the driving forces of globalisation and ICT have shifted focus to the knowledge economy and a networked society. In this way, innovation is driven through increasingly multiplex and collaborative arrangements between different and often disparate groups. The client's role in construction innovation has led to a concentration on the performance aspects governing whole-of-life, value and intangibles and has consequently driven a shift away from the prescription-based approaches conventionally favoured in the industry.

This chapter also acknowledges the difference in values between the business and social sphere. These value sets are viewed as the site for engaging in a series of trade-offs rather than mutually exclusive arenas as the economic imperatives for city infrastructure and the concomitant need for the provision of quality of life and community well-being to sustain that economic growth are intertwined. The living laboratories project is an excellent example of innovation driven by clients as the emergence of mobile workers drives the need for new and flexible kinds of spaces and arenas for connection that transcend the notion of traditional offices and buildings as fixed sites.

Part 3: Theoretical and practical issues in construction innovation

The chapters in this part expand on the themes introduced in the key concepts. New relationship-oriented arrangements to deliver and manage projects, innovations in occupational health and safety, and innovations driven by changes in legislative and policy processes together with developments in ICT are important components of this section.

The uptake and increased use of ICT has changed the construction industry radically and enormous shifts have occurred as a result of the adoption of these sophisticated technologies. However, there has not been an industry-wide spread and disjuncture in differing levels of technological advancements causes costly delays and productivity suffers. The careful and strategic implementation of innovation is as important as the innovation itself.

The cases examined in this part often uncover that an expedient response or a low cost option is not necessarily the best solution to issues and problems within the construction industry. The shift from low cost to quality, allied with ground-breaking ways of recouping investment, offers the prospect of harnessing innovation to create a more competitive industry. However, structural issues of fragmentation and lack of infrastructure to support new ways of working militate against developing a coherent innovation system.

The research demonstrates that bringing clients and informed stakeholders into the planning stages fosters innovative solutions, and that client buy-in and involvement is a high impact way of achieving innovation. It was found that the time to develop appropriate strategies for capturing the benefits of innovation and implementing the innovation was required but not often able to be factored into the project time horizon.

Walker, Hampson and Ashton (2003) in their research on procurement found that a project champion not only provided the driving force for the project, but established the type of leadership that allowed new ideas and fostered the innovative capacity of the team. The research findings across the construction industry consolidate the need for a champion to lead innovation.

Part 4: Case studies of clients driving construction innovation

The case studies focus on real-life problems that have been solved in innovative ways or have the potential to develop new understandings of the translation of theory to practice in the construction industry. Winch (1998) called for greater attention to case studies of construction innovation to aid in understanding the way in which innovation occurred. The case studies in this volume draw on a rich set of data to elaborate on the innovation process in construction. The studies range across the construction industry from occupational health and safety through to finance and environmental sustainability.

A case study may be defined as an "empirical enquiry that investigates a contemporary phenomenon within its real life context in which multiple sources of evidence are used" (Yin, 2003). Case study research deals with the intricacies, processes, roles and changes in the organisation (Marshall and Rossman, 1989). As such, it allows a window into the operation and management of organisations in addressing problems and issues from multiple viewpoints.

The case studies focus mainly on innovation in processes, which moves away from the reported problems of attention being given to improvements in products highlighted by Winch (1998). Winch (1998) suggested that the tendency to product improvement as the mainstay of innovation in the construction industry inhibited a greater rate of innovation in the industry. The shift to process innovation, organisational learning and creating a culture of innovation demonstrates the possibility of a greater ability to improve the innovative capacity of the sector.

THE CAPACITY TO INNOVATE

Clients, together with manufacturers, are identified as one of the six major factors within the innovation system in construction (Blayse and Manley, 2004). Further, it is argued that clients have a fundamental role in innovation through the strategic intervention that they are afforded by both institutional and organisational means.

Osborne and Brown (2005, adapted from Rogers and Shoemaker, 1971) contend that the five characteristics of success for innovation are the superiority of the change to the previous state of play, the ease of ability to trial the innovation, the ability to observe how the innovation achieved results and the relative difficulty of comprehending the innovation by the intended users. These features indicate that it is not enough to develop a novel way of doing things; there needs to be an underpinning structure and support arrangement, coupled with implementation of the innovation and a means of diffusing the innovation throughout the market.

In addition it is argued that both top-down and bottom-up approaches to innovation are required as part of an effective implementation (Baldock and Evers, 1991, cited in Osborne and Brown, 2005 p. 148). In this way, clients are integral to innovation as they operate at the bottom-up level through identifying and specifying their needs that may be a novel departure from accepted ways of doing things but also from a top-down perspective in leading through, for example, their buying power.

Research into innovation has been driven by two differing approaches. The first is based on treating innovation as a process within a system and the second approach treats innovation as a dynamic within a cultural context. Both approaches are necessarily interconnected as innovation exists as both a process and an outcome (Osborne and Brown, 2005). The cultural aspect seeks to establish innovation as part of organisational learning developed through relationship building and problem solving (Winch 1998).

Walker and Hampson (2003) contend that change requires both systems and culture to be adapted. In order to develop an innovative culture in procurement it was argued that a relationship-based approach was a critical factor (Walker, Hampson and Ashton, 2003). The key factor is the constant exchange and interchange that are characteristic to a relational approach creating the conditions for

innovation. Thus, in order to capitalise on the dynamism and prospects for innovation, the innovation system requires an appropriate support structure to be built and an innovation culture to be sustained.

CONCLUSION

The chapters seek to extend knowledge about innovation in the construction sector and contribute in a tangible way to the on-going development of the industry. The chapters reflect the underlying dynamism and high level of value-added activity in construction that may not be immediately obvious when issues of the relatively weak sectoral performance of occupational health and safety, industrial unrest and productivity problems come to the fore. Winch (1998) suggested that knowledge of the evolution of innovation in the construction sector was poor and that innovations needed to be followed closely from emergence to maturity as part of a coherent approach to understanding the innovation process.

This edited volume seeks to extend understanding and knowledge of the pivotal role of the client in driving construction innovation and in so doing, documents and examines the evolution of innovation in construction as suggested by Winch (1998). It brings together theory, concepts and frameworks to inform practice and showcases and analyses studies of innovation in the construction sector. In turn, the incorporation of a greater understanding of the determinants, processes and characteristics of innovation set the scene for charting a way forward for further innovation in the construction industry.

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Part 2
Key Concepts In Clients Driving Construction Innovation

CHAPTER 2

Clients Driving Innovation

Janet Holmes À Court

As Chairman of the Australian construction company, John Holland, I think the things we do are pretty impressive, but more importantly, so do most of our clients.

First, I would like to discuss what happened in September 1990. At that time, Robert Holmes à Court, my husband and Executive Chairman of Heytesbury Holdings died, and, while there were many assets including 12 theatres in the West End of London, 4 horse studs and around 250 horses, Vasse Felix winery in Margaret River and 220,000 cattle on 15 properties, there was also much debt. All these activities were capital intensive and there was an urgent need for a cash generating business that was not capital Intensive. The construction industry was chosen, although this sector was balance sheet intensive. I found that the construction sector was macho, adversarial and confrontational. Certainly, I used to say "women wouldn't do business this way." It was as if there was war between clients and contractors.

While the focus of my topic is "Clients Driving Innovation", our experience has been that both client and contractor need to play an active role in encouraging project innovation for truly successful outcomes.

I must note, however, that over the years we have entered into contracts with clients that range from highly cooperative arrangements, where new ideas and better ways of doing things are encouraged, through to contracts which seem to promote minimal cooperation with each party holding their cards close to the chest.

It is no surprise, of course, to find which of these types of contracts end in time and cost over-runs, break-down in relationships, and in the worst cases, litigation.

I am a firm believer that if the contract is filed away in a bottom drawer, a project is going well, but if it's main home is on the project director's desk, we all have problems.

Contracts are there to set the framework of a formal relationship, provide the project scope and to refer back to when one party needs more clarity or an issue resolved.

Contracts should not specify how every nuance of a project is to be run, nor should managers try to run their project with the contract always on his or her desk. There is no greater way to kill innovation.

At John Holland, we have found that with the right framework or concept, our projects can deliver mutually beneficial outcomes.

A very well known West Australian, Jack Mann (deceased), was the winemaker at Houghton's for many years. He had three 3C's he lived by – Cricket, Christianity and Chablis.

Our 3C's at John Holland are:

Sound **concepts** …. **collaboration** … and **communication**.

I contend we must follow these three key principles to encourage innovation in our construction projects.

By this I mean, getting the **concept** or framework right to allow innovation in the first place, encouraging **collaboration** between each party, and **communication** with each other, client and contractor, our staff, sub-contractors and suppliers.

CONCEPTS

It's fine for us to talk about innovation after we've signed up to a new project, and look for ways to make construction more efficient. There's nothing wrong with that, and it should be encouraged, but opportunities may have already been missed.

If we're not looking to make our projects innovative BEFORE we sign a new contract, the horse may have already bolted.

Our key clients in the construction industry are Government, developers and industry. However, in the construction supply chain, main contractors like John Holland are often the 'clients' to suppliers and the subcontractors who carry out much of the work.

So, why do clients drive innovation? Often because:

- There is a specific technical need;
- It might be something they do to enhance their image;
- It may be for philanthropic reasons;
- Or perhaps in consideration of sustainability and life-cycle cost.

But most often, the drivers for clients are construction cost and project delivery time.

It is at the tendering or contract stage where clients have their greatest level of influence over project outcomes, and it can so often be where things go wrong. A client driven purely to save a dollar at the expense of the contractor is likely to create a tough, adversarial environment via the contract as he or she seeks to protect his/her interests at all costs.

Similarly, a contractor keen to win a big job can often be forced into a situation where they sign now … and worry about the consequences later. It might sound ridiculous, but it happens regularly in the industry, and no company can say they are completely immune. Often the pressure from governments, communities or businesses to just 'get on with the job' can also lead to rushed tendering and contract formalisation.

It is at the **concept** stage of a project that the rules of the game are established, the teams selected, and the coaches give their instructions.

How often in the construction industry have we all seen two teams go head to head, goal for goal in a game where the winner takes all? This situation is often in relation to client versus contractor. How often have we wondered if the two teams are even playing the same game? Especially if one team tries to change the rules at half-time.

But what if I told you it doesn't have to be that way? Imagine the score if the two teams decided to stop tackling each other and kick toward the same end? It may seem fanciful, but at John Holland we're starting to show that this strategy can pay dividends for both teams.

In West Australia, the John Holland Rail Division has demonstrated, together with their client WestNet Rail, that getting it right at the **concept** stage has encouraged a far more innovative environment than previous client and contractor relationships.

John Holland and WestNet Rail have had a strong working relationship for eight years, so the climate of trust was right to test a more innovative approach to doing business.

The two parties entered into a unique rail maintenance contract in which both WestNet Rail and John Holland agreed to work "together in a cooperative manner to deliver the project for the mutual benefit of each party".

That might seem like the type of motherhood statement you find in most contracts, but here's where this one is different …

- The terms are that no liquidated damages are payable by John Holland, and there are no penalties payable by WestNet Rail for impedance of John Holland's rail access.
- John Holland provided the estimate for the maintenance works, and allowed WestNet Rail to fully review our costings with our senior managers.

- A project margin was agreed, based on an agreed estimate and defined scope. Any change in scope will be treated as a variation.
- All costs will be entered into a project ledger and accessible to both parties.
- And here is the main point ….. Benefit and risk is shared EQUALLY by both parties. Any overrun or underrun in cost is shared equally. In the case of John Holland's return, this is capped at up to double our agreed margin if we can work together to reduce costs, and the other side of the coin is capped at a total loss of margin to John Holland if we collectively under-perform.
- The project partners work out of one office

Clearly, when both parties stand to win or lose equally, the rules of the game shift from a 'winner takes all' mentality to both teams kicking in the same direction.

A similarly successful approach has been adopted by John Holland in Queensland as part of the Brisbane Water Enviro Alliance.

The client behind this Alliance is Brisbane Water, with contractors John Holland, technology supplier Aquatec Maxon, and water industry designers MWH and JWP. The work involves the upgrade of three of Brisbane's waste water treatment plants.

The cooperative approach adopted between client and contractors as part of the Brisbane Water Enviro Alliance has already seen tangible benefits delivered to all parties, including:

- Better risk management, as all Alliance partners collectively assume all risks associated with the delivery of the work, except any specially identified risks assumed by Brisbane Water;
- Improved stakeholder relationships;
- Innovations in safety are shared via a reference group;
- There are significant time savings in decreased conflict between the parties; and
- All businesses are benefiting financially with the potential for higher margins.

This brings me to my second key theme to encourage innovation, the need for **collaboration**.

COLLABORATION

So, the concept has been given some thought, and the framework put in place.

Now, we have to deliver on our commitments. This is where it is most essential we look toward innovative work practices and construction methods.

Collaboration between client and contractor needs to be given more than just lip-service if both parties are to benefit.

It is through collaboration that we share our previous successes and failures, learn from experience and each other's knowledge to achieve project outcomes as efficiently as possible.

The John Holland / WestNet Rail experiment is fairly new, but it is already paying dividends:

- Everyone has a clear understanding of the scope and price;
- There have been no delay issues, claims or contractual disputes. This outcome means management from both teams have more time to focus on actually managing the works;
- Access to the railway line for our maintenance is maximised, resulting in efficient use of our rail crews; and
- Our client is working with us to help us undertake as much work as possible within maintenance access 'windows' on the railway lines.

In essence, WestNet Rail and John Holland are **collaborating** as to how best to access the busy railway lines for maintenance, and how to work as efficiently as possible so both teams can reap the financial and time rewards.

As one of our project directors remarked last week: "It's so fantastic to see a client working hard to give us maximum access and they are impressed that we're exceeding their expectations by getting greater amounts of work done in less time."

It seems so obvious, doesn't it? It's hardly rocket science, so why aren't all construction projects run so smoothly?

I think trust has a lot to do with it, and it always helps to have an established relationship with a client or contractor. These issues and concerns can be overcome with the right **concept** or contractual framework.

It also requires quite a culture-shift for clients and contractors alike. We all want to produce outstanding balance sheets as contractors, or to keep the costs as low as possible as clients. But the culture of 'winning at all costs' and adversarial contractual relationships has surely proven to be so counterproductive to innovation over the years that it is time to move on. The only real winners in that environment are lawyers.

The drive 'to win' over the other party can be countered if, as clients and contractors, we can show our Government Ministers or shareholders that an equal split of the rewards is financially better than a risky attitude of working to protect our own interests, before working toward mutually beneficial outcomes.

The other culture shift needed in the construction industry is the need for greater sharing of information. I am not talking about giving up trade secrets, but I do feel there is a need to share our innovative ideas to better the industry as a whole.

This brings me to the third ingredient needed to encourage innovation, which is **communication**.

COMMUNICATION

Communication is something easily taken for granted. We all go to meetings, and know how to send group emails. These are valid forms of **communication**, but are often one-way and limited.

Innovation can be achieved through simply conceiving, trialling and implementing new ideas.

Indeed, much of the innovation that occurs throughout the construction supply chain comes from company personnel in the course of their normal work. If we are not setting up the right **communication** channels for our staff, sub-contractors and clients to communicate with us, we risk not learning about safer or more environmentally friendly concepts, or more technologically efficient ways to work.

It is surprising how many innovative work practices are being employed by your own individual staff every day. The danger is that they keep their ideas to themselves, tired that "the boss won't care about what I have to say".

Ask yourself these questions. How often do I complain about a budget over-run on an invoice? Then consider: How often do I take the time to talk with my staff about their ideas to reduce costs and be more efficient?

If you answered "always" to both questions, I'd like you to consider coming to work with us at John Holland, because I strongly value managers who not only question what's going on, but take the time to work through better ways of doing things by communicating with their staff and suppliers.

While a lot of innovation is the product of trial and error in the field, there is also a lot of structured research and development going on within organisations, professional bodies, and research and academic organisations acting on behalf of the industry.

I am proud that John Holland is a founding partner in the Cooperative Research Centre for Construction Innovation and has been contributing cash and in-kind support to *Construction Innovation* and its research projects. *Construction Innovation* brings together 19 industry, government,

and research partners with the vision to lead the Australian property and construction industry in innovation and collaboration.

I am a strong supporter of conferences as it is vital that we continue to provide forums for the exchange of ideas. If we fail to **communicate** with each other as an industry, we will all be the worse for it.

Sound **CONCEPTS**, a commitment to **COLLABORATION**, and ongoing **COMMUNICATION** … are, I believe, the keys to fostering innovation. We all have a role to play, clients and contractors alike. It is time to start kicking in the same direction.

CHAPTER 3

Vectors, Visions and Values – The Essentials for Innovation

Peter Brandon

A PERSPECTIVE ON INNOVATION

Innovation is dead – long live innovation! With apologies to the royalty of Europe which tends to use a similar phrase when one of their number is deceased and another takes their place! The line of the monarchy is preserved and continuity prevails.

Innovation has certain of the same characteristics – it is continuous, often operates within a specified framework, is almost inevitable, and has the potential to improve on the one before! The issue is not one of whether we will innovate or how we should innovate but when the innovation will occur. Human history is one of innovation both in products and processes and has continued from the dawn of time through evolution and the intellectual capacity which humans bring to the drive for self improvement. It will happen, it does happen, and the question we are asking ourselves at this point in time is 'how can we make it happen more quickly?'

Not all innovations are positive and the modern world is full of well-meaning innovations which have seemed to provide a route for improvement only to find that in the ensuing years other factors have made that innovation harmful to the planet or those who inhabit it. Much of what the world considered improvement in the past century is creating problems which the present generation is trying to resolve. These range from energy plants to economic relationships between countries to methods of governance and many more.

In the last century the dominant innovation area has been technology, often addressed as a series of independent initiatives without considering the impact on each other. The result has been a massive increase in our ability to use tools but with some concerns about where those tools are leading us in the way in which the future of the human race will proceed. Weapons, the use of non-renewable resources, the challenge to value systems through information exchange etc are all examples of where this reductionist approach has provided advantage for some, but disadvantage for others. Much of what we call innovation relates intentionally or unintentionally to power. Through a new tool, those who have it are empowered but others are not. Some will be economically advantaged and some will not. Some will be able to exercise force over another and some will have to submit. Often it is the viewpoint from which these matters are considered that determines whether a new innovation will be considered positive or not.

Property and Construction are not immune from these forces and the market economy will favour certain innovations above others. In a world where quality of life is thought to be paramount, the Built Environment plays a massive part in how people perceive their living standards. The demand for improved standards will affect market forces considerably. Innovation is not neutral when it comes to the impact on humanity or the value systems which we consider to be important. In any consideration of what drives innovation we need to understand the values which are being challenged or reinforced by the innovation under consideration. It is this aspect which will be briefly explored in this paper.

WHY DOES INNOVATION TAKE SO LONG?

In the context of history, innovation today is progressing at an alarming rate, possibly challenging the speed at which humans can evolve to match the changes that are occurring. Nevertheless, as this conference illustrates, many wish for the innovation to increase at even faster speeds to 'maintain competitiveness'.

A new technology is invented and recognised by those who wish to develop their competitiveness/performance. People become excited about the technology (especially research funding agencies) and investment pours in to the point where the potential is over-hyped for that point in time! The technology fails to meet the unrealistic expectations and disillusionment sets in followed by a severe negative reaction and investment dries up. In time it is realised that the potential is still there and we gain an improved understanding of what it will do and how it links to all sorts of other issues related to human development. Investment begins to increase until it reaches a sustainable level and is subsequently overtaken by the next innovation. Then the cycle begins again.

To those engaged in research and development this is a familiar pattern. There are far too many examples where the gap between recognition and sustainable development can be measured in decades and the question must be why this is so. We will all have our own views but it may be worth considering what one research study has revealed about the process of transferring ideas into practice. Undertaken by the Industrial Research Institute. Inc. Washington DC (1999) it shows that in manufacturing industries it takes about 3000 ideas to generate a single new product or service and there are various stages along the way. In some organisations such as Boeing such a process is more formalised and at each stage of the process additional resource is added to take the development further. In the early stages it might be nurtured by involving a mentor/manager to explore the idea further. As time goes on more 'hand holding' might be added and then cash and other resources allocated to examine, test and create prototypes until the decision can be made to manufacture. An interesting comment made by the study is that it is almost never the original idea that is enacted. In other words it is the process which is important and there is learning and feedback throughout the innovation trail.

It is also important to realise that there are few ideas generated that are completely new. Most arise from other work, which can lead to a new juxtaposition of ideas and which then leads eventually to the new product. The ideas arise from a complex inter-action between established knowledge, new research and a context of self improvement and practical experience and the balance between these aspects will depend on the individual with the idea and the nature of the problem being addressed.

Service industry improvement and innovation is likely to follow similar lines although the formal stage by stage approach is seldom there. However, the filtering and investment requirements must exist even if they are not made explicit. There tends to be an iterative process along the way involving feedback loops and new insights which may be the reason that the original idea gets modified to the point where it is almost forgotten by the time the product is commercialised.

Many of the books relating to innovation talk about the need to "Think, Play, Do" (Gann D. 2004) or words to that effect. In practice this means that ideas are presented, some kind of simulation where experimentation can be undertaken follows, and then implementation occurs. There are parallels in some other work such as Lester Thurow's 'Zero Sum Society' (1980) where he uses the analogy of road building to identify different types of research. He describes the first stage as *Scientific Research* where the terrain is explored to see the direction a road might go. This is followed by *Engineering Research* which determines 'How' the road should be built and whether it is possible to do it. Lastly he suggests a form of *Implementation Research* whereby it is discovered whether it is possible to build the road effectively in terms of economic cost and time. There is inter-dependence between these

different types and it would be unwise to assume that the latter can exist without the preceding types being enacted. In the case of the applied industries such as Property and Construction it is usually the use of generic research developed independently of the industry which is then harnessed for application in the applied domain. A familiar example would be the adoption of general software in the IT industry and making it applicable and useful for construction design and management professionals to use.

Nick Valery is quoted in an editorial (R&D Efficiency 2004) in his summing up of the 2nd Annual Innovation Summit for the Economist in San Francisco 2004 as suggesting that change can Come in many forms:-

- From the unexpected
- From an incongruity between what is supposed to happen and what does
- From a refusal to accept the inadequacy of a product and process
- From a sudden change in the structure of the market

It is the third and fourth of these in which clients or stakeholders are largely engaged in promoting change and innovation.

Valery also echoes the content of Figure 2 when he describes one approach to an innovation strategy to be:-

- Scan the environment
- Select the ideas which give the best chance of giving a company a competitive edge
- Resource those ideas
- Implement the result
- Review the strategy to see if it needs to be altered. This he considers to be the most important!

He goes on to say:-

"The real test of an innovation strategy is sustained growth from continual innovation."

CLIENTS DRIVING INNOVATION

The usual definition of innovation (Websters) is *to make changes by creating something new.* This is a rather all-embracing definition and does not distinguish between innovation and invention very well. The CRC in Construction Innovation in Australia suggests that it is to do with 'driving ideas into practice' but again this does not clarify the situation. The nature of 'clients' is also difficult to define as during the life of an asset many hundreds of people can claim to be the sponsors or users of projects to varying degrees. This is why the term 'stakeholder' seems to be gaining more acceptance. However the concept is one of the 'demand side' of the industry driving the 'supply side' to do better. Even this runs into problems when the demand requires something original from the service provider and therefore the appointment of a professional who has demonstrated that they can innovate. Who is doing the driving? In this case the demand side is responding to innovation already demonstrated by the service supplier. This is particularly the case with the appointment of signature architects. Many happy, but fruitless, hours can be spent discussing these issues! Looking at significant case studies can however be useful.

Case study 1: Micro-filtration membranes in the water industry

In this example the client was the water supply company for the North West of England called 'United Utilities'. In 1996 there was a drought in the UK and current water stocks were exceptionally low. This required a quick response which needed to be cost effective. The problem they faced was that the conventional way of purifying water was basically to add chemicals to coagulate the impurities, then let the solids settle out by creating 'quiescent' or very still conditions. This requires the construction

of very large open structures and it is not unusual for the construction and commissioning of these tanks to take two to three years. It was not possible to wait that long.

The response from United Utilities was to adopt the process of micro-filtration which had been researched and developed in the 1970s but it was not until the 1990s that it was taken up by the water industries. This required a completely different process and plant and was more like a chemical processing plant than the heavy engineering traditional approach.

In February 1996 a decision was made to build an 80 million litre a day plant. The plant was delivered in July 1996 and it was the world's largest micro-filtration plant at that time. It went into immediate use and the cost effectiveness of the technology was demonstrated. This innovation produced considerable savings in land use and the elimination of sedimentation. The modularisation of the process increased flexibility plus speed of construction and the water quality improved as there was a physical barrier to contaminants. In addition there was a retrofit capability allowing use of different membranes and a reduction in chemical usage.

Barriers to this innovation did exist. Previously there had been only limited large scale demonstration projects. It was difficult in a cost-cutting environment to investigate and develop the new technology. There was the problem of social consensus – would the public trust the new technology? There was no risk-sharing mechanism as nobody wants to be the first example of anything which has an impact on health! There was insufficient training and education of the industry personnel to assimilate the new technology and the existing infrastructure was not suited to the new approach which was more related to production engineering. There were not many benefits for linear scale up and revenue costs were higher.

However the lessons for adoption of innovation of this type are clear:

- A real need must exist
- The client must be prepared to shoulder a substantial portion of the risk and not be risk averse.
- The technology must be mature enough for an informed decision to be made.
- The potential for improvement must be significant
- In matters of public concern, health and safety must not be part of the risk.

Case study 2: Integrated design, management and manufacture through IT

Design is the discipline which probably has more impact than any other on the process of innovation of the product and to some extent the processes of property and construction throughout the life cycle. Almost by definition a new and often novel solution must be found to a particular client's problem. In this case the designer is the agent of the client bringing his or her skills to drive towards something new which satisfies the clients' requirements. Often there is a mismatch and the question of 'meeting client needs' arises as a key issue in many future studies (e.g. Hampson K and Brandon P (2004)). The role of information technology in understanding, communicating, recording, testing, simulating and demonstrating ideas and solutions is considered by many to be the key to real advancement of the industry and the role of clients.

One of the best exponents of the use of technology is the firm of Frank Gehry Associates who have taken established technology used by other industries. In this case it was the CATIA system developed by Dassault Systems, originally for the aircraft industry, and they applied it to new building design and construction. Frank Gehry is one of the world's foremost architects and has produced a string of exciting designs including the Guggenheim Museum in Bilbao and the Walt Disney Concert Hall in Los Angeles. Frank Gehry (Gehry, 1999) works through a number of phases, which include sculpturing, drawing, analysing function, determining needs and experimenting with new materials. The design process defies normal conventional design and the complexity of the product requires new

methods of representation and manufacture. This is particularly so with regard to future planning and alteration of the finished product.

The designer, in this case, required a technology that would not hinder his process in producing original novel designs but also supported him in the method he adopted to realise his imaginings and to evaluate his proposals. It should also be linked to the manufacturing process so that materials and fabrication can be manufactured off-site to tight tolerances and be easily assembled. In addition the designs were so complex that it was important to take the client with him on the journey of design and therefore visualisation was important. It was these significant factors that led to the choice of a technology from another industry where these matters were already being resolved.

Gehry (1999) makes the following point :-

> *"The new computer and management system allows us to unite all the players …..with one modelling system. It's the Master Builder principle. I think it makes the architect more the parent and the contractor more the child – the reverse of the twenty first century system.…..In Europe there is a person called the mettier that takes off the quantities of the building. We don't need him anymore. The computer does that in an instant….as we design we have an instant mettier that takes off as we go. Consequently I am designing with specific conditions and I don't go out of bounds".*

Traditional CAD systems did not seem to meet the needs of the client's agent. As Lawson (2004) has said 'real computer aided design will support the *thinking* of designers rather than the superficiality of their drawing actions.' The CATIA system and its companion systems allow representation more easily, can use laser scanning to input physical models, evaluate from a variety of different perspectives, transmit data to manufacturing plant, can provide a common model for the whole of the design team, can simulate process, allow immersive visualisation, facilitate setting out direct from the model using laser technology and a variety of other tools.

The Gehry partnership, in which Jim Glymph is the technical partner responsible, is relatively small with perhaps 60 employees. However, it has transformed its process of design and opened up new avenues for creativity through technology that has not constrained the methods of the creative designer. This is an important point when it comes to innovative design. Changing the thought process of the designer to suit a technical requirement can result in poorer design or possibly complete frustration. As Gehry (1999) says regarding CATIA *"They're tuned into understanding the way architecture is practiced* and can make new buildings possible – more exciting shapes in the landscape instead of just plain boxes."

The lessons for innovation from the use of CATIA by Gehry are as follows:

- The need for technology to support imaginative processes to meet the client's demands was paramount to the client's agent, the designer. It could not be achieved by conventional means.
- It was necessary to go outside the construction industry to find a mature technology to meet the needs of the designer.
- The technology enabled risk to be understood more easily through visualisation and simulation to enable 'try before you buy'.
- Integrating models allowed a reduction in risk by designers and contractors in complex and new situations. The interface problem at this level was removed.
- The technology company was willing to adapt to the designer's need for flexibility and improved manufacturing tolerances.
- The culture of the company was one of continuing innovation. This latter point is key. As Jennifer Chatman is quoted as saying (Editorial, American Innovation, 2004) *"Sustainable innovation requires embedding the value of innovation in your company culture"*. She goes on to point out that a culture will form anyway and it is too important to be left to chance.

These were all important drivers for innovation and subsequently a new product is being developed known as Digital Project, based on CATIA, which will be specifically tailored to the construction industry.

VECTORS, VISIONS AND VALUES

The above case studies have illustrated some of the key factors that relate to getting ideas into practice. A key factor is necessity or meeting a particular need at a specified point in time. If there was not a drought, would the micro-filtration technology be adopted? If Gehry had not wanted to create new and exciting designs, would Digital Project be on its way? In this case necessity is the mother of innovation. The technology needed to be available but its application needed to wait until a whole series of circumstances were brought together in a benign union. The case studies are just examples but there are underlying generic issues that can be identified related to the innovation process.

Firstly, there needs to be tools available which are sufficiently mature to be adopted for commercial development and implementation. These tools are usually measurable and indicate a general direction for improvement. In a general way (admittedly rather loosely) they might be called **'Vectors**'. A Vector might be defined as 'a quantity completely specified by magnitude and direction'. Many of the technologies which are used for innovation are physical or virtual tools which can be represented and quantified giving a sense of direction to the improvement that can be expected. They have been created and tested and their performance can be assessed, perhaps not completely, but certainly in such a way that a level of confidence can be placed in their use. They provide a part of the kit that is absolutely necessary for the innovation and implementation to take place. Without them a vague wish list would be created without the means to realise the demands being made. In the two case studies it was the research and development that had taken place that produced tools that could not only do the job required but also give a sense of direction as to where the improvement might lie. It is not always evident what the total future benefit might be.

Secondly, there is a need for **'Vision**'. If the thought processes of the client or the industry are fixed on the current position in today's practice then it is unlikely that the potential for the future will be realised. The industry will fossilise around its own set of problems and solutions. Indeed, it could be said that the history of construction has been one of creating and solving its own problems without considering how technology could help. Too few people have looked up and seen what has happened in other industries and developed a clear vision of what can and should happen to property and construction. There is no reason why construction could not have been the lead industry on so much innovation but its structure and attitudes have made it a perpetual runner up. Many of the people now driving innovation in construction have come from other industries and seen the weaknesses of our processes. The length of construction's history and its craft nature are probably major factors in why innovation and sensitivity to research are not high on the construction industry agenda. Directions are needed and quoting Steve Betros (CEO of the Facilities Management Association of Australia), "*I think it is pretty hard to get somewhere if you don't know where you're going*". This is one of the reasons why the CRC undertook a 2020 visioning exercise engaging a wide spectrum of contributors. Innovation needs this understanding of the future potential to give it purpose, encouragement and a fertile ground for operation. Without this vision the industry will focus on tactical issues based on the here and now and forget the strategic potential for change that will give it competitive edge. In the case of construction it is not only competition in markets across the globe but also in attracting the best personnel who have the ability to move the industry forward.

Thirdly and finally, the industry must address the **'Values**' of the society in which it performs. If innovation is to take root then it has to be sensitised to the needs of those who can benefit from it. At

the same time it must not undermine the interests of others, unless society too can see some longer term benefit related to its value systems and possibly make amends to those who suffer from the change. If the values are those of the market then meeting demand will prevail over all other issues. On the other hand, if society believes that the market forces need to be modified (e.g. to consider the needs of future generations as expected in sustainable development) then the market forces will be modified through a whole variety of social forces such as the legal and regulatory framework and the education system.

In the Construction 2020 exercise (Hampson K. and Brandon P. 2004) the prevailing visions were those related to meeting the needs of society and the industry and the remainder related to the technologies that would enable these value systems to be put into effect and improved more easily. (See Figure 3.3)

Figure 3.3 The Relationships Between the Main Themes of the CRC Construction Innovation Visions

Potential Impacts: Strong / Medium / Weak	**Design & Communication**		**Process & Manufacture**	
	ICT	Virtual Prototyping	Off-site Manufacture	Improved Manufacturing Process
Environmentally Sustainable Development				
Market Environment (meeting client needs)				
Business Environment				
Working Environment				
Research and Innovation				

(Source: Hampson and Brandon, 2004)

In the diagram above the items on the vertical axis relate to values and in particular meeting different people's needs. Sustainable development is related to meeting the needs of future

generations; market environment is meeting the needs of clients; business environment meets the needs of industry; working environment meets the needs of personnel; research and innovation meet the needs for self improvement. The horizontal axis on the other hand provides technologies that have the potential to facilitate the meeting of these needs. Without these value systems the technologies would have little value. It is these driving forces that provide for innovation to take place and drive ideas into practice.

One of the major problems today is that we live in a world that has technology and ideas available in plenty but they do not necessarily relate to the values that society (or in this case, the part of society relating to the Property and Construction industries) considers to be important. This link with society's values is seldom made explicit in research of whatever kind and therefore a gap exists between what is provided and what is wanted. We have our tools and we have a vision of what we would like to be but the value systems that underpin our choices are often understated.

In much research we create the tools and techniques but do not place them within the framework of society and the values that that society holds. Consequently the value of that research is not recognised until some time later when that connection is made. This brings us back to Figure 1. Why is there the gap between periods recognition and improved understanding in so many projects? If the above discussion holds good then it can be summarised as follows:

- The research on the tools, technologies and techniques must continue and be made available otherwise the means by which the expectations can be realised, will fail. These provide the mechanisms by which progress can be made and give direction to what is possible in the future.
- To achieve take-up of these tools the industry needs a vision of where it wants to be and this provides the aspiration and driving force that will take it forward.
- The final cog in the wheel is the values that pertain to that society and that provide the fertile ground on which the innovation culture can grow. These also determine the value that will be placed on the innovation and the level of investment that will follow.

All three are essential for innovation to take place but the most important is understanding the values of the people and society from which the stakeholders for the built environment are found. If they have already been or can be convinced that change is necessary for improvement then innovation will follow. Perhaps we need to overtly include in all applied research projects an assessment of how the research is expected to impact on the values of society.

A final thought for those who want to remain with the status quo……

"Soon you will attain the stability you strive for. In the only way it's granted. In a place among the fossils of our time" (Jefferson Airplane)

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CHAPTER 4

Occupational Health & Safety – The Caring Client

Bill Wild

INTRODUCTION

Does anyone care?

When you look at occupational health and safety (OH&S) statistics in the construction industry – fatality rates three times the national workplace average; injury rates 50% higher than in other sectors; long term compensation claims double the national workplace average; and a plethora of long term health issues such as hearing loss – one has to ask whether anyone in the industry cares about occupational health & safety … and unfortunately, I think that it is fair to say that many in the industry don't.

Certainly there are sectors of the industry that have very poor statistics, even against the low achievement of the construction industry itself. If these statistics are a measure of "Caring" in any significant way, then these sectors certainly don't care.

However, some parts of the industry do care.

In particular, we see clients who stand apart in the requirements they impose on themselves and their contractors and the effort they go to in order to improve safety in their operations.

The importance of "caring clients"

One of the things that are abundantly clear in occupational health & safety management, is that success is driven from the top – in the client/contractor equation, by the client, and within the individual organisations, by senior management.

Therefore, when you see a very good OH&S performance on a venture or a project, you can be pretty sure that at the top of the structure is a "Caring Client".

You can also be pretty sure that as you go down the "food chain" you will find "Caring Contractors" – caring clients simply do not accept contractors who aren't, irrespective of commercial and other considerations. Of course in turn the caring contractors are "Caring Clients" to their subcontractors.

You will also find that in these "Caring" organisations, the responsibility for good OH&S behaviour is not just accepted by senior management, but is driven by those people personally. In such organisations it is usually the CEO or even the Chairman who is the champion of the "Caring" culture.

I will therefore be talking today about "Caring Clients" and describing some of the things that caring clients, and caring contractors such as John Holland, do. A lot of what I say is really about "attitude", because good OH&S behaviour is a culture without which good outcomes are simply not possible.

The presentation

Before I look at particular "Caring Clients" and some of the things they do, I will talk a bit about the industry and some of the issues that now confront it.

I will mention my company John Holland, not just for the opportunity to get a plug in, but because I believe that we have established a position in the industry that entitles us to speak about some of the industry's successes and its shortcomings.

I will talk a little about the Cooperative Research Centre for Construction Innovation (CRC-CI) and a project it is undertaking which probably illustrates how far we have to go in the construction industry.

In presenting an overview of the wider industry, I will present a few statistics and touch on some of the behavioural issues that we face. …and while talking about behaviour, I will touch on a topic that is starting to get some real attention, and assuredly will get a lot more in the future; that is the changing compliance aspect of OH&S management. If the legislative requirements themselves do not impress on industry players the need to become "Caring", I expect that some of the penalties applicable under new legislation may.

I hope that case studies on "Caring Clients" that I will present, will not only give credit to their achievements, but will show the way forward for others.

JOHN HOLLAND

John Holland's history

Firstly, a bit about my company.

John Holland & Co. was founded in April 1949 and soon after began its first project, a woolshed on the property of former Prime Minister Malcolm Fraser at Nareen in Victoria. John Holland grew strongly in the post War years and through the 50's and 60's, came to be acknowledged as one of Australia's leading engineering contractors.

After a period of difficulties and several ownership changes during the late 80's and the 90's, John Holland's ownership changed again in February 2000. Now it is owned 70% by the listed Leighton Holdings Limited and 30% by Janet Holmes à Court's family company Heytesbury Pty Ltd.

Over the past few years John Holland has undertaken a number of strategic acquisitions, including the rail equipment supplier and operator Loram, the building company Fletcher Projects, and another iconic Australian construction company, Transfield Construction.

John Holland Group once again is one of Australia's largest general contractors with uncompleted work in hand of more than $2 billion and annual revenues of approximately $1.7 billion. We directly employ 2,300 people, of which 1,100 are salaried staff.

As well as being one of the largest construction contractors, John Holland is arguably the most diverse.

John Holland is a leader in civil, structural mechanical and process engineering, and it has a large building business. We are the industry leader in rail, tunnelling, water and power transmission systems.

John Holland prides itself on engineering excellence, professionalism, ethical behaviour and strong client relationships. We are recognised as an industry leader in occupational health and safety.

Commitment to safety

At John Holland our commitment to the health and safety of our employees and others involved in our work is central to our business culture. We are determined not just to be, but to be recognised as the industry leader. We strive to achieve our vision of "no harm".

This preoccupation with safety is ingrained in John Holland. However such a company culture is not achieved or maintained unless it is driven personally by the company's leadership.

Without doubt the primary driver in our case over the past decade and a half has been our Chairman, Janet Holmes à Court. Janet has a fervently held belief that "we should send home our employees in the same condition they were when they came to work". She continually talks safety and, more importantly, she walks the talk. Janet visits sites, undertakes formal site
safety inspections, and talks to staff and the industry about safety. She gets the message across, as much to the management and workforce of the company as anyone else, that John Holland demands a total commitment to safety.

I believe that over the past four years I have strengthened this commitment even further. It is a strongly held view of mine that we, both as a company and personally, have a moral obligation to ensure that the health and safety of our people is the paramount consideration in all our operations. Our determination to be safe must be driven by a belief that safety is an end in itself, not just "good business".

I think that John Holland is a caring contractor and, to our subcontractors, a "Caring Client".

OH&S management in John Holland

John Holland recently undertook a full, formal review of our occupational health and safety performance, our management systems, and the way we go about planning for and implementing workplace safety.

This review quantified where we want to be on performance; it identified areas where we need to improve; and it established what we need to do to achieve the level of targets we had set ourselves.

Among the principles that drive our "Improvement Strategy" is that we want to be self motivated and self regulated. We want to have and maintain minimum standards for ourselves which apply no matter where we work, what type of project we undertake, or what the client and indeed legal expectations are.

I believe that this is also a key identifier of a "Caring Client". It is a determination to set standards on the basis of your own belief in what is right, and to lead the way in implementing and enforcing those standards.

COOPERATIVE RESEARCH CENTRE FOR CONSTRUCTION INNOVATION

The CRC

John Holland is one of the founding participants of the Cooperative Research Centre for Construction Innovation (CRC-CI). While we are engaged in the overall activities of the CRC-CI and directly participate in many of its research projects, of particular relevance to the topic of this paper is our leadership of the project titled *Safety Critical Positions: a Safety Management Competency System for the Construction Industry*.

The safety management competency project

Surprising as it may seem, our industry does not have a competency system in place. The industry does not have a "Standard" which for example sets down those positions considered "safety critical" and what competencies are required of the people in those positions.

Dean Cipolla, the John Holland Group Safety Manager, is the project leader for this research which is being carried out in conjunction with Bovis Lend Lease, the Queensland University of Technology and the University of Western Sydney.

Specifically, the project will identify and then set down implementation requirements dealing with:

- which management and supervisory positions are critical to safety performance;
- the tasks and functions of those positions;
- the skill and behavioural competencies required by persons who occupy each of the positions; and
- the training, exposure and experience required to achieve those competencies.

The ultimate goal is the development of an industry standard, *Construction Industry Safety Critical Positions and Required Competencie*s. We hope to work with NOHSC to introduce these standards into the industry.

In this project, we are a "Caring Client" driving innovation in occupational health and safety.

THE CONSTRUCTION INDUSTRY – AN OH&S OVERVIEW

Industry behaviour

The Royal Commission into the Building and Construction Industry in Australia found that:

> *"…the OHS performance of the building and construction industry is unacceptable"*

and

> *"…the poor performance was found to be as a result of the industry striving to complete projects on time and on budget, and that too often these competitive forces work against OHS standards which are neglected as being too expensive and time consuming."*

Without wishing to disagree with the Royal Commissioner, I must say that I believe that the poor performance of the industry – and it is indisputably poor – is not a "result" of time, budget and competition issues, notwithstanding that they are substantial issues in the industry. The poor performance is a result of a lack of commitment to safety on the part of clients and contractors. If that commitment was there, then irrespective of other pressures, safety would be paramount, and we would be seeing a much better safety outcome.

It is about time that the industry stopped seeing other elements of the business such as profitability and performance as somehow necessitating that safety be disregarded. Safety is not inimical to profit and performance, in fact the contrary. Nor is safety something that can be given a lower priority when times are tough and other pressing issues occupy management time.

Statistics

Data

One thing that becomes very evident whenever one tries to present safety statistics is that there are plenty of them, but rarely are they consistent. Substantially different indices are collected, and very different definitions and data are used for what are, on the face of it, the same indices. Until this is resolved direct comparisons are very seldom useful.

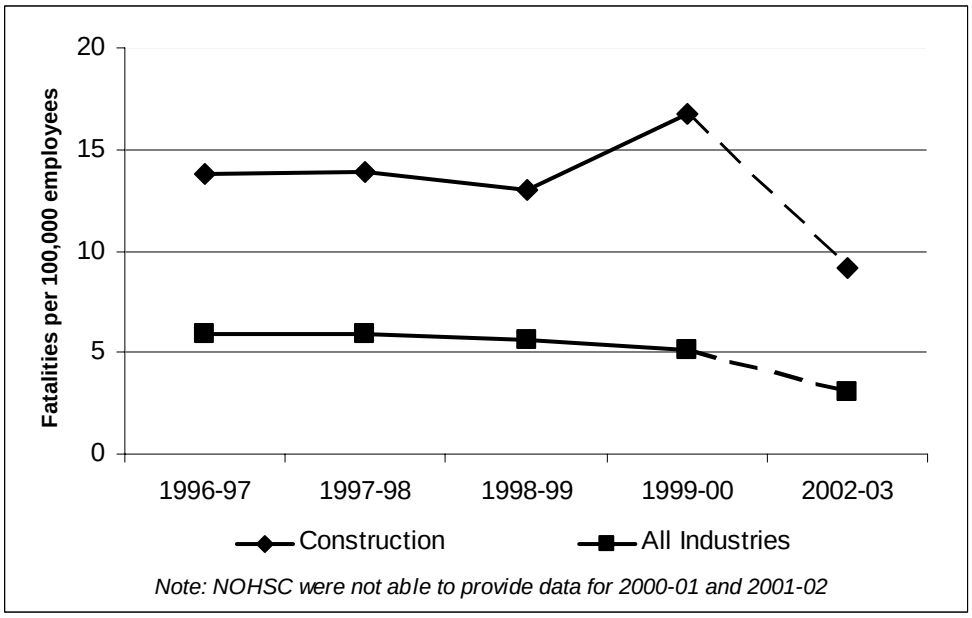
Notwithstanding, we can only run with what we have, and hope that they tell a sufficiently accurate story.

Fatalities

There are more than 50 fatalities in the Australian construction industry each year. This fatality rate is comparable to the USA and Europe, but it is double that in the United Kingdom.

In 2002-2003 the incidence of workplace fatalities in the construction industry in Australia was 9.2 fatalities per 100,000 employees, which is nearly three times higher than the national workplace average of 3.1.

Figure 4.1 Fatalities



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Injuries

The usual industry measure of injury frequency, the Lost Time Injury Frequency Rate (LTIFR), is 50% higher in the construction industry than it is across all industries. (Refer Figure 4.4)

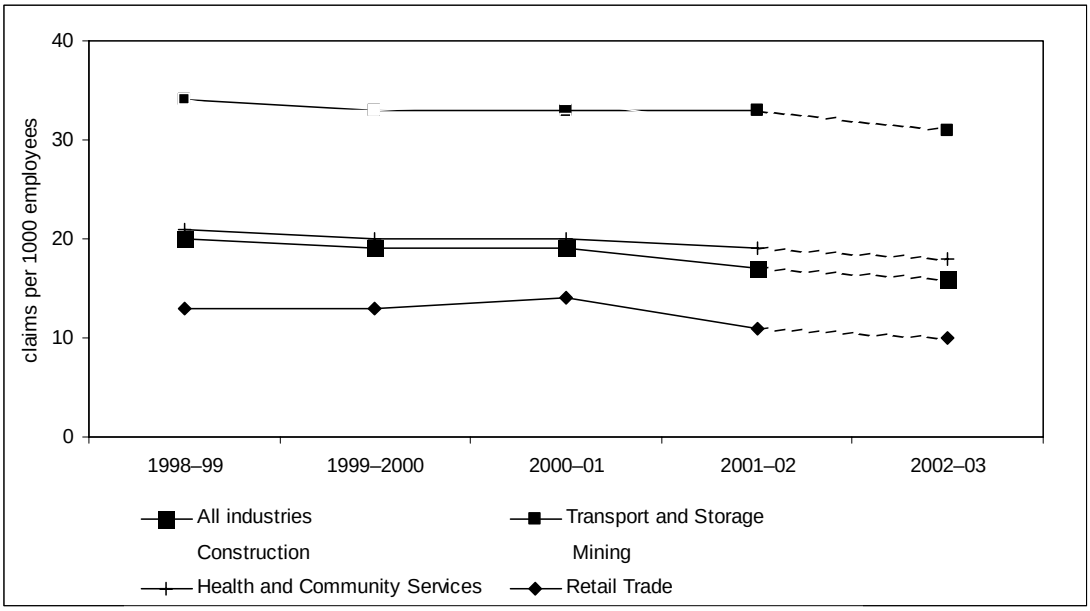
Compensation Claims

In 2002-2003 the construction industry employed approximately 5% of the Australian workforce but accounted for 9% of the accepted workers' compensation claims involving one or more weeks off work.

Compensation claims in the construction industry for 2002-03 were 27 claims per 1,000 employees. While this was a decrease from a rate of 34 claims per 1,000 employees recorded in 1998-99, it is still much higher than the current national average of 16 claims.

When compared with particular industries, construction lags not only in its performance but in what we are doing about it. The mining industry for example has worked very hard over the past few years to improve its performance, and the results show that they are making progress.

Figure 4.2 Compensation Claims By Industry



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The Industry Players

Clients

Clients have differing standards and expectations. Many contractors in the construction industry change their level of safety management to suit the projects they are undertaking and the requirements placed on them by clients, contracts and base legislative requirements. This is across the industry, especially with medium and smaller contractors.

Contractors

The 15 or so largest contractors in Australia comprise the Australian Contractors Association (ACA), and they represent the large contractors. However, in total there are some 4,500 identified "construction contractors", and they range from the members of the ACA, through smaller though nevertheless substantial firms, to a plethora of very small, even Ma & Pa organisations.

The industry is notorious for its low barriers to entry, and not only do we have these small operators, many of whom are undoubtedly efficient and honourable businesses, but we also have a full range of far less honourable operators, including the infamous 'phoenix' sub-contractors, which were exposed in the recent Royal Commission.

In the absence of genuine client commitment to safety, and unless there are effective pre-qualification schemes in place to eliminate these companies that have no commitment to safety, then we will continue to see safety compromised in the interest of price.

The Australian Constructors Association has been addressing safety performance of the industry and a couple of years ago started to collect and compile the safety statistics of its members. It was not an easy exercise.

Firstly there was the inevitable difficulty with confidentiality – I guess members were either jealous of their own results or embarrassed by them. However, eventually a process was developed to everyone's satisfaction whereby results would be collected and published in a way that showed the figures for the ACA in total by quartile performance. Each contractor was to be presented with his own figures so that he could compare them against the
results of the unidentified others.

Then came the problem of what data was being collected, and what statistics should be compiled. There were as many options and views as there were members of the ACA. It was interesting to find that national standards were of little help.

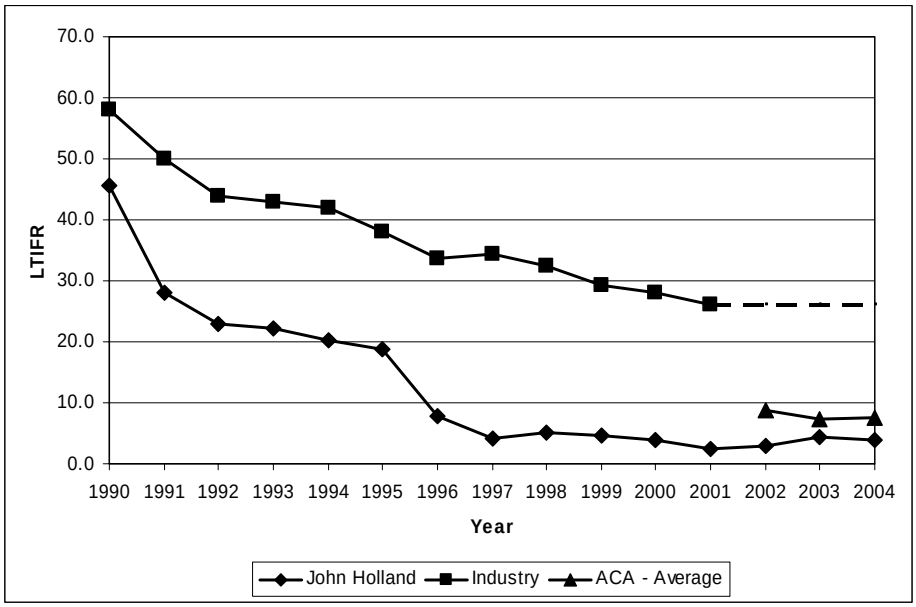
Eventually it was agreed what statistics should be collected and how they should be defined and compiled.

It has been running now for a couple of years and the various problems are getting bedded down. The data is proving to be both enlightening and useful.

Eventually the ACA will be publishing the results, although not in a way that identifies individual performance. But of course that is enough, because each contractor knows that clients will eventually use this information in prequalification assessment and they will ask a contractor where he stands in comparison to the ACA figures.

The ACA is behaving as a "Caring Client" with this initiative. It is a great pity that the rest of the contractors, whose statistics are four or five times worse, do not have the same focus or interest.

Figure 4.3 Lost Time Frequency Rate



(John Holland figures after 1997 are for the financial year)

(Source: Adapted from NOHSC, 2004)

The workforce

The workforce itself is probably one of the biggest difficulties. It is itinerant and there is a high degree of staff mobility, and this makes it difficult to instil a robust safety culture or to undertake effective

training. Furthermore, much of the workforce is employed by first and second-tier subcontractors and is only indirectly responsible to the principal contractor. Those subcontractors each have their own safety culture, commitment and practices. Many have no interest in safety.

To make matters worse, sections of the union movement see safety as an industrial tool. They impose strikes and bans ostensibly on safety grounds, but really as industrial leverage. Some of the union organisers would not have done a proper safety inspection on a project in decades, but they are vocal and seemingly sincere about safety when they shut a contractor down for alleged safety breaches. More often than not the safety issue seems of secondary importance when negotiations start.

It is also amazing how many unsafe contractors and subcontractors, generally the smaller ones, seem never to have safety issues with the unions even though their safety performance is abysmal. Presumably they satisfy the unions in other ways.

If Governments are serious about safety they will legislate to prevent safety being used in this manner.

Compliance issues

Establishment of FSC and a national code of practice

The Royal Commission recognised that *"Governments fund a significant proportion of building and construction activity … and are therefore important clients of the industry."* It proposed the introduction of a Federal Safety Commissioner (FSC) as part of a package to ensure that the Australian Government leads by example and fully uses its powers as a client to improve safety outcomes.

It is intended that the FSC will:

- develop a National Code of Practice for Safety on Commonwealth Government funded projects
- raise the level of consideration that is given at the design stage to reducing, if not eliminating, the OH&S risk in construction;
- manage an OH&S accreditation scheme for Australian Government building and construction work;
- build commitment to improved OH&S performance; and
- raise compliance levels with OH&S law.

This initiative has been adopted by the Commonwealth Government, and we hope to be involved in the development of the proposed Code of Practice and the associated audit processes.

If action in this regard does eventuate, then the Commonwealth Government will certainly be acting as a "Caring Client".

Prosecution and penalties

In recent years there has been considerable pressure on State Governments from the community and from the union movement to introduce more stringent legislation and harsher penalties. Most of the States have either done so or are in the process of doing so.

This legislation is targeting not just the companies themselves, but their officers and directors.

Section 26 of the Occupational Health and Safety Act 2000 (NSW) for example states that:

> *"If a corporation contravenes, whether by act or omission, any provision of this Act or the regulations, each director of the corporation, and each person concerned in the management of the corporation, is taken to have contravened the same provision unless the director or person satisfies the court that:*
>
> *(a) he or she was not in a position to influence the conduct of the corporation in relation to its contravention of the provision, or*

(b) he or she, being in such a position, used all due diligence to prevent the contravention by the corporation."

Whilst this Act provides one of the clearest and most direct statements of directors' and managers' liability, similar provisions exist in the Acts of other states and territories.

The penalties that can be applied for breach now are very substantial, and in a number of jurisdictions can include jail terms even for first offences. While no one can reasonably object to such penalties where management flaunts the requirements of good safety practice, there are elements of the legislation that seem directed more at placating the unions than ensuring that safety management is the real beneficiary.

One must be generous enough to say, however, that the States are behaving as "Caring Clients" in bringing in these changes. But it is a pity that there has not been more recognition given to what I believe are genuine concerns with some aspects of the legislation.

CONCLUSIONS

The construction industry's OH&S performance is poor in comparison to that of other industries.

It is clear that the diverse and mobile nature of the construction industry presents it own problems in terms of effective management of health and safety, but this doesn't excuse the poor performance.

The final report of the Royal Commission into the Building and Construction Industry stated that *"Too often safety is neglecte*d." This is unfortunately true.

The whole industry must come to the understanding that legal compliance is necessary but not enough. Legal compliance may prevent prosecution but it will not prevent injuries and incidents. Furthermore, if we as an industry set our sights on legal compliance alone, we will ensure that increasingly onerous legal obligations and legal penalties are imposed.

Firms and the industry collectively must set their own standards that are substantially above those mandated by legislation. They must take it on themselves to be proactive in pushing the boundaries and finding ways to make their own operations safer.

"CARING CLIENTS" – SOME CASE STUDIES

Comalco alumina refinery

The Project

The new Comalco Alumina Refinery in Gladstone, Queensland was constructed under an Alliance comprising the client, his EPCM contractor and a number of subcontractors. John Holland undertook a major portion of the structural steel fabrication and erection, pipe work installation, and the assembly, installation and alignment of pumps, materials handling and other process equipment.

Under the Cost Reimbursement Performance Incentive there was provision for reimbursement of direct and indirect costs, payment of a fixed fee and payment of an incentive based on performance. The payment based on performance took two forms: a payment based on performance against overall key performance indicators (KPI); and a bonus payment to the workforce teams under a Team Based Performance Incentive Programme.

The contracting arrangements were innovative and the outcome on the project was excellent, with the project completed on time and within budget.

Comalco and its parent company Rio are also extremely focussed on OH&S management and performance. They have a number of internal programs which are leading edge, including a comprehensive Behavioural Based Safety programme. They demand that their contractors and subcontractors are equally focussed, and will not tolerate behaviour that is less than the best. They are willing to pay for good safety performance, but on the other hand they demand it unequivocally.

Client initiatives

Comalco set “zero incidents” as the target on the site and to support this “zero incidents” focus they established a number of initiatives.

The KPIs for both the company and the workforce teams had safety performance as the top weighted item. The impact of any safety lapse was financial and immediate.

Other initiatives demonstrated their commitment to the “zero incidents” goal:

- Safety was the first item on the agenda for every meeting held on site;
- Each construction group was assigned a Safety Advisor to work directly with their OH&S personnel to promote efficient open communication and speedy resolution of any issues as they arose;
- A process of managing safety (lead indicators) was employed instead of solely looking at the statistics (lag indicators). This was a key element of KPI assessments and the Team Based Performance Incentive Programme;
- Comalco actively promoted the People Based Safety Program (Behavioural Based Safety) which called for the involvement of all staff members. In John Holland’s case over 40 planned “job observations” were performed each week;
- Employees were empowered to participate in the programme and were provided with one-on-one feedback to constantly improve understanding of the process;
- All supervisory personnel actively participated in the Project Leadership programme as well as the training of Core Skills for Supervisors;
- Innovative ideas for improving safety in the workplace were encouraged and received from the workforce, and individuals received Excellence Awards for their contribution.

John Holland on the Comalco alumina project

In such an environment, it is not possible or acceptable for a subcontractor not to also be proactive in OH&S management. Accordingly, some of the Initiatives implemented by John Holland included:

- The use of Hazard Based Competency Assessments to ensure that operators were familiar with the occupational health and safety aspect of the machinery and tools that they were given to use;
- Information gathered during the job observation process and incident investigations was collated and fed back to supervisory personnel with daily reports. In turn they fed the information through to the workforce;
- A Hazard Status Board was posted at each work location and the team personnel recorded all hazards identified and the controls put in place to manage them. This information was used to develop a “living” risk profile for the various tasks undertaken;
- “Boot Camp” training for supervisors, designed to ensure that all supervisory personnel had achieved a common standard of understanding of the occupational health and safety requirements of the project and John Holland.

Performance

Table 4.1 Occupational Health and Safety Performance, CAR Gladstone

Hours Worked (end of May)	821,755
Lost Time Injuries	1
Medical Treatment Incidents	3
Lost Time Injury Frequency Rate	1.22
First Aid Incidents	169
Job Observations	1,849
Competency Assessments	3,949
Minor Workers Compensation Claims	60

BWEA alliance

The project

The BWEA Alliance has been established to upgrade three of Brisbane's wastewater treatment plants and have those plants operating by October 2006. The principal objectives are to improve the water quality in Moreton Bay and to provide for future capacity with the best whole of life design.

Client initiatives

This project is also being carried out under an Alliance, which includes the client, Brisbane Water, as an active participant.

Brisbane Water demands outstanding performance in several areas other than capital cost, and safety is one of the highest rated. To reinforce this demand, the alliance partners receive incentives for outstanding safety performance and are penalised for poor safety performance.

Alliance partner initiatives

The Alliance has established a number of focussed safety initiatives:

- The Alliance Zero Harm Target is linked with Brisbane Water's own Zero Harm Target;
- Systems of Brisbane Water and the BWEA Alliance are linked;
- Joint inductions are undertaken between Brisbane Water and the Alliance;
- The project team has been given a "Vision" for safety performance;
- Safety is treated as part of the total project delivery by incorporating safety in design, procurement, construction planning and operations;
- A reference group (BSAG) mobilises input from the whole Alliance Team to provide guidance and strategic direction to the programme;
- The operations group is involved in all levels of the project delivery;
- Safety is the first item on all agendas.

Performance

Table 4.2 OH&S Performance, BEWA Alliance

Staff hours	129,353
Direct Project Labour hours	69,506
Subcontractors hours	55,869
Total Manhours	254,728
Lost Time Injury Frequency Rate (LTIFR)	0
Medical Treatment Injury Frequency Rate (MTIFR)	11.77
Medical Treatment Injuries	3

Woodside Energy Ltd phase iv expansion (train 4) for the north west shelf venture onshore LNG production facility

The project

Train 4 is Woodside's new LNG Production Facility on the Burrup.

John Holland's was the contractor for the civil off plot works, which included the concrete foundations for the Power Generation and Acid Gas Removal Unit areas of the plant and all underground electrical and instrument cabling.

Safety in an operating LNG plant is paramount.

Client initiatives

Woodside has one of the most demanding commitments to safety that I have observed. It demands the highest safety performance, irrespective of cost, and it really does practice the "it starts at the top" culture. It demands that its contractors behave as it does.

During the project, I personally attended site on a quarterly basis for "Sponsor Meetings". These meetings went on for a fair part of the day and were meant to address all the project issues that involved the particular contractor. I and our senior regional management and our project manager would represent John Holland, and the General Manager Onshore Projects of Woodside and his senior staff and senior representatives of his contract superintendent all attended. A very high level meeting you would say.

There were usually many pressing issues – program, variations, budgets, industrial matters, technical difficulties, weather etc. However, and notwithstanding that by any measure there were no or very minimal occupational health and safety problems, we invariably spent most of the time addressing OH&S performance and management.

On site, this attention showed. The site "house keeping" was impeccable, with many novel ideas being used to ensure that this was so.

Figure 4.5 Site Housekeeping – Woodside LNG Train 4

The care taken to protect people working at height – any height – was extreme.

Figure 4.6 Foundation Construction Access and Barriers – Woodside LNG Train 4

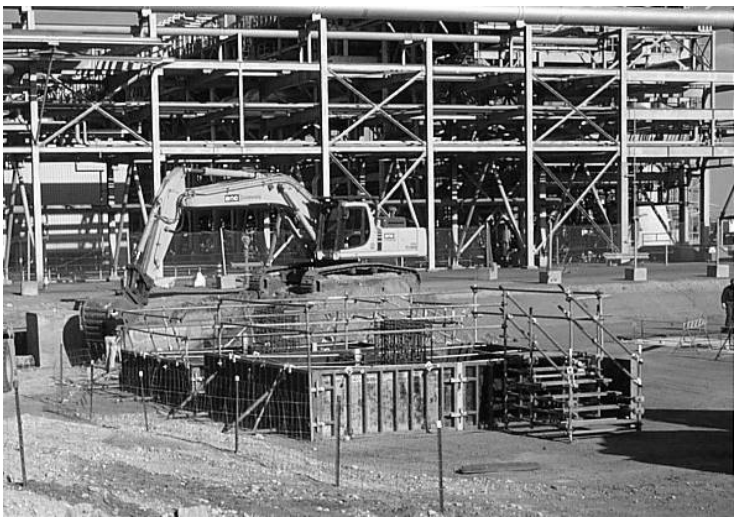
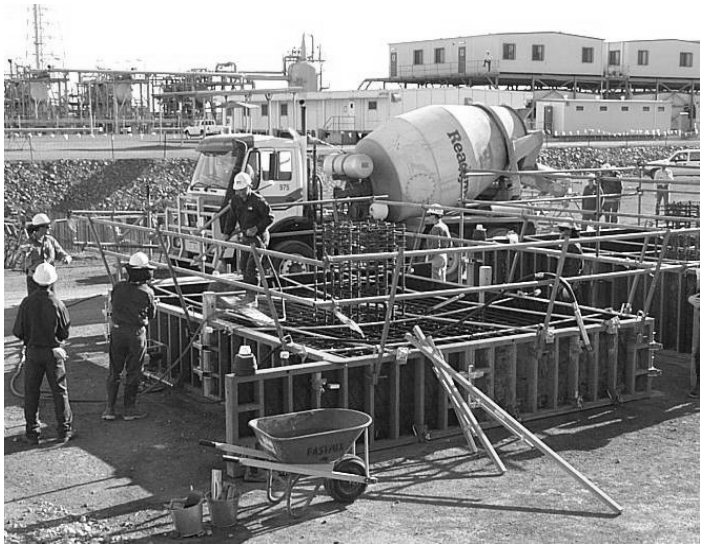


Figure 4.7 Foundation Construction Access and Barriers – Woodside LNG Train 4



All of the workers met in small groups each morning before work commenced for a ten or fifteen minute talk on the safety issues of the day. And these start meetings were attended by management representatives.

Woodside set the most rigorous occupational health and safety targets for the project and staff incentive schemes were designed to ensure that the importance of safety to the company would be reflected in the importance to staff personally.

Woodside initiated tools such as Step Back 5x5, and the Hazob (Hazard Observation/Improvement) Programmes.

Step Back 5x5

Based on the Dupont "Take Five" (minutes) system the Step Back 5x5 system calls for individuals to step back 5 metres and take 5 minutes to assess the risks. Workers carry a small booklet in their pocket which lists a series of questions to answer when doing a Step 5x5.

Hazob

The Hazard Observation / Improvement Programme provides a mechanism by which all individuals participate in identifying potential risks and hazards, and suggesting ways in which processes or practices can be improved. This system:

- promotes a 24-hour, 7-day philosophy to health, safety and the environment;
- empowers all individuals to be advisers on health, safety and the environment;
- raises awareness of others to accident potential, and captures the knowledge and experience of individuals; and
- promotes continuous improvement and accountability.

The number of Hazobs and Step 5x5's that workers did each week were measured.

John Holland initiatives

Under the Woodside leadership, John Holland also pushed its safety management to the boundaries.

We initiated a system called OAR, an acronym for opportunity, authority and responsibility.

This system was designed to:

- assist the project in achieving goals and targets;
- enhance the client initiated health and safety tools;
- reinforce to individuals the newly learnt, project specific health and safety requirements and information;
- formally pass on to each person working on the project the opportunity, authority and responsibility (OAR) to stop any undesired work practices, or have rectified any potential hazards or risks that the identified; and
- encourage individuals to objectively observe and evaluate their workmates undertaking activities, and to discuss with them the work practices, methodology and health and safety requirements in relation to the task specific job safety analysis and the health and safety manual.

Performance

Table 4.3 OH&S Performance, Woodside

Staff	18
Direct Project Labour (Peak)	100
Subcontractors (Peak)	40
Total	158
Total Manhours	193,000
Lost Time Injury Frequency Rate (LTIFR)	0
Medical Treatment Injury Frequency Rate (MTIFR)	10.4
Medical Treatment Injuries	2
Workcover Claims	0

BHP Billiton Port Kembla Bag House

Scope of the Project

The project entailed the erection of building steelwork and installation of mechanical process equipment for the Coal Fines Dryer.

Client Initiatives

The contract was with Dendrobium, a fully owned entity of BHPB. BHPB were directly in all aspects of safety management and performance on their site. They left nothing to chance and demanded very detailed and specific systems, safety deliverables and performance outcomes on John Holland before and during the delivery of this project.

Some of the key initiatives which BHPB initiated on this project were:

- They reviewed their operations and identified tasks and activities which contain hazards which have the potential to kill or maim, and have developed specific "Fatal Risk Protocols" which mandate detailed specific performance standards and requirements for each particular activity on their sites. The requirements within the "Fatal Risk Protocols" were mandatory across all operations.
- Their project construction manager was directly involved in all aspects of safety on site, was involved in all project planning meetings and ensured that safety was the first point on the agenda and considered in all planning activities.
- Safety was the first consideration for any activity to be undertaken. If a full risk assessment and control plan was not in place and approved then no activity was allowed to commence.
- All site managers, John Holland and BHPB were required to undertake formal safety inspections and observations on a daily basis and stay directly involved in workplace safety
- All incidents were investigated jointly by JH and BHPB.
- Employee input in all aspects of task and workplace planning and safety was mandatory.

John Holland initiatives

A full project risk assessment was undertaken before mobilisation to site. The risk assessment included identifying the risks involved with all project scope activities and hazards which are not normally covered by the John Holland Safety Management System and included them in the development of the Project Safety Management Plan and Procedures.

As a part of this process we also reviewed the BHPB Fatal Risk Protocols and ensured that we had integrated their specific requirements as well.

Performance

Table 4.4 OH&S Performance, Port Kembla Bag House

Total Manhours	49,481
Lost Time Injury Frequency Rate (LTIFR)	0
Medical Treatment Injury Frequency Rate (MTIFR)	40.4
Medical Treatment Injuries	2
WorkCover Claims	0

John Holland group board safety sub-committee

Background

With the increasing personal liability that company directors and officers are facing in respect of their roles in companies, we are starting to see in business generally a reluctance on the part of such people to undertake particular roles which increase their personal exposure. In the area of safety management, we can expect more of this "risk aversion" as legislation progressively increases the risks and penalties to which individuals are exposed.

Against this trend, the John Holland Board has actually moved into a more direct role in safety management by establishing a Board Safety Sub-committee. John Holland is a leader in doing this and unique within the construction industry.

The Board decided to take this innovative step, not only because members of the Board feel very strongly about the health and safety of John Holland's workforce, but because some of them in

particular felt that people needed to show leadership in this area and be prepared personally to do something about the poor safety performance of our industry.

Sub-committee composition and meetings

The Sub-committee comprises three non executive directors, one of whom is the Sub-committee Chairman, the John Holland Group Managing Director, the Managing Director of John Holland Construction, the Corporate General Manager HR/IR/Safety and the Group Manager Safety.

The Sub-committee meets at least quarterly, at the time of Group Board Meetings.

The meetings are of a day's duration and include site inspections, generally of one or two projects, and a formal Sub-committee meeting. Other company officers and sometimes a specialist advisor are invited to meetings.

The report of the Sub-committee is an agenda item at the main Board meeting.

Committee charter

At the inaugural meeting the Sub-committee established a charter which specifically sets and communicates the committee's purpose and intent across the Group.

The key elements of the charter are:

- oversight of the company's occupational health and safety strategy and performance; and
- ensuring that the company's commitment to safety is visible and effective.

The Sub-committee members:

- undertake specific training in occupational health and safety at a level appropriate to Sub-committee membership;
- must become and remain aware of relevant regulatory changes which may affect the Company in relation to occupational health and safety;
- review and authorise the Group Occupational Health and Safety Strategy and monitor its implementation;
- review the Company's safety statistics and performance;
- review all Class 1 and Class 2 actual and near miss incidents, and assess corrective actions arising from the investigations;
- participate in activities designed to demonstrate management's commitment to safety including recognition activities, safety inspections and face to face discussions with Company employees;
- must become and remain aware of world class safety organisations and initiatives across all industries.

As can be seen, these are onerous obligations and require a serious commitment on the part of the Sub-committee members.

It is a source of great pride to me that our Board has members who are prepared to enter into such commitment.

John Holland & National Occupational Health & Safety Commission (NOHSC)

In June 2004, a landmark conference brought together governments, industry and unions to push for improved occupational health and safety performance in the building and construction industry. Since the industry has a reputation as among the worst OH&S performers, this was a great opportunity for all parties to do something about it.

For its part, the NOHSC is working to conduct forums to engage the building and construction industry on safety issues, particularly at CEO level. John Holland Group will be working in

partnership with NOHSC on this and other initiatives to promote health and safety in the building and construction industry.

CONCLUSION

If the safety performance of the Australian construction industry is to improve, we need more "Caring Clients" and "Caring Contractors". We need to get rid of those who don't care.

Governments fund a significant share of construction activity and are the most influential clients of the industry. All the individual governments do to some extent use their buying power to drive improved industry performance in health and safety. However, much needs to be done nationally to further this approach. The creation of the position of Federal Safety Commissioner and the development of a National Code of Practice may be a step in this direction.

Whilst I have significant issues with some aspects of the "industrial manslaughter" type legislation that is currently being promulgated, I certainly believe that the time has come for a substantial tightening of legislation to increase the obligations of all the industry players, from clients and designers, to contractors, and to employees and unions.

For many, occupational health & safety has become a plaything. The industrial relations games that are played by some unions must cease; the lip services that is given to safety by too many clients and contractors must cease; the political point scoring that is engaged in by Governments (at all levels and of all persuasions) must cease.

More "Caring Clients" would be a good start.

CHAPTER 5

Innovative Ways of Delivering Improved Satisfaction – How Can Clients Lead the Way?

Keith Futcher
Vivien Lau
Mona So
Connie Yau

EASTPOINT PROPERTY MANAGEMENT

EastPoint Property Management Services Ltd (EastPoint) was first established by the Jardine Matheson Group in the early 1980's as an offshoot of another business. It has been re-branded several times and steadily grown over two decades of operation. The company provides property-related management services in Hong Kong and Macau for a portfolio of 300 Hong Kong properties. Over ten per cent of the population of Hong Kong live or work within these properties based upon the numbers of residential, commercial and retail units contained within these sites. 3,000 staff are employed including 400 white collar staff managing the 2,600 blue-collar building supervisors/attendants and other frontline operatives at the properties typically two decades older than themselves. The professionals require a tertiary education as a prerequisite for employment. They are multi-lingual in Chinese, English and Putonghua. In contrast, the blue collar staff need a minimal-level education and be eligible to hold a Security and Guarding Licence issued by the government authority. Their principal language is Cantonese with basic skills in spoken English. The company is centralised for business efficiency but provides decentralised services at the many property sites it is managing. This operational differentiation requires a high degree of procedural integration to achieve high standards of customer service and to accord with ISO9000:2000 quality accreditation. IT business, communications, and management information systems are increasingly used to integrate the business at the managerial level.

Business efficiency and customer satisfaction is achieved if all personnel perform their duties well, individually and as part of the corporate entity. The management of the Company regards profitability, growth, and reputation as the principal goals for the business with stakeholder satisfaction being the fundamental prerequisite for this achievement. In this sense, staff engagement, customer satisfaction, and shareholder appreciation are the drivers for the business. The stakeholders for EastPoint are a large number of people, more than 3,000 employees that are working to exceed the customer expectancy of more than 5% of the population of Hong Kong – about 63,000 households. The nature of property management in Hong Kong is that to a large extent, contracts extend automatically, year-on-year unless dissatisfaction causes a termination. The ultimate test of satisfaction is in the retention of this customer base.

Evolution to a customer facing service industry

In 1999, the Company, then a multi-real estate services company, reviewed its statements of 'mission' and 'vision' to align with the perception of senior management of the role of the business. The nub of this was the self identity of the personnel in being professional and highly qualified in the subject of the built environment. The vision was that the purpose of the business was to excel at providing professional expertise in the management of buildings. In 2000, the company was re-branded as a result of the de-merger of the joint venture. Out of this exercise came a valuable appreciation of our core values. Professional management of property infrastructures in all forms is a fundamental of our business but the critical success factor is caring for the communities of people within these infrastructures. We have re-aligned our strategies accordingly. These communities judge us – they are the customers to be satisfied. They are the individuals that we must communicate with. Community websites, customer benefit programmes, Total-Quality-Management circles are used to rapidly increase the customer contact involved in our work processes. We are aware that the business is shifting to a customer-centric operation and that a distribution network of information and added value services with B2C connectivity will be the new business model for property and facilities management. We are positioning technologies and resources accordingly whilst continuing to service today's customer and to deliver shareholder value whilst we do it.

A further evolution of this thinking is focussed on the end-user of our delivered services. We estimate that about five percent of the population of the Hong Kong SAR is a direct customer of EastPoint. More than ten percent of the population per day receive a service from our staff. Our vision today is to provide 'lifestyle services' to this customer base. Our appreciation of the service to be provided and of the needs of the end customer has shifted from a technical orientation to be more akin to the hospitality industry. For these reasons, that industry provides a good theoretical basis to apply to other customer-facing service businesses.

Customer service models for facilities management

Service quality is a measure of how well the service delivered meets customer expectations, resulting from comparing these with the actual performances on both the outcome and the process dimensions of the service. From the provider's perspective, delivering service quality means conforming to or exceeding these expectations consistently. (Jafari, 2000)

In terms of the services sector, 'service quality is a measure of how well the service level delivered matches customers' expectations' (Parasuraman *et al*, 1985). Furthermore, 'perceived quality is also result of a consumer's comparison of expected service with perceived service.' Their qualitative research in their initial study (1985), found that service quality had ten underlying dimensions. Later (1988), these were consolidated into a five-dimensional index:

- **Tangibles** – the appearance of physical facilities, equipment, personnel and communication materials
- **Reliability** – the ability to perform the promised service dependably and accurately
- **Responsiveness** – the willingness to help customers and provide prompt service
- **Assurance** – the knowledge and courtesy of employees and their ability to convey trust and confidence
- **Empathy** – the caring, individualised attention the firm provides its customers

In 1988, the same authors defined perceived quality as 'a global judgement or attitude relating to the superiority of the service'. When 'expected service (ES)' is greater than 'perceived service (PS)', then 'perceived quality' is less than satisfactory. When ES is equal to PS, then 'perceived quality' is satisfactory. While if ES is less than PS, then 'perceived quality' is more than satisfactory. According

to the study of Ingram and Daskalakis (1999), we can use the five dimensional index described above to assess the gap between ES and PS. Organisations determined to attain a unique position and advantage in the competitive business world of today most likely realise the importance of delivering high quality service by meeting or exceeding customers expectations. Thus a means to measure customers' perceptions of an organisation's service quality becomes necessary. Executives who are truly dedicated to service quality must work with a continuous process for monitoring customers' perceptions of service quality, identifying the causes of service-quality shortfalls and taking appropriate action to improve the quality of service. (Zeithaml, 1990) It should be borne in mind the 'expected service' should also establish the cost to be paid i.e. the service value.

Service quality itself is an abstract construct because of three features in which it differs from goods in terms of production, consumption and evaluation: **services are intangible** as they are experiences rather than physical objects, **services are heterogeneous** because services often vary from producer to producer, from day to day, and from consumer to consumer, and for many services the **production and consumption of services are inseparable and simultaneous activities** (Gronoos, 1982: Parasuraman et al., 1988; Zeithaml et al 1990). Service quality is a judgement about the superiority of a service (Robinson, 1999), quality refers to the extent to which a service is what it claims to be (Mudie and Cotton, 1993), it is the fulfillment of customers' expectations (Edvardsson et al 1994), and can therefore only be defined by customers (Palmer, 1994).

Parasuraman et al's Service Quality Model provides a means of appreciating the issues in delivering service that achieves customer satisfaction by closing five gaps, as outlined below (Payne, 1993).

- Key determinants of the service expected by customers include word-of-mouth communications, personal needs, past experiences, and external communications from the service provider (Zeithaml et al, 1990)
- There is a difference between the customer's expectations and what the management perceives the customer expects (Parasuraman et al, 1985). Management has to obtain knowledge and understanding of customers' expectations (Zeithaml et al, 1990)
- The difference between management's perceptions of customer expectation and the quality specifications set for the service need to be reconciled. (Parasuraman et al, 1985). When applying standards that actually project what customers expect, customers' perceptions of service quality can improve, minimising or even closing the gap. (Zeithaml et al, 1990)
- A difference exists between the service quality specifications and the actual service delivery (Parasuraman et al, 1985).
- There is a difference between the service delivery and external communications (Parasuraman et al, 1985). When more is promised than delivered. (Kotler et al, 1996)

The same researchers identified a range from the desired, perceived and adequate service level to reflect 'a zone of tolerance'.

In the zone of tolerance, the customer's expectancy of service quality is measured on two levels, namely:

- Desired Service – The level of service representing a blend of what customers believe can be and should be provided;
- Adequate Service – The minimum level of service that customers are willing to accept presumably at this price.

This work is useful in considering pricing and performance for built environment services. A review of the continuing validity of this early work and of subsequent greater detail produced by the original researchers is provided by Grapentine in 1998. This is further useful in bringing together concepts of value for money on both sides of a contract.

MULTI-METRIC PERFORMANCE ASSESSMENT

Dependence on surveys of customer satisfaction

EastPoint has maintained quality assurance certification to ISO9000 series since 1999. That certification has been upgraded since then to the latest 2000 version of ISO9001 and to include accreditation in 'occupational health and safety (OHSAS18001)' and also environmental control systems (ISO14001). Since 2000, EastPoint has carried out an annual Customer Satisfaction Survey in the form of standard format 'tick-the-box' questionnaire. This is a standard requirement for accreditation to ISO9001:2000 standards of quality assurance. It is also a feature of the Baldridge method of assessment of company performance used by EastPoint for self assessment of managerial performance and strategic development. It is, none-the-less, regarded by the company as an imperfect measure of customer satisfaction: due to less than 9% response from the population surveyed; a tendency for satisfied customers to be passive and not motivated to respond; it is too coarse a measure, at too long an interval, for management to respond to adverse trends; and it is a reactive rather than proactive assessment. Table 1 shows the inadequate representation achieved in the surveys of 2001 to 2003.

Table 5.1 Extent and Rate of Response From Customer Satisfaction Surveys

Summary of Customer Satisfaction Survey results for 2001- 2003									
	2001 (August survey)			2002 (August-Sept survey)			2003 (Sept-Oct survey)		
	No. of returned questionnaires	Response Rate	Total nos. of Distribution	No. of returned questionnaires	Response Rate	Total nos. of Distribution	No. of returned questionnaires	Response Rate	Total nos. of Distribution
Overall	**5,148**	**7%**	**67,509**	**6,777**	**8%**	**83,122**	**5,482**	**10%**	**53440**
Commercial	*100*	*6%*	*1,744*	*256*	*12%*	*2,170*	*277*	*12%*	*2,350*
Residential	*3,598*	*11%*	*32,667*	*3,878*	*10%*	*37,949*	*4,437*	*11%*	*40,490*
Public Residential	*1,285*	*4%*	*29,698*	*2,202*	*6%*	*39,951*	*286*	*4%*	*7,706*
Shopping Centres	*43*	*4%*	*1,202*	*386*	*32%*	*1,219*	*388*	*37%*	*1,060*
Industrial	*52*	*3%*	*1,817*	*55.00*	*3%*	*1,833*	*94*	*5%*	*1,834*
No. of properties exempted from survey			35			60			68
No. of households exempted from survey			12,500			15,531			30928
Overall satisfaction rate from survey			**55%**			**66%**			**74%**
HK SAR statistics									
Population of the HK SAR			6,725,000			6,787,000			6,803,000
% of population in EastPoint care			**5%**			**6%**			**4%**
No. of households in HK SAR			2,101,000			2,162,000			2,198,000
% of households in EastPoint care			**3%**			**4%**			**2%**

Innovation to better indicate actual performance

From an EastPoint point of view, the issue in knowing customer satisfaction is to achieve a rational measurement of performance from a stakeholder viewpoint that includes a broad range of objective measures to offset the natural bias in customer satisfaction surveys in which a majority does not respond. In this context, rational means based on objective measurement; performanc**e** means the actual standards achieved by EastPoint personnel and systems against benchmark minimum standards set by the Company and/or stakeholders' expectations, and/or norms for the industry. Whilst stakeholders are the Board; the executive management; the operations management; operatives; direct clients, such as Incorporated Owners Committees or the Hong Kong Housing Authority; and indirect clients such as owners, tenants or visitors to managed properties. Broad-range of objective measures means all practicable measures of performance in existence or to be innovated in 2003.

EastPoint introduced a methodology in 2004 that uses multi-attribute indicators of performance as a means to indicate more objectively stakeholder satisfaction. We currently measure twelve independent indicators of performance that are related to customer satisfaction. Table 2 places these measures of importance in order of their validity as a measure of customer satisfaction based upon the following nine attributes of each metric:

- Objective/subjective data is gathered;
- Is the data range broad (rich) and therefore more indicative of performance;
- Is the data consistent each time it is measured;
- Is the measurement monthly, quarterly, half yearly, or random;
- Is the measurement free of bias;
- Does the measured data come from a credible source;
- Is measurement process credible;
- Is the measurement representative of the portfolio;
- How is the metric related to customer satisfaction, (H/M/L)?

Table 5.2 Performance Measures in Order of Validity as a Measure of Customer Satisfaction With Corresponding Weighting

Metric	Attributes of the performance measure									
	Objective/ Subjective	Data rich (H/M/L)	Consistency	Routine/ periodic (H/M/L)	Bias-free (H/M/L)	Credible source	Credible measure	Represents portfolio	Valid for CS	**Diff Wgt**
CRM/Help Desk	O	H	H	H	H	H	H	H	H	**1.0**
External audit	O	H	H	M	H	H	H	M	H	**0.9**
Internal audit	O	H	H	M	M (-ve)	H	H	H	H	**0.8**
Directors Inspections	O	H	H	M	M	H	H	H	H	**0.7**
Customer Satisfaction Report by Service Centre	O	L	H	M	H	H	H	L	H	**0.6**
Annual customer satisfaction surveys	O	H	H	L	H	L	H	M	H	**0.5**
Client assessments	O	M	H	M	M (-ve)	H	H	L	H	**0.4**
Night Audits	O	M	H	M	H	M	H	H	H	**0.3**
Six monthly staff satisfaction surveys	O	H	H	M	M (-ve)	M	H	H	L	**0.2**
Property Managers Inspections	O	M	M	M	L	M	M	M	M	**0.1**
Customer complaints and commendations	S	L	L	L	L	L	M	L	H	**0**
Contract Interim Survey/Exit Interview	S	L	L	L	L (-ve)	M	M	L	L	**0**

On the basis of this evaluation, the Contract Interim Survey/Exit Interviews and the Customer Complaints/commendations are not included in the aggregation of the measures. Weighting between 1 to 0 is applied to the remainder to reflect relative validity as a measure of customer satisfaction.

The performance measures noted in Table 3 are recorded each month, or as appropriate, and reported in the Directors Monthly report accompanied by a trend analysis commentary.

Table 5.3 Combination of Measurements for an Overall Benchmark of Customer Satisfaction

Performance measure	Annual metric	Wgt	Score (metric x Wgt)
1) CRM/Help Desk	47%	1.0	8%
2) External audit by the HKQAA	68%	0.9	11%
3) Internal audit of the EastPoint integrated management systems	66%	0.8	10%
4) Directors Inspections	64%	0.7	8%
5) Customer Satisfaction Report by Service Centre	72%	0.6	8%
6) Annual customer satisfaction surveys	74%	0.5	7%
7) Client assessments	69%	0.4	5%
8) Night Audits	98%	0.3	5%
9) Six monthly staff satisfaction surveys	60%	0.2	2%
10) Property Managers Inspections	NA	0.1	NA
Total =	618%	Total =	64.4%

Eastpoint's measures of performance

CRM/help desk management-information-systems

At present, customer service requests are predominantly made on our 300 property sites. Previously these would have been recorded there using manual methods making it impracticable to measure performance. This arrangement is impracticable to measure customer satisfaction in terms of our response to these requests and in identifying indicative trends as part of our strategy to improve customer satisfaction and client retention through outstanding performance. Our earlier investment in IT-based information management systems using proprietary software provided by Management Reports Inc (MRI) provides a technological alternate to manual methods across our wide-area-network of computers. This was implemented in 2003/4 to enable centralised recording of customer requests and their timely closure. It provides a central resource for data mining of customer issues. This database is analysed to provide metrics on the speed of response and in measuring the satisfaction of pre-set Key Performance Indicators (KPI's) that are either implicit or stated service level agreements with the client.

One hundred sites are online with the CRM MIS. These represent the most important contracts and are prioritised on a pareto basis according to the CRM ranking described later in this paper. In this respect they constitute more than 90% of the value of the portfolio and include all valued CRM targets.

External audit by the Hong Kong Quality Assurance Association (HKQAA)

HKQAA, a Certification Body of ISO9001:2000, ISO14001:1996 and OHSAS18001: 1999 systems, visits EastPoint twice a year to conduct external audit/ surveillance visits at 25-35 randomly selected properties which account for around 10% of all managed properties to check compliance against the ISO/OHSAS requirements and legal requirements. Performance is measured by assigning a mark of 200 per property for a faultless performance but 50 marks are deducted for each major non-conformity (M), 10 marks for each minor non-conformity (D) and 5 marks for each observation (OBS) identified during the audit. These are aggregated to produce a single measurement for the external audit based on of the total marks received for audit: by property and by portfolio.

Internal audit of the EastPoint integrated management systems

Internal Audit of the EastPoint Integrated Management System is conducted by Performance Management Unit (PMU) on a regular basis, at least twice a year for each performance system (ISO9001/ ISO14001/ OHSAS18001). The aim is to ensure the compliance of internal system procedures and legal requirements and follow up the effectiveness of corrective/preventive actions taken for the findings since last internal/external audits or through other performance inspection, such as directors' inspections and night audit. A standard audit checklist is prepared by PMU to ensure full coverage of all system procedures and all managed properties within a 3-year cycle. In each internal audit, depending on the available resources, around 40 to 60 properties will be selected which usually lasts for a month and areas of concern will be identified as the main focus of audit. Performance is measured by assigning a mark of 100 per property for a faultless performance but 10 marks are deducted for each major non-conformity, 3 marks for each minor non-conformity, and 1 mark for each observation identified during the audit. These are aggregated to produce a single measurement for the external audit based on the total marks received for audit: by property and by portfolio.

Directors' inspections

Directors' inspections were started in February 2003 to enhance 2-way communication between management and frontline operations and to achieve continuous improvement in the property operations. Ten executive staff are each assigned with 26-28 properties to be inspected within a period of 6 months. A standard inspection report of twenty aspects of operational performance is used with each being marked on a Likert scale between 1 to 5. The results are entered into a single database and form part of the annual performance appraisal for the site management staff concerned. Any property received scoring less than 3 on any item, or with comments/suggestions for follow up, is required to prepare a proforma action plan. A total score of maximum 100% will be calculated in every inspection as an overall assessment of the operation performance and will then be reflected in the annual performance appraisal on a weighted ratio. A single measurement for the Directors/Managers Inspection is the average of the marks received for all inspections.

Customer Satisfaction Report by the Customer Service Centre (CSC)

The CRM/Helpdesk facility gathers two metrics over time by property and any other aggregation of property data i.e., by management team, division, or product line. First, the satisfaction of predetermined KPIs; these are quantitative judgments of our timely response to an issue/request that is automatically measured by the CRM module and a personal accountability of the assigned operative. Second, the results of random feedback solicited by the CSC through a telephone call initiated by the CSC. These solicit qualitative responses to a predetermined closed question survey that produces, in a consistent manner, a performance mark of the quality of the achievement between 0 and 10. Any

result below 5 is deemed unacceptable and requires remedial action by the Director concerned. This feedback is gathered by Customer Helpdesk staff phoning Customers at random within 48 hours of the job completion.

Annual customer satisfaction surveys

Contracts or clients are categorised in terms of importance to the business for the purposes of customer relationship management and performance monitoring. The customer satisfaction survey is now available in paper or internet versions using a small number of better tailored closed questions to ascertain customer expectancy and perceived satisfaction. This modified instrument was first used in 2003. It includes:

- 1st an enquiry on overall satisfaction with EastPoint performance;
- 2nd an enquiry on specified performance attributes briefly covering our principal services, image and competences;
- 3rd an enquiry prioritising five areas of desired improvement; and
- 4th a Yes/No enquiry 'would you recommend EastPoint to others?'

Performance assessment/measurement used by certain Clients

Large public sector clients such as the Hong Kong Housing Authority, the Government Property Agency, and the Mass Rapid Transport Corporation use surveys of end user satisfaction as key performance indicators of the performance on their service contracts. They assess performance at monthly intervals, at each property/ station. These are integrated to provide a single metric of performance.

Night Audits

By regulation, property management companies in Hong Kong must arrange for a random night audit at properties in accordance with the legal requirement in order to ensure that they perform to mandated standards of security. EastPoint has outsourced the night audit services to a security guarding company on an annual contract basis and monitored by the company's Performance Management Unit (PMU) who reports directly to the Managing Director. PMU also conducts quarterly night audits with the outsourced security guarding company in order to monitor the quality of night audits as well as the standard of night operation at our managed properties. The result of night audits by outsourced security guarding company will be converted into score/property. The total marks received to evaluate the staff performance will be reflected in the annual performance appraisal on a weighted ratio. These are integrated to provide a single metric for the portfolio.

Six monthly staff satisfaction surveys

Employee satisfaction surveys are conducted semi-annually. Thirty-eight statements are to be answered on a Likert scale of 1 to 8 An 'Overall Satisfaction Percentage' is used as the single indicator of the survey. To better reflect the stakeholder participation in the success of the business, the survey will be changed in 2004 to an Employee Engagement Survey.

PARETO APPROACH TO CRM

EastPoint has adopted a two-attribute method of prioritising contracts for the purposes of client relationship management (CRM), primarily based on value in dollar terms and value to the business for other defined reasons. Using this methodology the Company places its ongoing contracts and

potential future clients into 5 classes of CRM from Rank A, to E as noted below. The Contract will be identified as having an 'important' attribute if they meet one or more of the definitions listed below.

The EastPoint definitions of these categories are:

- **RANK A i.e., mission critical** -means contracts that are in the 20% by number of the highest value contracts and are additionally more than 60% important for other defined reasons;
- **RANK B i.e., protect at all costs** - means contracts that are in the 20% by number of the highest value contracts and are additionally less than 60% important for other defined reasons;
- **RANK C i.e., nurture** - means contracts that are not within the 20% by number of the highest value contracts but are more than 60% important for other reasons;
- **RANK D i.e., maintain** - means the remaining active management contracts;
- **RANK E** are contracts that are due to expire or have expired.

Table 5.4 Contract Categorisation

	Definition of important contracts
PR/Reference Sites	✓ 1st, 2nd, 3rd priority most significant within a sector/ High Profile/ Blue chip or a leader in their sector/ Beneficial to be associated with them
Developer	✓ > 2 properties could be outsourced within 2 years
Growth Potential	✓ Generate increased income over two years, from same/ other contract
Cross Relationship	✓ Connection / influence (financial, political, family or colleague) to >1 properties
Valued	✓ Trust relationship and revenue above 50% of current market developed over time

The CRM effort is the personal accountability of the Executive Director in charge of Commercial Enterprise of the company. Minimum, the objectives and targets are defined for each category of contract/client. For example, for Category A contracts: the MD will fraternise with three influential persons for that contract; the Executive Director for that contract will be held personally accountable for business development and service delivery and will meet informally at monthly intervals on these topics; the Director for that property has a personal accountability for on-site performance; performance monitoring is at monthly intervals, quality audits are at quarterly intervals, and SixSigma will be operational at the site.

CONCLUSION

In a customer-facing, services business it is not sufficient to consider a customer satisfaction survey as a meaningful assessment of end-user contentment or as indicative of a successful business. It is better to combine many mutually exclusive, objective indicators of stakeholder satisfaction into a benchmark rating and matrix of performance indicators that can be used for trend analysis and performance improvement. In a portfolio management approach to service delivery, a Pareto methodology ensures that effort is expended in ensuring satisfaction for the most relevant customers as a priority above customer expectancy norms for the remainder. It also recognised that the service quality modelling of

Parasuraman *et al* is also applicable to the service industry of the built environment as it repositions from professional technical services to a life style service industry.

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CHAPTER 6

On the Way Towards a Sustainable Knowledge Society – The European Approach

Pekka Huovila

INTRODUCTION

This chapter discusses international innovation in three ways. Firstly, examples of selected recent Information Society Technology (IST) research roadmaps are given to describe how different sustainable knowledge society landing points can be reached. Secondly, two communities are presented as innovation incubators, or catalysts for systemic innovation. Thirdly, the concept of cities as living laboratories is introduced as a stimulating platform for innovation processes. The built environment, especially cities, is presented as a natural meeting point of public and private investments supporting sustainable business opportunities.

The given examples focus on experiences within European collaboration, based on a rich diversity and strong cultural heritage of individual countries and regions with different history, priorities and constraints. The presented European systemic innovation approach is placed in a global context.

The European Union policies (EC 2002) define the priorities

- to become the most competitive and dynamic knowledge based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, by 2010
- to perform transition to a knowledge economy in a global networked society
- with sustainable development at the heart of integrated policies for growth, employment, social cohesion and the environment.

One key challenge is to understand better the systemic relationships between different dimensions of sustainable development; the dynamics of a service-oriented networked knowledge society and its relationship to sustainable development.

Today research and development is carried out in an increasingly complex environment. The interdependencies between goods and services increase and new concepts of product ownership appear. Global competitiveness needs innovative capability. Innovation is regarded as a key driver of competitiveness. This can be achieved through a comprehensive programme of integrated research activities (Liikanen 2004). The European Commission (EC) Framework Programmes form an important technology development platform to obtain a critical mass that enables reaching these goals.

Innovation dynamics and innovation processes have changed from sequential to concurrent. All kinds of innovations interact in a multidisciplinary innovation space. This involves collaboration across the traditional boundaries. Bringing the technology and application innovations together into systemic innovation supports the transition to new paradigms.

Cities and the built environment should provide a healthy and stimulating living, working and innovation environment for present and coming generations. Therefore, Facilities and infrastructure must be planned, designed, constructed, operated, maintained and refurbished to perform for several

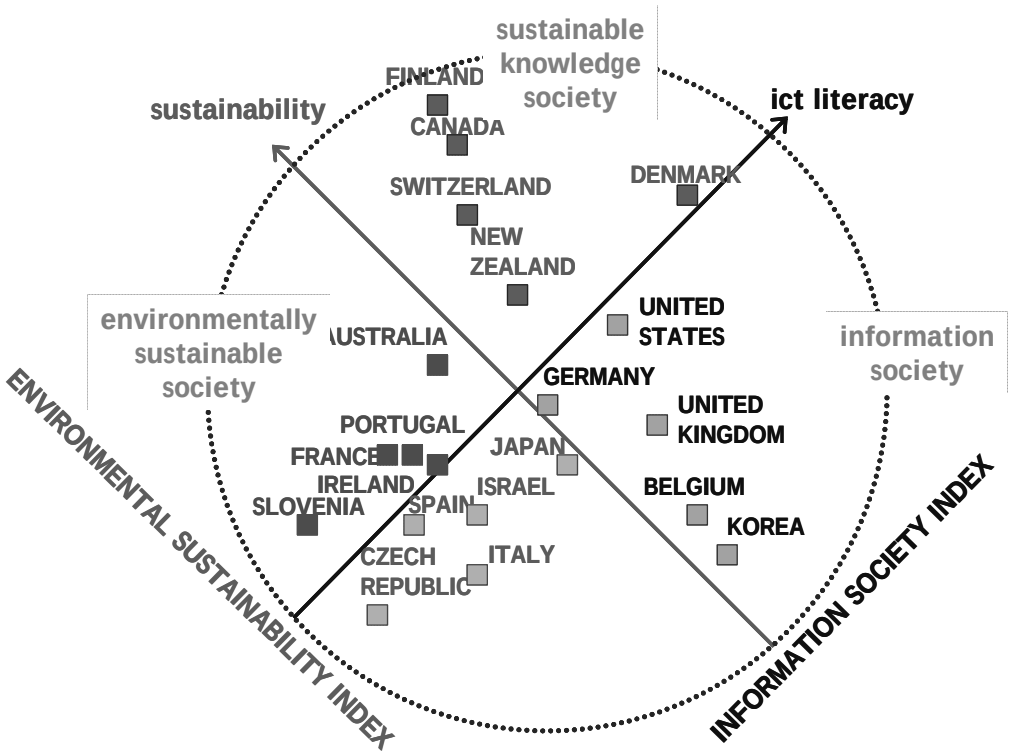
decades, even centuries, to meet the needs of their changing users in varying circumstances. Living in cities and occupying buildings has health impacts, it creates the biggest environmental burdens and it has important social consequences. It is economically important to manage the asset of constructed facilities and infrastructure.

INFORMATION SOCIETY RESEARCH ROADMAPS

The EC 5th Framework Programme launched an IST Call in spring 2002 to shape roadmaps paving the way towards different landing points of the knowledge society. The roadmaps were commissioned to direct future research in the 6th and 7th EC Framework Programmes. Almost 30 such one year research roadmap projects were funded in summer 2002 covering all industrial sectors. Key findings from some of them are presented here as international innovation supporting examples. It must be noted that strategic research roadmaps differ from technology (Sipilä 2002), product or industry roadmaps.

A look at the international innovation playground is shown in the following figure where a sample of 20 countries is positioned into four quarters of a sustainable knowledge society matrix according to their country indicator values. The matrix axes correspond to Environmental Sustainability (ESI 2002) and Information Society (ISI 2003) indicator systems. In some countries the acceptability of ICTs, understanding the environmental consequences of different decisions, access to information or participation in decision making is different than in other countries. National or local development strategies vary as well. The future steps in the countries shown low in this illustration do not need to follow the same path as that of the current forerunners - some staging posts may be bypassed and other counties overtaken, even very quickly. In Europe, the potential is significant especially within the newly associated states.

Figure 6.1 Environmental Sustainability and Information Society Country Indexes



The previous figure is not sufficient for drawing conclusions about the progress of different countries. That would require a detailed analysis studying individual indicators and their interrelationships instead of comparing aggregated country values as shown here.

ESI is a result of collaboration among the World Economic Forum's Global Leaders for Tomorrow Environment Task Force and the Universities of Yale and Columbia. It is a system measuring overall progress towards environmental sustainability, developed for 142 countries. The scores are based upon a set of 20 core indicators, each of which combines two to eight variables for a total of 68 underlying variables.

The other indicator system ISI was first launched in 1996 as the first global measurement of information wealth. Along the years new benchmarking variables have been added to reflect the technological progress. Broadband households, mobile Internet users and wireless telephone subscribers are examples of some newer variables, whereas some traditional indicators, like number of PCs or education level, still remain integral to the index.

Sustainable urban development and intelligent cities

Intelcity roadmap faces the challenge of realising sustainable knowledge society visions in intelligent city environments aspiring in network of different communities from Sustainable Urban Development and Information and Communication Technologies (Curwell et al. 2003). Five alternative future visions and scenarios outline features of eDemocratic City, Virtual City, Cultural City, Environmental

city and Post Catastrophe City. These city scenarios, intended as plausible alternative futures, both desirable and undesirable, were analysed to test the robustness of underlying questions or policy options.

The stakeholder meetings in different European regions showed distinct priorities, boundary conditions and development paths in different countries. Varying scenarios were also combined in some city visions to have distinct development taking place simultaneously in various quarters in the same city. (Huovila et al. 2002) Finally, research priorities integrating Sustainable Urban Development and the ICTs were listed in 3 years (2006), 5 years (2008) and 10 years time (2013) to accomplish the Intelcity Roadmap.

ICT in construction

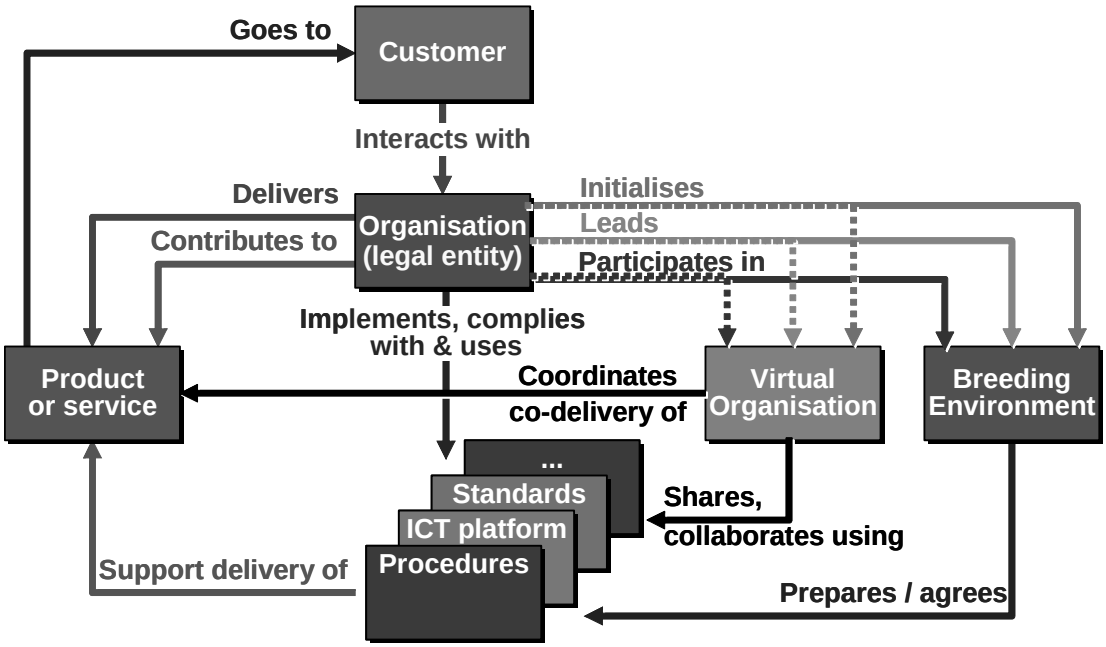
The Strategic Roadmap towards Knowledge-Driven Sustainable Construction (Hannus et al. 2003) is based on the vision that construction sector is driven by total product life performance and supported by knowledge-intensive and model based ICT enabling holistic support and decision making throughout the various business processes and the whole product life cycle by all stakeholders. The Roadcon roadmap aims at total life cycle support consisting of different dimensions, such as adaptive and self-configuring systems, ambient access, collaboration support for distributed virtual teams, digital site, flexible interoperability, knowledge sharing, model based ICT, smart buildings and embedded systems, and performance driven process.

The current situation in construction is closer to the prescriptive-based than to the performance-based practice (Lee et al. 2003). Customers, however, are increasingly aware of whole life costs, perceived value and intangible assets. The vision is that performance driven process ensures conformity to customers' needs and emphasises end user satisfaction and value. ICT solutions support capturing and fulfilling predefined performance criteria. As the service component becomes an essential part of core business, the traditional value hierarchy in the sector will be transformed. Choices of material and the functionality of structures will be based on whole life considerations. Users choose service packages for housing, e.g. increasing the flexibility. It is essential to understand customer needs and integrate them to production processes

Virtual organisations and breeding environments

The vision statement of Design for Collaborative Virtual Organizations in Dynamic Business Ecosystems (Camarinha-Matos et al. 2003) is that in 2015 most enterprises will be part of some sustainable collaboration networks that will act as breeding environments for the formation of dynamic virtual organisations in response to fast changing market conditions. As a result, a strong and cohesive social fabric is built in response to turbulence and uncertainty.

Figure 6.2 Breeding Environments and Virtual Organisations



The key features of VOmap roadmap can be summarised as well founded collaboration models, management systems for breeding environments replicable to a large variety of sectors, generic and invisible infrastructure and re-utilisable service toolbox based on interoperability standardisation, extensive use of pervasive computing, virtual organisation management principles adapted to emerging behaviour in complex networks, accepted mechanisms to handle innovation and new value systems, social responsibility including life maintenance based on a suitable ethical code and comprehensive international legal framework for virtual organisations. Distributed innovation management will become a decisive task for virtual organisations. Efficient innovation processes are a clear competitive advantage for those networks (Eschenbächer et al. 2004).

Corporate responsibility and stakeholder reporting

New Partnerships for Sustainable Development in the Knowledge Economy (Allee et al. 2003) Roadmap is about measuring progress towards a sustainable and inclusive society. It provides a systemic view of developing and integrating new measures for the assessment of qualitative aspects of economic, environmental, social and cultural dimensions. It emphasises that the reporting systems developed and used by corporations do not really correlate to the needs of cities or citizens. More transparency is requested by different stakeholders. Triple bottom line reporting considering also both economic and social and environmental aspects of companies' outcome may affect decision making of individuals, organisations and governments.

The main statement in Neskey Roadmap is to increase the transparency of companies and cities in a compatible way. That requires enabling technologies that support social change and collaborative process technologies with an open source ICT platform for gathering, managing and disseminating

data. The 360 degrees accountability of business and cities can be built on intangible indicators and valuation, sustainability reporting and measurement, and integration of methodologies.

From the built environment point of view (Huovila et al. 2003) in the short term it is possible to make a direct contribution to sustainability through the better management of existing buildings, using modern energy management technologies and services. In the medium term, it is possible to make a direct contribution to sustainability by investing in the improvement of the built environment on the basis of a lifecycle or total-cost-of-operation analysis. This should explicitly link changes to the built environment with work and work-force productivity due to flexible buildings and better working conditions. In the long term, it is possible to contribute to sustainable development by linking patterns in the evolution of telework, homework, mobile work with changing demographics of cities and the planning of future urban environments.

Decision making within companies is ultimately driven by a 'business case' rationale. In cities, on the other hand, decision making is driven by a 'public service' rational that incorporates a 'business case' at the mezzo or macro-economic level, as well as a 'social case'. The two cases are not perfectly separable. They coexist in a system of trade-offs relating to the need for investments that support economic growth of the city and the need for investments that ensure the city provides a good quality of life for its citizens. It is possible in principle for enterprise and cities to contribute to a common cause such as 'sustainability' for entirely different reasons. However this requires a clarity-of-cause that does not as yet exist either at city or at enterprise level in most parts of Europe or the world.

In particular, a common language and a shared set of concepts will contribute to the design of policy level sustainability interventions that effect enterprise by helping to move debate beyond adversarial patterns of lobbying via networks of influence, towards a more rational democracy based on forms of open negotiation and enlightened self-interest.

INNOVATIVE COMMUNITIES

Two examples are given as innovative community building cases: the International Group of Lean Construction (IGLC 2004) and Ambient Intelligence at work (AMI@Work 2004). Their common denominator is a shared interest between experts on a novel collaboration field. Their institutional formalities are not highly visible, membership fees are replaced by enthusiasm and constitutions by innovative visions.

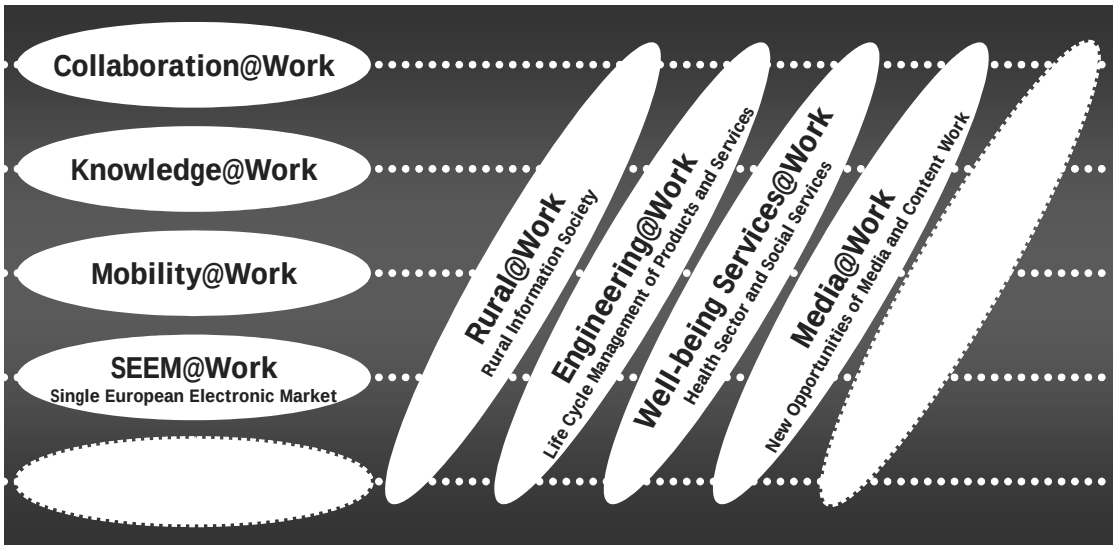
The International Group of Lean Construction gathered first time together at VTT in Espoo in 1993 and has met annually ever since (once in Australia and in Asia, three times in South and in North America and twice in Europe). The nature of its annual workshops is to call together researchers and practitioners sharing common interest towards lean construction philosophy. New findings are disseminated to end users and new research paradigms are discoursed within this informal research community. IGLC published a book (Alarcon 1997) of its early achievements as one concrete deliverable.

Ambient intelligence at work family of European Research and Innovation Area Communities is an initiative to catalyse systemic innovation. It is a European Commission initiated self-organising community in movement. It operates currently in eight interest groups, such as Engineering@Work, Mobility@Work, Well-being Services@Work and Knowledge@Work. The AMI@Work interest groups are facilitated by elected leaders. Those families, or tribes, share and develop further future objectives of key challenges in their domains. In some of them the platform is built on ongoing research projects funded by the Commission. In others the members prepare together new ones.

The concept was first tested in Brussels in July 2003 with almost 100 participants discussing the initiative and its communities. AMI@Work launch preparatory workshop was held in Brussels in March 2004 with over 200 interested participants. Budapest hosted the second launch preparatory

Workshop in May 2004 and the main launch was finally in held Brussels in June 2004 with some 300 participants concluding the next steps for the coming year.

Figure 6.3 AMI@Work Family Members



THE BUILT ENVIRONMENT SUPPORTING MOBILE INDIVIDUALS – LIVING LABORATORIES ACROSS EUROPE

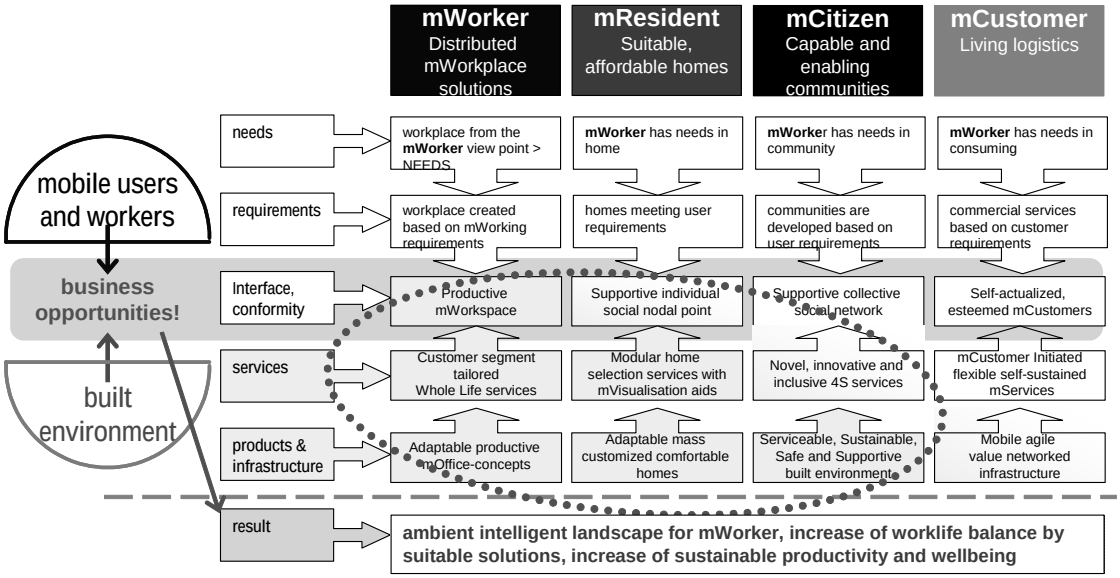
Living laboratories are presented as a process innovation supporting concept. The idea is to provide self sustaining business opportunities in cities or neighbourhoods forming a natural meeting place for public and private investments and interests. From the research perspective, user studies may be conducted in that environment supporting niche development. The living lab approach empowers mobile individuals through the development, provision, deployment, training, and take-up of applications and services supporting the individualisation of both site independent and site dependent environments. It will create a paradigm shift enabling mobile work at all times, in all places, and in all contexts.

Innovation process and ambient Intelligence across interlinked cities and communities is the clear ambition. The impacts will be achieved through concrete steps connecting existing mobile work laboratories in various locations to inter-connected living labs. These will serve as key hubs, integration channels, and show cases for further take-up. It uses an iterative thematic approach centred on delivery of context based applications and services to mobile workers and site specific applications and services to enable mobile work in the built environment. These serve as the catalysts for mobile workers and users in the living lab network. The living labs in turn act as the baseline and launch-pad for development of next generation mobile work environments.

The kind of work that can be done on a mobile basis, when truly enabled by the supporting infrastructure, user friendly applications and interfaces together with flexible spatial and desk solutions, could considerably decrease the need of traditional office space (e.g. 70 %). At the same time it may set new needs for flexible connectable work space at homes and in public environments.

The objective is not to stress individuals to work around the clock, but increase the quality of life e.g. by avoiding non value adding time wasted commuting. Contemporaneously with the potential of liberating important quantities of office rooms of low rate of occupancy a huge global market is open for sustainable refurbishing of environments to meet the needs of the mobile individuals of future knowledge society. The big question still remains if the real estate and building sector is willing and capable of providing customer driven services over the whole life of constructed assets for their owners and users.

Figure 6.4 The Built Environment Supports Individual Mobile Life



SUMMARY AND CONCLUSIONS

This chapter proposes sustainable knowledge society as a common intended and desirable vision. International innovation is justified to be a prerequisite that enables reaching this objective supporting the seamless transition process. Four recent IST research roadmaps are presented from the city, construction, collaborative work and corporate perspectives. Two self organising interest groups are given as examples of innovative research communities. Finally, the living laboratory concept in cities is presented as a promising innovation breeding environment bringing customers and suppliers together integrating at the same time both public and private sector interests and investments.

These examples, described more in detail in the references provided, show the clear ambition towards not only technological, but also social and cultural innovation, processes which can lead to our future sustainable knowledge societies.

One challenge will naturally be how to bridge innovations with research and place. Since it is often claimed that innovations don't always take place in office kind of facilities we must think about how to transform workplaces to a more stimulating form and shape. The other dimension, supporting location and time independent access to information and communication, is of utmost importance.

The final conclusion is that investment in cities (e.g. sustainable ICT infrastructure) supporting systemic innovation has enormous potential to incubate self sustaining business opportunities and to improve well being and quality of life of present and coming generations.

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CHAPTER 7

4D CAD and Collaboration: Method and Benefit for Cooperative Research Between Industry and Academia in Construction

Martin Fischer
John Kunz

VIRTUAL DESIGN AND CONSTRUCTION

Stanford University's Center for Integrated Facility Engineering (CIFE) defines Virtual Design and Construction (VDC) as the use of multi-disciplinary *performance* models of design-construction projects, including their

- Product (i.e., facilities),
- Organisation of the design-construction-operation team,
- Work Processes, and
- Economic Impact (i.e., cost and value of capital investments), in support of (explicit, public) business objectives (Kunz and Fischer 2005).

The simultaneous and possibly integrated modelling, simulation, and visualisation of these four critical aspects of a capital facility can inform more project stakeholders about more project issues in a more timely and informative manner than possible with traditional methods. This can lead to better understanding of a project by more stakeholders, more informed decision making, and improved buy-in at a time when changes can still be made relatively cheaply because the project is still only virtual. However, the effective use of VDC methods requires the understanding of new technologies and the implementation of new work processes and organisations. It is often difficult for project teams to provide the contractually required and project-focused performance while trying out a new technology, work process, and organisation. CIFE researchers work with project teams of its industrial members to design, deploy, and document the work process, cost, and value of VDC methods.

CASE EXAMPLES OF COOPERATIVE RESEARCH BETWEEN ACADEMIA AND INDUSTRY

These two case examples illustrate how CIFE research teams assist construction project teams with the application of VDC-enabled work processes, the documentation of the VDC implementation, and the dissemination of the lessons learned from these pilot projects. The first case study discusses a cooperative research case that took place a few years ago. A value of this older case is that several years later the impact of the cooperation can be assessed more fully. The second case discusses an ongoing cooperative research effort. A value of the second case is that it is current, but it is too early to make statements about the longer term impact of the innovations piloted through the cooperation.

Application of 4D modelling to construction planning for Disney's California Adventure ™: case example 1

In the summer of 1998, the Research and Development (R&D) organisation for Walt Disney Imagineering (WDI) invited CIFE researchers to support the construction planning of the Paradise Pier portion of its – then under design –Disney's California Adventure ™ theme park. Paradise Pier presented significant construction challenges because its main attraction – an innovative roller coaster – needed to be built at the same time and location as many other attractions and facilities. WDI wanted to study the constructability of the proposed design and confirm that there was an economical way to build the proposed scope given the access and completion constraints. Traditional means of construction planning seemed unlikely to enable the construction planners to develop several sequencing alternatives and to evaluate the alternatives with input from many stakeholders. Because of its visual representation of the project scope and schedule 4D modelling seemed like a better method to engage the various stakeholders who needed to provide input and feedback to the construction strategy and workflow on site. CIFE had gained experience in the application of 4D modelling on earlier projects (Collier and Fischer 1996, Koo and Fischer 2000, Staub-French and Fischer 2001).

4D modelling process and example

Over the summer, with the help of WDI R&D, 3D modellers from WDI's virtual reality group, and Paradise Pier project team members, two CIFE researchers managed the development of the 3D models necessary for 4D modelling of Paradise Pier. They also explored technology options for 4D modelling and quickly concluded that the demands of this project required the design and implementation of a new 4D modelling tool. The two principal reasons for this decision were that the existing 4D modelling tools could not use the 3D CAD models that came from a variety of 3D modelling tools in an intelligent way, and they did not enable the construction planners to create many construction sequencing alternatives at different levels of detail at the speed required by the project schedule. The CIFE researchers therefore also specified and guided the implementation of a 4D modelling tool that overcame the limitations of the then available systems. They built 4D models and trained project team members to use the 4D modelling tool. In the fall, many groups of stakeholders from Paradise Pier and from adjacent parts of the park reviewed the 4D models. As had been suspected by the R&D and project team several issues came to light in these reviews. To the surprise of many project team members their resolution happened in a much more collaborative way than on other projects. As a project participant put it "problems found together are solved together." 4D models helped stakeholder groups find and resolve scope and schedule problems together, which then enabled the project architects and project management team to incorporate the suggested changes in the specifications for the project.

Specific example

For example, the 4D modelling effort illustrated that a good schedule requires input from many parties, and that 4D models make it far more effective to get and incorporate this input into a project's execution strategy and understand the ramifications, advantages, and disadvantages of various construction strategies. The most important question, at least initially, was how to build the roller coaster. From left to right, right to left, or in some other sequence? Why was one approach better than the other, why not? Of particular concern was what impact a particular way of building the roller coaster would have on the construction of all the other parts of the project a lagoon and other attractions immediately next to the coaster and site logistics like access roads and staging and layout

areas. A major challenge on the project was that the owner's construction management team had to orchestrate the building of many facilities in a short time on a tight site. The answer to these questions (where to start the coaster construction, how to proceed from there and why) emerged through several meetings with many stakeholders around several versions of the 4D model. The following points illustrate one series of meetings with stakeholder groups that led to insights informing the best sequence of construction.

1) Construction management made the first schedule. Their strategy was to build everything around the six-acre lagoon from the lagoon, using the lagoon as the laydown and staging area for this work, and complete the lagoon towards the end of the project, and to build everything in the backfrom the back. This strategy nicely separated the work into two major areas of attack (from the lagoon and from the back) and lead to a good schedule from the construction perspective, maximising the utilisation of space on site over time.
2) In one of the review meetings, one of the other major stakeholders in the project, the testing team, reviewed the schedule. Not only were they able to understand the schedule quickly because of its visual presentation as a 4D model, but they were able to point out an important constraint for their work that had gone unnoticed up to this point: they needed the lagoon completed much earlier so that the water would be in the lagoon for the testing of the roller coaster, whose launch area is right next to the lagoon. The testing team wanted to test the operation of the coaster under operating conditions with the water in the lagoon.
3) The 4D model was then very helpful in finding the appropriate time when construction could get out of the lagoon so that it had enough space to build the project and give testing enough time.
4) As a result, the lagoon work was scheduled earlier than in the initial schedule the construction management team had prepared. This meant that the Ferris Wheel, which sits in the lagoon, needed to be built earlier too.
5) When the construction management team reviewed the revised schedule in the 4D model with the Ferris Wheel and the lagoon being built earlier, they noticed that the hill of the coaster that is behind the Ferris Wheel was now scheduled to be built after the Ferris Wheel. This would be difficult, uneconomical and time-consuming to do because the steel for the coaster hill would have to be lifted over the top of the Ferris Wheel, since there was other work that needed to be done in the back of the hill, and access from the other side was not possible at the time when the hill needed to be built.
6) Hence, here was an answer to where to start the coaster construction: Start with the hill behind the Ferris Wheel so that the Ferris Wheel can be built so that the lagoon can be built. While the Ferris Wheel and the lagoon are being built, the rest of the coaster can be built and when the coaster is finished the lagoon will be finished which will allow the testing team to test the coaster launch area.
While these relationships were obvious to everybody once they were discovered through the 4D model building and review process they had not been articulated before schedule development by the construction planning and management team.

Early stage application and benefits of 4D modelling at WDI

Throughout the Fall of 1998, there were many similar uses of the many versions of the 4D model built for this project by individuals, small groups (2 to 5 people), and larger groups (around 10 people) in the three months before the project design and specifications went out to bid. The model was displayed on computer screens, with a computer projector, sometimes using two projectors to two alternative schedules side by side, and in a CAVE (Computer-Assisted Virtual Environment). Meeting participants came from the Paradise Pier project team, the project teams working on other parts of the park, representatives from Disney Corporate, and other stakeholders (the City of Anaheim, neighbours, the Fire Department, etc.). For some of the meetings, the CIFE researchers assisted in the

preparation of the 4D models for the meeting, and the CIFE researchers documented the use of the 4D models for some of the meetings (Liston et al. 2001). At this time, CIFE researchers also continued to assist in the further development of the 4D modelling tool and helped answer questions about 4D modelling and evangelise the application of 4D modelling within WDI and in the industry (Fischer et al. 2001).

At bid time, WDI elected to invite the four general contractors who had been invited to bid on the Paradise Pier portion of the park to individual pre-bid meetings to discuss the scope, schedule, and challenges for the project. Throughout construction, WDI staff maintained the 4D model with the monthly schedule submissions of the general contractor and used these models to facilitate milestone, sequencing, and logistics discussions with the contractor.

These applications of the 4D model contributed to the following benefits for WDI:

- Better project specifications through the 4D-model-based project review process that engaged more stakeholders more fully than on other projects
- Narrow difference between the four general contractor bids
- Lower change orders
- More coherent and better informed owner project team
- Faster incorporation of new team members during the project
- Insights into future project delivery technologies and mechanisms

CIFE and Stanford University benefited in the following ways:

- Case study of the application of a new technology on a challenging construction project
- Education, experience, and test case material for three Ph.D. students (e.g., Akbas et al. 2001, Liston et al. 2001)
- Testing of concepts developed on other research projects
- Visibility of the research program to industry

In addition, the 4D technology developed for Paradise Pier was eventually commercialised and has been available on the market place for several years.

In a project close-out discussion about the application of 4D modelling, the project team suggested that the 4D model could have been used to coordinate site utility work and off-site work with on-site work to gain additional benefits.

Trajectory of 4D modelling at WDI after first pilot project

Soon after the application of 4D modelling on the Paradise Pier project, WDI R&D supported CIFE researchers to test the application of 4D modelling on a few other projects (e.g., a small renovation project and the strategic planning of a large new project). It also supported the CIFE research team to validate the 4D modelling approach in other organisations, e.g., on the Concert Hall project designed by Gehry Partners in Los Angeles (Haymaker and Fischer 2001). WDI R&D staff also carried out a review of the change orders on Paradise Pier to determine whether a more in-depth and prolonged application of 4D modelling could have avoided some of the change orders. The analysis showed that the benefits would have accrued in the same way on small and large projects and that about 40% of the change orders could possibly have been mitigated with the timely application of 4D models. In addition, the R&D leadership engaged the design and project management professionals and management at WDI in discussions about the application and value of 4D modelling and the rethinking of project management processes and metrics. Eventually, these discussions led to other pilot projects and to a serious reconsideration of the project management approach at WDI, and today, 4D models have become part of the toolbox for the delivery of projects at WDI (Muller 2003).

Deploying building information modelling at GSA: case example 2

CIFE researchers have been working with the GSA (General Services Administration, the organisation that develops and manages many of the facilities for the US Federal Government) for the last two years to develop case studies and a strategy to deploy VDC methods on GSA projects, with a particular focus on the application of BIM (Building Information Modelling). A CIFE Ph.D. student has spent this time in the Office of the Chief Architect of the GSA to carry out or assist these case studies, document the case studies, and disseminate the lessons learned through the GSA and the industry. For example, in the first year, the case studies included dramatically different projects with a wide range of VDC technologies and applications for BIM, for example:

- A structural retrofit and renovation project of a historic facility in a seismic zone, focusing the application of 3D and 4D modelling on historic preservation challenges and constructability
- Sustainability and energy simulations for a large existing office building that is scheduled for partial renovation
- Tenant space planning and construction sequencing for the renovation of a major office building
- Study of design and structural options (materials, prefabrication, construction assemblies) for a large program of simple buildings in various climate, access, and operational conditions

The insights from these and other case studies are currently being assembled into case studies and into project management guidelines for the implementation of VDC-supported project work processes. In addition, CIFE researchers are assisting the GSA in the development of an implementation strategy to operationalise the use of VDC methods across many more projects in all the regions.

CONCLUSIONS

These two case examples illustrate the key aspects to a successful cooperation between academic research teams and industry:

- An engaged and visionary executive sponsor in the industry organisation, who also commands respect in day-to-day operations
- Clear customers of the VDC models at the construction project level with clear and frequent (weekly, monthly) expectations for the scope, quality, timing, and application of VDC models
- Strong faculty leadership
- Highly-skilled and motivated students who are able to earn the respect of leading practitioners on construction projects
- Clear and measurable short-term and long-term application and research goals and alignment between the industry implementation and academic research goals
- A commitment by all parties to spend some effort on the long-term goals and on documenting and quantifying lessons learned on the application of new methods in practice in spite of the inevitable pressures for short-term deliverables and results on the construction projects that serve as the case examples
- Frequent and open communication between the project team, the R&D team, and the industry and faculty sponsor
- Funding for the R&D team (student tuition and stipend, faculty support, travel, and computer infrastructure are the main cost items for the type of innovation presented in this paper)

These ingredients form the foundation for successful and sustainable cooperative research relationships between industry and academia to design, test, and implement innovative work processes supported by new technologies.

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Part 3
Theoretical And Practical Issues In Construction

CHAPTER 8

Owner Initiated Modernisation of Bridge Safety Inspections

Thomas Mills
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William Bushman

BRIDGE INVENTORY MANAGEMENT APPROACH AND PHILOSOPHY

The annual cost for maintenance and improvements to the world's transportation infrastructure is billions of dollars. Much of this cost is associated with bridge maintenance, rehabilitation and replacement (MR&R). Within the Unites States, an individual state department of transportation (DOT) is eligible for federal highway support funds through the Federal Highway Administration (FHWA). Eligibility is contingent on each state establishing its own methodology to inspect and report bridge deterioration in compliance with National Bridge Inspection (NBI) Standards. All states report their inspection results in a standard format for inclusion within the NBI inventory (NBIS 23, 2002). State and federal laws and associated policies mandate the frequency of inspections. These inspections range from a monthly cycle to once every four years with a routine bridge inspection usually required once every two years. Within the state of Virginia alone, there are approximately 22,000 structures (bridge and culverts,) requiring between 7,000 – 10,000 inspections annually.

The primary objective of any bridge management system (BMS) is to make the best use of available funds in an overall bridge MR&R program while maintaining an infrastructure that's safe for public usage. Without regular maintenance, the overall conditions of any infrastructure element including a bridge will deteriorate over time. Therefore, a BMS must utilise accurate and accessible inspection information to predict a bridge's structural conditions over time.

A fully functioning enterprise wide BMS, or any other infrastructure management system, involves four major informational processes. These processes span the entire structure's life cycle. First, among these processes is the maintenance of an accurate inventory of structure information. This information must be retrievable, updatable, and reflective of the actual inventory item. Second an enterprise wide BMS needs to maintain a consistent and timely inspection and reporting process. Third, a needs assessment process that is coupled to a strategic MR&R optimisation program is necessary to meet the goals of a safe and effectively administered infrastructure. Fourth, an MR&R projects development program allows for timely and cost effective budget allocations consistent with infrastructure management goals. At the state level each of these processes is handled internally across several different operational departments, including information technology (IT.)

Informational fragmentation of the inspection process

At present, the VDOT bridge management enterprise has coherence in intent although throughput is slowed by the fragmentation of informational support tools. This system wide fragmentation has both

technical hindrances and cultural bottlenecks that must be overcome if an effective and integrated BMS is to be achieved. Research to modernise the BMS can be extensive and cumbersome crossing many DOT operational domains.

Bridge information in Virginia, like many other states has a combination of IT tools that assist in managing its inventory. Virginia in particular combines this information within two distinct database applications, 1) Highway Traffic Records Information System (HTRIS), a coded inventory only database that exists within a Disc Operating System (DOS), and 2) Pontis, a well developed software application that operates within a Windows Operating System environment and maintains significant amounts of condition state data. The HTRIS inventory application is a relic of the 1980's, yet does all that is asked of it which is little more then maintaining inventory data. As currently used by the owner/agency Pontis data is typically restricted to coded entries although it has capabilities for modeling and simulating "what-if" scenarios within an MR&R project decision making environment. A third component of Virginia's overall BMS is a non-indexed structural inspection report (SIR) that is the only visual and verbal description of a bridge's condition. The two databases (HTRIS and Pontis) help the state meet its obligation for compliance with federal laws and NBIS. The SIR is composed of written commentary, deterioration quantities, graphical data, and photographs compiled from inspector observations and allows for a non-codified assessment of a structure's condition. Collectively these three applications form the backbone of informational support and inspection data for Virginia's BMS.

The "bridge management databases" themselves are diverse and have low interoperability and fragment the inspection process. There is limited throughput within these three databases as they cross the four BMS domains of inventory, inspection, needs assessment, and project/program development. With the advent of wearable and handheld computing the opportunity for transforming an inherently fragmented paper based asset management process into one that is seamlessly integrated has become achievable by any large asset owner, public or private.

OWNER INITIATED TRANSFORMATION OPPORTUNITY

It was this awareness of a fragmented process that precipitated the VDOT Bridge and Structures Division (BSD) to embark upon an initial investigation to minimise or eliminate all inspection process fragmentation within the inspection domain by advocating the use of personal digital assistants (PDA's). Previously the owner/agency had implemented a process whereby laptop computers were issued to all field inspection teams, with the express purpose to allow field based reporting for later uploading to the agency database.

This previous effort failed for a variety of reasons, one being that basic inspection workflow process was neither investigated, nor documented as a necessary aid to overall process improvements. It was discovered after deployment, that even though new computer capabilities were added, work processes never changed. Therefore, a charge for this investigation was to not repeat this mistake.

It has become evident upon completion of the initial research that specific process improvements can still be derailed through organisation structures that fragment improvement processes. The charge of not repeating a past mistake is proving easier said than done. This was apparent during the research proposal stage and was later reinforced by the Bridge Inspection Division's decision to implement a "hardware first" direction.

Virginia transportation research council (vtrc)

To further improve transportation research the state maintains the Virginia Transportation Research Council (VTRC) as a state-sponsored centre for innovation in advanced transportation-related engineering technology and for improvements in state agency management and operational practices.

These objectives are intended to be met by conducting a broad-based program of applied and basic research, including support for technology transfer to the VDOT. In this capacity as innovator the VTRC is a coordinating agency that assists in interfacing between agency needs and university researchers to address innovative research issues (VTRC, 2004).

Although the VTRC acts as a catalyst, many of the research activities are internally linked back to a specific VDOT organisational unit. In the instance of inspection improvements the direction and focus is being provided by the BSD. This mechanism of yielding major research direction to an operational arm of the agency adds to process fragmentation, yet allows for broader user led and initiated research. This fragmentation was, to a certain extent, obvious in the initial research proposals and further reinforced by the BSD post research decisions and the VTRC's weakness in redirecting these decisions.

Fragmented research strategies

The VTRC had previously discussed strategies with researchers to improve the inspection processes; it took the BSD to make the initial call through the VTRC for process improvement proposals. Upon receipt of the call an initial proposal was prepared that addressed only inspection process improvements through; 1) research on work processes, 2) defining optimum user needs; 3) developing process improvement strategies, 4) proposals for specific hardware/software solutions, 5) the implementation of prototype trials, 6) development of implementation procedures, and 7) measuring and assessing improvements. Upon proposal review the BSD countered that only hardware/software solutions are proposed with a particular desire to target a specific hardware solution set.

This "hardware first" solution was indicative of the previously mentioned laptop implementation failure. Preconceived notions without process understanding are doomed to failure. A second proposal was prepared to address this owner-driven approach. Fortunately, the VTRC recommended otherwise. The VTRC recommended that agency work processes must be researched and understood before any hardware solution could be proposed. This lead to a third proposal that addressed a simple work processes investigation within a transformation strategy of incorporating wearable/handheld computers into the inspection process.

RESEARCH APPROACH

The strategy for this research was to map the work flows as described and then observe how field personnel actually proceeded with their work tasks. To quote Anjard (1996), "A processes map prompts new thinking about how work is done." Additionally as Symonds and Jacobs (1997) have shown in their work, multi-level process maps can produce higher levels of detail and hence higher levels of understanding and opportunity for innovative process improvements. Thus the use of simple mappings to understand and analyse workflow can be quite successful in identifying change opportunities.

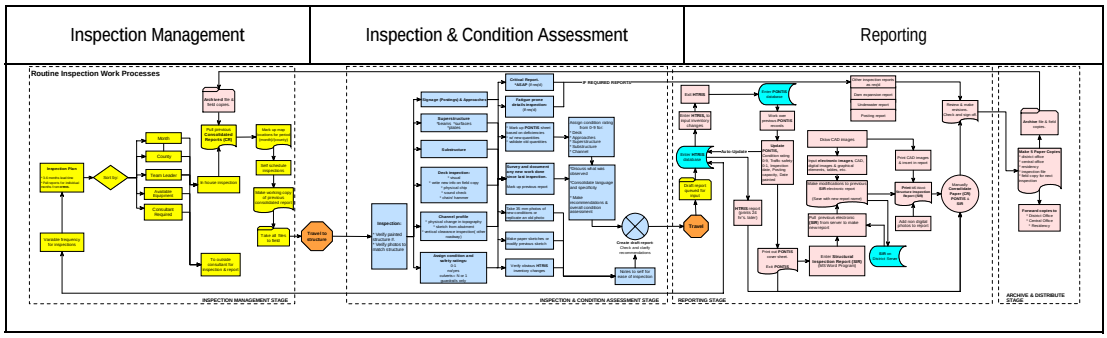
Due to the uniqueness, diversity, and locations of the state's asset inventory it was determined that several bridge inspection teams or districts operational processes would be observed and mapped. To find out how different people and different teams approached and conducted similar inspections, and to get reliable and transportable mappings, bridge inspectors from four different districts were interviewed and then physically observed in the field and office as they implemented the inspection process. Not unexpectedly the observations of the different inspection teams identified a common work process. Although the processes had commonality in accomplishment and outputs the actual procedures were sequenced and implemented differently by each of the different teams. This validated the need for a modernisation strategy that could incorporate mobile computing technology into standard operating procedures but also allow different teams to work in self-defined sequences.

RESULTS

Most if not all states, including Virginia, provide its inspectors with standardised training through comprehensive courses based on the FHWA's "Bridge Inspector's Training Manual" and NBIS. This commonality in training is intended to standardise the process by minimising the variability in inspection observations and reports. Although inspector training and reporting requirements are standardised to comply with FHWA requirements, each state is free to develop its own inspection and reporting methodologies. Therefore, each state has a unique inspection, collection, internal reporting, and archiving methodology.

In general, the different inspection teams accomplished their basic inspection tasks using similar process that operates within three distinct and sequential functions, 1) Inspection Management, 2) Inspection, and 3) Reporting.

Figure 8.1 Current Inspection Workflow



In all instances data collection by field inspectors was done by marking up, in red, the previous paper reports with any new data. Later the inspectors would return to the office and manually input the newly recorded data into three separate electronic applications and print out a paper archival report. The data collection and reporting systems used to complete an inspection was characteristically paper based with the results being manually transferred and archived into three separate and distinct software applications, 1) HTRIS, an older DOS-based asset inventory database; 2) Pontis, a Windows-based proprietary database application; and 3) a word processing document that contained text, graphics, and images. These three applications have limited interoperability and required a manually composed report combining paper outputs from all three applications to produce a final archival report.

Work processes identify information fragmentation

It was determined that at the inspection level information was compiled, stored, and archived within three functionally independent information interfaces. Although these interfaces exist independently and have limited interoperability they are collectively used to record bridge/structure inspection data and to manage the state's bridge/structure assets. The three independent information archives having been previously described are; 1) HTRIS (DOS-based), 2) Pontis (Windows-based), and 3) SIR (text with graphics and images).

Table 1 is an example of the level of fragmentation in information accessibility that exists within the state's bridge/structure inspection process. Access to each of these information types is necessary to fully comprehend the condition of a bridge and to develop any MR&R strategy (Mills and Wakefield, 2004). As can be observed in Table 8.1 no single software application provides an assessment of the structure's condition that is usable and adequate for competent asset management.

Table 8.1 Bridge/Structure Condition Data Fragmentation

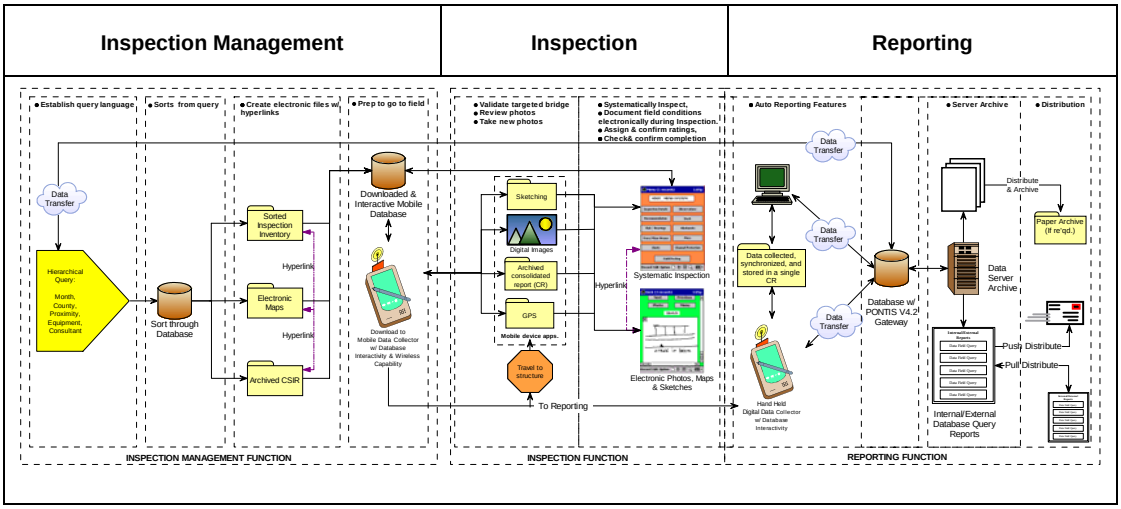
Information Type	HTRIS	Pontis	SIR
Text commentary			√
Graphical data (sketches)			√
Photographs			√
Geometrical data	√		
Condition ratings	√	√	
Inspection frequencies	√	√	
Element conditions		√	
Maintenance & improvement cost		√	

From an analysis of the research data, it was determined that a modernising of the inspection processes through the implementation of mobile computing devices could improve the processes within the inspection management, inspection, and reporting functions.

Modernisation recommendations

A series of recommendations were offered to the agency that described a deliberated and phased approach to the agency's goals of modernising the inspection process by incorporating mobile computing devices and current information transfer mechanisms. Figure 8.2 is a workflow redefinition of the current work practices with an attempt to address redefinition by incorporating mobile computing technology. The recommendations proposed a tiered strategy for modernisation that attempts to incrementally modernise the process by defining varying levels of internal improvements prior to any revolutionary hardware/software transformation.

Figure 8.2 Proposed Inspection Workflow



Tier One improvements are intended to foster an achievable level of internal agency action. This was to be accomplished by; 1) simple procedural adjustments that eliminated agency redundancies and minimised internal inefficiencies without any new hardware/software additions, and 2) adopting agency procedures that would aid in the standardisation of upstream and downstream information transfers to improve the chances of a more successful transformation when mobile inspection tools were added to the process (Mills and Wakefield, 2004).

Tier Two work proposed an implementation sequence that mimicked the first research proposal and offered three alternative mobile computing solutions to the agency and the VTRC. Essentially the work proposed that the BSD; 1) establish its inspection modernisation priorities through a facilitator led workshop, 2) that three proposed solutions be investigated, 3) that VTRC/BSD create a mobile field application pilot program with solution supplier support, and 4) that VTRC/BSD pilot the solutions and present the findings to the agency.

Upon a complete assessment of the pilot program a prototypical mobile inspection assistant could be compiled for actual field testing and benchmarking. Once this phase was completed a hardware/software solution could be established, followed by a procurement, implementation and adoption procedure. This last phase of the work was to implement a field monitoring assessment to monitor productivity improvement (Mills and Wakefield, 2004).

A FRAGMENTED STRATEGY FOR MODERNISATION

Prior to completion of the Phase I work, the BSD was desirous of a quick solution and proceeded to initiate a “hardware first” solution. This effort was consistent with the BSD’s initial strategy to ignore the work processes and focus on a solution before understanding the existing work processes and how they could be modernised. Thus the BSD proceeded in designating an “affordable” Palm OS device as the pre-designated solution to integrating mobile computer assistance for modernising the inspection process.

Ramifications and the return to fragmentation

It is being discovered that the BSD "hardware first" solution is not meeting with much success. During this attempt to implement the solution before determining the problems, researchers of Phase I were not contacted nor consulted. The researchers are aware that the results of Phase I have been read by BSD and there has been discussion of continuing the research. What becomes apparent is that without a studied and careful effort to understand the problems, any solution is primed for failure. A research focused facility such as the VTRC has the vision to foresee this problem and as such initiated the Phase I research that yielded a reasonable strategy and excellent opportunity to modernise the processes much as proposed.

What is also evident is that by observing BSD's desire for a quicker solution and VTRC's mediated phase one proposal the fragmentation that exists reinforces an action versus research dilemma in transforming an organisation's operational processes. The acceptance of a reasonable proposal that staged the progression of deliverables and allowed research findings to be incorporated into action prior to report completion would have allowed fast-tracking and a quicker solution.

Concluding lessons learned

History has a unique way of repeating itself. The innovative VDOT laptop deployment that failed earlier has the opportunity to repeat itself during VDOT's current efforts to modernise their antiquated inspection processes. Successful innovation requires an adequate understanding of the problem and the issues that make innovation possible and successful. Innovative solutions take understanding and understanding requires time. To be a successful innovator, an owner/agency must gather buy-in from all users and allow time for the process to develop. VTRC and VDOT dedicated research approach fosters buy-in through the very elements that aid fragmentation. Any fragmentation within an organisation hinders the organisation's ability to quickly foster innovation and modernisation.

When an organisation is unclear on its internal roles and responsibilities, action or research, it will encounter difficulty in driving innovation. VDOT's efforts to modernise their inspection processes are resulting in multiple starts, stops, and redundancies that characterise the process with internal delays and failed successes. With regards to VTRC/BSD effort to modernise their inspection processes, the end users' (BSD) needs should drive the research and the research group should drive the investigative process.

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CHAPTER 9

ICT in the Australian Construction Industry: Status, Training and Perspectives

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Todd Remmers
Stephen McFallan

INTRODUCTION

This chapter outlines the results of a survey conducted in November 2003 aimed at investigating the Australian construction industry's current performance in ICT related issues. The survey targeted three broad areas:

- Current ICT status including annual ICT investment, access to and use of ICT devices according to annual turnover;
- ICT training including training participation by individuals, training support within respondent organisations with regards to workload and time flexibility for employees, preferred mode of training for individuals, and level of ICT competence expectations of the various construction project participants of their colleagues; and
- ICT trends and opinions on the Benefits/Drivers and Barrier/limitation to the implementation and use of ICT on construction projects.

The survey was implemented on a National (Australia) basis within the construction industry - including non-building, building (commercial/industrial), and residential sub-sectors - with a view to informing the decision makers within the construction industry on ICT policy relating to:

- The types of ICT being used across the construction industry sub sectors and for various project sizes to enable them to identify possible improvements through ICT uptake;
- The preferred mode of training amongst construction industry employees allowing them to implement suitable ICT training regimes for employees; and
- The Benefits/Drivers and Barrier/limitation to the uptake of ICT on construction projects to enable them to identify suitable ICT implementation strategies within their organisations.

SURVEY METHODOLOGY

The survey reported here was carried out using web based survey methodology. An email was sent to potential respondents with a web link embedded enabling respondents to hotlink to the survey web server. Respondents were asked to complete each of the four sections and submit the responses - which were stored in the web server. After the nominated survey closing date, the responses were forwarded for analysis by the project team. Further details on the methodology including the survey

development, pilot study, response rates, and general principles are outlined in Kajewski, et. al. (2004).

Survey respondent profile

Respondents where asked to answer specific questions to enable detailed comparative analysis of the responses. In terms of a general profile, the analysis revealed that:

- 92% of respondents were from the East Coast of Australia;
- 78% of respondents have some form of Tertiary Qualification;
- 71% of respondents were in some form of managerial role within their organisation;
- All respondents had greater than 1 year and 54% had at least 10 years service in their present position;
- 63% of respondents were from a contracting organisation and 29% were from a consultant/specialist organisation with the remaining 12% being spread between Supplier and Client organisations;
- The majority (74% of those who knew the organisation's annual turnover) of respondents' organisations had annual turnover's of less than $5M and 10% of respondents' organisations had annual turnover's of $100M+ or greater; and
- At least 80% of respondents were from the Vertical/Building construction sub-sector.

CURRENT ICT STATUS

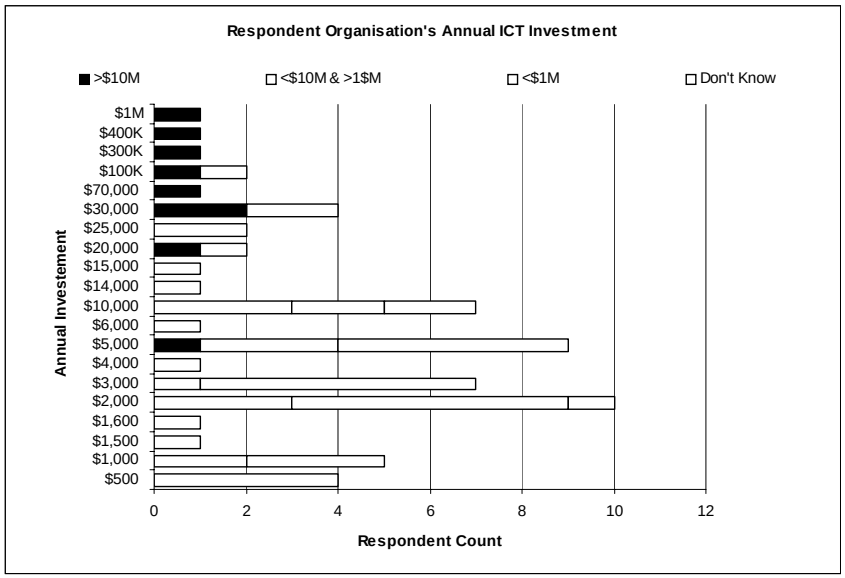
This section investigates the respondents, and respondents' organisations where appropriate, current ICT status including:

- ICT organisational investment: including further analysis of ICT investment according to sub-sector and annual turnover; and
- ICT device access and use: including use and access for various devices, access and use of emerging/innovative technologies by annual turnover.

Organisational investment

Respondents were asked to specify how much their company currently invests in ICT annually. The amount spent varied considerably from $500 to $1,000,000 with the most frequent amount specified being $2000. The factors expected to be influential on ICT investment included annual turnover and the industry sector. Figure 9.1 displays the distribution of the respondents' organisations' annual ICT investment commitment by turnover category. The categories were arbitrarily set at greater than $10M, between $10M and $1M and less than $1M. A further category (Don't Know) is provided to cover respondents that did not know their organisation's annual turnover.

Figure 9.1 Distribution of ICT Investment Amount by Annual Turnover

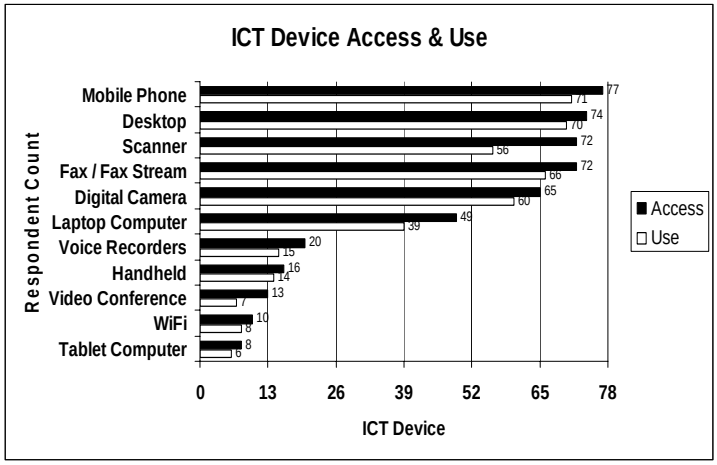


To test whether a relationship existed between the annual investment in ICT and annual turnover ranges, a correlation test was performed. The annual turnover responses were coded from 1 to 9 with 1 being the lowest turnover category and 9 being the highest. The correlation statistic used for this test was the Spearman's Rho. The analysis between annual turnover (coded) and ICT investment indicated a positive relationship exists (Spearman's rho 0.51, Correlation is significant at the 0.01 level). It is worth remembering that a proportionally higher number of respondents from the non-building sector were also represented in the higher turnover ranges, which could be confounding the results.

ICT device access and use

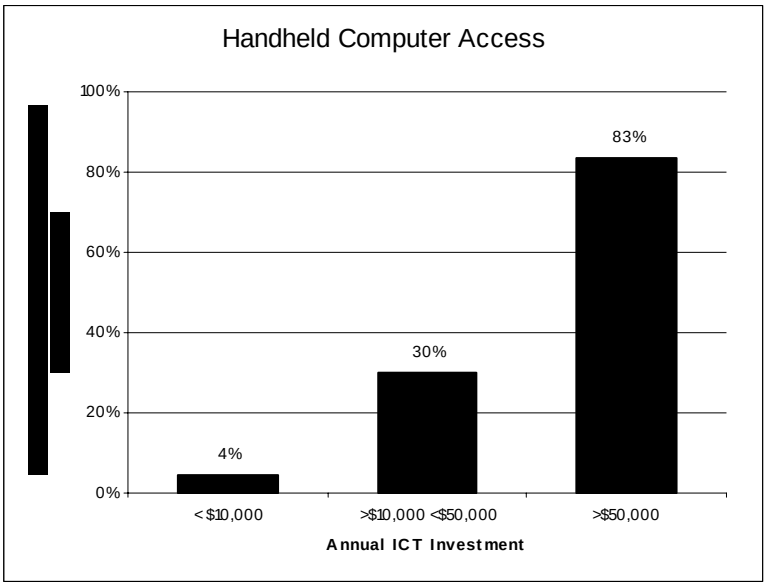
Respondents were asked to identify which ICT devices, from a specified range, they have access to within their company and subsequent to this, which of these devices they used on a range of project sizes. Details of project size the respondent participates in was not readily obtained, thus the data were pooled and analysed for any project size. Responses for both of these questions are illustrated in Figure 9.2.

Figure 9.2 ICT Access and Usage



The list provides a range of ICT technologies. Some ICT technologies such as Desktop computer, Mobile phone, Scanner, Fax and Digital camera are established technologies and according to the responses are accessible by most respondents. Based on the responses, these technologies are widely used on construction projects. When considering emerging technologies such as Wi-Fi, Handheld and Tablet computers, and Video Conference equipment, the analysis revealed that the amount of annual ICT investment of the companies apparently impacts on accessibility. Organisations with higher investment budgets have a higher proportion of these emerging technologies. This is illustrated in Figure 3 which displays the distribution of access to handheld computers according to the ICT investment category. This chart shows that 83% of the respondents with an annual ICT investment budget greater than $50,000 have access to handheld computers compared with only 4% of those with an ICT budget of less than $10,000. A similar pattern emerges when analysing technology usage for other emerging technologies.

Figure 9.3 Distribution of Handheld Computer Access



ICT TRAINING

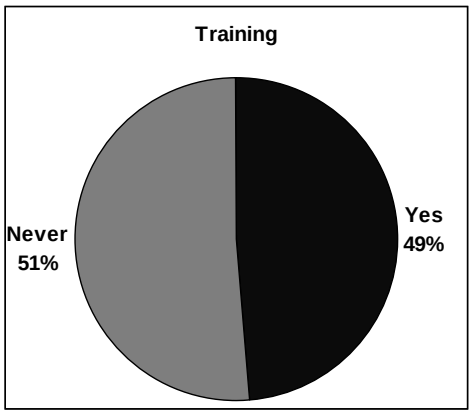
This section investigates the ICT training characteristics of the respondents and respondents' organisations including:

- Official ICT training participation – including overall participation, participation considering annual turnover, and participation variability in the sub-sector groups;
- ICT training company support – including whether the respondents were allowed time or workload flexibility to undergo ICT training, sub-sector analysis was also completed;
- ICT training mode preference – including analysis dependent on annual turnover ranges;
- ICT competence expectations – including respondent's expectations dependent on sub-sector group.

Official ICT training participation

Respondents were asked to indicate whether they had undergone any official ICT training. Almost half (49%, Figure 9.4) of the respondents indicated they had undergone official training. When comparing responses by the company classification, sub-contractors were more likely to have never undergone official training. Larger ($100M+ turnover) organisations had a higher proportion of respondents indicating they had undergone official training, as did respondents who indicated their core sector was non-building construction (both 5 out of 7). While worthy of note, these were not statistically significant findings.

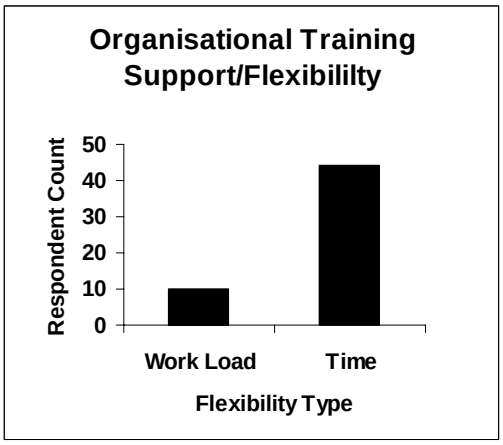
Figure 9.4 Proportion of Respondents Who Had Undergone Official ICT Training



ICT training and company support

Respondents were asked to indicate whether their company allowed them sufficient time during office hours to undergo ICT training with over half indicating that such time was made available (Figure 9.5). Although respondents from the residential construction sector were less likely to be provided adequate time for training (13 out of 21), this was not a statistically significant finding. Respondents were also asked whether their company adjusted/reduced their workload to undergo ICT training – with only 10 respondents indicating that such an adjustment had been made. Interestingly, six of those were from companies with a turnover range between $1M -$5M.

Figure 9.5 Organisational Training Support



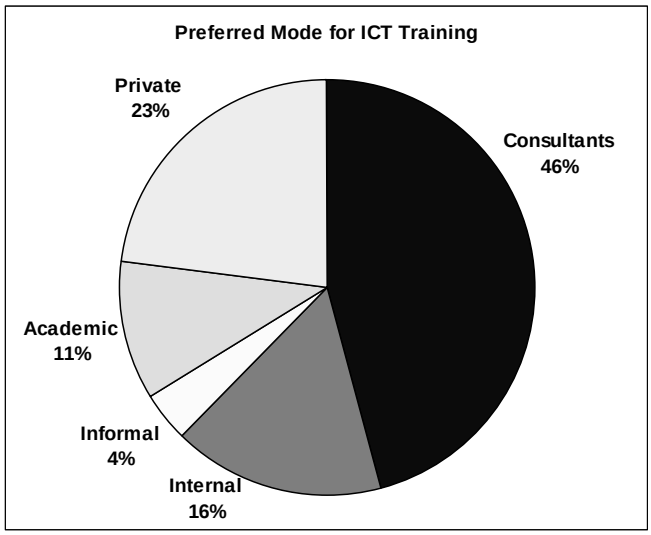
Overall, only two had undergone official ICT training and had been allowed sufficient time and had their workload adjusted to undergo training. Conversely, 18 respondents indicated they had not undergone any official ICT training or received any adjusted workload or time. The residential building sector was heavily represented in this group. Based on the responses, 59 respondents

indicated they either have had either official training or have had their workload reduced, or have been allowed sufficient time during work hours to undergo training, implying at least 76% have undergone some kind of training.

ICT training mode preference

The respondents were asked to nominate their preferred mode of training from a selected list. As is evident in Figure 9.6, the preferred training mode was with professional consultants, with 46% of respondents nominating this method.

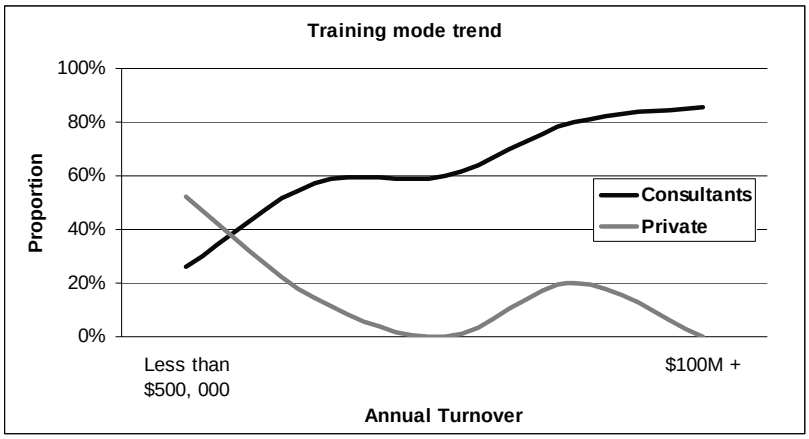
Figure 9.6 Preferred Mode of Training



Both of the respondents who had undergone official ICT training and had been allowed sufficient time and had their workload adjusted to undergo training, indicated a preference for training with professional consultants. This preference was supported by the 18 respondents who indicated they had not undergone any official ICT training or received any adjusted workload or time to undergo ICT training.

Figure 9.7 shows the response trend for preferred mode of training dependent on the respondent's turnover classification. The chart shows an increasing preference for professional consultants as the annual turnover category increased. 86% of respondents from the higher turnover categories indicated a preference for training mode with professional consultants compared with the lower turnover categories, where 52% indicated a preference for private training.

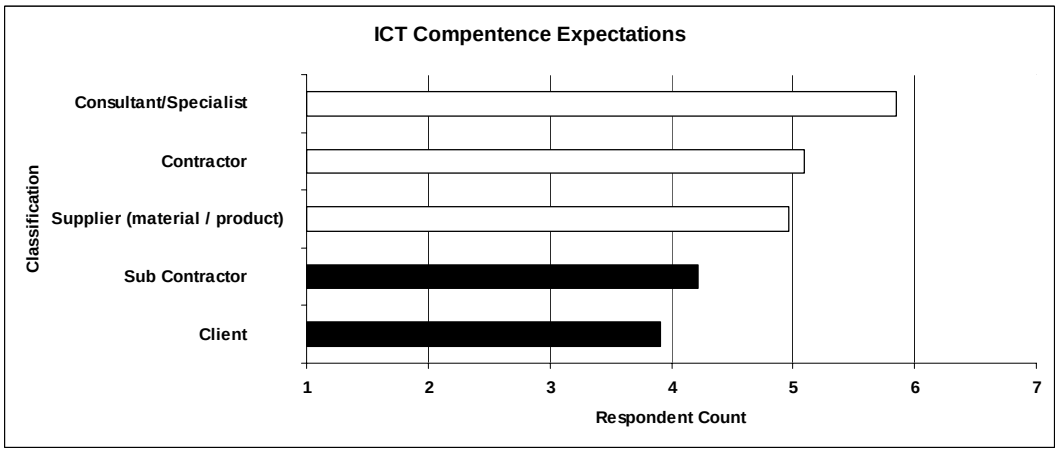
Figure 9.7 Training Mode Preference Trend



ICT competence expectations

Respondents were asked to indicate what overall level of ICT competence (capabilities, skills, etc) they believed specific team members should have on a project. Overall respondents expect the consultant to have a greater level of ICT competency than all other team members. This result was statistically significant. Contractors and Suppliers were rated next with Clients and Sub-contractors rated lowest however, still expected to have at least average competence.

Figure 9.8 Average Responses For Overall Level of ICT Competence



When comparing the responses dependent on the role of the respondent it was apparent that those in managerial roles tended to expect a higher competency from all team members than did other groups. This was not a statistically significant finding. When comparing responses based on the respondent class, sub-contractors tended to expect a greater level of competency from sub-contractors in general

than did other groups. They also expected a higher level of competency from contractors than other groups.

ICT PERSPECTIVES

Benefits and drivers for ICT on projects

Respondents were asked to indicate what influence a specified range of benefits and drivers has on their decision to implement or use ICT on projects. The issues presented included:

- Benefit 1. To help improve overall team/company efficiency (productivity).
- Benefit 2. To help enable electronic banking etc (eCommerce).
- Benefit 3. To help enable electronic tendering (eTender).
- Benefit 4. To help enable electronic archiving of documentation (eArchive)
- Benefit 5. To help set up a dependable ICT infrastructure within your company.
- Benefit 6. To help become Industry leaders in ICT adoption.
- Benefit 7. To help downsize or become a leaner company/team.
- Benefit 8. To help increase business opportunities.
- Benefit 9. To help gain increased efficiency (improved productivity).
- Benefit 10. To help support industry Research and Development.
- Benefit 11. To help receive tangible rewards (pay/job advancement).
- Benefit 12. To help receive intangible rewards (respect, self-fulfilment).

The response options ranged from no influence at all to highly influential with a total of seven rating options.

The mean response rating for most issues was above average suggesting that most issues were influential in their decision to implement or use ICT on projects. The only issue with a below average mean response was '*to help become industry leaders in ICT adoptio*n'. The mean response for the issues is displayed in Figure 8.9.

Figure 9.9 Mean Response For Benefits/Drivers Influencing ICT Implementation

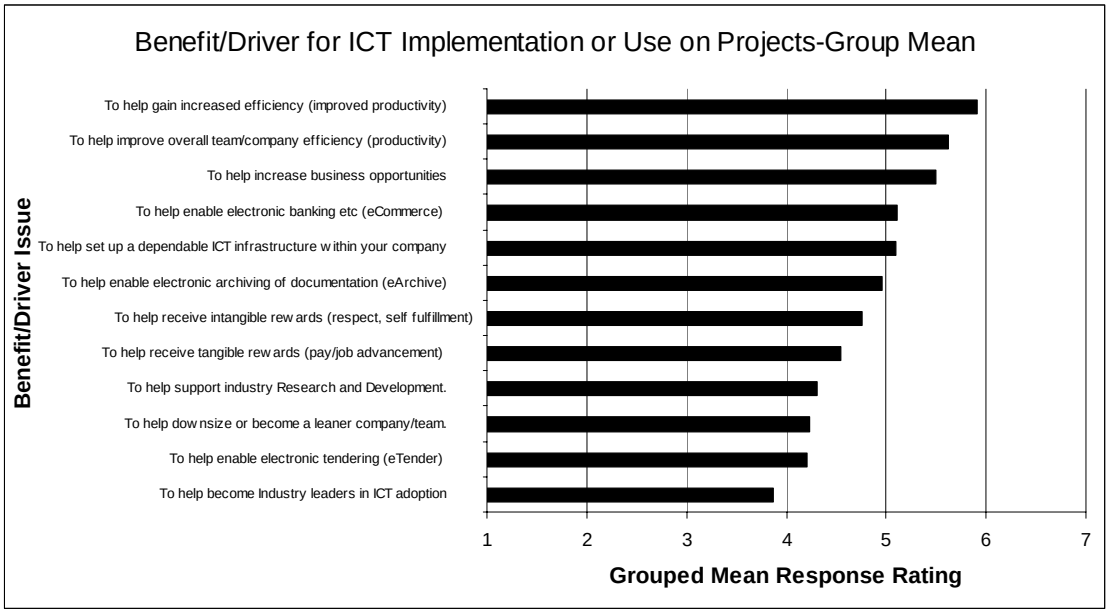


Figure 9.9 shows the issue with the highest mean rating was *'to help gain increased efficiency (improved productivity*)' followed by '*to help improve overall team/company efficiency (productivity)*' and '*to help increase business opportunitie*s'.

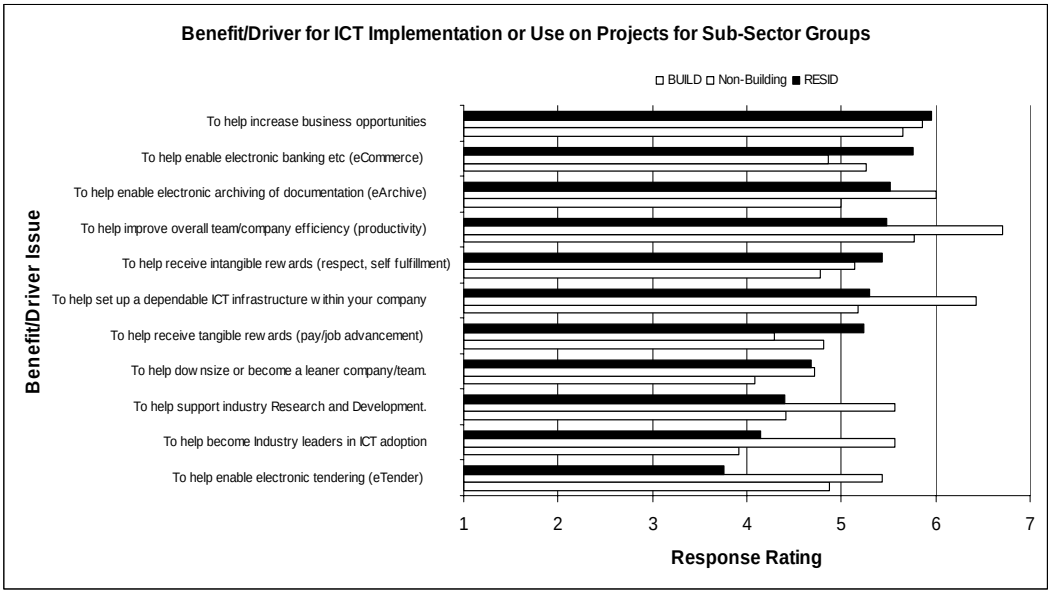
Based on the sample error the results showed a statistically significant difference in the mean response between issues, with the top three issues being significantly different to the bottom six issues. This result suggests that the top three issues are likely to be the most influential for the population in general.

The issues found to be of least influence, in order of influence include *'to help become industry leaders in ICT adoption'; 'to help enable electronic tendering (eTender)';* and *'to help downsize or become a leaner company/team'.*

Essentially, respondents perceive ICT to provide productivity benefits to their project operations, both at the individual and team/company level. They also perceive some strategic benefits in the way of improved business opportunities that the ICT may provide.

When comparing the responses dependent on the analysis factors, there was considerable variability between the core sectors (Figure 8.10), in particular the responses for the non-building sub-sector. Due to the small number of respondents in this category the differences, in general, were not statistically significant. Figure 10 below displays the results of the core sub-sector analysis. The non-building sub- sector respondents perceived '*to help improve overall team/company efficiency (productivity)*' and '*to help gain increased efficiency (improved productivity)*' as the most influential benefits/drivers respectively to ICT implementation or use on projects. Other issues, which have a strong influence for the non-building sub-sector respondents, in order of influence are *'to help set up a dependable ICT infrastructure within your company'; 'to help enable electronic archiving of documentation (eArchive)';* and *'to help increase business opportunities'.*

Figure 9.10 Mean Responses for Benefits/Drivers by Core Sector



It is worthy of note that those in the non-building sub-sector indicated that "*to help set up dependable ICT infrastructure'* was more influential than "*to help increase business opportunitie*s" where the overall mean response showed a different result. This sub-sector also rated (4th highest) eArchive capability more influential than did the group mean, which gained a ranking of 6th highest overall. In addition, worthy of note was that all issues raised had higher than average influence response for the non-building sub-sector.

Building construction (commercial/industrial) respondents perceived *'to help gain increased efficiency (improved productivity)'* and *'to help improve overall team/company efficiency (productivity)'* as being the most influential benefits/drivers respectively to implementing or using ICT on projects. Other issues, which have a strong influence for building construction sub-sector, in order of influence are *'to help increase business opportunities'; 'to enable electronic banking etc (eCommerce)';* and *'to help set up a dependable ICT infrastructure within your company*'. These results are in line with the grouped mean response for all sub-sectors where the top 5 issues match in order of influence.

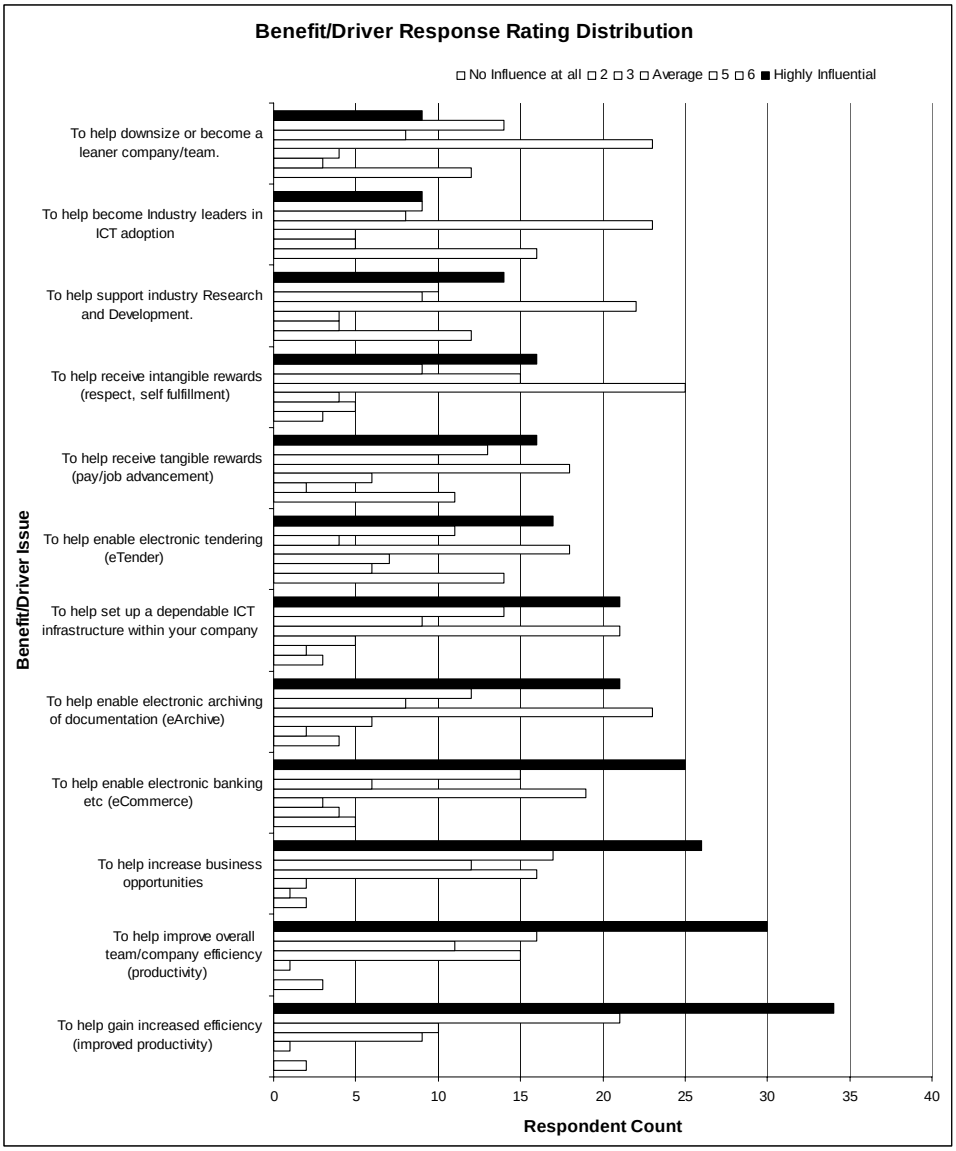
The residential sub-sector respondents perceived *'to help gain increased efficiency (improved productivity)'* and *'to help increase business opportunities'* as their most influential benefits/drivers respectively to ICT use and implementation on projects. Other issues, which have a strong influence for the residential sub-sector, in order of influence are *'to enable electronic banking etc (eCommerce)'; 'to help enable electronic archiving of documentation (eArchive)';* and *'to help receive intangible rewards (respect, self fulfilment)'.*

It is interesting to note that the residential sub-sector rated the increase in business opportunity benefit/driver as more influential than the other sub-sectors. Another interesting result for residential

sub-sector is the relatively high influence rating, compared to the group mean, for the issue '*to help receive tangible rewards (pay/job advancement)*'. It is also interesting to note that the issue '*to help enable electronic tendering (eTender)*' had less influence for those in the residential construction sub-sector than the other two.

Figure 9.11 displays the rating response distribution for the influence the specific benefits/drivers had on their decision to implement or use ICT on projects.

Figure 9.11 Response Distribution for Benefits/Drivers Influencing ICT Implementation



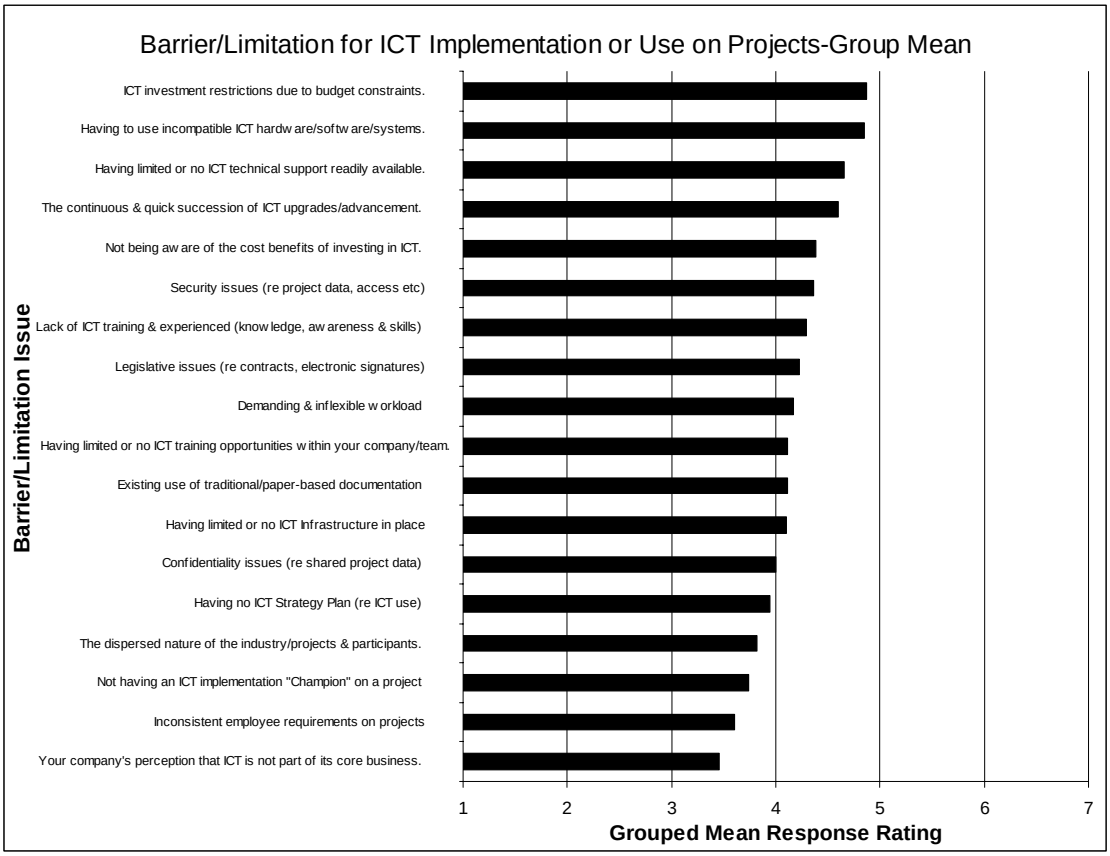
Barriers and limitations for ICT on projects

Respondents were asked to indicate what influence a specified range of Barrier/limitation has on their decision to implement or use ICT on projects. The issues presented included:

- Barrier 1. Not having an ICT implementation "Champion" on a project.
- Barrier 2. Existing use of traditional/paper-based documentation.
- Barrier 3. The dispersed nature of the industry/projects & participants.
- Barrier 4. Having limited or no ICT Infrastructure in place.
- Barrier 5. Having limited or no ICT technical support readily available.
- Barrier 6. ICT investment restrictions due to budget constraints.
- Barrier 7. Not being aware of the cost benefits of investing in ICT.
- Barrier 8. The continuous & quick succession of ICT upgrades/advancement.
- Barrier 9. Having to use incompatible ICT hardware/software/systems.
- Barrier 10. Security issues (re project data, access etc).
- Barrier 11. Confidentiality issues (re shared project data).
- Barrier 12. Legislative issues (re contracts, electronic signatures).
- Barrier 13. Having no ICT Strategy Plan (re ICT use).
- Barrier 14. Your company's perception that ICT is not part of its core business.
- Barrier 15. Inconsistent employee requirements on projects.
- Barrier 16. Lack of ICT training & experience (knowledge, awareness & skills).
- Barrier 17. Demanding & inflexible workload.
- Barrier 18. Having limited or no ICT training opportunities within your company/team.

The response options ranged from no influence at all to highly influential with a total of seven rating options. The mean response for these issues is displayed in Figure 9.12. The chart shows that all issues are grouped between slightly below to slightly above average influence and that '*ICT investment restrictions due to budget constraints*' was most influential. This result confirms results in previous sections, where in general annual turnover, hence project/organisational budget, has had a great influence on both ICT status and ICT training outcomes.

Figure 9.12 Mean Response For Barrier/Limitation Influencing ICT Implementation



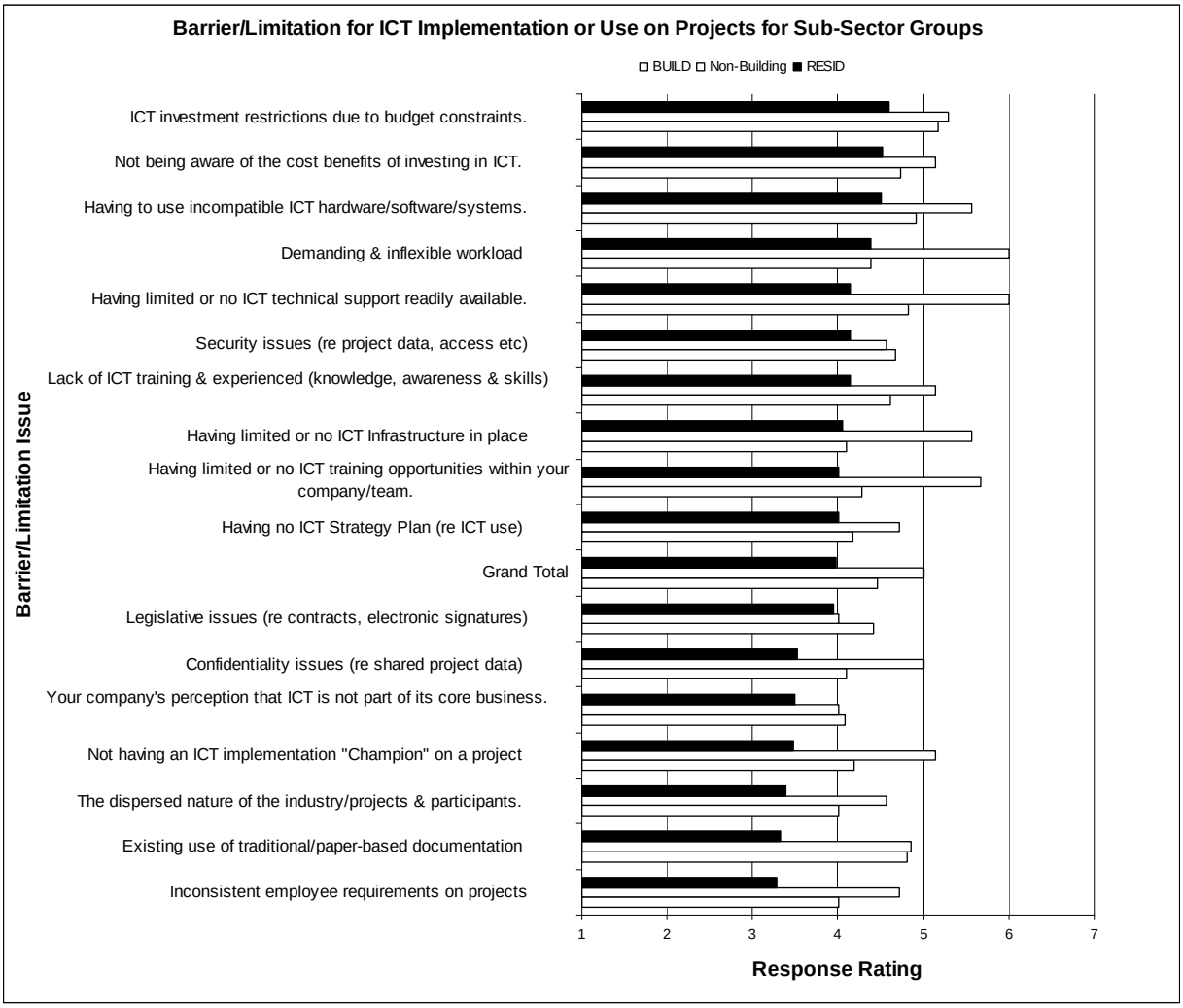
Technical issues such as *'having to use incompatible ICT hardware/software/systems*', *'having limited or no ICT hardware/software support readily available'* and *'the continuous & quick succession of ICT upgrade/advancement'* were the next most influential barrier/limitation issues when considering to implement or use ICT on projects. The issues found to be of least influence, in order of influence include *'your company's perception that ICT is not part of its core business'; 'inconsistent employee requirements on projects'; and 'not having an ICT implementation "champion" on a project'*.

Another technology which is allowing interoperability amongst collaborative project members is the Internet, which through networking technologies such as Virtual Private Networks (VPN) and Application Service Providers (ASP), is allowing clients to provide services with minimal technological requirements, only requiring a Web Browser to access the project web site and sophisticated software applications. This leads to another influential (6 the highest mean response) issue amongst respondents, the issue *'security issues (re project data, access etc.)'* In an electronic collaborative environment such as construction project websites, data security becomes a major consideration in the implementation and use of ICT for project participants.

Sub-sector groups were analysed to find results of any significance with regard to the barrier/limitation influencing ICT implementation or use on projects (Figure 8.13). Non-building construction respondents perceived *'having limited or no ICT technical support readily available'* and

'demanding and inflexible workload' to be equally the greatest barrier/limitation influencing their decision to implement or use ICT on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were *'having limited or no ICT training opportunities within your company/team'; 'having to use incompatible ICT hardware/software/systems';* and *'having limited or no ICT infrastructure in place'.*

Figure 9.13 Mean Responses For Barrier/Limitation By Core Sector



It is interesting to note that *'ICT investment restrictions due to budget constraints'* was not as highly influential for this sub-sector than for the other two. This may be as a result of the relationship between ICT investment and annual turnover, where results indicate that a large percentage (86%) of the non-building sub-sector respondent organisations were in the high (greater than $5M) annual turnover ranges. It would appear they typically have more money to invest, hence their lower

perceived restriction on budgets for ICT, and their tendency to be more innovative. All of the issues presented were perceived by the non-building sub-sector to be at least an average influential barrier/limitation to ICT implementation or use on projects.

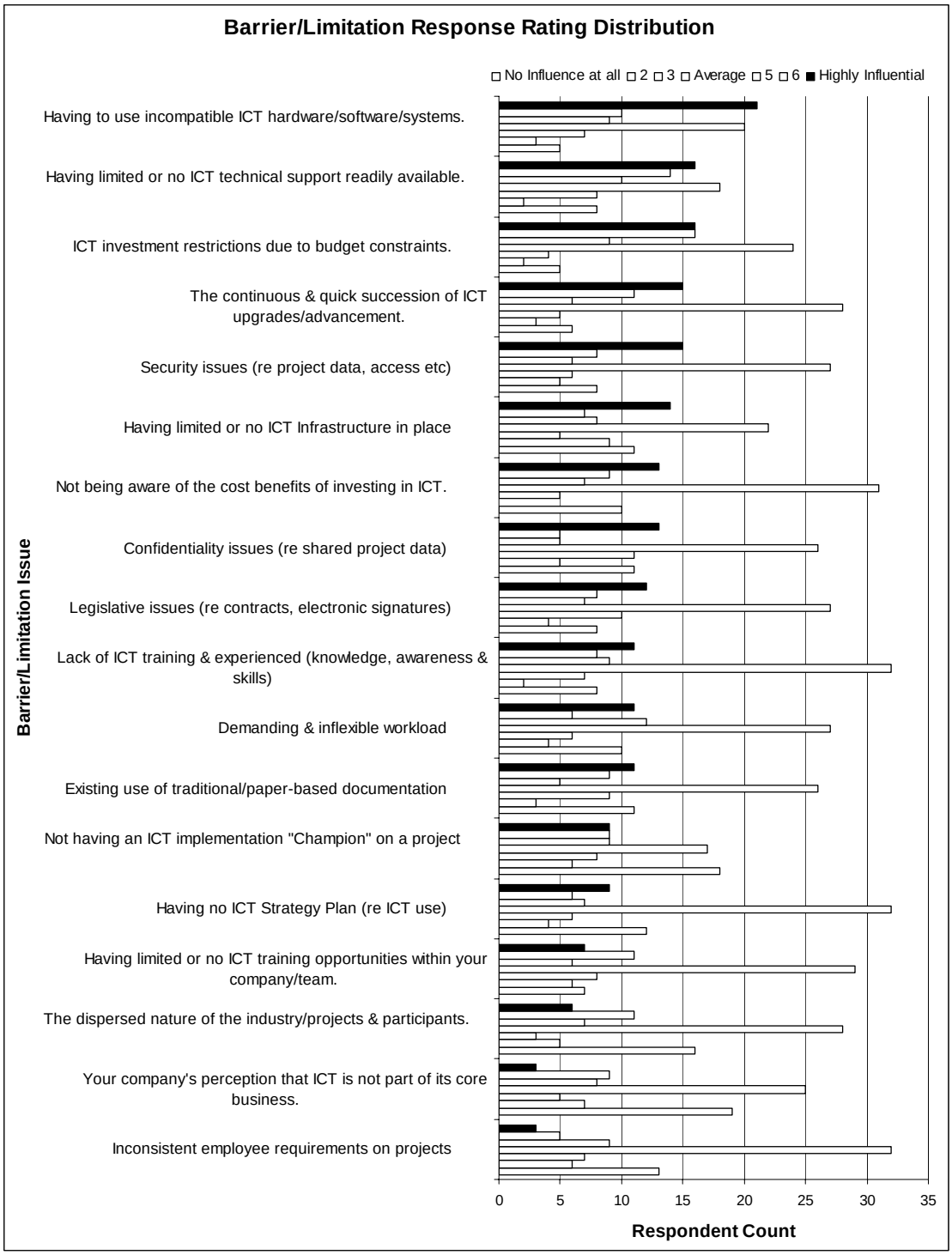
The relatively high influence of *'having limited or no ICT training opportunities within your company/team'* is an interesting result due to the fact that all respondents in this sub-sector indicated that they are allowed sufficient time during office hours to undergo official ICT training. However, only one respondent indicated that they are able to adjust or reduce their workload to undergo ICT training, indicating that workload may be a significant determining factor when it comes to ICT training for the non-building sub-sector.

Building construction (commercial/industrial) respondents perceived *'ICT investment restrictions due to budget constraints'* and *'having to use incompatible ICT hardware/software/systems'* as being the most influential barrier/limitation respectively to implementing or using ICT on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were *'having limited or no ICT technical support readily available'; 'existing use of traditional/paper based documentation';* and *'the continuous & quick succession of ICT upgrades/advancement'*.

The residential sub-sector respondents perceived *'the continuous & quick succession of ICT upgrades/advancement'* and *'ICT investment restrictions due to budget constraints '* as their most influential barrier/limitation respectively to ICT use and implementation on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were *'not being aware of the benefits of investing in ICT'; 'having to use incompatible ICT hardware/software/systems';* and *'demanding and inflexible workload'*.

Figure 9.14 displays the distribution of responses indicating what influence the range of barrier/limitation had on their decision to implement or use ICT on projects. As is clear many respondents indicated the issues had an average influence on their decision to implement or use ICT on projects.

Figure 9.14 Distribution For Barrier/Limitation Influencing ICT Implementation



Summary of ICT perspectives

Table 9.1 summarises the results of the most influential Benefit/Driver issues for respondents.

Table 9.1 Benefit/Driver Issue Ranking According to Respondent Group

Group	Benefit/Driver Influence Ranking				
	1	2	3	4	5
Total Mean	*To help gain increased efficiency (improved productivity)*	*To help improve over all team/company efficiency (productivity)*	*To help increase business opportunities*	*To help enable electronic banking etc (eCommerce)*	*To help set up a dependable ICT infrastructure within your company*
Non-building	*To help improve overall team/company efficiency (productivity)*	**To help gain increased efficiency (improved productivity); and* **To help set up a dependable ICT infrastructure within your company*		*To help enable electronic archiving of documentation (eArchive)*	*To help increase business opportunities.*
Building	*To help gain increased efficiency (improved productivity)*	*To help improve overall team/company efficiency (productivity)*	*To help increase business opportunities*	*To help enable electronic banking etc (eCommerce)*	*To help set up a dependable ICT infrastructure within your company*
Residential	*To help gain increased efficiency (improved productivity)*	*To help increase business opportunities*	*To enable electronic banking etc (eCommerce)*	*To help enable electronic archiving of documentation (eArchive)*	*To help receive intangible rewards (respect, self fulfilment)*

Table 9.2 summarises the results of the most influential barrier/limitation issues for respondents.

Table 9.2 Barrier/Limitation Issue Ranking According to Respondent Group

Sub-sector	Barrier/Limitation Influence Ranking				
	1	2	3	4	5
Total Mean	*ICT investment restrictions due to budget constraints*	*Having to use incompatible ICT hardware/software/systems*	*Having limited or no ICT technical support readily available*	*The continuous & quick succession of ICT upgrades/advancement*	*Not being aware of the cost benefits of investing in ICT*
Non-building	**Having limited or no ICT technical support readily available; and* **Demanding and inflexible workload*		*Having limited or no ICT training opportunities within your company/team*	*Having to use incompatible ICT hardware/software/systems*	*Having limited or no ICT infrastructure in place*
Building	*ICT investment restrictions due to budget constraints*	*Having to use incompatible ICT hardware/software/systems*	*Having limited or no ICT technical support readily available*	*Existing use of traditional/paper based documentation*	*The continuous & quick succession of ICT upgrades/advancement*
Residential	*The continuous & quick succession of ICT upgrades/advancement*	*ICT investment restrictions due to budget constraints*	*Not being aware of the cost benefits of investing in ICT*	*Having to use incompatible ICT hardware/software/systems*	*Demanding and inflexible workload*

CONCLUSION

The most significant observations from the survey results were that annual turnover has an effect on the uptake of ICT and training performance in ICT for an organisation.

Identified effects of budget on uptake and/or current ICT status include:

- In general, higher ICT investment was observed for higher annual turnover organisations;
- In general, higher ICT investment, hence annual turnover organisations, had a higher rate of use and access to emerging or innovative ICTs such as Handheld and Tablet computers, Video Conferencing and Wi-Fi devices; and
- The most significant barrier/limitation to the implementation or use of ICT on projects was budget constraints.

Identified effects of budget on ICT training include:

- Lower turnover construction organisation respondents were less likely to have undergone ICT training;
- Lower turnover construction organisations were less supportive of ICT training through flexible workload and time allocation; and
- Higher turnover organisations had a greater preference for the professional consultants mode of training and conversely, lower turnover organisations had a greater preference for self-learning.

Technical issues such as interoperability (incompatibility) and not having an ICT professional on site or within ready access were found to be strong influential barriers to the uptake of ICT on projects for most respondents. When investigating results according to sub-sector, several of the groups were

found to rank highly issues that were not in the top five as a sample group. For example, the non-building and residential groups ranked their demanding and inflexible workloads as being in their top five barriers to uptake of ICT for projects.

The overriding driver for ICT uptake for respondents was to improve their operational performance through improved productivity at both the personal level and the organisational /team level. Improved business opportunity was also highly influential for respondents. Similar results to these were found on investigation of results according to industry sub-sectors. Interestingly the residential sub-sector rated the driver of improved business opportunities higher than the other two sub-sector groups.

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CHAPTER 10

Non-Price Criteria for Selecting Innovative Contractors

Fredrik Waara

INTRODUCTION

It has been well recognised that government agencies in several countries increasingly use multiple criteria instead of lowest price when awarding construction contracts. Recent examples include China, where the introduction of competitive tendering practices (Shen and Song, 1998) has resulted in construction contracts being awarded on a multi-criteria basis (Lai et al., 2004; Shen et al., 2004), and Turkey, where multiple criteria are used in contractor prequalification (Topcu, 2004). This movement can be explained partly by increased knowledge about negative consequences of lowest price selection (Hatush and Skitmore, 1998). Another contributing factor is reforms in legislation and regulation on public procurement which have opened up for multiple criteria practices. Whereas the traditional lowest price regime results in a certain type of price competition between contractors, it could be asked whether this multiple criteria movement has led to another type of competition—more focused on innovation and technological change. This is not necessarily the case.

This chapter deals with non-price criteria in municipal construction procurement. The purpose is to investigate the relation between multi-criteria contractor selection and innovation. It is generally acknowledged that innovation and technological change are important sources of productivity growth and material welfare in countries (Edquist, 1997). There are also studies that have investigated whether governments can adopt a pro-active approach and stimulate innovative activities through its procurement practices. Lichtenberg (1988), for example, studied procurement by design and technical competition in the U.S. and found that this kind of competitive procurement stimulated considerable private R&D investment. Dalpé *et al.* (1992) studied the public sector as first user of innovations and concluded that public procurement practices may indeed affect the pace and direction of innovative activity in industry. In construction, procurement has been recognised as an instrument (Manseau and Seaden, 2001: 17), but not a major one. The literature on multi-criteria contractor selection and its relation to innovation seems scant and underdeveloped.

The remainder of this chapter is organised as follows. First, an analytical framework based on theories of innovation and entrepreneurship is presented. Second, the use of non-price criteria in construction procurement is discussed and empirical data from a recent survey of Swedish municipal construction procurement is described and analysed. Some alternative routes of action for government agencies are also covered. Third, a brief comparison between Swedish and Australian practices is made. Finally, the conclusions of this paper and their implications for practitioners and future research are presented.

INNOVATION AND ENTREPRENEURSHIP

In this section the analytical framework is presented.

Price competition vs technological competition

Schumpeter held technological competition (competition through innovation) to be the driving force of economic development and growth (Schumpeter, 1942). He criticised the strong focus on price competition and argued that what counts is technological competition, "[…] competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives" (Schumpeter, 1942:84). Thus, following his view, a nation striving for sustainable economic growth is heavily dependent on technological competition and innovation.

In construction procurement it could be argued that the traditional lowest price regime results in price competition between contractors. Thus, if we adopt the distinction between product and process innovation (Abernathy and Utterback, 1988), price competition leads to process innovation rather than product innovation. However, do multiple criteria open up for technological competition that in turn open up for product innovation? This could be the case if the non-price criteria refer to features of technological competition.

The notion of entrepreneurial opportunities

In research on entrepreneurship the notion of entrepreneurial opportunities is at the centre. Shane and Venkataraman (2000) have defined the field of entrepreneurship as involving "[…] the study of sources of opportunities, the process of discovery, evaluation, and exploitation of opportunities; and the set of individuals who discover, evaluate, and exploit them." One source of entrepreneurial opportunities is technological inventions where entrepreneurs with particular prior knowledge (Shane, 2000) can discover how an invention can be used and introduced in the market. Technological development and change thus created entrepreneurial opportunities. Another source of entrepreneurial opportunities is the division of knowledge (Hayek, 1945) in the market. Krueger (2003) has noted that entrepreneurs are likely to recognise patterns in the myriad of cues and signals that we receive; patterns that may indicate entrepreneurial opportunities. If contractors discover entrepreneurial opportunities this may be an incentive to invest in R&D. Here, the important question that we should ask is whether non-price criteria create entrepreneurial opportunities or not.

In a seminal article Kline and Rosenberg (1986) argued that in successful innovation both technical and market needs must be fulfilled. Kline and Rosenberg questioned the conventional "linear model" of innovation (where R&D leads to production and marketing of a new product) and pointed out that innovation is both complex and uncertain. If we are to link innovation and entrepreneurship we can note that invention and innovation might result in new entrepreneurial opportunities (Shane, 2000). Conversely, if individuals or companies discover entrepreneurial opportunities this may result in R&D investments that later on result in new products or processes. Both demand and supply matter.

THE USE OF NON-PRICE CRITERIA

Procurement of construction projects can be performed either as a single-stage procedure or as a two-stage procedure. In the single-stage procedure all contractors are allowed to submit tenders on a construction contract. In the two-stage procedure the buyer usually distinguishes between prequalification and final selection of contractors. All contractors are allowed to enter the prequalification stage, but only those that qualify are allowed to enter the final selection stage. Multi-criteria contractor selection can thus refer to both single-stage and two-stage procedures.

Non-price criteria in Swedish municipal procurement

In order to gain an understanding of various non-price criteria an empirical survey was conducted in the spring of 2004. The sample consists of 386 tendering documents, representing construction projects procured by 171 (out of 290) Swedish municipalities in 2003. Lowest price selection was used in 42 tendering documents (11%), but these are not referred to further in this paper. In Sweden it is common that government agencies use a standardised system (AF AMA) for tendering documents. The AF AMA system facilitates the review and codification process as information is presented under particular headings in the documents (e.g. AFB.52 for information on award criteria). The tendering documents were derived from a commercial database which contains records of tender invitations from government agencies in Sweden. Construction procurement was defined according to the Common Procurement Vocabulary codes (CPV) employed in the European Union. There is probably a slight bias in the sample towards municipalities that use more sophisticated approaches, since this might be correlated with a propensity to provide electronic tender documents. In line with the scope of this paper we focus on three factors that have been extracted from the empirical data. These factors are (a) the type of award criteria, (b) the weightings of non-price criteria, and (c) the degree of transparency and precision.

The type of award criteria

A great diversity of multiple criteria practices is represented in the sample. However, based on an analysis of the tendering documents ten main categories of award criteria could be identified. These were (1) tender price/unit price, (2) operation and maintenance cost, (3) contractor capability, (4) project duration, (5) environmental issues, (6) quality issues, (7) function, (8) references, (9) service quality and attitude, and (10) financial capacity. Thus, one category refers to price criteria and nine categories refer to non-price criteria. Given these criteria categories we can ask whether using them stimulates innovation. Criteria that are most strongly related to technological competition are 'operation and maintenance cost', 'quality issues' and 'function'. These criteria refer to general features, while most of the other criteria refer to prescriptive specifications. 'Contractor capability', for example, is more related to how efficiently the construction project can be carried out, than the introduction of new products.

The weights of non-price criteria

In using multiple criteria government agencies also have to rank and assign weights to these criteria. Thus, they have to make a trade-off between price and various non-price criteria. The empirical data shows that some municipal agencies assign very low weights to non-price criteria compared to the tender price criterion. The lowest weight that was identified for a non-price criterion was 0.5% (mean 11.3%). Obviously, by assigning low weights to non-price criteria, municipal agencies lower the incentives for contractors to improve their non-price performance. In fact, very low weights for alternative criteria result in a selection of contractors that resembles lowest price selection.

The degree of transparency and precision

When private companies procure construction projects they may decide to keep their initial preferences secret. They can review tenders and make the trade-off between price and non-price criteria *ex pos*t, instead of *ex ant*e. In public procurement, on the other hand, there is need of transparency and precision in contractor selection. Otherwise there is always a risk of government personnel being accused of favoritism or sweetheart deals (Wilson, 1989). Based on the empirical data a Transparency and Precision Index was created (see Table 10.1). The index indicates how transparent

and precise the municipal agencies were in their award criteria. The tendering documents in the sample achieved a score of 3.17 on average (standard deviation 1.30).

Table 10.1 The Transparency and Precision Index

Transparency and precision index	Description
5	Award criteria with rankings, weights, and scales
4	Award criteria with rankings and weights
3	Award criteria with rankings
2	Award criteria without rankings
1	No information

A high score signifies that the municipal agency revealed much information on how tenders were to be evaluated. This gives contractors a chance to analyse their competitiveness on the basis of the weights and scales assigned to each criteria. A low score signifies that the municipal agency revealed little or no information on how tenders were to be evaluated. Thus, contractors were faced by greater uncertainty regarding their competitive advantages.

At first glance one might argue that a high score in this index is more beneficial for innovation among contractors, especially in light of the new European Union Directives on public procurement which requires that weights shall be assigned to all award criteria. A high score indicates that there is close to perfect information rather than a confusing "myriad of cues and signals" where skilled entrepreneurs could discover commercial opportunities. Those opportunities that exist are decided *ex ante* by the municipal agency, and they are likely to be discovered by all contractors. In contrast, when little information is given to contractors *ex ant*e, municipal agencies have greater possibilities to make the trade-off between price and non-price criteria *ex pos*t. There is also a chance that contractors discover opportunities that were unknown by the municipal agency *ex ant*e. A lower degree of transparency and precision thus gives a municipal agency a wider range of possibilities to reward such discoveries. This analysis suggests that it would be optimal to combine a low degree of transparency and precision in tender invitations *(ex ant*e) with a high degree of transparency and precision in contract award notices *(ex pos*t).

A note on alternative routes of action

Indeed, there are other routes of action available for government agencies than using non-price criteria (either as prequalification or final selection). One example is performance-based specifications that could result in a type of technological competition that fosters innovation and technological development. Another example is when government agencies allow contractors to propose alternative designs or technologies, even though traditional prescriptive specifications are used. A contractor can thus question decisions made by the government agency or its designers in earlier stages of the process. Is this design the most appropriate? Could space be used more efficiently? These routes of action could be combined with lowest price selection of contractors and yet stimulate innovation in industry.

A COMPARISON WITH AUSTRALIAN PRACTICE

A detailed discussion of Australian practice is beyond the scope of this paper. The Australian Procurement and Construction Ministerial Council has published a *National Prequalification Criteria Framewor*k, aiming to achieve national consistency in government agency prequalification of contractors (APCC, 1998). The document presents eleven prequalification criteria: (1) technical capability, (2) financial capacity, (3) quality management, (4) occupational health and safety & rehabilitation, (5) compliance with code of practice, (6) human resource management, (7) commitment to client satisfaction, (8) co-operative contracting and partnering, (9) management of environmental issues, (10) management for continuous improvement, and (11) compliance with legislative requirements.

It is interesting to note that this Australian framework bears similarities to the ten categories of criteria that were identified in the Swedish sample. However, while Australian practice appears to be characterised by an increased degree of national consistency, Swedish municipal practice is characterised by diversity. It is also interesting to note that the prequalification criteria under 'management for continuous improvement' include the following: "[t]he extent of a contractor's commitment to continuous improvement can be gauged from […] a corporate policy on research and development, including the encouragement of improved design and/or construction processes or products […]". This prequalification criterion is closely related to innovation. None of the non-price criteria in the Swedish sample had an explicit reference to contractors' R&D track record. One reason can be that Swedish legislation stipulates that award criteria should be narrowly related to what is being procured, which makes it uncertain from a legal viewpoint whether Swedish municipalities could use a R&D track record criterion.

CONCLUSION

In the introductory section I posed the question whether multiple, non-price, criteria foster innovation in industry. As we have seen this is not necessarily the case. Multi-criteria contractor selection can promote innovative initiatives, but that depends on the type of criteria used, and the weights that are assigned to such criteria. Furthermore, the degree of transparency and precision seems to play an important role. A high degree of transparency and precision implies a trade-off between price and non-price criteria that is frozen in the early stages of the procurement process.

What are the practical implications of these findings? Contractors need to be alert to the type of non-price criteria that government agencies use, and their weightings, when deciding upon areas of improvement. There might be limited opportunities for contractors to introduce new products in the tendering stage. However, process innovations for more efficient construction seem to be more easily implemented. For policy-makers, there seems to be need of an understanding of the potential negative effects of higher demands on transparency and precision in public procurement. This is also an area where more research is needed. The field of entrepreneurship can provide a useful framework for describing and analysing this phenomenon further.

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CHAPTER 11

Implementing Innovation on Commercial Building Projects in Australia

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Mike Swainston

INTRODUCTION

This chapter addresses the research question 'who are the key players in implementing innovation on Australian commercial building projects and what roles do they play?' The aim of this paper is to demonstrate the nature of successful innovation implementation processes in this context. The paper makes an original contribution to the literature by examining the roles of project participants in project-based innovation, in the Australian commercial building context. The need for the study arose from widespread evidence of poor performance in the sector in Australia and globally (Gyles 1992, Egan 1998, Cole 2002a), and local evidence suggesting that many industry participants, particularly SMEs, were unsure about how to go about implementing innovation (Manley and Blayse 2003). This evidence about innovation is concerning, given the established links between innovation and economic growth (OECD 2000). This relationship exists regardless of whether the innovation is an original development, or whether it involves the adoption of best practice, which already exists, but is new to the adopting firm.

Historically, there have been few incentives for the construction industry to undertake innovation, due to the absence of strong competitive forces (Seaden 1996, 1). However, since the 1990s the industry has been under increasing pressure to improve efficiency and effectiveness. The drivers of industry improvement that emerged last decade still apply pressure today. These include the emergence of more demanding clients as public sector resources decline; the challenges of increasingly global competition; and the demands of strict environmental legislation (Seaden 1996, 3). In Australia, as in other developed countries (particularly the UK), significant government programs have been introduced to remove the obstacles to industry growth. Since the Gyles Royal Commission in 1992, considerable attention has been paid to improving the industry's performance. This culminated in a partnership between the Commonwealth Government and the industry to develop an Action Agenda, with government funding of $3.6 million devoted to a comprehensive suite of initiatives to promote industry growth. These activities ran between 1999 and 2002 and an evaluation of the program in 2004 found that innovation performance had improved, but that better outcomes were possible given a better demonstration and diffusion effort (DISR 2004, 2-3). The current paper responds to the opportunity to further improve innovation outcomes revealed by the evaluation.

Despite the contributions of a range of authors on the broad topic of innovation success factors (eg. van der Panne et al 2003, Gann 2001, Winch 1998), there remained an opportunity to extend the literature by exploring different types of participants as innovation implementation drivers on Australian commercial building projects.

Perhaps the most relevant academic work to the current study is Ling (2003), Slaughter (2000) and Gann and Salter (1998). Ling's (2003) study is a quantitative study of the factors that support innovation benefits. The case study work undertaken here helps to flesh out her results and provides a different focus by examining the roles of particular types of project participants.

Slaughter (2000) conceptualises the implementation stages for construction innovation, as a component of a business's innovation strategy. The current study adopts a broader approach by looking beyond intra-firm processes to examine innovation as the result of inter-organisational relationships. This builds on recognition of the collective nature of innovation process generally (Manley 2003) and the project-based nature of production in the building industry (Gann and Salter 1998). Gann and Salter (1998) provide a useful framework for mapping participants and dynamics as part of an innovation system, which forms the conceptual background for the present study.

METHODOLOGY

A case program was adopted to determine the types of participants in the industry who were most active in driving effective implementation of Australian commercial building innovations. The resources available to the program dictated that three case studies in this sector could be undertaken over nine months, between April and December 2003.

The case studies were nominated by industry partners associated with the research. The industry partners comprised key repeat clients and key consultants. The case studies they nominated were considered best-practice examples of innovation. Only examples with measured benefits from innovation were eligible for inclusion in the program. The innovation examples showing the greatest benefit to a construction project were selected for study. The examples covered innovation arising from the contractor, consultant, client and supplier sub-sectors.

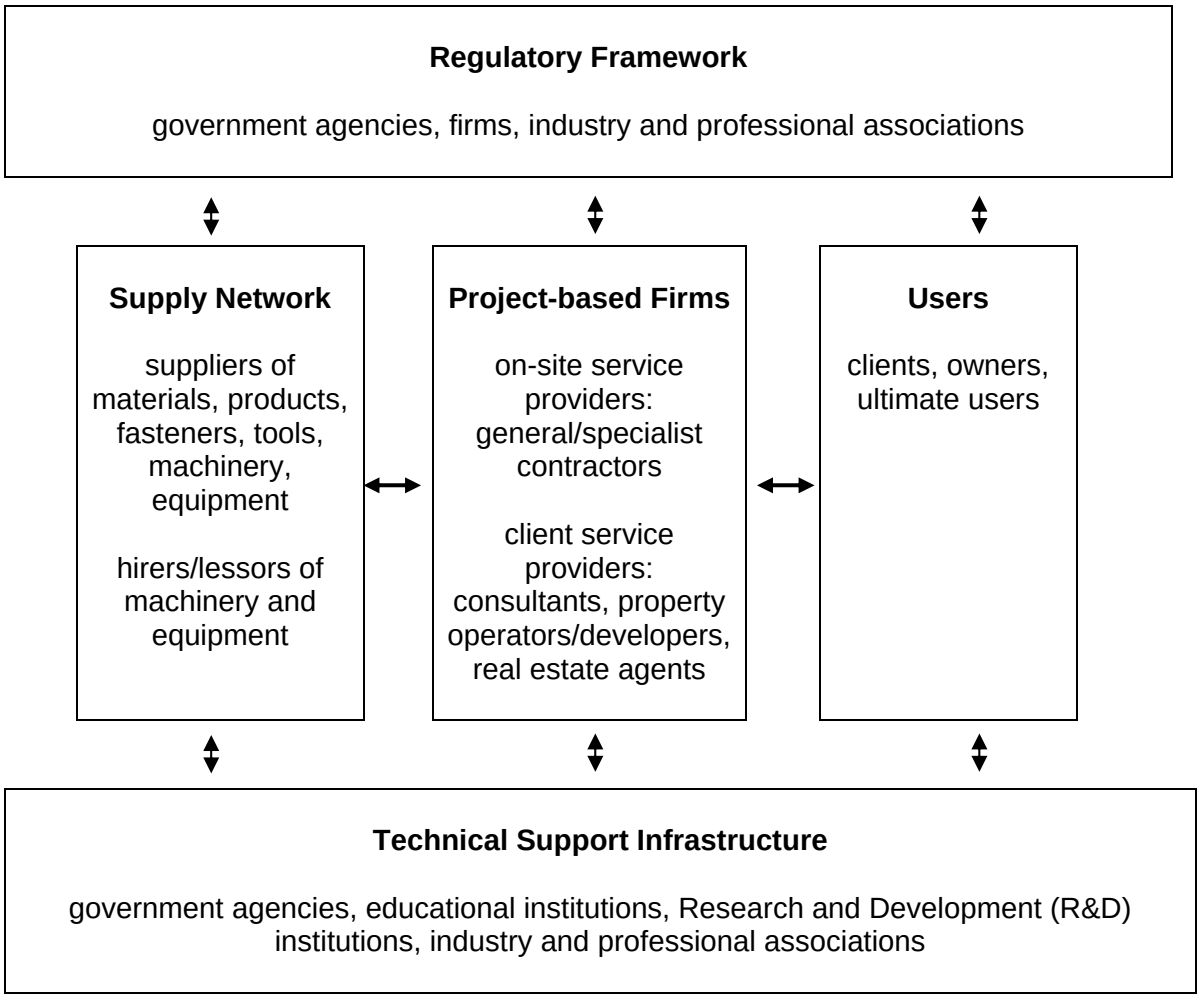
The program reviewed innovative projects in Queensland, New South Wales and Victoria. The focus on building and construction (B&C) projects arises because most readily identifiable innovation takes place there, rather than within particular organisations. The focus on the three states was driven by the fact that they account for 80 per cent of Australia's B&C activity (Cole Royal Commission 2002b, 16).

The case studies were based on semi-structured interviews, and background documentation including award submissions, academic papers, magazine articles, internal reports and workshop presentations. Each case involved multiple interviews covering at least two of the organisations on the project. Each interviewee was a senior technical or management representative and the range of interviewees covered all types of industry participants including clients, contractors, consultants and suppliers.

CONCEPTUAL FRAMEWORK

The case studies were interpreted according to the influential work of Gann and Salter (1998). These authors emphasise the non-linear and highly interactive nature of innovation processes, taking a broad view of the boundaries of the B&C industry. Figure 11.1 is based on their approach:

Figure 11.1 The Context for Innovation: Participants and Relationships in the Building and Construction Industry



(Source: based on Gann and Salter 1998)

Figure 11.1 provides a good summary of the relevant participants in the B&C industry. It helped in structuring the case studies and positioning key relationships, and provided a useful analytical tool to assist in thinking about the audience(s) for the results of the study, as part of the research dissemination process.

The diagram shows five key classes of participants: project-based firms, suppliers, users, regulators and technical support providers. Sub-classifications are also shown. Relationships between the participants are multi-directional. There is no starting point in the innovation process, as it is not linear. Innovation may be championed or implemented by any of the participants. The empirical work

undertaken by the present study aims to further define the roles these participants play in innovation on Australian commercial building projects.

Figure 10.1 guided qualitative analysis of the case studies. This analysis identified four key innovation participants and their roles in influencing implementation processes. Prior to discussing these findings, the innovation implementation processes are examined.

CASE STUDIES OF INNOVATION IMPLEMENTATION PROCESSES 1

This section describes three case studies of innovation on projects in the Australian commercial building sector, focussing on implementation processes and the way in which obstacles were overcome. The next section interprets the findings according to the conceptual background of the study and summarises the key learnings from the exercise.

William McCormack Place: Case A

William McCormack Place is a 4,568m 2 (net lettable area) four-storey commercial office building in Cairns, Australia. It was built for a public sector client by a private sector construction manager under a two-stage, design and construct, guaranteed maximum price contract with an overall budget of $A17.5 million including fit-out and public art. The building was opened in September 2002, delivered on time and within budget, after an 18-month design and construction program.

The innovation profiled on this project involved a suite of advanced air-conditioning components, including the use of a chilled water thermal tank and a total enthalpy thermal wheel. The thermal tank eliminated the need for a low-load chiller and the associated prolonged periods of inefficient low-load operation of the chiller sets. The moisture-absorbing thermal wheel was used to recover cool and dehumidified outside spill air energy to precondition incoming hot, moist ventilation air. Both these advanced technologies have been employed to a limited extent in Australia and overseas, and their rate of uptake is expected to rapidly increase as the benefits they can deliver become more established.

The implementation process

A key driver for adoption of the thermal tank and wheel was the client's desire to improve the energy efficiency of its buildings, while the mechanical and electrical consultant was motivated by the potential improvement to its reputation and the belief that this would enhance its competitive position in the marketplace. Both were strongly motivated by the opportunity to enable the building to win the first 5-star energy rating, awarded under the Australian Greenhouse Rating Scheme, for a commercial office building. This aim was achieved.

Thermal Tank

The client's original brief suggested that three chiller sets be installed to manage air-conditioning requirements. However, the consultant advised that it would be more efficient to replace the third low-load chiller with a thermal tank to get maximum efficiency from the chillers. The consultant designed the first large-scale tank in Australia in the late 1990s, roughly a decade after the first use of tanks overseas, and was motivated to do so after having monitored their performance through industry association newsletters and international networks involving R&D conducted by the university sector.

The consultant understood the technology and had proved its effectiveness and the accuracy of payback periods. The client's audit engineers reviewed the design and agreed that energy performance was likely to be significantly improved by the thermal tank. The adoption decision took into account

the climatic conditions of the building. The heat and humidity in Cairns is quite extreme, demanding the use of innovative technologies to minimise environmental impacts.

Thermal Wheel

The consultant introduced the first total enthalpy thermal wheel into Queensland in 1986 and has since designed several hundred. They were early adopters of this technology, as such wheels only emerged globally in the mid 1980s.

The company's ability to encourage clients to use the wheels was assisted by its review of developments overseas. Its knowledge and experience enabled it to strongly champion the use of a thermal wheel on the William McCormack Place project, and the client was able to confirm the value of the technology with internal mechanical engineers who knew the wheels were widely used in Europe.

The Queensland Government had an interest in local employment for this regional project through its Local Industry Participation Policy, which provided the consultant with the opportunity to be involved. The consultant was a local firm with considerable expertise, and experience with the often extreme local weather conditions, whilst also having linkages with technical experts in Australia, America and Europe. The success of this project shows that regional firms can be technology leaders and that knowledge can be gained *from* them, rather than merely imparted *to* them.

Overcoming obstacles

Obstacles to the adoption of environmentally friendly technologies, such as the thermal tank and wheel, have traditionally been high up-front costs and risk aversion. However, this case has shown that:

- the cost element is circumventable when addressed in the overall design and
- construction of a building; and
- clear objectives and design can reduce the risks for both managing contractors
- and clients to acceptable levels.

Another problem has been that building users are unaware of the negative environmental impacts of conservative approaches to building. However, as concerns about energy and other conservation issues become more prominent, building users are demanding energy-minimising buildings and creating the need for appropriate project delivery mechanisms. William McCormack Place illustrates the positive impacts of this trend.

The client's traditional method for delivering new office buildings was for a specialist unit to manage the design and construction of a building and then hand it over to the property management area on completion. There were few drivers within this system to maximise building performance, particularly in terms of user-needs and whole-of-life costs. In the case of William McCormack Place, senior management decided that the team responsible for the ongoing management of the building would deliver the project.

This meant that project decisions could be made on the basis of time, budget and quality, and also on the functionality and manageability of the property, based on the building life cycle from a *facility management perspectiv*e. This was the first time the client had managed a major contract in this way, with the facility manager playing such a significant role. The client's role as an informed buyer was enhanced, with the required awareness to encourage the adoption of advanced technologies.

The adoption of advanced technologies was also facilitated by the construction management style of contract, which involved the builder very early in the design process. There were no 'rude shocks' when the advanced technologies were incorporated into the design. The guaranteed maximum price

element of the contract ensured that the design was as thorough as possible, to reduce the builders' risk, and to ensure that the final design was 'buildable'.

Finally, there are often obstacles to adoption of advanced technologies and practices when tender selection is based solely on cost, as innovation is rarely associated with the lowest cost tender. In this case, the mechanical and electrical consultant was selected on experience and ability, not just on competitive cost. This approach was critical to adoption of the thermal tank and wheel.

Suncorp Stadium: Case B

Suncorp Stadium is a 52,500-seat, world-class football facility, constructed by a private sector managing contractor under a two-stage, document and construct, guaranteed maximum price contract, with a project budget of $A280 million. The stadium was opened in June 2003, delivered on time and within budget, after a two-year documentation and construction program.

The innovation examined by the study was a new method of manufacturing concrete planks and connecting them to supporting steel beams. Formed rebates were designed for the ends of the pre-cast pre-stressed polystyrene-voided concrete planks. Complementary design of concrete topping and reinforcement details ensured a crack-free, reliable composite connection between the steel beams that support the grandstands.

Polystyrene-voided planks and formed rebate details had only been combined on a few occasions globally in the building industry. The particular planks and the particular rebate, and associated details, were unique to the Stadium project.

The implementation process

The 'clever plank' innovation arose in part from the opportunities for designer and contractor interaction inherent in a document and construct contract. The engineering consultant noted that:

> … the contractual arrangement was not like a lump sum fully documented contract, where the contractor is basically given the design and told to go away and build it. Here, the Joint Venture was encouraged to look at alternative forms of construction

The preliminary stadium design on which the managing contract was tendered incorporated a structural system assessed as the lowest cost option by quantity surveyors, that is, conventionally formed concrete beams and slabs. When the Joint Venture was appointed, the joint venturers agreed that the conventional approach was the cheapest in direct costs; however, they pursued the idea of a steel beam and plank design, based on advantages related to time, risk and management of sub-contractors. The Joint Venture asked the consultants to explore the technical feasibility of such an approach. The consultants found that, while the components were more expensive for beam and plank construction, the timber and sub-contractor savings related to the absence of formwork more than offset the extra expense.

Formwork is very material and labour intensive. The advantages of not requiring formwork for the stadium included:

- a less congested site without large numbers of form workers;
- reduced car parking and concrete truck access problems in the inner city location;
- no concreter delays/disputes to hold up following trade work (previous experience with highly unionised workforces and industrial action fed into the decision-making process);
- no obstruction of the areas underneath the grandstand with temporary propping, which restricts trade work;
- lower safety risk because there is no need for scaffolding, planks and ply; and
- easier quality control and guaranteed standards when concrete planks are manufactured off-site.

The above advantages result for either extruded or voided planks employed in a conventional non-composite way, although voided planks can be more efficiently attached to supporting beams by adjusting the pattern of voids to create solid ends for more robust fixing. The consultant looked beyond these advantages in response to the contractor's request to find further savings.

The contractor's interest in savings was driven by the form of contract. The contract allowed for the development of alternative designs and for shared benefits between the contractor and client if the project was delivered below the guaranteed maximum price. It seems this contractual driver helped to create an environment where innovative ideas were explored and embraced.

The consultant's study of a series of steel and precast plank options found that there were potential cost savings with lighter steel beams, if a reliable and practical method of achieving composite connections between planks and beams could be developed. After consulting with leading international researchers in the field of composite steel connections, it devised the innovative rebate design. It then calculated the theoretical capacity by extrapolating from available theory and codes, and arranged for full-scale prototype testing to verify the accuracy of the design calculations and the efficiency of the connections. The construction program dictated that the manufacture of the clever planks be commenced before the prototype testing was completed, but the designers were confident that the results would be positive. Their confidence in the design has subsequently been borne out by the prototype test results and the faultless performance of the planks and concrete topping on site.

The implementation of the clever plank innovation will not end with this project; both the consultant and the supplier intend to use the innovation on future projects. The consultant will maximise these opportunities by publicising clever planks on its internal skills network, which is a formalised knowledge-sharing system operating across the organisation's global operations. The company also plans to submit a paper for publication with the Institution of Engineers, Australia and is currently providing advice to colleagues considering similar plank and beam approaches. Further, the clever plank innovation has been submitted to the consultant's innovation competition, which feeds into the organisation's marketing efforts. Such initiatives encourage employees to take the time to write up the benefits of their innovations, an activity that can otherwise be marginalised in the project-to-project rush of work.

Overcoming difficulties

A large part of a consultant's role is to provide ideas to clients and contractors, which benefit these two parties, but not necessarily the consultant in a direct sense. Certainly, reputation is important for consultants, especially reputation for money-saving innovations, and the consultant on the project profited in this sense. Nevertheless, the benefits from construction innovation are not evenly spread along the supply chain, nor does the proponent/inventor necessarily profit directly. This problematic incentive structure is likely to constrain innovation efforts.

In the clever planks case, the consultant was aware of recent changes under the Queensland government's prequalification system for building industry consultants, which have seen 'innovation history' added as a criterion. Such moves help to make the benefits of innovation to a company's reputation more tangible, by recording and valuing the extent of the organisation's innovation activity.

Overall, there were few obstacles to the implementation of clever planks on the Stadium project, due to the positive drivers established by the form of contract, which encouraged the contractor to seek and support money-saving innovations.

Australian Art Building: Case C

The NGV (National Gallery Victoria)-Australian Art Building is a centrepiece of the Federation Square development in Melbourne. Federation Square is one of Australia's civic and cultural icons,

incorporating multi-media, art, museum and office buildings. The NGV-Australian Art building was constructed by a private sector managing contractor and was completed in 2002 for approximately $A65 million.

The innovation on the NGV-Australian Art Building examined by this study has three main elements: use of the performance-based Building Code of Australia (BCA); use of Quantitative Risk Assessment (QRA); and use of unprotected steel while meeting fire safety requirements.

The implementation process

The key to the benefits achieved by the use of unprotected steel was the QRA, which, in turn, was made possible by the recently implemented performance-based BCA. The managing contractor drove the design shift from concrete to steel, based on its experience of the benefits of steel. The design team drove the use of *unprotected* steel, reaping time and cost benefits, principally by employing QRA.

Risk assessment techniques, such as QRA, are used to evaluate the frequency and probability of threatening events such as fires. Once risks are assessed, options to reduce the risks can be examined and costed, and the most effective option adopted.

There are a number of approaches to risk assessment for fire safety decision-making. One of the most complex of these approaches is QRA, which is based on fault and event scenarios. Fault scenarios can be used to identify mechanisms of failure leading to fire starts. Event scenarios can then identify the probability of the fire advancing from ignition to the various stages of fire development and define the levels of threat to occupants and property. In Australia, this approach is known as an Evaluation Extent 3 or System Risk Evaluation approach, as defined in the Australian Building Codes Board Fire Safety Engineering Guidelines.

In the case of the NGV-Australian Art Building, the concept of five states of fire growth was used to assess the probability and consequences of various times-to-activation of the fire safety systems and human intervention. Further, a number of events and factors were incorporated into the analysis and the associated probabilities enumerated in order to determine the overall probability of fire development and damage to property. These three features – the five fire states; the application of QRA to property; and the method of probabilistic analysis – are cutting-edge. They have been used only rarely globally, and were adopted by the fire engineers on the project through their linkages with international experts, such as engineers conducting R&D with the National Research Council of Canada.

Overcoming difficulties

One of the primary challenges in the adoption of the fire engineering/unprotected steel innovation was addressing the safety concerns of a number of stakeholders, including the client, about the new approach. One of the key reasons for concern, particularly for the client, was that the QRA approach to fire safety engineering is an analytical process, as opposed to a physical testing-based approach. Acceptance of the QRA results requires an understanding of its theoretical underpinnings, and of the logic that leads to the outcomes. These can be more difficult to communicate than results based on physical testing of materials. However, members of the design team were able to effectively use fire engineering tools, and a cooperative approach, to educate the stakeholders about the relative risks and allay their fears.

QRA is a significant departure from *prescriptive, rule-based* approaches to building construction, and this may also have been a reason for concern. Despite the capacity of QRA to arrive at what are, in many cases, safer and less expensive construction methods, there is still a residual tendency for many stakeholders to prefer uncomplicated rules prescribing conventional building materials and methods. Indeed, QRA is harder to understand than prescriptive rules and this can result in risk-averse

responses to its adoption. However, as this case demonstrates, it is possible to reduce this problem using education and a cooperative approach.

DISCUSSION AND CONCLUSIONS

The cases highlight the active role taken by four key types of industry participants in promoting innovation on projects: clients, regulators, technical support providers and consultants. To some extent, these are the likely suspects, although such a list, if it were comprehensive, would also include suppliers. Indeed, suppliers are shown to be significant in research related to that described here (Manley and Blayse 2003).

The literature highlights the importance of the four types of participants emphasised here: clients, regulators, technical support providers and consultants (Briscoe et al 2004, Gann 1998, Nelson 2004, Hislop 2002, Salter and Torbett 2003). This chapter adds value to that existing knowledge by investigating in detail the roles of these participants in the implementation phase of innovation on commercial building projects in Australia.

From Case A, it has been shown that informed clients can facilitate the adoption of advanced technologies and practices by expertly cross-checking innovative proposals. For public sector agencies, this creates a driver for retaining skill bases within the agency, and reduces the likely benefits of outsourcing. It was also shown that clients who are willing to entertain acceptable risks can lead the industry in demonstrating the benefits of innovation. This 'entertainment of reasonable risk' is a best practice approach to risk. Unfortunately, the public sector is still dominated by a culture of risk aversion (Manley 2001). Indeed, the findings of Case C provide an example of a risk-averse client, which potentially created an impediment to innovation. In that case, consultants played a key role in allaying fears by educating the client. Yet, there remains a need for tailored programs across Australian public sector agencies to encourage greater risk-taking.

On a more positive note, Case A revealed that innovation can be prompted by clients who invite users to be involved in project scoping and management. User involvement tends to create pressure for minimisation of long-run operating costs and results in more functional buildings. The action of the client in this case responds to calls in the literature for client-led strategies to improve supply-chain integration (Briscoe et al 2004). Indeed, the findings here support the view that clients are 'key drivers of performance improvement and innovation and are the most significant factor in achieving integration in the supply chain' (Briscoe et al 2004, 193).

Case B illustrated other roles government clients can play in shaping the industry's innovation opportunities, through prequalification activities and contract types. Prequalification systems designed in part to measure innovation performance create a strong innovation driver, while the selection of contract types that involve as many parties as possible, as early as possible, leads to synergistic benefits and innovation. This last point is reinforced by the work of Ehrenkrantz (1998), which explores the links between procurement systems and innovation. Indeed, an emerging focus in the literature is the design of incentive systems within contracts to promote goal alignment between clients and construction industry participants, encouraging the flexibility that allows change and innovation (see Rose 2004 for a recent summary). This follows from the view that clients have a better chance of achieving their goals if they view their contractors and consultants as 'employees' and seek to motivate them accordingly (Turner 2004, 75).

Building regulators are also very instrumental in driving innovation through the supply chain. In Case C, it was shown that performance-based building codes encourage innovation, reinforcing the findings of Gann (1998), while in Case A, environmental standards were set just beyond current industry capabilities, creating a strong driver for innovation and efficiency gains. Nevertheless, the literature warns that regulators and standard setters need to have a good grasp of current industry

capabilities so that they are able to effectively set regulations and standards at levels that are appropriate to encourage innovation (Gann 1998).

The case studies support findings in the UK 'that, in general, performance standards allow firms the freedom to innovate while prescriptive standards stifle creativity' (Gann 1998, 291). The same study concludes that 'clarity and simplicity is needed in the regulatory process to enable the uptake of good practice and encourage innovation. Failure to provide clear and enforceable rules is likely to have repercussions which damage industry's capacity to change, constraining future developments' (Gann 1998, 291).

Turning now to the role of technical support providers in driving innovation implementation, recall that international industry associations provided primary stimulus for the innovation in Case A, and university research played a central role in facilitating the innovation in Case B, while in Case C, the quality of the innovation was enhanced by international linkages with global experts. Further, the case studies indicate that technical support providers are particularly important when innovation relies on formal R&D. This is because the industry's structure and profit margins limit the extent to which other participants, such as contractors or consultants, can sustain formal R&D programs.

One of the important features of the knowledge base, which is managed by technical support providers, is the relative ease with which industry participants can access it. The case studies reviewed here show that industry networking with technical support providers still matters to competitiveness, however, the literature warns that this could be compromised by the increasing inaccessibility of public-sector science, with negative implications for national growth rates (Nelson 2004). This inaccessibility is associated with commercialisation trends and associated patenting activity by public sector research organisations, which limits the diffusion of knowledge.

Finally, the role of consultants is reviewed. In some ways this is saving the best for last. It is clear that in all three case studies consultants were active drivers of innovation that was in turn facilitated by client behaviour, changes to regulations and relationships with technical support providers. Indeed 'there is widespread consensus that design is becoming increasingly important in determining competitiveness' (Salter and Torbett 2003, 573).

Consultant activity is pivotal on construction projects. Engineers and architects are responsible for translating technical possibilities into objects that respond to client needs and market opportunities (Salter and Torbett 2003, 573). However, the interviews conducted for the case studies revealed consultants that were not merely responding to 'demand-pull' pressures, but were proactively engaged in 'science-push' type activities. The consultants appeared to have the strongest links to international knowledge bases, compared to the clients, contractors and suppliers examined.

These four classes of participants – clients, regulators, technical support providers and consultants – stand out in the current context from all the participants reviewed in Figure 1. The effectiveness of these participants in promoting innovation is mediated by the type of contract employed on the project. Contracts that promote goal alignment, flexibility and integration are more conducive to innovation. There is an extensive literature on this topic and interested readers are referred to Turner (2004) and Briscoe (2004). Here, the underlying driver is discussed – effective relationships.

The case studies reveal the extent to which relationships between participants drive innovation implementation, particularly international linkages. Indeed, the need for strong industry networking is emphasised in the literature, in view of the fragmented and temporary nature of production activities in construction (Slaughter 1998, Blayse and Manley in print). The importance of an organisation's ability to absorb external information has been emphasised since the early 1970s (Freeman et al 1972) and has only been highlighted by the rapidly increasing pace of change as we move into the 21st century (Neville 1998).

The relationships reviewed in the case studies centred on the need for knowledge. The importance of knowledge in learning economies is highlighted by the literature on innovation and growth, which

is marked by the view that knowledge has become the most critical variable in productive activity (Marceau et al 1999, 2-9). In the construction industry, Green et al (2004, 72) found that poor communication is a key factor in constraining innovation rates. This finding is supported by the case work reported here, where successful innovation is linked to active inter-organisational and inter-sectoral relationships involving the communication of knowledge.

The case studies also show that the networking activity resulted largely in incremental innovation, rather than radical innovation. Incremental innovation is characterised by the adoption, refinement and enhancement of existing innovations. The study by Green et al (2004, 67) showed that the diffusion of existing innovations through incremental innovation was a key factor in construction industry growth, partly because of the impact incremental innovation has on cultural change. Incremental innovation involves an understanding of the need for continuous improvement, overturning the social norms in the industry that support complacency.

Yet, incremental innovation, like that demonstrated in the case studies, is typically problem-driven, reactive innovation. The lack of emphasis on more proactive innovation represents a relatively untapped source of industry growth. Incremental innovation helps in improving industry culture, however a 'blame-free' culture is even more important for proactive innovation and, as yet, opportunistic behaviour in the industry remains too dominant to allow this type of innovation to flourish.

The lack of emphasis on proactive innovation suggests fewer formalised R&D programs in organisations and hence less ability to access government programs that support R&D. Given this, a recent report suggests that programs supporting education and training initiatives can assist in promoting innovation rates. The same report argues that service industries, such as construction, need to be assisted in this way to match the support provided to manufacturing organisations through R&D programs (Thorburn and Langdale 2003, 38).

Overall, the experiences of innovators in the case studies emphasise the highly interactive nature of successful innovation implementation processes and the importance of robust business networking. Many construction industry participants are wary of sharing knowledge, reflecting a history of adversarial relationships. However, these case studies suggest that sharing knowledge pays. Cooperation is increasingly regarded as an essential component of self-interested growth. As the literature notes, 'knowledge sharing is not a zero sum game' (Green et al 2004, 12).

There are clear opportunities for further research. Indeed, in related studies, the authors are applying a similar perspective to a study of the Australian road and bridge industry, and are also undertaking a large-scale quantitative study of interactive innovation implementation processes in the Australian B&C industry. A number of specific issues raised in the present study warrant more attention and these include the relative merits of reactive and proactive innovation, and the policy implications of the relative inability of many construction organisations to conduct internal R&D compared to manufacturing organisations.

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CHAPTER 12

Stakeholder Engagement in the Performance Approach – The Australian and European Performance Based Building Networks

Greg Foliente

INTRODUCTION

The performance concept in building and construction had been practised in some measure, and in very specific situations, even before it came to be formally known as "the performance approach". The earliest, and most often repeated, example is the requirement that a house should not collapse and kill anybody in the Hammurabi Code (circa 1950 to 1910 BC). The concept is also reflected in the early architectural philosophy of the Romans, as described in Vitruvius's (1960) landmark "*The Ten Books of Architecture*".

Developments in the last century have led to a clearer description of what it means in both concept and practice, and what its potential, benefits and challenges are (Foliente 2000). These developments can be traced through the reports from the US National Bureau of Standards (1925, 1977), the proceedings of the series of joint CIB-ASTM-RILEM conferences on the Performance Concept in Buildings that were held in Philadelphia, USA (Foster 1972a, 1972b), Lisbon, Portugal (LNEC 1982a, 1982b), and Tel Aviv, Israel (Becker and Paciuk 1996a, 1996b) (with ISO as a co-sponsor of the Tel Aviv conference), and various CIB publications (CIB 1982, 1989, 1997).

But despite significant progress in some applications such as building regulations (IRCC 1998) and engineering design (BRI 1997, SFPE 1996, 1998, 2000), performance based building has not been applied in its entirety (Becker 1999) – i.e. across performance attributes and systematically throughout the project delivery process – and has not been adopted more widely in the industry. Thus, its full potential and promised benefits remain unrealised. There are technical and non-technical reasons for this (Becker 1999, IRCC 1998). Included in the latter is the lack of committed engagement by critical stakeholders in the full implementation of the performance approach.

In order to progress the technical developments in, and the practical implementation of, performance based building, the CIB Board and Program Committee initiated the Proactive Program on Performance Based Building in the 1998-2001 triennium (Foliente et al. 1998, Foliente 1998). Then with funding from the European Union (EU) Fifth Framework Programme, this was followed by the establishment of the Performance Based Building (PeBBu) Thematic Network, running from October 2001 to September 2005. In 2003, the Australian Performance Based Building (Aus-PeBBu) Network was also established, with funding from an Australian government department, industry

partners and the CSIRO, to promote the concept in Australia and to facilitate linkages and exchange of information between the EU-PeBBu Programme/Network and the Aus-PeBBu Network.

Both EU-PeBBu and Aus-PeBBu have provided an unprecedented opportunity to engage a wide variety of stakeholders in moving towards widespread application of the performance approach in building and construction. This paper presents the activities and accomplishments of these Networks, and identifies future development and implementation needs.

KEY STAKEHOLDERS IN THE PERFORMANCE APPROACH

In broad terms, the performance approach is the practice of thinking and working in terms of ends rather than means (CIB 1982). The "ends" usually relate to technical attributes of a building, whether expressed as a high-level goal (e.g. safety), functional requirement (e.g. structural stability) or specific performance requirement (e.g. the load-carrying capacity of a column should be greater than the vertical load it supports).

Performance based building spans the whole life of the building. It is applicable to cover different levels of the physical elements of a building (from performance of individual products or elements to performance of the whole building) and can accommodate a large set of attributes (limited only by what we can think of). It naturally affects everyone involved in the delivery and management of built assets. The list of important stakeholders includes (asterisks indicate relative level of importance in hastening and widening the adoption of the concept):

- Policy makers*
- Regulators** (planning, building & occupational health & safety, etc)
- Building officials
- Investors and financiers**
- Developers**
- Owners and owner-occupiers**
- Architects & designers*
- Engineering professionals*
- Specialist consultants
- Product manufacturers*
- Project managers
- Builders/contractors & sub-contractors*
- Facilities managers (FM)*
- Service providers to FM
- Owners, users/tenants**
- Software/IT professionals
- Researchers*
- Teachers/educators*

Since the performance approach is focused on meeting the needs and requirements of those that procure the building and/or will eventually use the building (i.e. the "demand" side), their engagement is considered very critical. And their level of importance is reflected in the list above with double asterisks.

Planning, building and occupational safety regulations specify minimum requirements. When these requirements are given in performance terms, innovative or cost-effective solutions are possible. Building regulations aim to eliminate worst practice and protect building users and owners and the community. Because of their legal status, in most countries, they can have significant influence in the industry and national economy.

The client/demand side has to know what can be asked beyond minimum requirements, be able to identify their desired building attributes, and communicate these to those who will deliver them (i.e. the "supply" side). The latter needs to be able to translate these attributes into functional or performance requirements. When progressive clients set requirements above and beyond those required in the building code or by regulations, they encourage and promote best practice.

Classification of stakeholders as demand and supply sides is a convenient simplification. In reality, however, the industry cannot be as easily categorised as consisting of these two sides. Some stakeholders, in some instances, can be on both sides (e.g. a developer), and in other instances be on either side. Since the performance approach is mostly about fulfilling the desired "ends" of the

demand side, any project that involves educated and innovative stakeholders on the demand side and well-equipped stakeholders on the supply side have a much higher possibility of success.

Researchers and teachers (of tertiary/professional and trade/technical students), who do not fit nicely into the demand and supply classifications, also play crucial roles in advancing knowledge and understanding, developing tools and methods, and educating and equipping the other stakeholders.

THE PeBBu NETWORKS

The main objective of the EU-PeBBu Network is to actively facilitate knowledge dissemination and practical implementation of the performance approach in building and construction practice worldwide. The EU-PeBBu activities were aimed at maximising the contributions to this effort by the international research and development (R&D) community. With the CIB Development Foundation (CIBdf) running the secretariat and programme coordination and management, the natural starting point for stakeholder engagement is the CIB membership and network. The following stakeholder groups are, therefore, well represented in the PeBBu network: R&D agencies, universities, progressive companies and consultants, regulatory and standardisation bodies, and professional organisations and associations.

Components of EU-PeBBu

The current PeBBu programme 1 is presented in Figure 12.1b. It includes the following "core" components:

- International programming/coordination of research within **6 Scientific Domains**
- Involvement of target groups/stakeholders through **3 User Platforms:** (a) Buildings Owners, Users and Managers, (b) Building and Construction Industry, and (c) International Standardisation and Conformity Community
- **4 Regional Platforms** in Europe to act as the bridge to and the initiator of aligned national activities (Northern, West/Central, East and Mediterranean)
- **Network Management** - through a Network Steering Committee, a Technical Committee and a Network Secretariat
- **Mapping of national and international research** related to various aspects of Performance Based Building.

At the onset of PeBBu, the programme had 9 scientific domains (Figure 12.1a). These spanned across the various themes and aspects of performance based building. Midway through the project, three of these domains ("Built Environment", "Organisation & Management" and "Information & Documentation") were terminated because the scope of these domains was too vast, research was slow or inactive, and/or they overlapped with other domain topics.

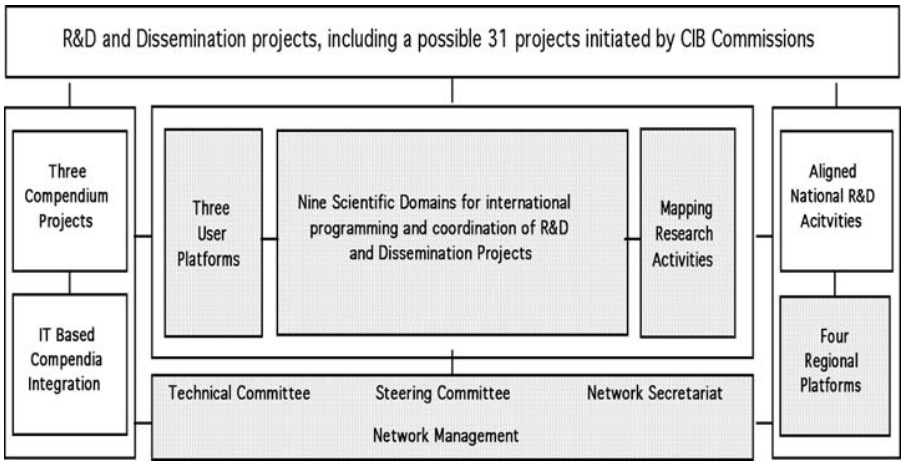
Some other relevant topics arose and were developed as new tasks to replace the terminated domains. These are:

1. Performance based building & the EU Construction Products Directive (CPD)
2. Decision making tool-kit for performance based building
3. Sustainability indicators for performance based building.

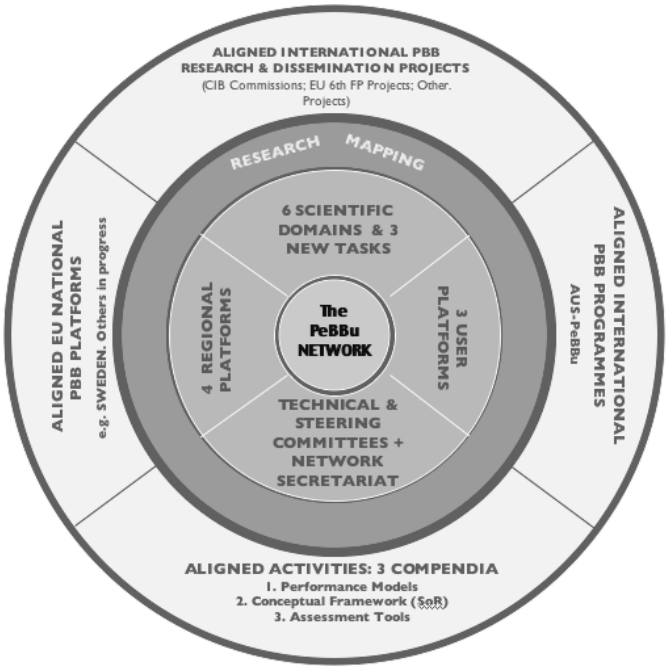
In addition to the core components, various aligned activities in support of PeBBu have been in operation (Figure 12.1b). They contribute significantly to the PeBBu Network, but are not directly funded from the EU-PeBBu budget.

Figure 11.2 The EU-PeBBU Programme

(a) Original Programme



(b) Revised Programme



[3]More detailed information on the Aus- PeBBu Network can be found in http://www.auspebbu.org . IRCC is an unaffiliated committee of ten of the leading building regulatory agencies from eight countries; see http://www.ircc.gov.au/ for further details.

Key accomplishments of EU-PeBBu to date

The PeBBu Network has made considerable progress in its few years of operation. Some of the main achievements to June 2004 include:

- **Expansion of the Network through the Newly Associated States (NAS) and observer-members.** Several Eastern European countries have been added to the Network as Newly Associated States (NAS) and 13 new organisations from these countries are now members of the PeBBu Network. In addition, several observer-members, from non-EU countries, have become a part of the Network.
- **Establishment of aligned activities such as the PeBBu Compendia**. The Compendium of Performance Based Building Models includes a database that at present includes more than 30 different models. The Compendium of Statements of Requirements aims for the development of a consensus derived performance based building conceptual framework and key terminology.
- **Production of 9 scientific domain report**s, which summarise the main content-based work and results emanating from the domain work and workshops along with 9 international R&D agendas.
- **Production of the International State of the Art (SotA) Repor**t, which gives an overview of the status of performance based building in an international context. The International SotA analyses the spread of performance based building principles through many National SotA reports from the European context, and reviews the use of these principles in other parts of the world. The International SotA has been published as a CIB special publication (2003). An East European SotA Report has also been produced.
- **Establishment of many strategic relationship**s. Examples of these are:
  The relationship between PeBBu Domain 1 and ISO, which has influenced the writing of standards related to the durability of construction materials and components;
  - Co-operation with ISO TAG8 (the ISO Technical Advisory Group that is responsible for building related standards) on a multi-year programme within ISO that aims for the production of performance based standards that are to replace or to be added to the current prescriptive ones;
  - Other strategic relationships including PeBBu and aligned activities have influenced new work in the Indoor Environment area;
  - The relationship that PeBBu has established with the E-CORE projects where performance based building will be one of the main building blocks in a future European Research and Development (R&D) strategy.
  - Co-operation with the Liaison Committee of International Associations of Civil Engineering aiming for the establishment of a joint committee on Performance Based Building and Pre-Standardization in Civil Engineering.
- **Moving towards a consensus on language, concepts and issue**s. This is mainly a result of the performance based building compendium on Statement of Requirements.
- **Involvement with/and support of several CIB Commission**s. This aspect has been further detailed at a later stage in this chapter.

The Aus-PeBBu network

An Australian version of the PeBBu Network (or Aus-PeBBu)2 was launched in October 2003. With one exception, its program matches the revised scientific domain themes in EU-PeBBu, to provide one-to-one correspondence of efforts and to maximise opportunity for participants in both Networks to discuss similar topics and issues and to cooperate on matters of mutual interest.

The main difference in the program is the inclusion in Aus-PeBBu of a domain "Sustainable Built Environment". With significant national and international interests, initiatives and investments in sustainable development, this topic provides a great opportunity to introduce the performance approach to a sector of the industry that is progressive, innovative and growing fast. With much dependence on the current use of environmental or "green" rating and assessment tools, and the promotion of demonstration projects, there are indicators that many are implicitly adopting a prescriptive approach.

Australia is one of the leaders in the move from a more prescriptive to a more performance based building code and is actively involved in international and national developments in this area. [The Australian Building Codes Board is involved, for example, with the Inter-jurisdictional Regulatory Collaboration Committee (IRCC)[3] and Aus-PeBBu.] But with less funding and much smaller scope than the EU programme, Aus-PeBBu has a relatively stronger focus on facilitating the proactive application of the performance approach through best practice project delivery processes. It aims to contribute to the following areas of long-term development:

1. Establishment of a basic framework (including performance indicators) and clarification of terms and definitions;
2. Establishment of (multi-level) performance criteria for attributes that do not yet have these;
3. Development and publication of a guide on methods of establishing/setting performance; and
4. Expansion and maintenance of the database compendium of performance models, tools or methods that can be used to achieve targets (e.g. during design), and to assess/verify/evaluate performance in-service.

Lack of understanding, relevant information and appropriate tools/methods on the topics listed above hinder the practical implementation of the performance approach.

While addressing these four focus areas assists both the demand and supply sides, the degree of assistance will tend to favour the supply side. To encourage the stakeholders in the demand side, we need to establish the benefits and value of the performance approach. This has previously been identified as a priority area in the CIB's Proactive Programme on Performance Based Building from 1998-2001 (Foliente 1998) and a CIB report has identified opportunities and challenges (Tempelmans Plat and Hermans 2001). Aus-PeBBu will also initiate a collection of case studies of projects relevant to Australia where the performance approach has been used before and where benefits have been gained.

The last area of difference between Aus-PeBBu and EU-PeBBu is the participation of different stakeholders (both demand and supply sides) within each domain in Aus-PeBBu; i.e. there are no separate user platforms. Anyone interested in the technical domains can participate; demand side representatives are actively sought. Communication and social integration of stakeholders are encouraged.

IMPLEMENTATION NEEDS AND CHALLENGES

Stakeholder Engagement

Within corporate and government client organisations, project decision-makers are often unaware of the concept, application and benefits of the performance approach. Our experiences with the PeBBu Networks confirm that the key to hastening and widening the adoption and implementation of performance based building within a country or region is actively engaging, and then motivating in a sustained way, critical industry stakeholders, especially those on the demand side. Even among these stakeholder groups, we need to identify the key opinion leaders, innovators, connectors and early adopters that can show the way in practical applications, benefit from it and help communicate to others the value of the performance concept. When the "early majority" adopts the approach (Smale,

1996), reaching an industry tipping point is more likely (Gladwell 2000; Foliente and Boxhall 2002). This is, therefore, one of the big challenges: identifying and demonstrating the value and benefits to these stakeholder groups. This also links the performance based building programme with the CIB proactive programme on Revaluing Construction.

In the international arena, although there is a growing interest in performance based building applications, both concept and language difficulties pose a major barrier to stakeholder engagement. There is fragmentation and divergence in understanding the concept and applications. Many factors affect this issue (Foliente et al. 1998).

In summary, the dominant need in stakeholder engagement seems to be clear communication of meaning, application and benefits of the performance approach, with emphasis on benefits and value. In other words, technical issues should give way to a compelling value proposition.

Technical challenges

The broad technical challenges in performance based building have been previously identified in Foliente et al. (1998), IRCC (1998), Becker (1999) and Foliente (2000). The primary technical challenges include the following:

- *Establishing target performance or outcomes* including objectives, functional attributes and performance requirements – beyond what are covered by building codes – as part of a project brief is currently seen as very onerous, if not very difficult. Both large repeat "clients" and one-time or occasional "clients" would benefit from a broad framework of requirements, which can serve as a checklist or reminder of performance outcomes to consider, and a set of guidelines on how to set these outcomes or targets.
- *The right tools or methods* to design or deliver solutions to meet target performance or outcomes, *and* to assess/evaluate whether a given design or solution meets these targets need to be provided. The CIB initiative on developing a Compendium of Building Models and Tools (which can be accessed through the Aus-PeBBu website) was an initial attempt to collect and provide a central database of these tools that can be accessed by anyone anywhere. But until this develops into a critical mass, and tool developers submit information and stakeholders access the information on a routine basis, it will have limited impact. There are a few areas of performance that have lots of tools and there are many that have no available tools. Where tools are available, appropriate guidelines on use, scope and limitations are required. The applicability of some tools is very specific to a country or local environment.
- *The extent of development and depth of knowledge are very uneven* across technical/functional topics (e.g. structural performance vs. indoor environment; fire safety performance vs. sustainability, etc). Multiple levels of quantified performance criteria are possible in one area but only a qualitative statement of requirements is possible in another area. Design tools and methods are available for one but not for another.
- *The inter-relationship of performance attributes is not always well established or understood*, and requires much further research and development. This inhibits optimum design, considering system performance where competing requirements need to be considered (e.g. structural safety vs fire safety vs sustainability/service life).

Implementation and application

In regulatory applications, the IRCC has done much in sharing knowledge and experiences in the development and implementation of performance-based building codes in developed countries with strong legal and technological foundations. Other developed countries can obtain much potentially useful information from IRCC reports and publications. But other countries, especially the developing

countries, need further materials and guidance on how to implement the performance concept in their own building codes. It is not appropriate for these countries to directly adopt those published in, and for, developed countries. Depending on many local factors – such as original content of building codes, legal status of, and degree of compliance to, local building codes, building approval process, degree of development and practice of quality control, certification and assurance (at both product and building levels), extent of involvement of professionals, etc – the appropriate mix of performance-based and prescriptive provisions in the code will differ. In other words, the entry point into the pathway of performance based building code development will be different for different countries or groups of countries. Guidelines to assist regulatory bodies in these countries will be helpful.

In trade applications, there is still much industry confusion on both requirements and processes for acceptance of products or methods from one country to another, even in a country where a performance-based building code is already in operation. Within Europe, the introduction and implementation of the CPD require supporting documents or guidelines. EU-PeBBu has initiated a new task to provide further practical explanations of what CPD means in the context of performance-based trade. In other countries where local building regulations and standards are unclear about required performance, ISO standards are sometimes accepted. Thus, ISO standards need to be consistently framed in performance terms.

In encouraging best practice in building procurement and production process, there is need for a facilitating platform (Becker 1999) and/or successful example(s) where the performance concept can be or has been used in its entirety from project definition to handover/commissioning and in-service/occupancy stage, and with as wide a set of performance attributes as possible. The process or successful example(s) should be fully documented to serve as a guide for others to try the *full* application of the performance approach in their projects.

CONCLUDING COMMENTS

The PeBBu Networks have kick-started a range of activities, not only in Europe, but also in other parts of the world that contribute to the engagement of industry stakeholders, the sharing of knowledge and experiences, trade facilitation, establishment of worldwide networks of agencies and professionals, and further development of performance based building. Much has been achieved even in a short period, and these achievements and those they spawn will be likely to have lasting contributions and impact beyond Europe, and well beyond the formal period of PeBBu activity and funding.

To effectively engage stakeholders and increase the rate of adoption of the performance approach, the dominant need seems to be clear communication of the meaning, application and benefits of the performance approach, with emphasis on actual benefits and value. Thus, priority effort is required to: (1) determine the value and benefits of performance based building for different stakeholder groups, underpinned with actual case studies, and (2) package them for a compelling presentation to these stakeholders. This will facilitate client- or demand-driven innovation, made possible by the performance approach.

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CHAPTER 13

Externalisation as a Source of Innovative Asset Management: The Case of the Transfer of the UK Department of Social Security Estate to the Private Sector

Frèdèric Bougrain

INTRODUCTION

During the last ten years, there has been a growing tendency towards externalisation (outsourcing). This situation is the result of technological developments, fierce competition, changing market conditions and the need to focus on core business.

Technological changes and the introduction of new information technologies transform relationships between clients and suppliers. Intensified competition places increasing pressure on organisations to reduce total operating costs and to focus on their core business. Moreover externalisation favours flexibility and facilitates both efficiency and cost-effectiveness. Outsourcing decisions often appear to be based on the idea that market forces can lead to an improvement in service quality innovation, a reduction of costs and a creation of economic value within the supply chain.

Conversely excessive outsourcing is also presented as a way to lose its learning capacity and its competitive advantage (Foss, 1996).

Outsourcing is not limited to repetitive tasks. Even activities such as R&D which have been considered as strategic, have been partially outsourced (Quinn, 2000; Ulset, 1996). This trend affects companies from the private and the public sectors.

According to Barrett, outsourcing (or externalisation) refers to "*one type of contracting-out; namely, the process by which a user employs a separate company (the supplier), under a contract, to perform a function, which had previously been carried out in-house; and transfers to that supplier assets, including people and management responsibility*" (Barrett, 1995, p.124).

In Europe, several public administrations have decided to outsource the management of all or parts of their estates. But none have been so far as the UK Government departments.

In April 1998, the UK Department of Social Security (DSS)[1] signed an agreement to transfer the ownership and management of almost all its estates to a private consortium. This transfer known as

[1] The Department of Social Security is now known as the Department for Work and Pensions (DWP). In 2003, the contract between the DWP and the consortium was expanded to include properties from the former Employment Service estate (NAO, 2005). Now the former DSS and ES estates are run as

the PRIME project[2] is the largest property transaction ever conducted by a UK Government department. Its net present value was £2.008 billion (using the government's real discount rate of six per cent).

The strategy literature has paid a great deal of attention to the factors that lead organisations to outsource part of their functions. Transaction costs economics and the agency theory have emerged as the main theoretical frameworks to explain outsourcing decision and contractual agreements. However the theoretical approaches slightly differ. The transaction cost theory is concerned "*with organisational boundaries, whereas in agency theorising the contract between cooperating parties, regardless of boundary, is highlighted*" (Eisenhardt, 1989, p.64). Because boundary choices are predominant in the decision of the British Department of Social Security estate to transfer most of its estate to a private consortium, we will use the transaction cost framework. Our aim will be twofold:

- The first is to explain the contractual arrangements at work between the consortium and the Department.
- The second is to examine whether this transfer leads to innovative asset management and to the delivery of better services to the clients.

The chapter is organised as follows. Section 2 presents the transactions costs economics. Section 3 describes the case study. In Section 4, we propose a theoretical interpretation of the transfer of the estate to the private consortium through the lenses of transaction costs economics. Finally, we examine whether the contractual agreements between all partners improved the quality of the service.

OUTSOURCING IN TRANSACTION COST ECONOMICS

The transaction cost economics provide a framework to compare alternative modes of governance: markets, hierarchies and hybrids. "*What matters is not the absolute amount of transaction costs, but the relative ranking of transaction costs associated with different organisational or contractual choices*" (Wang, 2003, p.4).

According to Williamson (1991), two behavioural assumptions and four attributes of transactions are especially important for understanding economic organisation and relationships between economic agents.

The four principal dimensions of transactions are asset specificity, uncertainty, transaction frequency and the ease of measurement. "*Of these four, asset specificity – which has reference to the ease with which an asset can be redeployed to alternative uses and by alternative users without loss of production value – has had the greatest significance for examining the governance of contractual relations"* (Williamson, p.79-80, 1991).

These characteristics of transactions become significant because of the behavioural assumptions: bounded rationality and opportunism.

Bounded rationality suggests that the human agents experience limits in formulating and solving complex problems. This will lead them to write incomplete contracts.

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one, under a single contract expiring in 2018. In this paper, we will only refer to the first contract and to the DSS instead of the actual DWP.

[2] PRIME stands for Private sector Resource Initiative for the Management of the Estate.

Opportunism is usually associated with the actions of economic agents which disclose information in a selective and distorted manner.

This entails information asymmetries and organisational problems. These asymmetries are very strong for new services (Djellal and Gallouj, 2000).

Different combinations of asset specificity, frequency, uncertainty and measurement problems will determine which governance structure is best adapted to manage transaction:

- The market is the appropriate mode of coordination for non specific assets and occasional transaction. All the contingencies that might affect the contract are foreseen by the agents. Consequently, the client and the supplier are able to write a clear and enforceable contract. The uncertainty is limited and it is easy to implement and monitor tasks. However, the market principle may fail because participants often adopt short-term oriented strategy and for each transaction it is necessary to learn about the other (Imai and Itami, 1984). In this case, outsourcing, characterised by classical and complete contracts, is appropriate.
- When transactions are recurrent and involve specific assets, outsourcing is not appropriate. Because of the specificity, the contracts are incomplete, complex and difficult to monitor. Consequently, the hierarchy is chosen.

  For example, by outsourcing some specific activities over a long period to a supplier, a client may have made himself dependent upon its supplier. Conversely, the supplier may have invested in a specific piece of equipment. This creates a bilateral dependency. In such a situation, vertical integration is best adopted to avoid opportunistic behaviours. This strategy also reduces procurement and negotiations costs.

  Conversely, the hierarchy might reduce the flexibility of the enterprise and decrease the performance level. Indeed, according to the agency theory (Jensen and Meckling, 1976), when an internal contract is established between a principal (for example the manager of the housing company) and an agent (for example a maintenance company), it is necessary to find an incentive system to avoid shirking behaviour (from the agent) and a loss of productivity.

  Moreover, the internal organisation of supporting activities might lead to the development of routines and to the limitation of operational efficiencies.
- The hybrid forms (between markets and hierarchies) are better suited when asset specificity is intermediary, transaction neither recurrent nor occasional. Williamson considers that this form of coordination is unstable and temporary. As soon as uncertainty increases and/or assets become more specific, hybrid forms entail transaction costs and vertical integration becomes more advantageous. The hybrid forms cover a wide range of organisational forms. Outsourcing and strategic alliances are some of them.

  Outsourcing with neo-classical contracts characterised by long-term arrangement can be adapted even when high asset specificity dominates. Uncertainty and measurement problems just need to be low.

Notwithstanding the interest of this approach to provide an analytical scheme for the study of externalisation, several limits remain:

- First, according to this theory, arm's length agreements are costly. First agents are engaged in negotiations to define the terms of the contract. Once the agreement is signed, they will undertake inspection to make sure that their partner is not shirking (ex post opportunism). Given these assumptions on opportunistic behaviours, transaction costs should reach prohibitive levels when new and complex contracts are involved. However, this is not the case. In fact negotiations which lead up to a bargain could be considered as an investment instead of a cost (Everaere, 1993). Agents rely on this process to learn about their mutual needs and to make decisions to avoid bottlenecks during the implementation of the project.

- Secondly, the theory considers that there is a perfect substitutability between external and internal activities. But when a resource is integrated to an enterprise, it becomes more and more specific. "*There cannot be substitutability because a resource entering into the firm acquires new qualities and changes its nature*" (Foray, 1991, p.395).
- Finally, the transactional approach puts too much emphasis on opportunism. However, "*an organisation should be understood at least as much as a mechanism to enhance co-operation than as a device to reduce cheating and shirking*" (Menard, 1992). By and large recurrent transactions lead partners to gradually trust one another. These collaborative relationships entail learning (Lundvall, 1993).

THE CASE STUDY

PFI and the transfer of the UK Department of Social Security Estate

The transfer of the UK DSS estate to a private consortium (the PRIME project) is part of the "Private Finance Initiative" (PFI) launched in 1992. By November 2003, 617 projects had been signed under the PFI with a capital value of over £56 billion.[3]

"*The PFI extends the role of the private sector in the provision of what are generally considered to be public services (such as health, education, transport infrastructure, prisons and the administration of the function of the state) by signing contracts with private sector partners to design, finance, build and manage assets and to deliver associated services*" (Froud, p.567, 2003). PFI is considered as a means of improving the quality of public services. "*PFI ensures that contractors are bound into long-term maintenance contracts and shoulder the responsibility for the quality of the work they do. With PFI, the public sector defines what is required to meet public needs and remains the client throughout the life of the contract*" (HM Treasury, p.3, 2003). The end goal being to deliver world class public services, it might present opportunities for enhancing client leadership and innovation.

The DSS estate was the largest civil estate in UK Government. 700 buildings covering a total floor area of 1.64 million square metres were transferred to the consortium.[4]

Key futures of the contractual agreements

The consortium acquired the ownership of the freehold properties (37 per cent of the estate) and responsibility for rental costs on leased buildings (both historic and modern leases). It also supported the cost of upgrading the buildings (NAO, 1999).

During the 20 years of the contract, the Department retains rights to occupy the estate. But on expiry of the contract, the estate will remain in the ownership of the consortium. During that period,

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3 This figure was doubled in 2002 and 2003 by the signing of contracts totalling £28 billion for the London Underground (IFS, 2003).

4 In 2001, a similar contract (the STEPS Deal) was signed between another consortium and several Departments (the Inland Revenue, HM Customs and Excise and the Valuation Office Agency). 698 buildings covering a total floor area of 1.44 million square metres were transferred to the consortium (NAO, 2004). In this project, the consortium underpriced its bid to enter the market. Experiencing difficulties with service delivery, it criticised the Performance Measurement System and requested contractual changes. Fearing the consequences of a premature end, the government renegotiated the contract.

the DSS may also vacate up to 35 per cent of the estate without charge. 10 per cent of the estate was declared surplus at the start of the contract (164,000 square metres). Because the level of vacant space was expected to increase, the department negotiated rights to vacate 2 per cent a year of space agreed to be flexible during each of the first 15 years of the contract (this "flexible" part concerns 25 per cent of the estate).

The Department also transferred its existing contracts for the 13 facilities management services to the consortium. Consequently, the Department will deal exclusively with one contract rather than 160 service contracts during the 20 years of the PRIME project.

To provide services to the users of the buildings that were transferred, the consortium subcontracts building maintenance, catering, cleaning, security, energy and utilities management, equipment and landscape maintenance and waste management. The contracts between the consortium and its subcontractors were initially signed for five years. In 2003, all of them have been extended till 2018.

The innovative aspects of the prime project

The PRIME project was very innovative from several perspectives:

- It was the first transfer of a Government department estate ever realised.
- The size of the project increased the complexity of the deal.
- The consortium members were at the origin a property investment fund, property investment specialists and facilities management companies. They almost started from scratch. They never worked together before PRIME and all of them were pursuing different strategic objectives. However this potential risk was mitigated by the competences and the financial reliability of the consortium members (the leading property investment fund was managed by the US investment bank Goldman Sachs).
- The consortium established several innovative arrangements with its service providers.
- The flexibility introduced for the estate management was also very innovative. The contract agreement allows the DSS to vacate without charge up to 35 per cent of the estate over the life of the contract. However the DSS had to pay additional costs when the deal was implemented, to compensate for the transfer of risk toward the consortium.

PRIME THROUGH THE LENSES OF TRANSACTION COSTS ECONOMICS

Based on the theoretical framework presented in section 2, we will examine the transfer of the DSS estate to the private sector. We will look at uncertainty, asset specificity and measurement problems

Uncertainty

Innovation usually leads to an increase of risks and uncertainty. Despite the aforementioned innovative characteristics of the contractual agreement, the uncertainty of the project could be considered as medium.

Indeed several ex-ante and ex-post transaction elements contribute to reduce the uncertainty:

- The estimated project procurement costs increased between the start of procurement work in 1996 and the implementation of the deal in April 1998. During that period, consultants, financial advisers, local property lawyers and agents helped the DSS to finalise the contract. Total costs reached £10.68 million. This was mainly due to the inability to predict the workload of external advice. But this increase of project procurement costs could also be considered as an investment. It helps the DSS and the consortium to get reliable information on the estate and to limit

contractual incompleteness. Consequently, it reduces uncertainty and potential ex post contractual problems.

- The five month period that followed the selection of the preferred bidder was dedicated to negotiations between the consortium and the DSS. Lots of estate data were not assembled in advance. Consequently, it was necessary to spend time and money to remeasure the buildings and to evaluate the assets. After the remeasurement, the estate was found slightly larger than the DSS previously thought. This operation lead to an increase of £ 44 million of the price of the deal but it also reduces potential disturbances during the life of the contract.
- The 13 facilities management services that were transferred to the consortium were not considered as sensitive functions. Catering, cleaning, security, landscape maintenance and waste management are mainly repetitive tasks that are among the most frequently outsourced services (SESSI, 2001). All of them can be considered as non-core business functions for the DSS. So uncertainty was relatively limited. Before PRIME, most of them were already provided by several private sector contractors. But contract duration was never more than three years. Conversely some activities such as IT hardware, software or infrastructure, telephony, switchboard, which are subject to technological evolutions, were not provided by the contract.
- Uncertainty can also be reduced through information disclosure. "*Because of the limited role of the price mechanism and of the uncertainties surrounding the appropriation of rent, information disclosure will be essential to the existence and stability of hybrid forms*" (Menard, p.159, 1996). In the case of PRIME, the DSS and the consortium agreed to introduce information disclosure in the contract to preserve the stability of the agreement. Information disclosure will allow them to share the benefits of improved operations of the estate. For example in the case of maintenance, the DSS will "*receive one quarter of savings from the deferral of avoidance of maintenance over a three year period*" (NAO, 1999, p.18). But to keep some incentives, they will not share in higher than planned costs. The sharing arrangements also concern the development of properties, utility cost savings and changes in contractor's service methods.

  In the first three years of the contract, 3% of the energy costs have been saved through investment and management.

However, despite the pre-operating investments, the contract was not completely secured. The start of the contract revealed that some risks were underestimated by both partners. For example, the consortium had to pay extra costs to provide buildings with security. Conversely, the DSS believed that they transferred the landlord service charges for leasehold to the consortium. But the risk was kept by the DSS.

Asset specificity

The transferred estate was classified into three parts: Freehold properties (37%), historic leases (14%) and modern leases (49%). It consisted mainly of traditional office buildings located in or close to the centre of British cities. So it seems that physical assets, and particularly the freehold properties that were acquired by the consortium, could be easily redeployed. As one of the UK's leading providers of total property outsourcing solutions, the consortium had the in-house expertise and was better placed than the DSS to find solutions to redeploy the estate. In the past, the performances of the DSS in this field were quite poor. Just before the transfer, the vacant space was spread over some 140 locations. It concerned 158,000 m² and cost the tax payer over £12 million every year.

The results so far seem to indicate that physical assets were not so specific and that the risk was appropriately estimated. For example, overall development gain share totalled £12 million in March 2001.

Conversely the consortium had to make specific investment to manage the estate and to provide the services required by the contract.

- It created a database that is updated every month to manage the estate. This database is associated with a strategic management and planning tool that was developed by the consortium to manage portfolios and compare alternative proposals for accommodation strategy. Previously the DSS did not have any incentives to make such an investment. The accommodation and office services were fragmented between individual business units.
- It established a call centre based in London to handle all calls and work orders from the potential customers in the estate (on average it receives 25,700 calls per month). This customer service centre is crucial for the service quality delivered to the DSS. All of the Department's staff can call the centre 24 hours a day. Then the calls are directed to the service providers. The efficiency of the centre is at the core of the service performance associated with the contract. Work orders have to be handled as fast as possible to avoid penalties.
- Working in the customer service centre requires quite specific skills. The consortium decided to develop in-house expertise by recruiting skilled staff and training them in technical and customer service issues. The staff has to identify the nature of the property service required and to direct the call to the appropriate service providers. This first diagnosis will determine the service quality to the end user. Such an investment was required because the customer service centre is at the core of the performance of the estate management strategy. It confirms that among the skills which contribute to the in-house expertise, human assets are very specific. "*These are probably the most important core skills when moving out of the realm of traditional manufacturing industries. In the service industries human asset specificity is probably the only asset that can give organisations relative advantages. Core skills here are know-how, experience, organizational routines and culture*" (Reeve, 1990, p.140).

All these investment would not have been possible under classical market contracts. A period of three years is too short and not adapted to the features of a transaction that requires specific investment. Because of the 20 years contract the consortium had incentives to develop such specific assets.

The measurement problem

Measurement issues have been ignored by the empirical literature (Poppo and Zenger, 1998). "*There are two conditions for measures to be effective: observability and verifiability. The first is the possibility for the principal to observe the performance of the agent. The second is the capacity of the principal to verify observations and supply evidence by measures*" (Aubert and al., 1996, p.59).

In the case of PRIME, several procedures have been established to observe and verify how the activities are performed:

- Firstly, the contract detailed all activities to be performed. A Performance Measurement System (PMS) has been established for the 13 services. Then 54 Key Performance Indicators (KPI) have been defined according to the expectations of the DSS. The level of achievement for each KPI is monthly reported for each property. In case of poor performance or buildings' unavailability the payments of the Department to the consortium can be reduced. For example, if no heating is available for two hours, the DSS will not pay for the availability of the building that day.
- Secondly, the records and history of all calls and work orders addressed to the Customer Service Centre are contained in an information system that provides service performance statistics.
- Thirdly, several audit procedures have been established and are supported both by the consortium and the DSS to examine all aspects of service delivery across the portfolio. To manage the contract and perform the audit, the DSS still employs about 128 people (instead of 210 before

PRIME). The Department can also order external audits and charge the costs to the consortium in case of failure (until a ceiling of £500,000).

- Finally, the consortium benchmarks its sub-contractors. For most services and at the level of the whole estate, it relies on two service providers. For example, it is the case for cleaning and maintenance.

OUTSOURCING AND THE QUALITY OF THE SERVICE

Customer satisfaction surveys are regularly conducted. In March 2002, the first survey indicated that 87% of DSS staff were satisfied by the level of service provided by the consortium. A further customer satisfaction survey was carried out in March 2003 which resulted in 90% of DWP staff being satisfied with the level of service. No similar study was carried out prior to PRIME but it seems that the transfer of estate has increased the quality of the service delivered to the end user of the buildings for at least following three reasons:

- The contract allows each partner to develop its own core competencies. The aim of the transfer was to allocate risk to the party best able to manage it. Before the transfer, the 160 local service contracts were not managed efficiently. Most of them were for three year periods or less. These 160 separate contracts were not standardised and were costly to manage (about £5 million a year for staff costs alone). Some directorates gathered several services under one single contract whereas others had separate contracts for each service. The management of the services associated with the estate was not the main expertise of the DSS. Conversely, the consortium members were at the origin a property investment fund, property investment specialists and facilities management companies. Its core competencies concern property financing, facilities services, capital project delivery, estate strategy and asset management and provision of new space. Because of its competencies, the consortium was better placed than the Department to manage the 13 facilities services and the disposal of surplus space. Moreover the consortium will benefit from economies of scale. Service providers will buy some components at a lower price than the former sub-contractors of the estate.

  So far the consortium has been able to develop effective estate strategies which meet the needs of the DSS and to reduce maintenance costs by investing in the refurbishment and the renewal of the estate.

  It seems that by transferring the responsibility for managing the estate to the consortium, the Department started to concentrate its resources on its core business: the management of the Social Security system.

- The consortium had to comply with the requirements of the contract. Before the transfer of its estate, the Department did not have sufficient resources to refurbish and to maintain the estate. Statutory requirements such as compliance with health and safety legislation were not fully met[5]. The estimated cost to fully comply with the legislation was £9.7 million of work.

  The contract provides for refurbishment and maintenance of the estate by the consortium. For example the consortium had two years to comply with statutory requirements and it still has to support risk of non-compliance.

- The length of the contract enables the consortium to make specific investment. It also provides partners with opportunities to learn from one another. It contributes to the establishment of common codes of information between partners. By providing the DSS and the consortium with

5 The Department already undertook all Category 1 health and security checks.

an identical set of references, it favours communication, develops the stability needed for exchange and enhances the efficiency of coordination. For example, the consortium and the DSS develop several Estates Committee Structures in order to resolve contractual issues, to discuss service and property related issues and to address local issues of customer concern.

The features of the PRIME contract also lead the consortium to sign long-term contracts with its service providers. Contracts between the consortium and its sub-contractors were initially signed for three years with a possible extension for two more years. In 2003, the contracts ended but the consortium decided to sign a new contract for 15 years with each of its service providers. The aim of these unusual and long term contracts is to enable the service partners responsible for maintenance, catering, security, cleaning, equipment maintenance and furniture to invest in the service.

For example, the security company developed an access control system with the consortium. It was in charge of the development of the software. It would not have invested in this system and make the right commitment to the partnership without long-term agreements with the consortium. Five years are usually too short to recover the initial investment.

Even service providers tend to cooperate together. Initially, there was no partnering between competitors (two service providers). But as time goes, they tend to share their best practices for their mutual benefits. For example, one company changed its way of operating the help desk by adopting its competitor's solutions.

In the long run, these elements should contribute to an increase in the quality of the service.

Despite the increase of service quality and the global satisfaction with the level of service provided by the consortium, some critics remain:

- It is still a problem to define the output and to measure the quality of the service. It appears more difficult to define a service than a product. For some services such as cleaning, there is a lack of tangible indicators. So it appears that the consortium is rewarded according to its compliance with method statements (for example its frequency of cleaning) and its ability to respond in time (and not always for the quality of the service).

  This confirms that services are difficult to determine a priori. "*Each service transaction may be considered as unique as long as it is produced on demand (tailor-made) in interaction with the client or as a response to a specific, not standardisable problem, and in different environments*" (Sundbo and Gallouj, 2000, p.44).
- The PMS would reward the consortium for being reactive in dealing with problems, rather than incentivise it to develop solutions to avoid problems.
- PRIME also shows the difficulties to have the same measurement performance system for about 700 buildings, located everywhere in the UK and having different characteristics and end users.

CONCLUSION

In this chapter we proposed a theoretical framework to analyse the way the UK Department of Social Security transferred its estates to the private sector. According to the transaction theory, outsourcing and long term agreement characterised by high asset specificity can be efficient when uncertainty and measurement problems are low. It appears from the analysis that several procedures have been set up to measure the performance of the consortium and that uncertainty has been mastered through information disclosure, the measurement of the buildings and the evaluation of the assets. The time and the money spent to get reliable information before the implementation of the deal reduced contractual incompleteness. This could be considered as a success factor. The contract is one way to "enforce" the trust between partners and to limit opportunism (Brousseau, 1997).

So far the length of the contract appears to be another source of success. Without such long-term agreements, it is doubtful that the private partners would have taken risks, innovated and made specific investments. After five years, this win-win strategy seems to have contributed to a better service performance.

But further research would be necessary to identify the key elements that would lead to the delivery of better services to the clients. In this field, the initiatives of the UK government to develop measures to help the public sector to become a better client (HM treasury, 2003) appear interesting. Indeed leading clients are always sources of innovation.

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CHAPTER 14

Supporting Collaboration and Multiple Views of Building Models in Virtual Worlds

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David Marchant
Andy Dong

INTRODUCTION

Current software tools for documenting and developing models of buildings focus on supporting a single user who is a specialist in the specific software used within their own discipline. Such tools tend not to be multidisciplinary and not foster collaboration. Collaboration in distributed virtual environments has the potential to support communication and collaboration in multi-disciplinary teams if a suitable design infrastructure could be added. Collaborative Virtual Environments (CVE) provide one kind of infrastructure to support communication and collaboration.

A Collaborative Virtual Environment (CVE) is a computer-based, distributed, virtual space or set of places. In such places, people can meet and interact with others, with agents or with virtual objects. CVEs might vary in their representational richness from 3D graphical spaces, 2.5D and 2D environments, text-based environments, to combinations of these (Li and Maher, 2000). Figure 13.1 shows, by way of example, the prototype CVE that we are developing. To facilitate distributed collaborative designing, a number of features are required. These can broadly be classified as either facilitating artefact modelling or as facilitating communication and collaboration.

CVEs, such as the Active Worlds[1] one shown in Figure 14.1, facilitate communication and collaboration by providing mechanisms for shared context, awareness of others, visual and textual communication, immersive manipulation of constructed artefacts, and a fostering of community design. What current CVEs do not provide are mechanisms for reasoning about artefacts and the representation of different views or properties by practitioners from different disciplines. This paper reports on the research, and a proposed approach, in supporting reasoning about, and representation of, different views in virtual environments.

[1] http://www.activeworlds.com

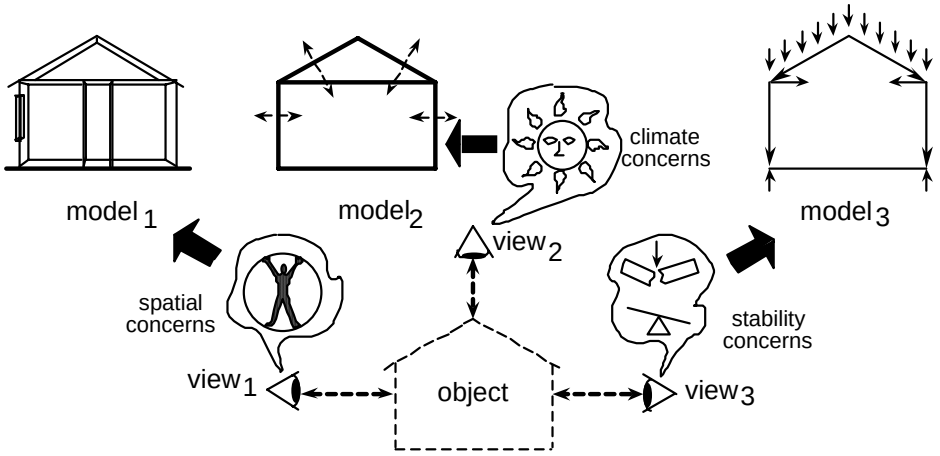
Figure 14.1 Virtual Worlds and the Prototype CRC Collaborative Designer

In this chapter, Section 2 considers representing the multiple views of a single design artefact that may be held by practitioners from different disciplines involved in a project. Discipline models allow each discipline to work according to its own concepts and representations, with a common model providing for the integration required between models. Section 3 describes an approach where role-based agents provide the reasoning mechanism that connects the visualisation of the objects in the virtual world with the discipline and common artefact models in a database. Section 4 introduces a scenario to illustrate these ideas using simple conceptual design artefacts.

REPRESENTING MULTIPLE MODELS

A model of an object is a representation of that object resulting from a particular view taken. Given a design object, such as a building, there are many views that may be taken, leading to different conceptual interpretations. For example, a building may be viewed as a set of activities that take place in it; as a set of spaces; as sculptural form; as an environment modifier or shelter provider; as a set of force resisting elements; as a configuration of physical elements; etc. A building is all of these, and more. For each different view of a building there will be a corresponding model, as illustrated in Figure 14.2.

Figure 14.2 Multiple Views and Models



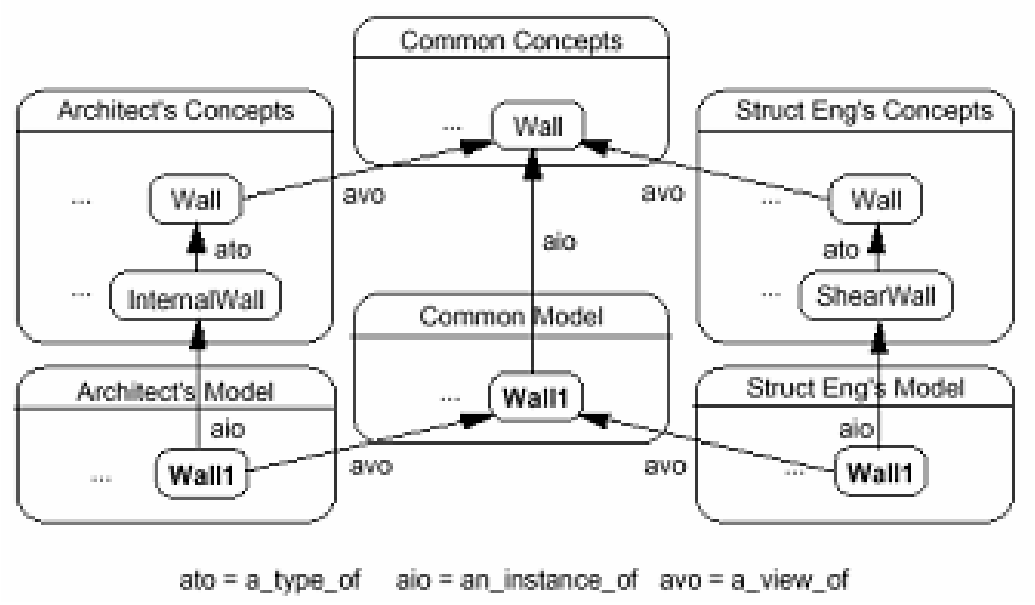
Depending on the view taken, certain properties and descriptions of the object become relevant. The sound insulating properties of a wall are not relevant to a structural engineer's description of that wall. In fact, many walls may not be relevant at all to a structural engineer if they do not either contribute directly to the stability of a building or indirectly by providing a substantial load. The architects will model certain elements such as floors, walls, doors and windows. For the architects, these elements are associated with the spatial and environmental qualities with which they are concerned. Structural engineers, however, see the walls and floors as elements capable of bearing loads and resisting forces and moments. Both models must coexist since the two designers will have different uses for their models. For example, the structural engineers will need to carry out calculations based on their model while the architects may need to ascribe different properties to their separate wall elements. According to Bucciarelli (2003) “There is one object of design, but different object worlds.” And “No participant has at any stage in the process, a comprehensive, all-encompassing understanding of the design. No participant has a ‘god’s eye view’ of the design.” The engineers may modify some of the properties assigned to elements by the architect and may add some new elements, such as beams and columns. The addition of such new elements may affect the architect's model (and vice versa). Any such decisions taken by the engineer must be conveyed to the architect by making changes in the architect's model as appropriate. It will be shown that such changes in another discipline's model can be done when the change affects a function which is the concern of that discipline.

There exists considerable work using a single model approach based on the construction of a model from 'primitive' elements from which multiple interpretations are derived (Howard et al., 1992; Amor and Hosking, 1993; Clayton et al., 1994; MacKellar and Peckham,1994). This approach is analogous to the formation of views in database management systems. However, it is argued that this approach is insufficient, since the 'primitive' elements themselves are subject to the views taken by the different viewers and hence different primitive models are constructed by each such viewer (Rosenman et al. 1993; Rosenman and Gero, 1996). Since the basic description of an object differs from viewer to viewer, each viewer may represent an object with different elements and different composition hierarchies. For example, while architects may model walls on different floors as separate elements, bounding various rooms, the structural engineers may model only a single shear wall. So that, not only is the interpretation of the meaning of a design object different from one viewer

to another but, also the description of the structure of the object differs. There exists no single unified model or even a single set of unique elements but rather different descriptions of the same elements and different subsets of these descriptions in different models. The disciplines have their own discipline models and there exist a number of core models that contain the common concepts between disciplines. We refer to this approach as the "common model" approach. It is similar to that taken by Nederveen (Nederveen, 1993; Nederveen and Tolman, 1992) and also Pierra in his work on PLIB (Pierra, 1993; Sardet et al, 1998).

Although each discipline creates and maintains its model, the various models refer to the same object and, therefore, must be consistent. Using the common model approach, this is achieved through the common models using the a_view_of relationship (Pierra,1993; Sardet et al., 1998), as illustrated in Figure 14.3.

Figure 14.3 Communicating Across Models Through the a_view_of Relationship



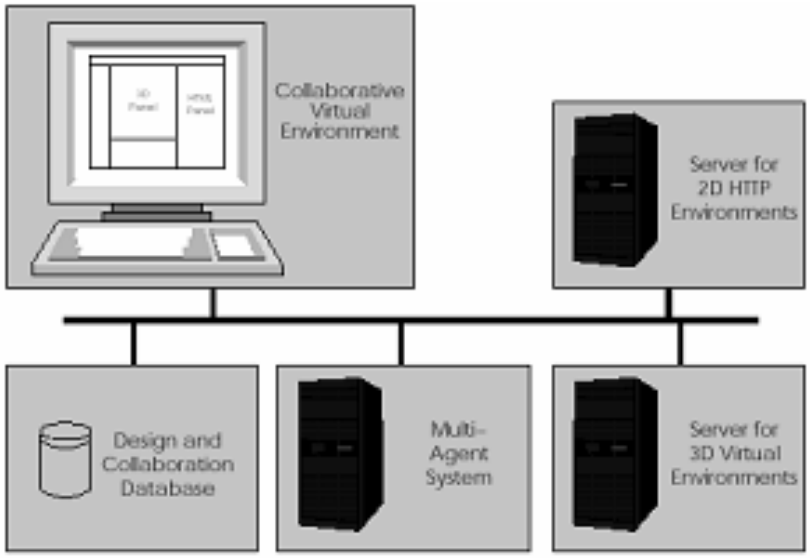
The discipline concepts (classes) hold those properties specific to the discipline. For example, the Wall (architect) concept may have a function that is to bound a space, while the Wall (structural engineer) concept may have optional functions of supporting elements and/or transferring lateral loads. The Wall (common) concept will have the structure properties, such as the material, shape, dimensions and location. Since both the architect and engineers Wall are a_view_of the common Wall, they will inherit properties from the common Wall. When either the architect or engineer creates a wall object (such as Wall1) in their model, a corresponding instance of the common class is created and the discipline object is related to the common object through the a_view_of relationship. Wall1 may be an instance of a Wall class either directly or as an instance of a Wall subclass such as InternalWall.

SUPPORTING COLLABORATION AND MULTIPLE VIEWS

Our approach to supporting collaboration and multiple views augments the inherently multi-user platform provided by the Active Worlds platform with additional collaboration tools (such as webcam, sketching whiteboard, etc); an object database; and an agent system to facilitate multiple views functions. The components are shown distributed across a network but need not be. Figure 14.4 shows a system architecture depicting our approach. The major components are:

- A client browser to a virtual environment provides the CVE experience to the designers with real time rendering to reflect changes immediately.
- A virtual world server provides the interactive 3D world to the CVE, as well as interactive chat.
- A 2D HTTP server enables server-side scripting of the web pages that provides information from the database, access to tools like a webcam, iphone, and sketching board.
- A database that holds the discipline models, the common model, mappings between these models and virtual world objects, and other data to facilitate collaboration as well as provide the basis for translating to and from specific CAD models.
- A multi-agent system to monitor and maintain the information in the servers and the database, providing a unified experience to designers.

Figure 14.4 System Architecture



The primary role of the agents is to construct and maintain multiple views, both abstractly of the design artefact, and concretely of 3D objects instantiated in a virtual world. Haymaker et al. (2000) describe how agents that play roles as filters, constructors or mediators interpret semantic database entities. Our agents play similarly classified roles except that the database entities that our filter agents interpret and update are the discipline and common models of Section 2.

Filter agents filter the view of the discipline and common models. The filtered view presented to constructor agents changes according to the disciplines of the designers that are currently collaborating and their current interest. Filter agents also provide the interface between the 3D objects

from which the 3D virtual worlds are constructed and the database objects that comprise the discipline and common models.

Constructor agents build design artefacts in a 3D world. They insert 3D objects to build artefacts, as well as moving and deleting 3D objects to reconstruct the space of the design artefact. Mediator agents associate 3D objects with designers and their 3D world avatars, handle text chat from designers to agents, handle remote method invocations from the HTTP server, control the work flow between filter and constructor agents, and enable session data to be logged. Data collector agents provide for logging and data collection for later cognitive and data mining analysis or simply as a record of important collaborative sessions.

Figures 13.5 and 13.6 show two typical interactions of the agents. Figure 5 shows an architect adding a new wall to an existing building. The architect sets parameters on the 2D build panel and clicks an insert button. This results in a message being sent via the HTTP server to the mediator agent. The mediator decides that construction is required and adds a new 3D object to the world, with selection of the object and its location being parametric. If successful, an identifier of the new object is returned by the virtual world server, which the mediator passes to the filter agents along with the other parametric details. The filter agents use these to update the models in the database. The virtual world server also sends update messages to each client browser to update their 3D views.

Figure 14.5 Interaction Diagram Illustrating an Architect Adding a New Wall to the Design Artefact

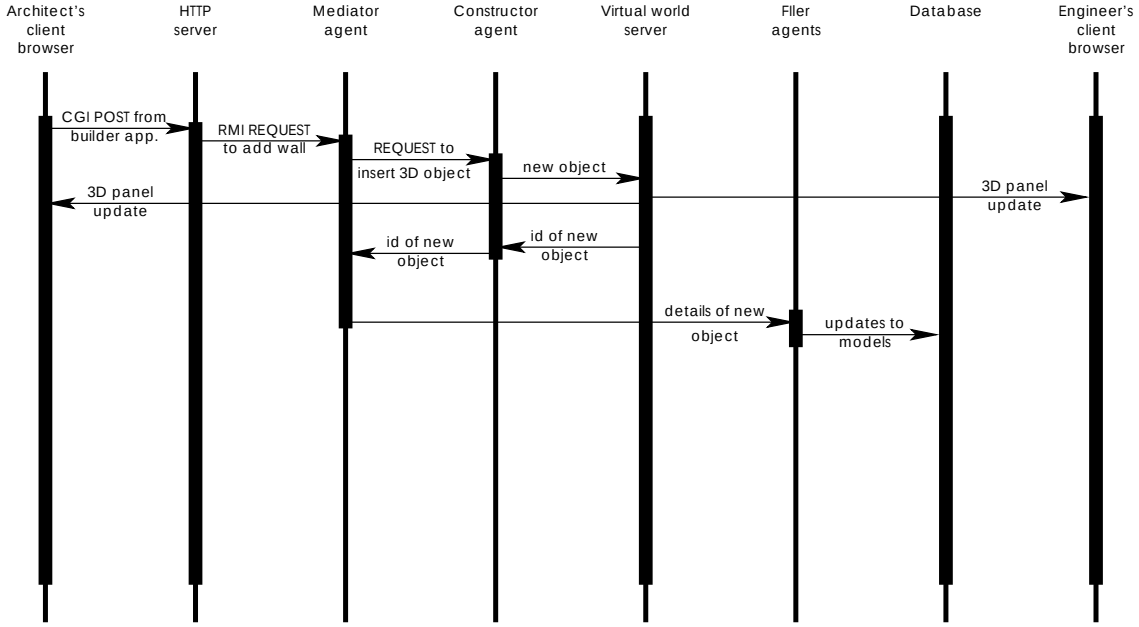
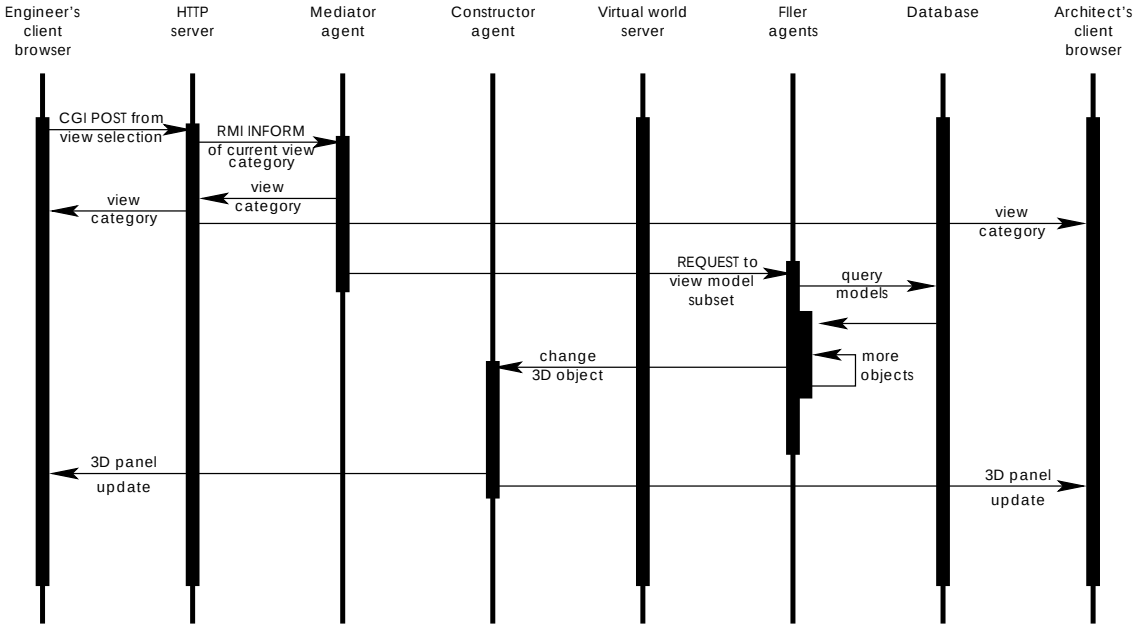


Figure 14.6 shows the interaction diagram for an engineer entering the world and changing the view of the building presented from that of an architect's view to that of an engineer's view. At any time the 3D view of the design artefact will be that of one of the disciplines. When a designer requests a change of view the mediator requests that the constructor change each object accordingly. What each change is will depend on the view and the object. For a change from an architect's view to an

engineer's view, some spatial objects may be re-rendered such that they are invisible as spatial concepts being generally not of concern to a structural engineer. Similarly, some other objects may become visible. Other objects that are of interest to both disciplines, but to different degrees, may change visual properties such as by changing colour, texture or transparency.

Figure 14.6 Interaction Diagram Illustrating an Engineer Changing the Current View From that of the Architects



PROTOTYPE IMPLEMENTATION AND SCENARIO

Figure 14.1 shows one view of the client browser on our prototype implementation. In this implementation, Active Worlds is used as the 3D virtual world server and their browser is the basis for the CVE. The long vertical panel on the left of the client browser shows the 3D worlds known to the 3D world server. Each designer is represented in their current world by an avatar, as seen in the large panel to the right of the worlds panel. This shows a 3D view from the viewpoint of the avatar of the person logged in on this browser. It is this panel, along with sound and chat, that provides the 3D immersive experience. The panel below the 3D view panel facilitates chat. To the right of the 3D view panel is a panel that shows dynamically served web pages that provide more information about the design or run interactive applications.

The right panel window shown in Figure 14.1 contains row of buttons at the top, each of which launches one application. Currently these applications include a builder, a distributed sketchpad, an interface to the data logger, a web cam with audio, and help pages. Figure 14.1 is showing the builder application. Help pages launch as separate overlay windows, as shown in Figure 14.1.

The sketchpad is an applet that provides for freehand sketching over a background image. The background image may be uploaded and so designers in different locations can sketch over a 3D view

of the design artefact. The current sketch and background image are saved in the database such that designers can work on the same sketch.

The web cam page shows live images of the online collaborating designers, plus will provide for audio after the manner of Voice-over-IP (VoIP). This is to facilitate collaboration over a distance using materials not otherwise catered for in a virtual environment, such as showing books, magazines, real world models, and so on.

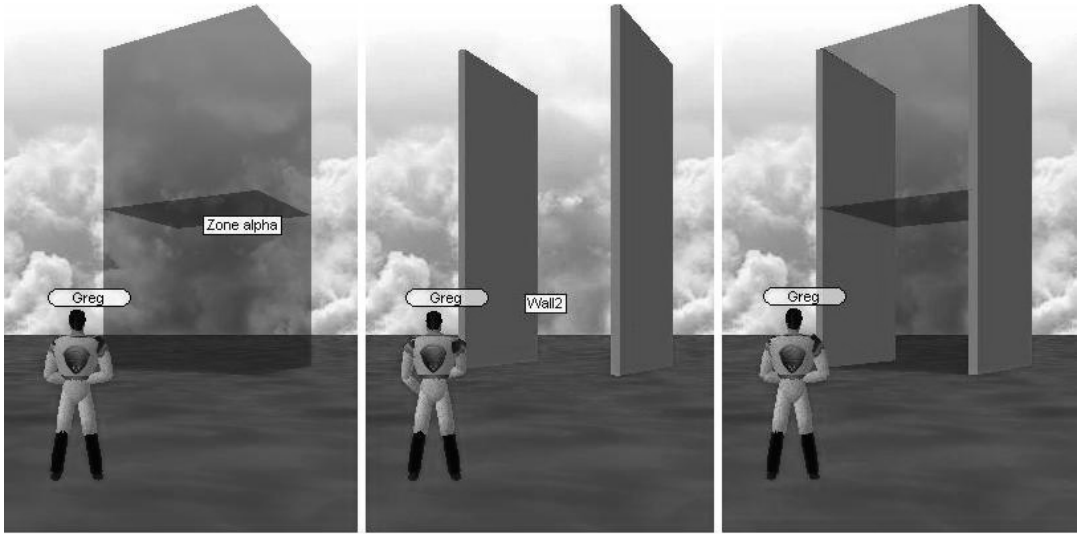
The agents are programmed in Java and C, and communicate with the HTTP server using Java remote method invocation (RMI). Agents interact with the Active Worlds server using the AW software development kit (SDK) using a java native interface (JNI). The mediator agent connects itself to the system as an RMI server with which to receive messages from the HTTP server. It also registers itself as a callback with which to receive textual chat from designers and avatar events from the virtual world. The mediator interprets these messages and forwards them to the filter and constructor agents. The constructor agents also register themselves as a callback with which to receive 3D object add, change and delete events. Filter agents communicate with the database. Currently queries are in SQL via Java database connectivity (JDBC); future versions may instead use XQuery on a native XML database. Previous research (Maher et al. 2003) has demonstrated how IFCs can be used to populate a database from an ArchiCAD model, and how this database can be used by agents to construct views in Active Worlds. Following from this, our database will hold the discipline models, the common model, mappings between these models and the virtual world objects, and other that facilitate collaboration.

In order to prototype this collaborative environment we consider only simple 3D models, although the database is being constructed with translation to and from existing CAD tools in mind. We illustrate the prototype with a scenario in which an architect and a structural engineer insert simple models to communicate their conceptual design ideas to each other. The architect
inserts two zone objects, showing how the two major spaces of the building are connected. These objects are shown in Figure 14.7 (a). The engineer inserts two wall objects, showing where the major load bearing systems will be located with respect to the spatial elements. The engineer's objects are shown in Figure 14.7(b). Figure 7(c) shows a view that displays both the architect's and the engineer's models.

In this scenario we show the visual interface using different colours and types of objects that indicate models from the different disciplines. The database represents each of these objects and includes properties that record the discipline that is associated with the object, the location of the object and the basic geometric properties of the object. The agents' roles include filtering the objects to be displayed, recording the changes to the database to create new objects or modify existing objects, and to manage the insertion of new objects into the AW server.

Figure 14.7 Collaboration Between an Architect and an Engineer

a) The architecht inserts a zone denoted “alpha”
b) The engineer inserts wall objects denoted “Wall1 and Wall2”
c) Combined View



CONCLUSION

This chapter has described research on augmenting existing virtual world platforms to support collaborative multidisciplinary design, with an emphasis on developing a representation and scenario that facilitates communication of function through simple forms. We take advantage of the distributed immersive 3D environment to facilitate communication, enhancing it with a distributed sketchpad, web cam and audio. Supporting multiple disciplines is handled by a multi-agent system that maps between a database of discipline and common models and a 3D view being presented in a virtual world. We describe here a prototype implementation that is the basis for ongoing development and cognitive studies of designers.

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Part 4
Case Studies of Clients Driving Construction Innovation

CHAPTER 15

Sustainability at William McCormack Place

Delwyn Jones
Graham Messenger
Karen Lyon-Reid

BACKGROUND

The Queensland Department of Public Works (QPDW) manages an 821,000m^2 portfolio of government owned and private sector leased commercial office space in Queensland. Each year, the QPDW office accommodation program provides for construction or refurbishment of over 50,000m^2 of office fitout. The program's aim is to contribute to the Queensland Government's environmental objectives by providing ecologically sustainable office accommodation according to the Queensland Government (2000) award winning ESD Guidelines.

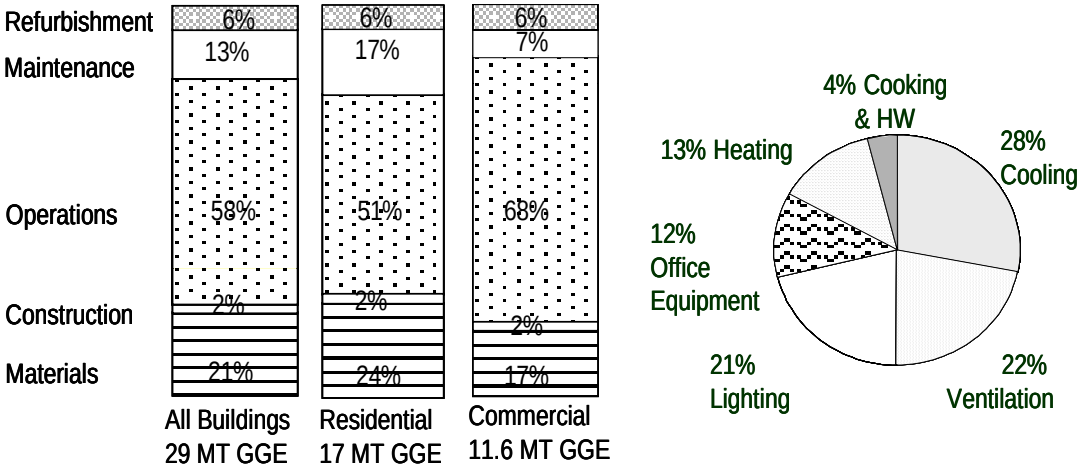
At Sheridan Street Cairns, the building is a four-storey commercial office building of 4568m^2 net lettable area owned and managed by the QPDW. Construction was by a private sector manager under a two stage, design and construct contract with a budget of $17.5M including fitout and public art. Innovative planning and tactical responses were exploited from project initiation.

Rather than the very significant technical innovations, the innovative management leadership had the greatest overall impact on project success. Manley (2004) individually characterised innovations as advanced proven effective and simple building, services and fitout technologies. In this project it was the integration of proven advanced technologies to work efficiently as whole building systems that was most technically innovative.

INTRODUCTION

The context for the energy savings targeted in this project as reported by Jones et al (2003, building sector share of Queensland greenhouse generation emissions (GGE) was 22% in 1999 and residential and commercial operations dominated as shown in Figure 15.1.

Figure 15.1 and Figure 15.2 1999 Buildings GGE By Source (MT) & Phase (%) and 1999 Commercial GGE Share (%)



As shown in Figure 15.2, the same studies estimated Queensland commercial building operational energy end-use shares as 28% cooling, 22% ventilation 21% lighting and 12% equipment.

Project focus and goals

One aim of the building owner was to prove that an office building could be planned, designed and built to meet strict energy and sustainable fitout targets while remaining economically and commercially viable in a normal commercial market. Project goals included that the project was to be a:

- Four star National Building Greenhouse Rating (NBGR) (SEDA, 2001);
- Four star rated fitout ESD Office Fitout (Queensland Government, 2000)
- Commercially viable building without any Government financial incentives.

Design goals were that the property was to:

- Suit the owner, manager and tenant over the long term building life;
- Be flexible and manageable considering a historically high churn rate;
- Minimise lifecycle environmental, social and economic costs; and
- Employ local businesses to capture and improve their knowledge base.

METHODOLOGY

To ensure integrated planning from investment to operational management, such as noted by Barton et al (2002), the building owner gave overarching project control at project initiation to:

- A team with the property's future management responsibility;
- Ensure decisions retained long-term perspectives for the property's operational and functional performance; and
- Maximise functionality and manageability and deliver on time and budget.

The Building Owner's Brief sought:

- Economic consideration for local firms, material and apprentices;

- A project brief specifying key environmental performance and use targets;
- More sustainable economic, environmental and social outcomes; and
- Integrated teamwork under FM project leaders with industry experience.

The Project Planning Brief called for building:

- Design, fabric and services with reduced energy and lifecycle costs;
- Compliance with a four-star ABGR rating in operations; and
- Compliance with a Sustainable Energy Development Authority, (2001), a four-star ESD Office Fitout rating in operations.

The Project Design Brief called for delivery of:

- Passive design elements to conserve energy in-use over the building life;
- A safe, accessible and pleasant work-place with landscaped curtilages;
- An open streetscape, low roof-line, and shade trees in a tranquil setting;
- A bright coloured 'tropical' look incorporated into the building exterior.
- Culturally sensitive large-scale artwork and reflective space outdoors.
- Artwork developing built, natural, social and cultural linkages
- Indoor aspects making a pleasant place for occupants' work;

The Interior Design Brief called for compliance with Queensland Government Ecologically Sustainable Office Fitout Guidelines. These provide designers, contractors, tenants and occupants with strategic advice required to ensure:

- A healthier ecologically sustainable fitout;
- Reduced risks associated with hazards; and
- Liaison with industry to improve sustainable trade and employment.
- The Building Services Brief required selection of active systems considering:
- Year-round air-conditioning in a hot, humid climate; and
- Simplicity, reliability and redundancy levels to compensate for occasional difficulty in obtaining spare parts in the semi-remote location.

Major project participants were

- Barclay Mowlem Construction Ltd as Managing Contractor;
- Design team lead by Cox Rayner and Cairns-based CA Architects;
- ARUP Structural/Civil/Fire Engineers;
- MGF Consultants (NQ) P/L Mechanical/ Electrical Engineers; and
- QPDW Project Services Office Interiors Design and Fitout.

RESULTS AND DISCUSSION

Results of project milestones, major achievements and key innovations are described initially followed by environmental outcomes in planning, design, construction, fitout, operations and disposal phases before economic and social outcomes.

Milestones

All project milestones were achieved on time and on budget including:

- Project approval and appointment of managing contractor in 2001;
- Completion of the design development stage in May 2001;
- Commencement of site works in May 2001;
- A fitout design freeze implemented in September 2001
- Practical completion in June 2002 and fully occupied July 2002; and
- ABGR Energy Audit August 2003 found it exceeded a four-star rating.

Major achievements

William McCormack Place became the first full-scale Australian commercial office building officially awarded a five-star energy rating. Indeed its performance exceeded that rating by 15% to set a new benchmark. Success in this project confirmed that:

- Clear objectives and thorough design reduced risks to accepted levels;
- Savings in system design and construction balanced any added costs;
- Regional firms were key technology leaders and knowledge providers.

Manley (2004) found that the innovative air-conditioning saved 37% energy costs and 61% in capital and maintenance costs compared to conventional systems. Passive building design for daylighting, fitout design for reliance on natural daylight in layout and high-efficiency luminaires acted together to significantly reduce lighting energy fuel consumption.

Tenants also selected efficient office equipment to reduce energy consumption. Improved performance, largely achieved without increased costs, was mostly due to combining proven advanced compared to typical technology.

Quantity survey reports show the cost of building environmental enhancements was no greater than a comparable ordinary commercial building. Along with attaining a new benchmark for reduced greenhouse gas pollution it set another benchmark for a commercially, community and environmentally friendly fitout for future commercial office buildings. Many systems improvements incorporated throughout acted together to achieve these benchmarks.

Key innovations

Some improvements relied on state-of-art technology while others exploited simple lessons learned in owning and operating QPDW's office portfolio. The innovative project delivery focus on integrating whole building systems successfully demonstrated achievement of new sustainability benchmarks without compromising quality, cost, time or scope. The innovative plant room depicted in Figure 14.3 houses the highly energy efficient, simple, reliable and highly redundant air-conditioning system with:

- A pre-conditioning unit with thermal wheel recovering 61% exhaust heat;
- Plant with rotary screw chillers on duty/standby each carrying 105% load;
- Pumps/Fans variable speed drives and zoned variable air volume boxes
- 15,000l chilled water storage tank to eliminate long period of low load and
- Building management system to control/monitor after hours operation

To improve performance in-use and maintenance proven technologies were innovatively integrated as whole building systems including:

- Extended eaves for shade and maintenance staff access without lifts;
- High performance glass and wall insulation to reduce solar heat gains;
- Recyclable cut-pile carpet tiles to reduce life cost 21% over loop-pile tiles;
- Flexible office space: through strategic columns placement; and
- Zone lighting control, occupancy sensing to limit conditioned air delivery.

An innovative response ensures ease of safe access to all parts of the building exterior with walkways incorporated into the sun shading, depicted in Figure 15.4, giving access to all parts of the façade for cleaning and maintenance without the use of lifting machinery.

Figure 15.3 The Plant Room

Figure 15.4 Shades For Maintenance

Environmental outcomes in planning

Thorough planning, open and honest business relationships between project stakeholders and good communication fostered the climate of change needed to incorporate environmental sustainability into all aspects of the project's development. Sustainability was not just an add-on but the essential foundation for the project.

The planning and consultation phase had the greatest long-term influence to reduce the property's environmental impact as decisions made during this critical period affect the way buildings perform over their lifetimes. Strategies applied in this phase ensured that vital life cycle environmental issues were addressed early enough to be successful and cost effective. Particular attention was paid to the passive building design, active air conditioning, electrical systems, interior daylighting and layout for facility flexibility, adaptability and simplicity.

Project planning incorporated features to minimise lifecycle costs, environmental impact and enhance manageability throughout construction, use, maintenance and eventual demolition. This was achieved through use of long lasting, low maintenance and recyclable materials that with correct timely maintenance will last as long as possible. Examples of this approach include use of:

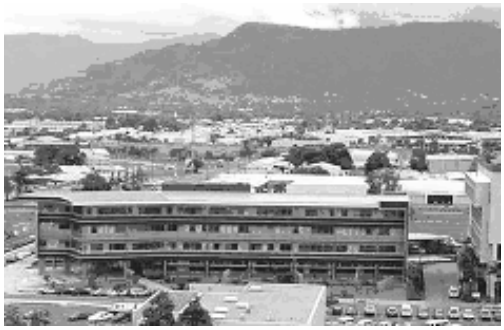
- Colorbond . steel cladding and
- Pre-finished aluminium sheeting façade;
- Colour-render rather than painted concrete and minimal applied finishes;
- Low maintenance materials such as stainless steel and aluminium; and
- Low maintenance floor/wall finishes to minimise use of chemical cleaning.

Environmental outcomes from design

Design for clean lines and visual amenity ensured it did not impose on nearby government and commercial premises as shown in Figures 15.5 and 15.6.

Figure 15.5 Clean Lines

Figure 15.6 View of the Environs



A low structure houses the top of the cooling towers as the only protrusion above the roofline and the lift motor rooms were located on ground floor and other plant rooms on level one. Passive elements incorporated in the design include that for the:

- Building shape and orientation to minimise façade exposure to direct sun;
- Façade material and glazing to minimise heat transmission to the interior;
- Extended roofline incorporating wide eaves to shade the façade;
- Window shade for 100% all seasons without impeding interior sight-lines; and
- Efficient roof insulation and air-tightness to minimise untreated outside air influx and control of waste air egress to maximise heat recovery potential.

As depicted in Figure 15.7, a perspective across the garden, the importance given in design to bring the natural and built environment together is evident. Public area artwork was designed on natural environmental and community themes. Major pieces commissioned after expressions of interest from artists include:

- Hew Chee Fong and Lorretta Noonan's Water and Earth, sculptures in the forecourt as in Figure 15.8, an apparently wet dry waterfall in granite; and
- Claudine Marzik's series of sculptural "Weather Report" panels in the forecourt and garden paths representing Cairns' tropical rainstorms.
- Wik Elder, Arthur Pambegan Jnr's foyer centrepiece as pictured in Figure 15.9.

These exterior artworks link natural and built environments while the entry foyer artwork brilliantly articulates the local indigenous people's ongoing spiritual connection to nature and the land.

Figure 15.7 View Over a Forecourt

Figure 15.8 Carved Granite Waterfall

Figure 15.9 Wik Elder's Artwork

Environmental outcomes of construction

As a direct result of the concise contractual requirements set out in the project brief, site environmental issues that arose were minimal and were dealt with swiftly. Thorough construction planning and design also minimised rework and wastage.

The imposition of the fitout design freeze nine months before practical completion was effective as it allowed the seamless integration of the 'hard fitout' into the construction program without the need to demolish and waste any already completed work. Fitout construction incorporated seamlessly into the shell construction and was completed shortly after the building itself. The partition, air conditioning duct work, and electrical and communication cabling hard-fitout was carried out by the managing contractor as a main contract variation to ensure it was incorporated in original construction and to avoid wastage due to removal or changes to work already completed.

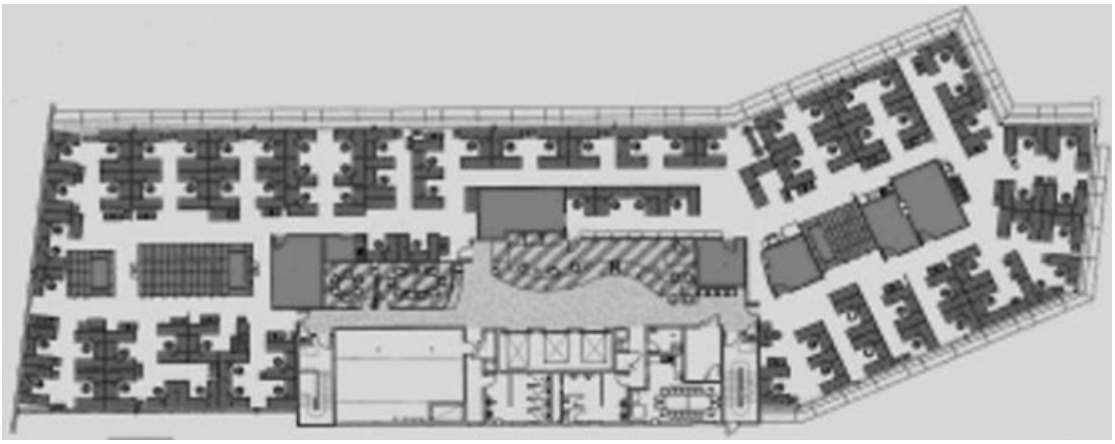
Environmental outcomes in fitout

The fitout is by QPDW's Office Interiors designers who engaged in consultation with EPA and staff to facilitate successful outcomes with features including:

- Open plan workstations near windows for daylight as Figure 15.10 shows;
- Offices and meeting rooms to the centre of the floor as Figure 15.11 shows;
- A highly flexible and open workspace with minimal built zones; and
- Demountable partitions and furniture of modular design.

Figure 15.10 Window Workstations

Figure 15.11 A Plan of the Interior Layout



The design features reducing environmental impacts include:

- Doors of uniform size to allow for future re-use;
- Assembly with mechanical connections to promote reuse;
- Very low off-gassing materials used throughout;
- Wide use of recycled materials in the furniture; • Mobile units, partition screens and shelves of recycled waste polymers;
- Screen fabric upholstery from recycled plastic bottles;
- Timber products from sustainably managed sources.
- Carpet selected for environmental/ economic life cost benefits including installation using water based solvents and low off-gassing of VOCs from the carpet or solvents.

Environmental outcomes in operation

The building is a low and unobtrusive structure set back from the street with complimentary landscaping, seating, public art works and local native planting providing a visually attractive and inviting presence appealing to staff and visitors. Indeed tenant surveys show that staff generally feel good about working there and EPA staff feel they 'practise what they preach' at work.

Environmental and economic benefits derived from a building's energy efficiency are both immediate and ongoing throughout its life. Passive design elements maximise daylight as shown in Figure 15.10, as well as minimising thermal penetration into the air-conditioned space. In turn active systems maximise heat recovery to reduce the air conditioning heat load.

These are extremely cost effective ways to reduce energy use over the building life. In typical building active systems the energy contained in the already conditioned waste air is simply lost as the air is allowed to leak from the building. However, in this building the waste air exhaust is controlled to facilitate recovery of a large percentage of the otherwise lost energy it contains.

As previously noted a common pre-conditioning unit provides all the outside air into the building. Used air is also exhausted through this unit where a thermal wheel recovers energy from the conditioned exhaust air to cool/dehumidify incoming outside air before it flows to ventilate/condition the main chiller plant room. This flow path effectively 'wrings' the last useful energy from the air before it finally leaves the building. The advantages of this system are:

- Humidity removed from supply air without inefficient reheat systems.
- 61% energy recovered from otherwise lost heat in waste air and then this normalised energy consumption is 109kWh/m2/annum and emissions 108kg CO2/m2/annum. The project brief called for a minimum of four stars having a normalised energy consumption of 179kWh/m2/annum, normalised emissions of 180kg CO2/m2/annum and total actual emissions of 1,074,175kg CO2/annum. The results show a reduction over the original consumption target of 40% and annual saving of 317t greenhouse gas emissions.
- Exhaust air to ventilate and cool chiller plant room without added fans.

Environmental outcomes in disposal

Upon eventual demolition of the building the bulk of the materials used in its construction will be recyclable. Construction as well as office recycling was facilitated via provision of space for bins and recycling service contractors. The generic design of the building facilitates future adaptive reuse as office space or for some other use. Even stripping back to its structural shell will involve minimal waste as most façade and internal components are recyclable.

The fitout with modular workstation components of recycled materials and mechanical fixings rather than glues, facilitates disassembly and adaptive reuse. The carpet tiles selected for environmental and economic lifecycle cost benefits can be 'remanufactured' to give an extended life and benefits include:

- 15 year 'first life' prior to lifting, minimal remanufacturing and re-laying;
- Backing recycling of the carpet is finally replaced;
- 30 year useful life, 4 times broadloom that is discarded to land fill;
- Sections more easily replaceable than with broadloom; and
- Replacement runs can be supplied so spares are minimised.

These concepts are being used in the 33 Charlotte Street fitout, a 15,000m^2 new development for the QPDW in the Brisbane CBD.

ECONOMIC OUTCOMES OVER PROJECT LIFE CYCLE

The business case described the project economic objectives as a commercial venture. Inclusion of environmental and sustainability initiatives in property development did not increase project economic cost, reduced operating costs and contributed to improvement in the market rental position.

The project also aimed to provide short and long term economic benefits for the Cairns community. The Queensland Government's requirement to employ local people under its Local Industry Policy meant that maximum use was made of local consultants, contractors and suppliers for the project. This policy had a major effect on the Cairns economic environment.

During design and construction, the project generated 12,550 person weeks of work. Two new full time positions were created for direct building operation. In addition many local contractors and suppliers are employed in the day-to-day operation and maintenance of the property adding to the 'economic mass' of the Cairns region.

The success of the project ESD initiatives and its resultant high profile increased exposure and business opportunities for many of those involved. In particular, Cairns firm MGF Consulting gained industry-wide exposure as the designer of the mechanical services and electrical systems that contribute greatly to the building's active systems energy efficiency.

QPDW has developed strategies to communicate the success of this project to interest groups in the construction and facilities management industries including promotion of the project with various industry groups; making it available for case studies; and facilitating the flow of project information and data to students and others through Internet publications. It is a practical working model of how

environmental sustainability can be addressed without compromising quality, cost, time and scope parameters.

SOCIAL OUTCOMES

It was important that William McCormack Place contributed to the social environment of the community of Cairns as much as it achieved environmental and economic outcomes. Tenants actively participated in the design development process that valued the contribution and worth of individuals and connections between tenant organisations and the local community.

The project has delivered a safe, accessible, inviting place connecting with those living and working nearby, that reflects local area cultural and heritage values. Low-targeted external lighting, prominent entry and limited 'blind' corners contribute to a safe secure place for staff and visitors, day and night.

Pedestrian and cycling access from all directions is incorporated into the building that is designed to be fully accessible by people with disabilities. Occupants and visitors can recognise visible environmental aspects of a building made to ensure it is a pleasant place to work as well as to visit as it has features incorporated including:

- Seating near shade trees in a tranquil space for occupants and visitors;
- Open streetscape and artworks for a pleasant soft visual impact; and
- Cycle parking with change room facilities for staff cycling/walking to work;

Public art works feature prominently and to reflect the intrinsic diversity of the local community works of local indigenous cultures are integral in the building to celebrate reconciliation and difference. The artworks also promote concepts of community engagement and shared ownership. Some aspects of the project have been far-reaching and found to be contributing to the social capital of the area in unforeseen ways. Wik Elder Arthur Pambegan Jnr produced a large-scale version of his traditional work that encapsulates his people's story of the flying fox legend. While many of his pieces are displayed in galleries in larger southern cities now locals can see his work close-by in Cairns.

EXTERNAL VALIDATION OF PROJECT OUTCOMES

Compared to a 3½ star 'average', the building consumes 45% less energy, saves 419t GGE and costs $68K less in a year to run. It sets benchmarks for new buildings and demonstrates how to go about improving energy efficiency. This project provided QPDW with an ideal opportunity to develop a building that realised the State Government's objectives for sustainable office accommodation. While William McCormack Place is a practical example of ecologically sustainable design with best practice environmental outcomes it is also achieving best practice economic and social outcomes planned and achieved at every lifecycle phase and for the building's lifetime.

An official energy audit in August 2003 resulted in it being the first new commercial office building in Australia awarded the highest rating, a five star energy rating in the Australian Building Greenhouse Rating Scheme. It was also the joint winner of the 2004 Facility Managers Association of Australia Sustainable Energy Authority Environmental Excellence Award.

CONCLUSIONS

The key project goal achieved was to prove that an office building could be constructed to meet strict environmental targets while remaining economically and commercially viable. The paper confirms that the project demonstrates that inclusion of environmental and sustainability initiatives in property development need not increase project economic cost, can reduce operating costs and contribute to

improvement in the market rental position. William McCormack Place surpassed initial targets for energy consumption.

The success of this project was largely due to the owner engaging a strategic approach to the project's development and providing the means to implement sustainable solutions and strategies. From project initiation, the team responsible for the day-to-day property management, showed how facility management resolves lifecycle environmental, social and economic issues.

Those involved in the project are taking the knowledge and experience back to their respective organisations in a practical way that will provide the basis for ongoing improvements to practices and processes. Ongoing monitoring, analysis and reporting of the outcomes will contribute significantly to the knowledge base on sustainable development and improvements in similar developments in the future. Sustainability lessons from this project are that

- System savings balanced out cost of improved design and construction;
- Sound objectives and design process reduced risk for builder and client;
- Early facility manager involvement lead to optimal building performance;
- Regional firms can be leaders in technology as well as local knowledge; and
- Clients managing risk can lead industry in showing benefits of innovation.

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CHAPTER 16

Development of the 'Competitive TOC' Alliance – A Client Initiative

Brad Cowan
John Davis

INTRODUCTION

Many will be aware that the Alliance concept was first significantly used in Australia (in terms of broader industry recognition) in the Western Australian oil and gas sector, with two notably successful Alliances being the East Spar development and the Wandoo Platform.

Of relevance to a particular theme of this paper, it is noted that the Alliance concept was introduced through the private sector. This contrasts with the introduction of partnering, which is usually attributed in origin to the US Army Corps of Engineers; and was widely promoted in its initial introduction to Australia by the Queensland Main Roads Department (who have more recently also been a significant user of Alliance formats).

The Alliance approach to project delivery, since it is fundamentally just about a different approach to targeting outcome and sharing risk, can be and has been applied to a wide variety of project types – from highly risky major capital infrastructure projects to relatively mundane term services contracts.

When introduced to Australia, and as still widely applied, the Alliance contract model was of a form that is now commonly known as the 'Pure' Alliance. This model has been widely reported and analysed, with papers by Jim Ross of Project Controls International amongst the most widely circulated.

In more recent times, particularly in public sector applications, two specific variants of the Alliance model have been implemented which have some significant differences to the 'Pure Alliance' model; and it is considered that these variants may offer a number of owners a project delivery instrument that is more suited to their particular situations. These two variants are:

- the 'Project Alliance'; and
- the 'Competitive TOC Alliance'.

In each case, all the key elements of the project delivery phase are very much the same as a 'Pure Alliance', including the key risk allocations and the project management structures. Indeed, in risk allocation, the 'Project Alliance' and 'Competitive TOC Alliance' models have more in common with the 'Pure Alliance' model than, for example, such well known Alliance variants as the National Museum of Australia project. These similarities distinguish the 'Project Alliance' and 'Competitive TOC Alliance' variants from other delivery processes that, whilst they have been described in headline documentation as Alliances, in reality have had as little similarity with the key principles of an Alliance as has the C21 Partnering Agreement (the latter, of course, standing on its own merit).

The principals of Southern Pacific Alliance Network ('SPAN') developed the 'Project Alliance' model in 2000 for the particular circumstances applying in local government use of Alliances, although the model has much wider applications. Subsequently, the same group released the first known Australian application of a Competitive TOC Alliance in mid 2001 – as part of the $50M Bega Valley Sewerage Project in southern NSW; and has since facilitated or commenced work on another three 'project' applications and one 'program' application of the 'Competitive TOC Alliance' variant.

This chapter:

- explores the reasons for the development of both the 'Project Alliance' and 'Competitive TOC Alliance' models by the authors;
- examines broader criteria for considering which project situations may be best suited to 'Pure', 'Project' and 'Competitive TOC' Alliance models; and
- provides an outline of the current structure and implementation of the 'Competitive TOC' Alliance model as practiced by SPAN.

DEVELOPMENT OF THE 'PROJECT ALLIANCE' MODEL

Alliancing in the public sector

Shortly after the Wandoo and East Spar project successes, the first (apparent) appearance of Alliance contracting was for the maintenance services outsourcing contracts by Western Australia's Water Corporation, in 1994. These relatively large service contracts (circa $15M pa) seemed to industry observers to be using the Alliance model to achieve several objectives other than those normally associated with the performance improvement objectives of Alliances; not the least of which was ensuring that the services were only partially 'let go'; as the Alliance model used left a Water Corporation executive with a final say on all disputes, and had all assets captured in a Special Purpose company that could readily be taken over by Water Corporation in the event of any breakdown in the service relationship. Nonetheless, Water Corporation has subsequently become somewhat of a champion of Alliancing, with the success of the Woodman Point Alliance widely promoted; and, notably, the second known application of a Competitive TOC Alliance model.

Subsequent public sector applications included all major infrastructure sectors: water, rail and road. The Queensland Main Roads Department, as might be expected from its early championing of Partnering, became an early and consistent user of Alliances; on a range of projects with widely ranging objectives. Notably, all the implementing agencies were large State agencies or GBEs. Accordingly, none were constrained by detailed tendering regulations such as those that typically apply to local governments.

Alliancing in local government– the genesis of the 'project alliance'

In early 2000, Maroochy Water Services – a business unit of Maroochy Shire Council – approached the authors for advice on the most appropriate delivery model for the proposed construction of a sewage treatment plant upgrade. When it was identified that the project required a high degree of integration between operators, designers and construction managers, an Alliance was suggested. Assessments of the potential applicability identified some particular issues that concerned the Council:

- that the participation by the Council under a normal 'Pure Alliance' model, e.g. as the 'owner participant', would cause the entire project to be captured by the tendering requirements of the Local Government Act and thereby losing the inherent flexibility provided by contractor procurement processes expected under a 'design and construct' project scope; and

- that the Council team, working with the usual very limited resources available to a local government engineering business, could contribute operations skills and experience but little else to a potential integrated project team.

Of course, the procurement issues arising from the Local Government Act had not been an issue for the corporatised GBEs, and obviously were not an issue for private companies, in applying the Alliance delivery model.

In addition, the relatively small size of the project meant that project-specific PI insurance was not available; and the usual 'no-sue' provisions of an Alliance would leave the Council exposed to post-completion design error risks in a manner that it was not usually exposed to, yet were typically a reasonably significant source of risk for a water business (in accepting externally designed and constructed treatment plant infrastructure).

As the Maroochy project was the first known local government application of Alliancing, the advisory team sought to develop tailored solutions to the identified issues, against a very limited budget.

The solution developed was the first generation of the 'Project Alliance' model, which has subsequently been refined over a number of other local government applications.

Key features of the 'project alliance' model

Key features of this model are the establishment of a relationship between the Council and the 'Alliance Contractor' where:

- Council contracts for the delivery of the 'works' by the Alliance Contractor
- The Alliance Contractor is free to run an optimised procurement system unfettered by the constraints under which Council would normally operate
- Council offers limited resources (usually with operations and maintenance knowledge) for integration into the alliance teams
- The Alliance Contractor agrees to a management structure and process that incorporates Council staff on a part-time or full-time basis
- The Alliance Contractor owes the normal responsibilities of delivering the works to Council hence the normal indemnity insurance is accessed.
- The Alliance Agreement is structured to deliver the same outcomes as a 'Pure' Alliance in areas such as:
  - Risk / Rewards
  - Quality Pools and Key Performance Indicators
  - Limitations on Liability
  - A 'Best For Project' focus
  - Relationship management
  - Issue resolution
  - High performance team development

Other applications for 'project alliances'

With the relatively recent collapse of the insurance market and the unavailability or lack of affordability of project specific Professional Indemnity insurance, the Project Alliance Model has potentially wider appeal. Points of attraction for the 'Project Alliance' Model are:

- Access to post-Alliance, Professional Indemnity insurance coverage; and
- The ability to enter into alliances despite the owner having limited resources to deploy into any prospective alliance team structure.

DEVELOPMENT OF THE 'COMPETITIVE TOC ALLIANCE' MODEL

Both the 'Pure Alliance' and 'Project Alliance' models select a single contractor team on a 'best for project' principle. At project commencement under these models, the team, including the owner's personnel, work together in a collaborative/alliance culture environment to develop the concept design for the project and to estimate the cost at completion of the project; and this cost is commonly termed the Target Outturn Cost (TOC).

Contrasting the alliance model in the private and public sectors

As noted in the introduction, the (widely recognised) introduction of the 'Pure Alliance' model into Australia was through the Western Australian oil and gas sector – with early leading examples including the Wandoo Platform and the East Spar project. This 'route' to the Australian market reflected the initiation of Alliances through supply chain review in the Cost Reduction In the New Era ('CRINE') project within the North Sea oil and gas industry.

Private sector projects – price tension

The private sector nature of these key reference projects was, in the authors' view, a critical factor in the successful application of the Alliance project delivery model; and the relevance of this factor becomes particularly apparent when contrasted with some of the concerns expressed about Alliance project outcomes in some public sector projects.

In the private sector context, after selection of the preferred 'best for project' team the development of the Target Outturn Cost ('TOC') is invariably in the context of a business case development. That is, the Alliance was being charged with bringing a project in within the budgets necessary to achieve the business case hurdles for the project – *"don't get the costs and risks down to under the business hurdles, and the project simply won't proceed*".

Alliance teams in this context are incentivated to achieve stretch outcomes (through the application of innovation, 'best for project' decision making, and a highly integrated team focus) in developing the TO*C.* Clearly, a key driver for achievement of highly competitive outcomes in the TOC development phase was the very real risk that the owner would not proceed with the project unless the identified corporate business case hurdles were met. The East Spar project is an excellent example of this principle in application, with the Alliance successful delivering considerable innovation in order to surpass the hurdles.

Public sectors projects – price tension

This 'business case driver' can be compared with the usual situation in public sector applications where the project is almost always certain to proceed. An example of a public sector project where the TOC significantly exceeded the owner's estimates but the project still proceeded (simply by way of example and without comment as to the inherent validity of either estimate) is the Port of Brisbane Motorway; where the TOC was nearly double the owner's pre-tender estimates. It is difficult to imagine that any private sector investment project would have sustained that type of cost increase and still proceeded.

However, it could be more broadly argued that, in the situation where a single team is developing the TOC estimate and is without a challenging business case hurdle to pass, the driving force that characterised the success of the early oil and gas Alliances has invariably not been present. The TOC

development phase is simply establishing what the price will be: there is little doubt that the project will proceed. Readers could ask themselves a question to test this hypothesis: *how many public sector Alliances have been canned because the TOC was too high?* In such circumstances, and giving some deserved respect to the underlying commercial incentive of private contractors, where can confidence be placed that a genuinely challenging or commercially competitive TOC has been achieved?

The independent estimator and the price

Of course, the use of the independent estimator is a tool to provide some confidence to the owner that the TOC is reflective of current market practice. However, there are examples known to the authors where the ability of the independent estimator to argue a case for a reduced TOC has been curtailed, for any number of reasons, only to see the savings that were argued for almost immediately materialise after project implementation. In reality, can independent estimators really drive every productivity estimate, every parameter, and every rate to current market practices? The question then is – is the independent estimator mechanism not being properly used, or is it simply not effective?

The difficulty in arguing the case for the effectiveness of the Alliance application in public sector projects is that there have been project outcomes that have resulted in relatively large project savings against the TOC – e.g. Port of Brisbane Motorway and Awoonga Dam. In the context of the points made above, one should not be surprised that doubts are raised in public sector senior management about whether Alliances are really delivering value – whether the TOC was ever a price that genuinely reflected the kind of competitive pressure meant to be reflected in an Alliance TOC. For advocates of Alliancing there is a real threat that broader adoption by the public sector is at risk.

Application of the 'competitive toc alliance' model

The matters raised above were important considerations for the clients deciding on their Project Delivery Strategy for the following projects:

- Merrimac Wastewater Treatment Plant Upgrade Project, for Gold Coast Water
- Beenleigh-Merrimac-Pimpama Wastewater Network Augmentation Program Alliance for Gold Coast Water
- Maroochydore Sewage Treatment Plant, for Maroochy Shire Council, and
- Wetalla Wastewater Treatment Plant Upgrading, for Toowoomba City Council.

In each case the client organisation has decided to use a Competitive TOC Alliance, facilitated by SPAN. All of these projects use a single client project manager and single, common client team to support each of the two tenderers.

The first known Competitive TOC Alliance development (developed by SPAN for the Bega Valley Sewerage Project) was not in response to issues raised above, but rather a situation where an overall competitive tender process for a $50M capex project faced particular constraints with a part of the project needed to address the inherent uncertainty of environmental approval processes in NSW. These constraints seemed ideally suited to an Alliance; as that could avoid losing the potential innovation offered by scheme proponents but nonetheless circumvent the very high risks of the approval process. As a very sensitive public context for the project necessitated a competitive tender process, the Competitive TOC process was developed, with the strong relationship contracting elements from the Alliance then committed across all elements of the project. Despite significant doubts amongst some industry respondents, the concept was embraced by leading tenderers and is now being successfully implemented.

The Competitive TOC Alliance approach was subsequently implemented for the Subiaco STP upgrade by Western Australia's Water Corporation (SRDC were the facilitators), and then for the Burnett Dam by Burnett Water (Evans & Peck were the facilitators), both using either a client project

manager or client team for each of the two tenderers. As noted previously, the SPAN team is now facilitating a further four 'Competitive TOC Alliances'.

STRUCTURING A 'COMPETITIVE TOC ALLIANCE'

Client teams for the 'competitive toc alliance' model

Client teams are required in the 'Competitive TOC Alliance' to support the proponents with information, knowledge and ideas throughout the TOC development period; although not quite to the same extent that they support a 'Pure Alliance' or Project Alliance' TOC development phase. An initial reaction may be to appoint separate client project managers or teams to support each proponent in order to respond to the high workload; however experience indicates that the single client team is a fairer and less costly option.

The single client team enables 'apples to apples' comparisons between the proponent teams and proposals as well as ensuring that the same information, ideas and knowledge are made available to both proponents. This puts significant demands on the time of the relevant client team staff. However, despite this much increased workload on client staff, the number of public sector clients embracing this model is increasing. This suggests that the competitive element is seen to more than outweigh any disadvantage.

Outline of a 'competitive toc alliance' model

The 'Competitive TOC Alliance" used by SPAN can be viewed as three phases. The first phase involves the Expression of Interest (EOI) that has all the usual features of a 'Pure Alliance' or a 'Project Alliance' project initiation.

Two proponents are then appointed to undertake the second phase, the Competitive TOC Development phase, in conjunction with the Client's Project Team. This phase involves four parallel processes:

- Concept Design development,
- TOC development,
- team relationship development; and
- agreement of commercial terms.

At the end of this phase each proponent submits the Concept Design and associated TOC as well as a signed Project Alliance Agreement. The proponent with the 'best value' offer (based on price and non-price criteria) is appointed as the Alliance Contractor. The Alliance Contractor, including the assigned Client team members, then commences the third Phase, an Alliance to deliver the project or program, which has all the usual features of a 'Project Alliance'.

CHAPTER 17

Lyell McEwin Health Service Redevelopment Stage a

Judith Carr
Derek Exton

LYELL MCEWIN HEALTH SERVICE REDEVELOPMENT

The Lyell McEwin Health Service (LMHS) at Elizabeth is one of South Australia's major acute hospital facilities. It had comprised a range of old and newer buildings with almost 50% of existing floor space greater than 40 years old. These buildings were dysfunctional, costly to maintain and no longer met the health requirements and health service delivery models of current practice.

In February 2000 Cabinet approved $87.4m expenditure on the LMHS Redevelopment Stage A. The budget was later increased to a total of $91.2m. Stage A has replaced the great majority of the outdated infrastructure and provided two new wards, CCU, Women's Health Centre, administration and education, CSSD, new emergency, imaging, ICU, HDU and operating theatres.

WHAT WERE WE TRYING TO FIX?

At the commencement of the Redevelopment Stage A project at LMHS, the Department of Human Services (DHS) and the Department for Administration and Information Services (DAIS) assessed the characteristics of the LMHS Stage A project and noted that it:

- was the largest single construction project stage being undertaken by DHS;
- was a project of high strategic value for DHS, the northern suburbs and Government;
- had a potential for providing significant economic benefits for the northern suburbs over a period of five years or more;
- needed the flexibility to accommodate changes in service delivery during the life of the construction (has occurred in regard to emergency, mental health etc);
- needed outstanding management of program and cost;
- justified significant focus on environmentally sustainable development (ESD) and building industry training initiatives.

Our experience with other such significant major projects, consistent with the experience in the private sector and nationally had been that in conventional delivery there was often:

- lack of consultant team cohesion;
- combative contractor and consultants/client relationships;
- poorly coordinated or incomplete documents;
- quality control concerns during construction;
- inadequate management of variations ;
- consultants working in a siloed, defensive culture.

Given the risks and opportunities profile of this very significant State government project it was decided that a relationship form of procurement (utilising a collaborative contract) would be used. In

the past it has been perceived that high performance organisation principles could not be transposed into the building project arena but the experience at the National Museum in Canberra and then the Adelaide Convention Centre Extensions project showed that they could be and there are significant benefits from doing so.

WHAT WERE (ARE) OUR EXPECTATIONS OF THE RELATIONSHIP CONTRACT?

We believed the relationship approach would provide better opportunity to realise the significant opportunities that the project offered and also mitigate the risks by

- establishing the project team with equality of input and common objectives to manage all aspects of the project pro-actively with progressive negotiation/management of all project issues;
- expecting the project team to manage the project rather than a project manager;
- encouraging innovation and problem solving; • setting objectives in addition to quality outcomes in design and construction
- including ESD, community relations and building industry training;
- offering performance incentives in support of key project objectives
- investing in team skilling and training in the relationship approach and in establishment of the right team culture;
- inclusion of the subcontractors in "The Team"

The implemented relationship contract was designed to establish a cohesive team including DHS, LMHS, DAIS, consultants, contractor and subcontractors with common objectives and shared accountability.

There were potential disadvantages identified as part of making the decision to proceed with a relationship contract and they were:

- relatively new approach with a "Leap of faith" required;
- expectation that project manager was required for success;
- complex briefing and tendering processes;
- greater investment in management and professional fees;
- no certainty of improved outcomes and difficulty in measuring improvements;
- if there was disputation it could be more serious than in a conventional approach;
- established project management practices could be compromised by the focus on new practices;
- the risk and reward arrangements are not well accepted by some sections of the professional community.

However we were confident that through engaging with the team in an open and consultative way, supported by JMJ in a coaching role, any concerns could be worked through and additional up-front costs could be made cost effective by the end result.

WHAT PROJECT OBJECTIVES DID WE SET?

Consistent with most major projects it was important to achieve time, cost and quality objectives in the project but the opportunity was taken to broaden those objectives given the very significant capital injection by the Government into the project. The key objectives were:

- achieve maximum value for the capital cost;
- achieve completion on time with minimum disruption to the operating environment; and
- deliver high quality;
- produce a new benchmark in Ecologically Sustainable Development (ESD).

- provide building industry training. The South Australian Government had a training initiative called Upskill SA in place but additional expectations were placed on the consultants and contractor to use the project as an opportunity to provide trainee, apprentice or work experience opportunities on site.
- achieve defect free completion. There was an obligation on the managing contractor to plan for and implement a regime of continuous inspection of the works to progressively identify and rectify defects. The advantage for the hospital would be an occupation process unencumbered by a requirement to continue to allow access to the contractor/subcontractors to address
- unfinished or incorrect construction items.
- develop community relations. The local community had become disillusioned with the state of its hospital and did not have the ownership of it that would be ideal. The project was seen as an opportunity to engage with the community through the design and construction process to rebuild ownership and interest.
- achieve outstanding results in industrial relations and workplace safety;
- demonstrate to the South Australian building industry that an alternative approach to project delivery was effective and in the interests of all stakeholders.

SETTING UP AND MINDSET BEFORE WE STARTED

The contract was developed using as its basis the C21 Managing Contractor contract designed by the NSW Department of Public Works and Services modified for use in South Australia by DAIS and Crown Law.

A decision was taken not to engage a Project Manager for the project as it was seen that the usual hierarchical project management role was inconsistent with objectives of the relationship contract and equality among all stakeholders. It was agreed that funding set aside for the Project Manager would instead be committed to team development, training and coaching.

DHS and DAIS were supported through the tendering process for the managing contractor by the collaborative consultant JMJ and Associates (JMJ). Amendments to the already in place consultant contracts were also developed such that the team had a common set of contracts that incorporated previous contract commitments. By agreement the arrangement for a primary consultant contract was varied to direct contracts with the engineering consultants to ensure that all consultants had an equal say in decision-making.

Then with the appointment of the managing contractor, JMJ worked to gain team commitment to adopt a change in the way the project would be managed and to develop a collaborative approach to decision-making and problem solving. The JMJ coaching and development process developed team member skills in:

- listening and the pitfalls to achieving genuine understanding between team members;
- the fundamentals of achieving sustainable agreement (alignment) and commitment to team decisions on technical and management issues;
- the ability to communicate with a view to creating solutions, or tabling issues with clarity;
- real accountability for what each person says and the actions promised; and
- the responsibility to act in a positive and multiplying manner which addresses the expectation that a team working as one should be able to create more than a team working as a set of individuals.

An incentive process was developed by the project team in a workshop environment to act as a driver for high performance. The incentive was due to the Managing Contractor and Consultants on successfully achieving the five key project objectives- time, cost, training, ESD and community involvement.

WE HAD A LONG WAY TO GO

As JMJ commenced the process of team development a number of issues came onto the table. SA generally has not had the disaster projects or the high levels of litigation that have been experienced elsewhere. Some in the existing team felt they needed no change and were wary of the relationship approach and whether or not the role of JMJ was adding value. Some viewed the investment in this form of risk management as wasteful. Others viewed it as an impediment to getting on with the work of design and construction effectively.

Initially there were several times when team members held back from taking responsibility for issues traditionally managed by a Project Manager. However over the first few weeks the team became accustomed to not looking to a Project Manager to fill in any management gaps and instead assigned responsibility to the person or group best able to mange the issue.

Senior bureaucrats and members of the Government were cynical about the "no blame" approach, having had more experience with "combative" contract forms. Some were wary of experimenting on such an important and significant scale project.

The degree to which individuals initially grasped and implemented the required higher levels of interpersonal skills varied but over time the culture of the team has changed substantially with these skills now evident throughout the team.

HOW DID WE GET GOING?

DAIS is a committed leader in the building industry in SA and DHS, with the largest capital investment program in buildings, is a leader in delivering an expert client role on its projects. We consulted interstate and reflected on the lessons learned from the Adelaide Convention Centre Extensions project.

The existing consultant team was engaged in the tender process for the relationship consultant with the result that JMJ, a specialist consultant was appointed ahead of other tenderers, which were generally project managers offering a relationship approach.

We drew on the experience of JMJ on many relationship contracts in the civil and building construction areas and designed the Managing Contractor tender process to commence team culture change. JMJ excellence through facilitation of the process was critical in "proving" the need for relationship consultant to some team members.

THE KEY BUILDING BLOCKS AND MAJOR LEARNING

The key building blocks as the team embarked on the delivery of the project were:

- a vision and objectives we all owned;
- everybody "throwing their hat over the wall";
- training to recognise our own non-collaborative / disempowering behaviour;
- identifying process champions
- discovering advantages of respectful plain speaking and acknowledgment of achievement;
- recognising that the project team included subcontractors as well;
- making key trades value based appointments.

Under the coaching of JMJ, the leadership group in the team became focused on team empowerment; recognising key leaders and their needs for skilling, support and empowerment. A culture of anticipating how observations or opinions "were going to land" with others grew because it was recognised that it was easy to disempower people without awareness and sensitivity. When the Executive Leadership Team (Steering Committee) and the Integrated Management Team had

difficulty finding balance between governance and empowerment the newly learned skills allowed the issues to be resolved effectively.

PERFORMANCE AGAINST OBJECTIVES SET

Achieving maximum value for the capital cost has been a significant success on the project. The construction contingency expenditure was only 2.5% from an allowance of 5% which has meant the release of $1.7m for additional work and an increase to the Furniture Fittings and Equipment fund.

While there have been excellent results in regard to minimising disruption to the operating environment, as the project progressed it became clear the optimum management for best project outcome meant balancing time, cost and quality and there has been an acceptance that time will under perform to ensure outstanding results in quality and value. The project was 16 weeks later than planned after encountering Latent conditions and a significant EBA bargaining period.

The quality of the facility was generally exceptional and there were some areas such as the cabling systems where outstanding outcomes have been achieved. Feedback after several months of occupation was very favourable. There was an exceptional and collaborative work relationship between the project team and the hospital in commissioning the project, which supported the hospital in implementing the change management opportunities that existed within the new facilities.

In regard to the ESD the objective was to be the most energy efficient hospital in Australia and:

- waste minimisation has achieved outstanding results including non-toxic demolition waste 100% recycled
- industry benchmark achieved for construction waste;
- energy efficient facades with high performance glass and all living space with natural light incorporated;
- sun shading doubles as safe access for cleaning and maintenance;
- solar availability maximised with solar hot water reducing energy consumption by 10%
- best practise building automation system installed.

The project has supported significant numbers of work experience students and worked with the local training authorities to provide traineeship opportunities. Graduates have also been given opportunities through the managing contractor and consultant groups. Upskill requirements have been exceeded and there is full safety training “Greencard” compliance. 41 traineeships and 29 work placements (including 10 long tern unemployed) and 1 full time apprenticeship were offered through the efforts of the team.

The hospital staff and the subcontractors particularly appreciated the defects free completion in regard to minimising returns to site for rectification work.

After a series of initiatives to hold information forums, develop a website and publish newsletters along with Lions run bar-b-que events on site and several milestone celebrations, community awareness of the project was high with 80% satisfaction on communication from the project. The program to introduce art into the project through local schools and professional artists has been very well received.

EBA issues affected the site but not as significantly as other large sites in SA. Safety standards exceeded industry benchmarks.

The relationship approach, integrated working and alternative project management model was a significant success and all team members and stakeholders recognise its benefits.

- The managing contractor effectively embraced a broader agenda than construction and tackled community involvement and ownership of the project, ESD opportunities and FFE procurement.

- Most subcontractors gave feed back that they valued the opportunity to genuinely join the team rather than simply be instructed and in particular the opportunity to contribute meaningful technical and constructability input.
- The consultant team are converts to the approach appreciating that there were real benefits through working collaboratively with the contractor through the design development and documentation stages. The documents were excellent.
- The experience has reinforced our view that project management can be a culture enhanced by a whole-of-team discipline rather than a role provided by an individual organisation.

WAS RELATIONSHIP MANAGEMENT HARD?

It is difficult to keep awareness raised about deliberately approaching all project issues in a fresh way and not reverting to "business as usual" when there were challenges or disagreements. While most projects give some consideration to these issues there was particular emphasis on applying good business practices including:

- A strongly supported vision;
- A clear set of objectives we all aligned on;
- Empowerment of all stakeholders in their respective roles;
- A commitment to make it work.
- A focus on being the team learning and culture to support achievement of the project and commercial objectives.

We don't normally put that effort into human resource development in a project – rather we focus effort on the physical outcomes and processes.

IT WORKS!

The performance of the LMHS team was outstanding, achieving major savings of project cost despite a difficult tender market and industry resource and industrial dispute difficulties whilst achieving exceptional design and building outcomes.

The collaborative approach to the procurement has changed most people engaged with it. Members of the team advise that they have translated the learning, improvements in management and communication skills to their roles in the project and to aspects of other projects. The procurement method appears to effectively create the environment where better than normal outcomes can be achieved through the power of teamwork.

For the stakeholders:

- all have become better team operators on and off project;
- team members don't ignore problems but fix them;
- concept of alignment is a strong one;
- subcontractors are genuinely in the game
- so is the hospital
- longer term relationships have been built.

The team is currently one of the best running; most harmonious and integrated teams experienced and still has potential for more. In this regard there is a proposal to Government that the team should continue into the next major stage of redevelopment to build on their successes.

OUR NEXT CHALLENGES

Our next challenge is maintaining momentum during the next stage of LMHS (subject to Cabinet approval of contract extension). By the time the next stage is complete the team will have been working continuously for several years.

Another challenge is to use the learning on other major Government projects. Already however the building industry in SA has responded with several significant private sector projects adopting some of the principles and techniques implemented at the Adelaide Convention Centre and LMHS projects.

Getting the balance between investment in the team and its culture and investment in the physical outcomes of the project right is another issue. Some still see the investment in team as wasteful use of scarce capital resources and we need to develop ways of measuring and demonstrating the benefit to the overall project.

LIKELY OUTCOMES

Relationship contracting made a significant contribution to a very successful result in the LMHS Redevelopment Stage A project. The SA government has requested that the model be applied to the $120M Stage 2 redevelopment at The Queen Elizabeth Hospital. It is anticipated that most projects in the SA Government Capital Investment Program will incorporate aspects of the relationship contracting approach in the future and several will adopt the integrated team project management approach in preference to the traditional project manager model.

CHAPTER 18

A Conceptual Framework to Investigate the Performance of Financial Incentive Mechanisms in Construction Projects

Timothy Rose

INTRODUCTION

Use of financial incentive mechanisms within construction contracts is common. They aim to reduce contract cost, minimise contract duration; and achieve performance standards in areas such as quality, program efficiency and productivity, safety and innovation. The optimal performance of a financial incentive mechanism is determined by its ability to increase and direct the contractor's effort to achieve above minimum standard levels, based on the client's project goals. It is argued in this paper that although incentives are commonly employed, they often do not operate effectively due to lack of information about the factors that shape their performance (Bresnen & Marshall, 2000). The value of such incentives is not questioned here, however there is a need for further definition and understanding of the motivational environment when designing and implementing appropriate mechanisms.

Against this background a large-scale research project is being undertaken to evaluate the performance of financial incentive mechanisms in Australian commercial building projects and explore the contextual attributes that influence motivation in various project configurations. This paper is the result of the first stage of this project, involving a comprehensive literature review and development of a conceptual framework that will be used to guide the case study fieldwork. This paper proposes a set of eight generic motivational variables, established from the integration of psychological and economic motivational theory principles that can be used to guide the performance evaluation of financial incentive contracts. The framework can also be employed to reveal the specific contextual attributes that influence the optimal implementation of such incentives in construction projects.

FINANCIAL INCENTIVE DESIGN IN CONSTRUCTION CONTRACTS

Contract strategy and financial incentives

The standard lump sum and cost reimbursable contract types have significant problems in promoting motivation to attain client specified goals that are above 'business as usual' levels. Despite incentive for cost-reduction efforts, the restrictive nature of the price in lump sum contracts increases the contractor's risks and thus increases their price contingency. This can lead to compromises in other

areas of the project such as quality (Howard *et al*., 1997). On the other hand, standard cost reimbursable contracts fail to motivate the contractor to minimise project costs and achieve other project goals above minimum standards (Berends, 2000). Financial incentive mechanisms built into standard contract conditions aim to alleviate these problems and direct and sustain contractor motivation towards achieving goals above 'business as usual' standards.

Many contractual arrangements between construction clients and contractors are confrontational, reflecting considerable mistrust and leading to increases in contractors' premiums to avert significant risk levels (Zaghloul and Hartman, 2002). According to Turner and Simister (2001), a significant issue that must be considered when formulating an appropriate contract strategy is achieving goal alignment between the client and contractor. Improved use of contracting options such as incentive mechanisms can balance the risk allocation between project parties and reward goal alignment.

HM Treasury's (UK) Central Unit on Procurements (1991) devised a set of benefits that can be achieved through the incentivisation of a construction contract. These benefits include lower cost though the appropriate allocation of risk and greater price stability; timely delivery of service without compromising quality of workmanship; enhanced achievement of desired outcomes; and improved management, control and monitoring of contract deliverables.

The primary aim of financial incentives is to "simply take advantage of a contractor's general objective to maximise their profits by giving them the opportunity to earn a greater profit if they perform the contract efficiently" (Bower *et al*., 2002, 43). This can be achieved when the contractor shares in the client's success. Financial incentive mechanisms can be applied to either fixed price or cost reimbursable contract variations, depending on the incentives structure.

In cost plus incentive contracts, the client's target cost is introduced into a reimbursable contract, and acts as the basis for the incentive mechanism. A cost under- or over-run is split between the contractor and client in predetermined portions (Broome and Perry, 2002).The contractor and client work together to minimise actual costs– the contractor is motivated to maximise their profit margin above their specified fee, and the client is motivated to minimise the total cost paid out (Broome and Perry, 2002). Thus, the contractor is motivated to take a share of the benefits of reduced project costs.

The second primary type of incentive mechanism used in construction contracts is the bonus/penalty performance incentive. These can be used in fixed price and cost plus contract types. The main purpose of bonus performance incentives is to motivate the contract agent with a financial bonus that is additional to their prescribed fee for meeting or exceeding minimum acceptable levels of performance (Washington, 1997). This award is based upon evaluations undertaken during and/or after the project to determine the amount of reward to be applied (Washington, 1997).

'Bonus' financial incentives can be used to motivate the contractor in many areas of the project other than cost, which is primarily managed in the cost plus incentive contract mechanism. Important to the success of bonus incentives are specific, mutually agreed and measurable performance targets (HM Treasury, 1991). However, such targets can be time consuming and difficult to apply due to the potentially subjective nature of assessment (Washington, 1997). 'Bonus' incentives include schedule incentives and technical incentives, which can include operation, non-disturbance, safety, quality and design integrity.

Schedule bonus incentives are being used more often in construction contracts, offering a bonus to the contractor for completion earlier than the target dates. Schedule performance incentives are usually based on a day unit rate of measurement, such as a predetermined amount paid for each day of early completion, and are very closely linked to project costs, since schedule delays usually increase costs (Arditi and Yasamis, 1998). Therefore, schedule incentives should be negotiated concurrently with cost incentives, as incentives encouraging early completion will reduce construction costs.

Technical bonus incentives may also be applied. These pertain to:

- Operation – A bonus incentive for efficient operation, based on the premise that improved operational performance would increase the chances for project success. Operation rewards can include site and project management, subcontractor management, quality and timeliness of reporting; cooperation and problem solving skills (Lahdenpera and Koppinen, 2003).
- Non-Disturbance – A bonus incentive for minimising the disturbance caused by the project. This may include minimising the disturbance to clients, third parties, the environment or existing buildings. Assessment criteria can be subjective and may include the number of interruptions to operations; noise levels; the use of surrounding spaces during construction; external impact of traffic (Lahdenpera and Koppinen, 2003).
- Safety – A bonus to minimise the risk of accidents on the construction site, as the direct and indirect cost of accidents to the contractor and client can be major (Lahdenpera and Koppinen, 2003).
- Quality – A quality performance bonus works on the premise that contractors are offered additional profit if they are able to achieve predetermined performance levels (Bower *et al*., 2002). When assessing product quality, standardised systems should be used, and should be applied selectively to the most important aspects of the work (Lahdenpera and Koppinen, 2003). However, a major problem with quality assessment is that it is subjective and can be difficult to measure.

Quality performance measurement tools have been developed by public clients with a high level of repeat construction, such as those used by Singapore's Construction Quality Assessment System (CONQAS) and Hong Kong's Performance Assessment Scoring System (PASS) for public housing (see Tam *et al*., 2000). Criteria may include quality of workmanship, flaws and defects, functioning of design and implementation and amount of rework (Lahdenpera and Koppinen, 2003). The aim of the bonus is to reward the contractor for outstanding quality, and not to penalise them for work that is less than outstanding, yet still satisfactory. Important to the success of the bonus incentive is that the definitions of performance, levels of the bonus, and units of measurement are agreed at the beginning of a project (Washington, 1997).

- Design Integrity – Bonus incentives can be provided for maintaining design integrity on a project, and are especially suited when major changes are to be made to the design throughout the project (eg. Hampson *et al*., 2001). Design integrity means the honourable representation of the original design intentions.

A major argument outlined in the construction literature is the combined use of multiple financial incentive mechanisms, to counteract any imbalance in the contractor's priorities, and to attain all incentive goals (eg. Arditi and Yasamis, 1998; Lahdenpera and Koppinen, 2003). For example, if the incentive contract is purely focused on motivating the contractor to meet objectives within a fixed or target price, this may lead to poor performance against the client's other goals, such as quality.

Financial incentives and the project environment

The optimisation of a financial incentive mechanism relates to its ability to motivate a contract agent to increase and direct their effort towards attaining project goals that are above minimum standards.

It has been argued that incentive mechanism motivation is influenced by its integration with the construction project environment (Bresnen and Marshall, 2000). Thus, the context in which the incentive is implemented directly influences its effectiveness. For example, if incentives are implemented in a project relationship that is plagued by underlying suspicions, the incentives are unlikely to induce a deep level of motivation and commitment, and could be seen as exploitation (a psychological response), causing their effectiveness to suffer significantly.

The construction management literature has argued the importance of a project environment that fosters cooperation and trust (e.g. Walker *et al.*, 2003). Traditional procurement methods, characterised by inappropriate risk allocation between project participants and the failure to develop a

cooperative relationship which aligns participants' goals, have discouraged innovation and resulted in poor project performance (Kumaraswamy and Dulaimi, 2001).

The use of incentive contracts in 'relationship-based' environments such as under partnering or alliancing, which are open in their dealings with risk, reward and project goals, can improve their chances of success. Relationship-based procurement attempts to achieve project outcomes that are acceptable to all parties involved. These methods have addressed the adversarial culture of traditional construction procurement, replacing it with strategies aimed at fostering cooperation and trust (Bennett and Jayes, 1995; Kadefors, 2003; Cheung *et al*., 2003).

Individual and organisational financial incentives

The level at which the financial incentive is administered (i.e. individual or group) influences the level of effort and output performance and should be considered when designing optimal solutions. Goals sought by individuals and goals sought by an organisation may not always be closely correlated (Bresnen and Marshall, 2000). Therefore, despite consensus within a project team on how it responds to an incentive, there may not always be a direct relationship between the organisational and individual response, which can lead to unachieved outcomes. Financial incentives should be applied to individuals and organisations to ensure that the motivational effects are harnessed at all levels. However, this may be dependent on the characteristics of the team's outputs.

Client-driven incentives for individuals and/or subcontractors 'on the ground' in construction projects have been limited. Bresnen and Marshall (2000) found that project staff had very little direct connection with project incentives, rewards and appraisal systems. In the past, decision-makers in construction industries have presumed that individual reward systems are unnecessary, which is in contrast to the attitudes of other industrial sectors in promoting motivation at all organisational levels (Bresnen and Marshall, 2000).

An example of the success in 'driving down' organisational financial incentives was the US Air Force's Peace Shield Project. The Hughes Aircraft company was awarded the ground/air defence systems contract, which was based on a mixed cost plus incentive/fixed price incentive contract, with cost (profit sharing arrangement) and schedule 'bonus' incentives built in (Kausal, 1996). Due to the scheduling pressures of the contract, Hughes decided to set aside 20% of the contract's incentives for the workers and subcontractors, which would then be distributed pro rata down the supply chain. The results for the client were significant, including a final product of extremely high quality, which was delivered more than six months ahead of schedule, and below cost. This success was closely attributed to the distribution of financial incentives down to the individual workers (Kausal, 1996). Incentives need to be tactical and strategic to motivate individual workers, and may include short-term incentives to meet interim milestones, and long-term completion bonuses.

In summary, there are many powerful financial incentive options available to a client to motivate the contractor to achieve goals above 'business as usual' standards and alleviate the motivational problems that are encountered with standard contract types. However, there is inadequate guidance for clients on selecting and implementing optimal arrangements. The next section discusses the motivational literature, which provides the basis for appropriate design of financial incentive mechanisms.

MOTIVATIONAL THEORY AND FINANCIAL INCENTIVES

It has been established in the construction management literature that financial incentive mechanisms can promote motivation and commitment to clients' goals. It is argued that their ability to motivate is founded in the principles of economic and psychological motivational theories. This section outlines

the psychological and economic streams of motivational theory, as the key contributors to our understanding of motivation. It then discusses current efforts to integrate these theories.

Maehr and Braskamp (1986) define motivation as a process where an individual or group uses resources such as their time, talent and energy, and allocates them as they see fit. If motivation is a representation of effort, incentives aim to energise, focus and sustain motivation, leading to increased effort and enhanced direction of effort.

Motivation indirectly influences performance. Mullins (1996) argues that ability and motivation determine performance. Also, performance is influenced by external factors such as market fluctuations. These factors are referred to as 'noise' elements in the organisational management literature (eg. Moers, 2000(b)). Combining these ideas, contract agent performance is determined by ability, motivation (effort) and external factors.

Contributions from psychological research

The motivational effect of incentive mechanisms on individuals and semi autonomous groups in the psychological literature is based on the cognitive 'process' motivational theories. Prominent process theories include expectancy theory, equity theory, goal setting theory and attitude theory.

Expectancy theory (Vroom, 1964) is based on the principle that contract agents will adapt their behaviour to achieve a desired outcome and will select the behavioural option with the greatest motivational force. Expectancy theory states that when an individual determines the motivational force (MF) of the behavioural option, they consider three perceptions. These perceptions are Expectancy (E), Instrumentality (I) and Valence (V).

MF = E x I x V

If any of the perceptions equal zero, then the whole equation equals zero because the motivation force is the product of all three perceptions (Vroom, 1964). *'Expectancy'* is the perceived probability that one's effort will attain desired performance goals. *'Instrumentality'* is the perceived probability that, if performance goals are met, the reward will be received. *'Valance'* is the perception of relative attractiveness or value an individual places on the desired outcome or reward. This perception depends on the individual's values, goals, needs, and preferences.

The basis of equity theory, originally developed by Adams (1963), is that individuals/groups are motivated by their need for fair treatment and will develop comparisons between one another in determining what is fair, just and reasonable. For incentive systems, the valance of the reward is determined by how fairly inputs are balanced against outcomes (e.g. money), and how this compares to the inputs/outcomes of others. If the input/outcome balance is not equal, it will lead to a loss of motivation, resulting in a potential loss of productivity.

Attitude theory states that an individual's motivation will depend on their attitudes (or their perceived beliefs) towards their environment (Ajzen and Fishbein, 2000). In a work environment, an individual who has favourable attitudes towards their work and their organisational setting will be more highly motivated to perform (Katzell and Thompson, 1990). Major work-related attitudes include job involvement (the importance of the job to the employee) and job satisfaction. Beliefs and values are major elements of an individual's self-concept (Katzell and Thompson, 1990). The principles of this theory suggest that an agent's motivation is partly influenced by their belief system and intrinsic job satisfaction.

Goal setting theory argues that goal commitment is a central determinant of motivation (Locke and Latham, 1984). For an individual or group to be committed to set goals, the goals must be challenging but realistic, clearly understood and meaningful. The theory also states that for goals to promote effort, timely and accurate feedback is required at appropriate intervals. Feedback will inform an individual that progressive goals have been attained, thus maintaining effort levels (Locke and

Latham, 1990). Under certain conditions, specific but difficult goals can lead to higher levels of motivation than vague or easy goals.

A major conclusion from psychological theories of motivation is that it is very important to understand the perceived limits of financial incentives to motivate groups and individuals and to be aware that financial incentives may only reinforce calculative trust, through financial gain. The use of other intrinsic motivational drivers, such as tools to foster close inter-personal relationships and cooperation between principal/agents can complement financial rewards, leading to increased levels of motivation and individual/team performance.

Contributions from economic research

From an economic perspective, incentives are founded in principal-agent theory, which is characterised by a principal (employer or client) who hires a contract agent (employee or contractor) to undertake actions on behalf of the principal (Jensen and Meckling, 1976). There are three assumptions in principal-agent theory; the agent is self-interested, the agent is risk-averse, and the agent possesses knowledge and information that is not available to the principal. These three assumptions lead to what principal-agent theorists call 'moral hazard'.

Agent self-interest is based on the assumption that agents only do what they perceive to be in their interest, and that they may be immoral in their undertaking to fulfil their personal gain (Howard *et a*l., 1997). Fehr and Falk (2002), argue that this is a narrow and empirically questionable view of human motivation.

The second assumption of principal-agent theory is that agents are risk-averse. Therefore, the agent will expect additional financial compensation if they are to retain the principal's risk. The agent will try to minimise risk and maximise compensation. It is also assumed that if compensation does not equal the level of risk retained by the agent, they will attempt to balance this inequity, to the potential detriment of performance (Jensen and Meckling, 1976). For example, if a contractor is allocated the full risk of cost overruns in a construction project, they will attempt to minimise, or avoid if possible, these risks, to the potential detriment of other project attributes such as quality and workmanship.

The final assumption of principal-agent theory is that irregularity of information can occur in the principal-agent relationship. The agent possesses knowledge and information that is not possessed by the principal. Therefore, the principal has limited information on their agent's actions, and the level of their effort. This theory argues that under conditions of uncertainty and incomplete information (a characteristic of all contracts), problems arise from the agent's self-interested behaviour.

Reciprocity theory and the acknowledgement of 'social preferences' in the economic literature are used to challenge the 'self-interest' principle of principal-agent theory (Fehr and Falk, 2002). Reciprocity theory states that agents prefer a condition of fairness in the exchange relationship with the principal. Depending on the behaviour of the principal, the agent perceives the value of the material incentive as positive or negative (Fehr and Falk, 2002). If the agent views the incentive as 'calculative' or hostile, their commitment to the principal's goals may be affected.

Other motivational theories do not completely discount principal-agent theory principles as they are, to a degree, prevalent within all principal-agent transactions. However, even the founders of principal-agent theory now acknowledge the importance of considering the psychological influences on behaviour when designing incentive contracts (Jensen, 1994).

Integration of motivational theory principles

Recently, attempts have been made to cross-pollinate the theoretical concepts to fully determine the effect of incentive systems on effort in the experimental organisation management literature. For example, Van Herpen *et al.* (2002) used principal-agent theory and cognitive evaluation theories to

study the motivational effect of a compensation system in a Dutch manufacturing company. Fehr & Falk (2002) combined principal-agent theory and intrinsic motivation principles to identify the non-financial motives in the economic environment, such as the desire to reciprocate.

Kunz & Pfaff (2002) identified an urgent need to incorporate intrinsic motivational principles into principal-agent theory. Although they acknowledged the difficulties in defining and measuring the effect of intrinsic motivation on financial reward, their investigation argued that financial rewards do impact on intrinsic motivation and voluntary cooperation.

To fully explore the role that financial incentives play in motivating individuals and organisations, it is clear that both psychological and economic principles should be taken into consideration. As discussed, there have been moves in this direction in recent empirical studies in organisation management research (e.g. Van Herpen *et al*., 2002) However, such efforts are in early stages of development, and there is a need to extend the work, particularly in relation to 'project' environments, with their attendant challenges. In the construction industry environment, motivation is influenced by both economic gain and the psychological intrinsic drivers of semi-autonomous project teams.

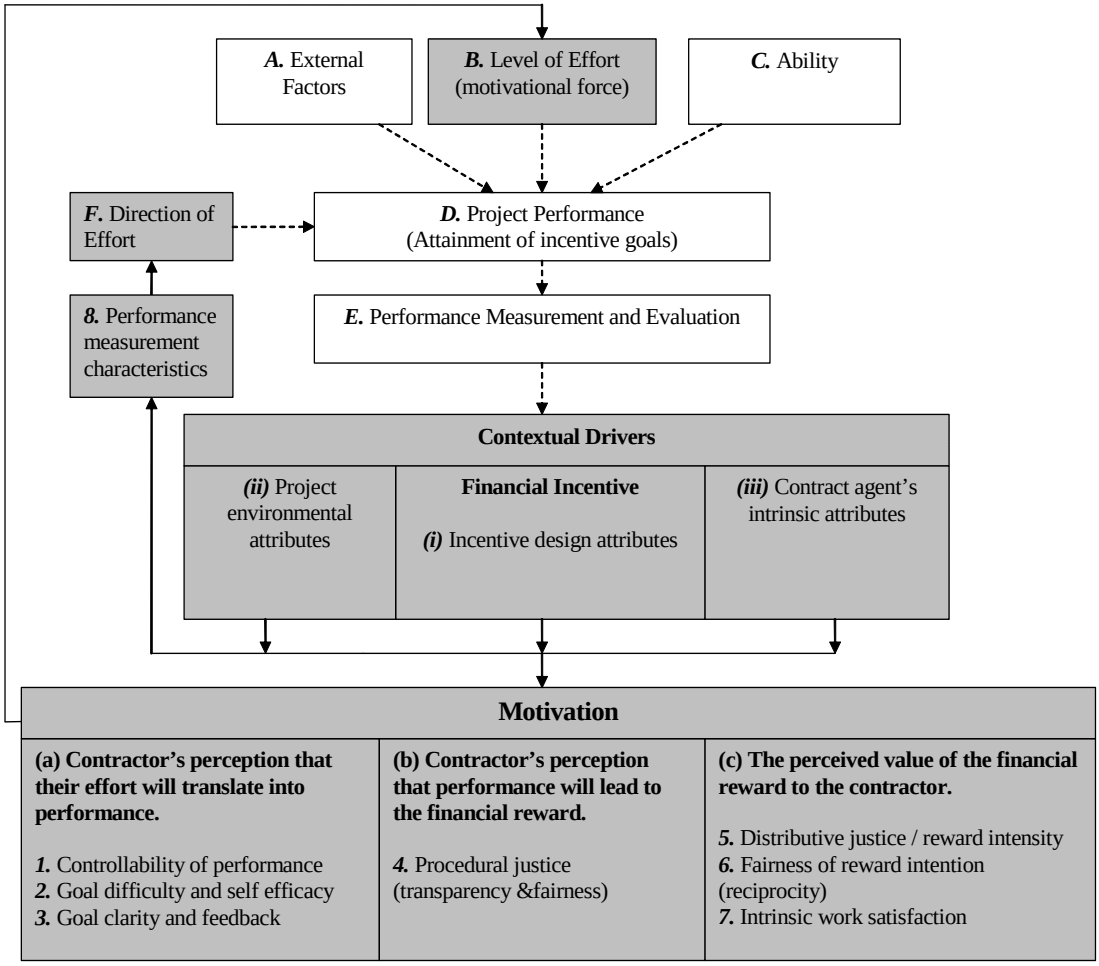
MOTIVATIONAL VARIABLES INFLUENCING EFFORT IN FINANCIAL INCENTIVE CONTRACTS

This section outlines the generic motivational variables derived from the economic and psychological streams of motivational theory literature. These variables have been incorporated into a conceptual framework outlining the key factors that influence the level and direction of effort (as a proxy of motivation) and their relationship with performance. This conceptual framework will be used in empirical work to follow, evaluating the performance of financial incentive mechanisms in Australian commercial building projects and to guide the exploration of the contextual drivers that are influencing the performance of financial incentive mechanisms.

Figure 18.1 illustrates the theoretical relationships that are argued to influence motivation in a construction project, focusing on the impact of financial incentive rewards on effort. This includes the level of effort (motivational force) and the direction of effort.

As illustrated in Figure 18.1, the motivational variables are broken down into expectancy theory categories including: (a) the contractor's perception that their effort will translate into performance (b) the contractor's perception that performance will lead to the financial reward and; (c) the perceived value of the financial reward to the contractor.

Figure 18.1 Conceptual Framework – Interrelationships Between Financial Incentives and Their Contextual Attributes, Level and Direction of Effort, Performance and the Theoretical Motivational Variables Influencing Contractor Effort Under Financial Incentive Mechanisms



The 'level of effort' motivational variables are:

Motivational variable 1: controllability of performance

The ability of an agent to control his/her performance in an incentive contract will affect his/her level of effort (Baker, 2002).

If agents believe that a performance goal is risky and they have limited control over whether they can achieve it, they will be less motivated to attain the goal. This is based on the concept from principal-agent theory that an agent will attempt to minimise risk to attain maximum profitability. Moers (2000(b)) shows that an agent's perceived ability to control his/her performance is dependent on the degree of 'sensitivity' (the effect the agent has on performance) and the level of 'noise' (the

environmental uncertainties outside the control of the agent that effect performance). The greater the noise, the less control the agent has on performance. Performance objectives that can be adequately controlled by the agent should be the target of financial incentive mechanisms, so the agent perceives his/her increased effort will translate into performance.

Motivational variable 2: goal difficulty and self-efficacy

The perception of goal difficulty and personal competence influences an agent's motivation. If the incentive target is perceived to be too hard, this will lower the contractor's self-efficacy (perceived competence to attain the target), leading to a low expectancy level, and low motivational levels.

This variable is based on goal setting theory and argues that incentive targets must be realistic to attain in consideration of the agent's perceptions of his/her competency to attain them. As agents are risk-averse (according to principal-agent theory), incentive targets that are set too high will lead to decreased effort because the increased costs of reaching the target exceed the benefit gained (Howard *et al*., 1997). Financial incentive targets should be set in accordance with the perceived competence of the contractor and the reward intensity (see variable 5).

Motivational variable 3: goal clarity and feedback

Goal clarity influences the perceived controllability of performance. If the goal is vague, the agent may believe that he/she does not have control over its performance, and will limit their effort. Goal setting theory states that performance targets must be clearly understood to induce motivation and increase the agent's perception that his/her effort will translate into performance. Thus, financial incentive mechanisms should have clearly set goals. The theory also suggests that timely and accurate feedback at appropriate intervals is useful in maintaining effort (Locke and Latham, 1990). Similarly, Spinkle (2000) (cited by Moers, 2000(b), 10) states that feedback on performance goal achievements facilitates learning, which 'makes performance more effort-sensitive', thus increasing motivation.

Motivational variable 4: procedural justice

Van Herpen *et al.* (2001) identified two aspects that influence the effectiveness of an incentive contract's performance measurement system. These are transparency and fairness of the procedures. These elements affect the agent's perception of procedural justice. Procedural justice reinforces the agent's perception that his/her performance will ultimately lead to the financial reward, thus influencing motivation, according to expectancy theory.

The transparency of the performance measurement system relates to the agent's understanding of the methodologies and measures that are implemented to assess performance. If the contract agent does not fully understand the performance measurement procedures, he/she will be less likely to be committed to its goals (Van Herpen *et al*., 2001). Therefore, a clear understanding by all parties of the financial incentive methodologies will assist in maintaining equity in the process.

The second aspect is fairness. The economic predictions of fairness and trust are not well developed. However, from the psychological perspective, perceived fairness and trust in the assessment procedures of a compensation system influence the level of effort exerted by the contract agent (Van Herpen et. al, 2001). Merchant (1989) identified the importance of measurement accuracy to the perception of fairness. Measurement accuracy depends on verifiability (it can be duplicated and confirmed) and objectivity (free from bias or external influence). If the agent believes the measurement procedures are inaccurate, it can decrease his/her motivation due to the uncertainty that performance will translate into the desired financial reward (Moers, 2000(b).

Motivational variable 5: distributive justice – reward intensity

Financial incentives should be set at an appropriate intensity to compensate for the agent's risk and promote effort. Incentive intensity, according to economic principal-agent theory, is the main determinant of an agent's level of effort in an incentive contract. This is because higher intensity increases the agent's margin in response to his/her increased effort. The reward must be significant enough to motivate the agent but should not exceed the value of the benefits to the principal. This is also supported by equity theory from the psychological literature (Adams, 1963), where, if the size of the incentive mechanism does not fairly equate with the desired level of performance, it will fail to motivate. Washington (1997) recommended allowing the agent to significantly contribute to the development of appropriate rewards for goals. This ensures the principal establishes the reward at a level that is perceived as worthy.

Motivational variable 6: fairness of the reward intention (reciprocity)

According to the psychological motivational ideals, the perceived honesty of the principal has significant impact on an agent's motivation. This variable is based on reciprocity theory, which states that the agent prefers an environment of fairness, where the principal's incentive intention is perceived to be honourable. If an agent perceives the financial incentive to be 'calculative' and hostile, he/she will be less committed to the incentive and will fail to increase effort (Fehr and Falk, 2002). This variable depends on the agent's perception of the reward intention in relation to the environment in which it is administered. If there is a lack of trust and cooperation in the working environment and the agent is questioning the principal's honesty, he/she will be likely to perceive the reward as hostile.

Motivational variable 7: intrinsic work satisfaction

Intrinsic work motivation refers to when individuals or groups undertake behaviour because of the enjoyment or the self-gratification of that behaviour. The behaviour itself is the motivational force. Intrinsic motivation is a psychological concept and is driven by human values such as decency, honour and dignity (Frey, 1997). Intrinsic work satisfaction is argued to have significant impact on the optimisation of financial incentives. Despite the arguments of the 'crowding out' effect of financial rewards on intrinsic motivation (see Deci, 1971), intrinsic work satisfaction has been argued to influence the level of effort, alongside extrinsic motivation (Kunz & Pfaff, 2002). Intrinsic work satisfaction should be taken into consideration when evaluating the worth of incentives in construction projects (Bresnen and Marshall, 2000).

Motivational variable 8: performance measurement characteristics (direction of effort)

The characteristics of performance measures used in an incentive contract determine the direction of effort, according to the principal-agent relationship (Moers, 2000(a)). The assumption underlying the direction of effort in an incentive contract is that the agent will direct the majority of attention to the areas of the job that are being measured (Holmstrom and Milgrom, 1991). The agent may manipulate the effort to maximise his/her incentive reward, possibly to the detriment of unmeasured areas, thus 'what you measure is what you get' (Moers, 2000(a), 4). The empirical evidence shows that financial incentive mechanisms should be designed to ensure that there is a proper balance between cost, schedule and performance incentives, according to the priorities of the principal (Arditi and Yasamis, 1998).

The selection of appropriate performance measures is dependent on the level of information asymmetry. If the principal cannot directly observe all of the agent's actions, he/she should implement

comprehensive performance measures to align the agent's goals with his/her own. There is also the potential for 'distortion' of the performance measures, that is, they can be manipulated to promote the wrong behaviour (Baker, 2002). The distortion of a performance measure depends on the types of measurements used. A diverse range of performance measures including subjective and objective measures can prevent distortion.

Also, illustrated in Figure 18.1 are the contextual drivers that influence the performance of the motivational variables, to be fully explored in the empirical work to follow this paper. These include: (i) Financial incentive mechanism design attributes, (ii) Project environmental attributes, (iii) Contract agent's intrinsic attributes.

Factors influencing incentive project performance (attainment of client's incentive goals) are also shown in the conceptual framework. As discussed previously in this paper, the optimal level and direction of effort (B and F), as the primary objective of an incentive mechanism, is a major contributing factor in the attainment of the client's incentive goals (D). The achievement of incentive targets is then evaluated according to the performance measurement system (E). Effort is accompanied by ability (C) and the external project performance factors (A) such as weather and market prices.

CONCLUSION

With guidance from the construction management and organisation management literature, and drawing from motivational theory literature, this chapter has identified a number of motivational variables which are argued to influence the motivation of contractors in financial incentive contracts in construction projects. These variables are integrated into a conceptual framework that outlines the relationships to be explored in an up-coming empirical study of Australian commercial building projects.

The conceptual framework developed from the review of related literature contributes significantly to the construction management research. There has been very little research identified that has comprehensively investigated the performance of financial incentives in a construction project, particularly from an integrated motivational theory approach. This work extends early attempts to guide the implementation of optimal incentive arrangements in construction projects, by combining economic and psychological motivational theory principles to evaluate incentive performance. It also provides a basis for the further exploration of the contextual drivers influencing their performance. It is anticipated that the performance results derived from the future empirical work will shed new light on the motivational environment of construction projects and provide recommendations for optimising the impact of financial incentive mechanisms in future projects.

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CHAPTER 19

Implementation of the National OHS Strategy 2002-2012

Wayne Artuso

INTRODUCTION

This chapter provides an overview of three important national occupational health and safety initiatives that will directly impact on the building and construction industry. These are the National Strategy, the development of national regulatory material and role of safe design in reducing construction related accident and injury. Socially, politically and economically, Australia is in a fortunate position. The population is well educated, we have a good health system, there are effective social services and the rule of law applies. The population has reached twenty million, with a workforce of about ten million, so Australia has a strong internal market. Internationally the country is a significant trading nation.

Every year however, one in twenty workers will probably suffer a work related injury or disease. There will be over two thousand work related deaths this year, most from work-related diseases. Billions are spent by the nine governments, by employers and by the community in trying to reduce this toll. In a recent study the cost of workplace injury and illness to the Australian economy for the 2000-01 reference year was estimated to be over $34.3 billion or 5 per cent of Australian Gross Domestic Product (GDP) (Access Economics, 2004). The economic cost of pain, suffering and early death is at $48.5 billion. Australian employers paid $7.5 billion in workers' compensation premiums in the 2000-01 financial year (Workplace Relations Ministers Council). In the construction industry the cost of insurance premiums (standard & self insured) for 2000-2001 was $733 million.

The building and construction industry is high-risk. It is estimated that around 50 building and construction workers are killed at work each year. Data in relation to people working in the industry suggest that they are more than twice as likely to be killed at work than the all-industries Australian average (Workplace Relations Ministers Council).

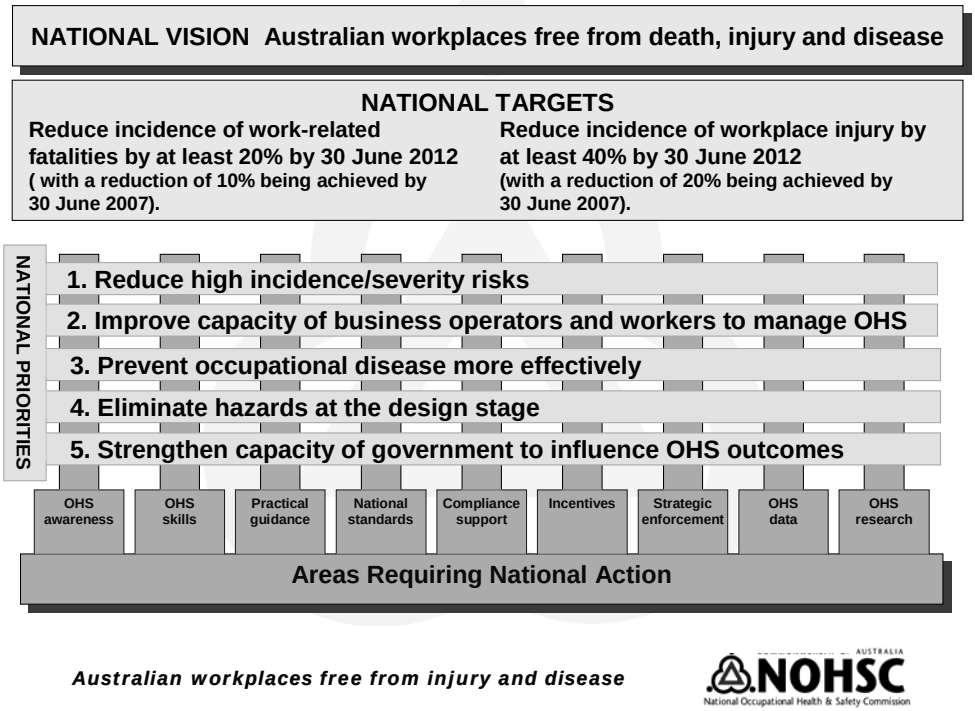
There is no quick solution to these problems. The challenges are compounded by many interrelated factors. The age and composition of our workforce is changing. The industry mix is altering rapidly and today over 90% of Australian businesses are small businesses. International trade and globalisation are making both borders and local regulation less relevant. Economic forces are changing the balance of power. New technologies are creating new industries and making many old ones and the skills associated with them irrelevant and unwanted. New ways of working are producing new hazards and risks. Increasingly, regulators, employers and workers are struggling to keep up with the pace of change. Many duty holders at workplaces do not know or understand their obligations, nor how to identify and address hazards and risks. Even where they do, there are frequently competing business pressures on them.

THE NATIONAL STRATEGY

Against this background, in 2002 the National Occupational Health and Safety Commission (NOHSC) developed and adopted its National OHS Strategy (see Figure 19.1), which will operate for ten years up to 2012 (NOHSC, 2002). We also received the express commitment of all Australian governments and the ACCI and the ACTU to the Strategy.

Why did NOSHC decide to take this step? Australia's constitutional arrangements distribute regulatory responsibility over nine governments. This puts us at risk of missing opportunities to align our efforts and share solutions and resources. The National Commission has always provided a forum for fostering this type of cooperation. Cooperation usually relied on a coincidence of interests at any given time rather than a planned program of activities that focused on the biggest problems. NOHSC felt confident in developing a National Strategy because it involved the efforts of members drawn from all Australian governments and the peak industry and union bodies. Since the Commission is accountable to the Workplace Relations Ministers' Council, we were also able to secure their support.

Figure 19.1 National OHS Strategy 2002-2012



NOHSC, 2004, 'copyright Commonwealth of Australia reproduced by permission'.

The strategy's vision

Our starting point for the Strategy was a shared national vision, namely, Australian workplaces free from death, injury and disease.

Importance of data and development of targets

NOHSC examined the available national data to identify the greatest causes of work-related injury and disease and we agreed on key emerging issues. The National Commission considered the trends and developed two initial minimum national targets for reducing the incidence of work-related deaths and injuries. The targets are to reduce the incidence of such fatalities by at least twenty per cent by 2012 and the incidence of work related injuries by at least 40 per cent. By 2007, the Commission expects a minimum improvement of one half of each target.

Benchmarking Australia's OHS performance

There is an additional informal target. This reflects the concern about the shortcomings in benchmarking against Australia's own past performance. NOSHC aims to have the world's best OHS performance, measured in terms of work-related fatalities and injuries. Therefore, the aim is to benchmark Australia against the rest of the world. This is very difficult as there are many gaps in the data used by various countries and differences in definitions, hazards and risks.

Even so, using non-standardised data, the ILO ranks Australia as the seventh best in the world (International Labour Organisation, 2002). If as a nation we are to become the world's best, making our Strategy work is even more important. This aim will only be achieved when everyone in Australia's workplaces takes the necessary action to make them the world's safest. To attain this outcome, improved hazard identification and control skills will be required in the workplace.

Priorities under the strategy

After deciding on the formal targets, the National Commission used them to assist in settling on priorities for national action. In each case, the threshold question was how much action in a particular area, or in a combination of priority areas, would help to achieve the targets. This was a very powerful criterion. It allowed the Commission to bring greater objectivity to the decision-making on the priorities.

Five National Priorities were developed, relating to

- reducing high incidence and high severity risks;
- giving business operators and workers greater capacity to manage OHS effectively;
- the more effective prevention of occupational disease;
- eliminating hazards at the design stage; and
- making governments better able to bring about good OHS outcomes.

Nine areas that underpin national action to achieve the priorities

The Commission also decided on nine areas to be the focus of our work consisting of

- comprehensive OHS data collections;
- a coordinated research effort;
- a nationally consistent regulatory framework;
- strategic enforcement;
- effective incentives;
- support for better compliance;
- practical guidance;
- OHS awareness; and
- OHS skills development.

They are mutually dependent; improvement in one area should lead to improvements in the others, and, equally, failure in any area will be a barrier to improvement in the others. These are substantial

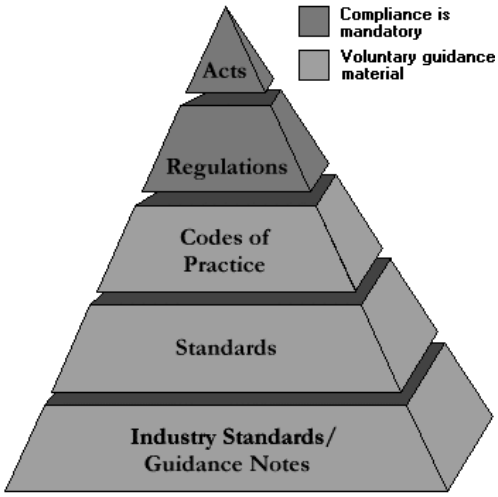
challenges for NOHSC. So how does this all impact on the OHS performance of the building and construction industry?

Regulatory material development for the construction industry

The Cole Royal Commission made a number of comments and recommendations in relation to the poor OHS performance of the $46 billion building and construction industry. Although there are many problematic issues in the industry, one issue that NOHSC is giving a high priority to is the development of uniform national OHS standards and codes of practice. In June 2004 NOHSC released for public comment the draft National Standard For The Construction Work (National Standard) and the draft National Code of Practice for the Prevention of Falls from Height in Construction. The National Standard aims to identify and foster the uniform adoption of best practice approaches to OHS in the construction industry.

NOHSC has also seized the opportunity to develop draft codes of practice that support the National Standard in the high risk areas of demolition and tilt-up construction, and construction induction training. The National Standard is the first tier of a national package of material for the building and construction industry, and contains the essential elements to be implemented by the jurisdictions. The proposed second tier of the national package is a series of national codes of practice addressing high-risk construction activities (for example, prevention of falls from height). The proposed third tier is a range of guidance material for performing specific construction tasks (for example, roof tiling). The National Standard is only enforceable by law when it is specifically included in a State/Territory health and safety regulation. An OHS regulatory compliance continuum including the hierarchical application of National Standards and Codes of Practice is set out below.

Figure 19.2 The Australian OHS Legal Framework



Australian health and safety law is governed by a framework of Acts, Regulations and support material including codes of practice and standards, as illustrated above. Each State/Territory has a central piece of law, the principal occupational health and safety Act.

NOHSC, 1998, ‘copyright Commonwealth of Australia reproduced by permission’.

The objective of the National Standard is to provide a framework to assist in the protection of persons from the hazards arising from construction work by requiring duty holders to eliminate the hazards (NOHSC, 2004a). Where this approach is not practicable, duty holders will be required to take steps to minimise as far as practicable the risks arising from the hazards, by ensuring that the hazards are identified and the risks assessed and controlled. The standard will also require the provision of information and training and will

- form part of a construction work regulatory package and provide the basis for national codes of practice and guidance material;
- provide nationally consistent construction specific performance based requirements suitable for adoption by the States and Territories;
- require relevant persons in the construction workplace to identify hazards associated with construction work and minimise risks of injury, illness or fatality in construction work; and
- allow for structures to be safely erected, maintained, repaired or altered, cleaned and demolished. Safe design information and obligations will be incorporated.

The draft National Standard proposes account be taken of emerging issues, such as the changed composition and mobility of the construction workforce. The need for a uniform standard for induction training, and mutual recognition of induction training across jurisdictions, has been identified, as has the need to address the safety issues of workers engaged under labour-hire arrangements.

It could be suggested that there is already a great deal of OHS regulation in place. However, a closer analysis of jurisdictional regulation would reveal that it is not only inconsistent, but there are large gaps in the coverage of hazards and risks. The adoption of uniform construction standards and codes of practice should reduce costs to industry, reduce uncertainty with compliance requirements and should have a tangible impact in reducing the industry's high accident and injury rate. A number of industry consultative forums have expressed support for the development of standards and codes. One recent forum in June 2004 was the 'Improving Safety in the Building and Construction Industry Conference'. Participants included major construction companies, unions, employer associations, state and territory governments and architects. The principal aim of the conference was to strengthen industry commitment to work together to bring about significant and sustained improvements to safety performance in the building and construction industry. At the conclusion the conference released a communiqué setting out a number of agreed outcomes;

- safety is a priority for all participants in the construction industry. The industry wants to have a safety culture which makes it one of Australia's leaders in good health and safety performance;
- all parties support the National OHS Strategy and agree to reduce fatalities and serious injuries by at least 10% by June 2007;
- the industry should adopt a 'life cycle' approach to OHS in building and construction projects – recognising that designers should provide for the safety of those building, working, refurbishing and demolishing structures;
- governments need to use procurement processes to actively improve OHS, the current approaches do not significantly improve safety;
- the industry will raise awareness and understanding of the health effects of exposure to chemicals used in building and construction;
- all states and territories should work together to ensure a national approach to regulation of the building and construction industry across Australia;
- NOHSC will convene a number of forums on construction specific issues, including a CEOs forum.

The integration of safe design principles into national standards

Construction sector injuries as a result of poor design

Some statistics concerning the construction industry and its OHS performance include: the construction industry employed approximately 5% of the Australian workforce and accounted for 10% of new workers' compensation claims in 2001/2002; the incidence of workplace fatality in the construction industry in 2001/02 of 9 deaths per 100, 000 employees is more than double the Australian average for all industries of 3.6 deaths per 100, 000 employees; and by the year 2005/06 the construction industry will be the lead contributor to work-related deaths and injuries in Australia if the industry continues along current trends for the ensuing years.

A recent study found that design related issues were definitely or probably involved in at least half of all serious and fatal injuries in the construction industry (NOHSC, 2004b). Although the OHS focus has traditionally been on the construction phase it is sometimes forgotten that building owners as end uses inherit the legacy of an unsafe construction design that may only be discovered as the result of an accident or injury, which sometimes only occurs many years after it was built. As a consequence, the design deficiency may not become apparent until a particular work activity occurs such as maintenance or refurbishment. The building owner may then be potentially faced with the legal liability for the accident arising out of poor design. However there are other sound reasons for design decision makers upstream to adopt a systematic approach that incorporates safe design approach.

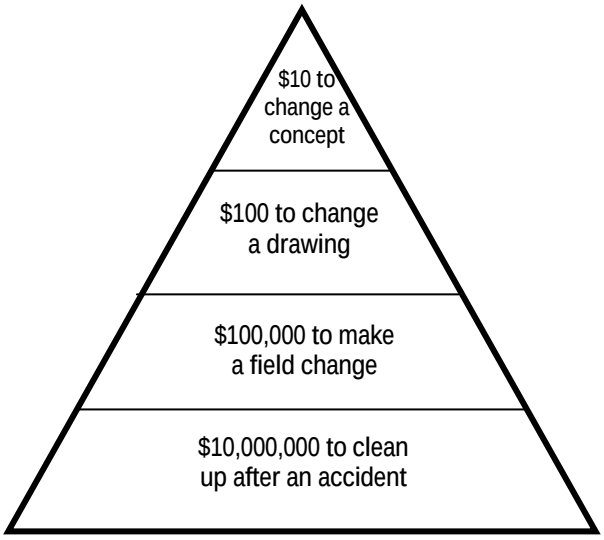
The business case

Applying the Safe Design approach means controlling risk early in the design process. A Safe Design approach results in:

- simplified risk control;
- a more informed ability to meet legislative responsibilities;
- a greater ability to predict and manage production and operational costs across the life cycle of the designed-product;
- a greater ability to predict and minimise costs associated with injury and environmental damage; and
- a reduced need for redesign and retrofitting, and its associated costs.

Costs associated with unsafe design can be significant (e.g. retrofitting, workers compensation levies, environmental clean up costs). If these costs can be identified and avoided in the pre-design phase, then there is a clear business case for adopting the Safe Design approach. Figure 3 shows the relative cost advantages of applying a Safe Design approach.

Figure 19.3 Cost Effectiveness of Early Intervention on Safety Problems in Construction



(Adapted from Wakeling, H. & Knight-Jones, P. 2000, pp.199-206)

ENHANCING OHS AWARENESS

By raising awareness of the need to proactively identify and eliminate potential unsafe design issues at an early stage NOHSC hopes to minimise the number of construction and building industry incidents and injuries. The challenge for the Commission was to develop a strategic approach that would focus on risks involving design at a number of different levels.

To facilitate this the Commission has developed the *Safe Design Action Plan 2004 – 2012* (National Priority 4 of the National OHS Strategy) to guide the implementation of safe design into key national standards. Three high-risk national standards have been initially identified for the integration of the safe design concept. These are manual handling, plant and the National Standard for Construction Work. Underpinning the Safe Design Action Plan is a set of four Safe Design Principles that will be used to guide the integration of safe design into National Standards;

- Assign responsibility to parties with real control over particular design functions.
- Adopt a life cycle approach to the designed-item to improve OHS for a range of people who will use or interact with the item.
- A 'designer' must ensure that a systematic OHS risk management process is implemented and ensure that those involved in design have the necessary, or access to, OHS knowledge and capability.
- ensure that key information is transferred from the design/planning phase and that those involved at later life cycle stages are informed about any residual risks that may affect their health and safety.

Nested within the Safe Design Action Plan are a number of regulatory framework initiatives that will lead the integration of safe design through;

- the development and promulgation of Safe Design Principles and definitions and the development of practical guidance on safe design;
- The review of regulatory framework and development of improvement options;
- Encourage the introduction of safe design principles into management systems; and

- The incorporation of safe design principles into national, state and territory standards and codes of practice.

At the industry level key activities derived from the Safe Design Principles that will assist the integration of safe design principles into business management systems include;

- Promoting the 'life-cycle' approach to OHS in building and construction projects – recognising that designers should provide for the safety of those building, working, refurbishing and demolishing structures;
- Identifying opportunities to influence and incorporate safe design and OHS into key standards such as the Building Code of Australia (BCA) and the Future Building Code (FBC);
- The integration of safe design into higher education and professional development curricula for design professionals;
- The engagement of parties with real control in the design, planning and construction work particularly those with OHS risk management obligations, such as design professionals, building contractors and clients;
- Ensuring that foreseeable risks are proactively and systematically addressed at the source throughout the construction or building lifecycle, but particularly as early as possible in;
  - The design stage;
  - Procurement of materials and methods;
  - Planning and organisation of work; and
  - Selection and coordination of contractors
- Making sure that those involved in the design and planning of construction works have the necessary OHS competencies and knowledge to adequately address foreseeable risks that may arise;
- Development of a culture of communication and cooperation that ensures that relevant OHS information is maintained and made available to parties involved in the service, maintenance and use of the building or construction.
- Ensure that any residual risk is documented/filed and transferred from owner to owner throughout the lifecycle to the decommission/demolition of the building or structure.

From this approach NOHSC seeks to deliver a message that buildings and structures throughout their lifecycle are used as workplaces and therefore must not only be safely constructed but remain safe for those who work in them. To achieve this NOHSC seeks to encourage architects, designers, planners, contractors and clients to take a proactive and leading role in the recognition and implementation of safe design has an integral part of the construction design process.

CONCLUSION

In conclusion the National Strategy, the advancement of safe design initiatives and development of regulatory material for state and territory jurisdictions is a systematic approach, which NOHSC believes should deliver a focused and uniform outcome that will result in tangible improvements to OHS performance in the building and construction sector.

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CHAPTER 20

Web-Based Collaboration Tools for the Construction Industry: The John Holland Experience

Claudelle Taylor

INTRODUCTION

John Holland is committed to develop the appropriate use of Optus inCITE applications throughout its businesses and to promote Optus inCITE in the construction industry as a whole. It is therefore Optus inCITE which has been, and will continue to be, the main focus of our exploration and implementation of Web-based collaboration tools.

All the same, many of the features of Optus inCITE applications and the issues relating to their implementation will be in common with other Web-based collaboration tools.

Background to Optus Incite

The concept behind Optus inCITE was developed by CITE Australia Pty Ltd (CITE). CITE was formed by a group of seven major contractors who came together with the specific purpose of establishing an on-line trading exchange for the construction industry. The seven contractors were Barclay Mowlem, Baulderstone Hornibrook, John Holland, Leighton Contractors, Thiess, Walter Construction and Transfield (the construction businesses of Transfield were later acquired by John Holland). The concept was for neutral trading exchange which would cater for the construction industry as a whole; accessed through a single Web-based portal. It was intended that the trading exchange would provide services such as on-line applications for communication, document management, procurement, industry publications, discussion forums, project and tender opportunities, and company information; all of which could be customised by the users depending on their requirements.

After a lengthy process of requesting proposals, analysing proposals and negotiating the details, CITE signed an agreement with Optus in October 2002, and Optus inCITE went into development. Under the agreement Optus committed to develop, own and operate the trading exchange; to market it to all sectors and participants in the industry, to provide training and support, and to continue development of the exchange to meet developing industry needs. For their part, the CITE companies agreed to sign off on and test the software, participate in marketing programmes, assist with further development of the exchange, promote internal use of the system, and encourage wider use to other sectors of the construction industry, with the intention that Optus inCITE should become an industry standard.

Optus inCITE came on-line in May 2003 bringing together three initial applications within one portal, and they are available to the Australian construction industry on a pay-for-use basis.

The applications

The initial applications selected for incorporation into Optus inCITE were Tender Management, from EU Supply of Sweden; Purchasing, from Conexa of New Zealand; and Document Management, from AEC Communications of Germany. These applications are accessed through a Web portal designed exclusively for Optus by Hothouse of Australia.

The portal

The Web portal is the single point for access, registration and administration for the trading exchange. Once logged onto the portal, users can see the various applications for which they are registered and can readily move between them.

Purchasing

The purchasing application (Purchasing) is an on-line system for both buyers and suppliers. It provides catalogue-based purchasing, issuing and receiving of requests for quotation, purchase order management and invoice matching.

The application can be customised to reflect the workflows or approval process of each company or business unit. Whilst a single set of catalogues may be used for a particular supplier, each purchasing company can maintain their own price list and terms. This allows each company to negotiate national and regional agreements with suppliers, and to make those agreements automatically available to all the purchasers of that company.

Tender management

The tender management application (Tender Management) covers both estimating and procurement phases of a project. Drawings and documents, electronic bills, and electronic question and answer forms are distributed to invited responders (contractors, subcontractors and suppliers) through the portal. These responders then indicate their interest to quote, compile their quotations and responses, and submit their quotations directly through the portal. When the quotations are returned, these can be analysed, compared and approved. The packages can then be let on-line or included in a tender. The system can be configured to follow required authorisation processes and it maintains a clear auditable trail of all transactions.

During the estimating phase (or pre-award) of a project, Tender Management is an e-tendering application by which tender documents are distributed to invited tenderers who then submit their tender on-line. It is multi-tiered in that it allows main contractors to receive tender invitations and documents from a client and then to break this information up into packages for quotation by subcontractors or suppliers. This information can be pushed down to further levels in the supply chain. As quotations are received, the main contractor can analyse and evaluate these within the application and include the appropriate prices and details in the final submission to the client, or the subcontract package to be let.

As a procurement (or post-award) application Tender Management generates invitations to subcontractors and suppliers to quote for discrete packages of work which, once returned, are analysed and awarded to successful bidders. Tender Management also incorporates a contract management module with which a commercial team can continue to manage the subcontract or supply agreements through the construction process.

Tender Management provides for tight version control with all parties looking at the same documents or sub-set of documents in the portal. When addenda are issued to the main contractor and the relevant documents are replaced on the system, the system will identify those subcontract

packages that included documents which have been amended. Notifications of revised documents (addenda) can then be sent automatically, and acknowledged by the recipient. The entire process can be monitored and traced.

Document management

The document management application (Document Management) provides on-line management of documents and drawings, and any required types of formal or informal communication. It supports collaboration by managing the workflows between clients, consultants, contractors, subcontractors and any other stakeholders in a project.

The application is fully configurable to suit project management procedures, approval and verification processes, and distribution and access rights (security). It is a fully collaborative system, in which each individual participant has his/her own identity, responsibilities and access rights in accordance with his/her role in the project and the company under which he/she is registered. Users only see documents or document types that are applicable to them as defined by the configuration, in other words, those for which they have been included in the distribution or given access rights.

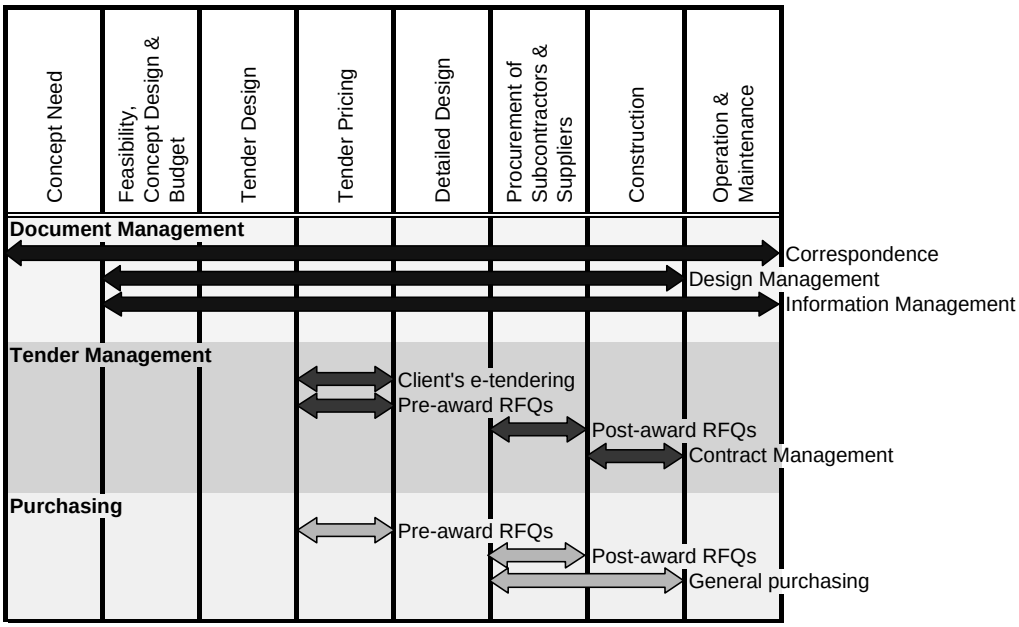
All the data are stored and secured in a single, third-party data warehouse that is owned and operated by Optus. This is a Government A1 accredited site.

Document Management provides for full traceability, identifying documents that have been received and opened, and providing a detailed reference of the document process (document history). It also provides strict version control of documents. Given the configurability of the system and its ready accessibility from any location, it is particularly powerful for use in joint ventures, alliances and projects involving a collaborative design and construction.

JOHN HOLLAND'S USE OF WEB-BASED COLLABORATION TOOLS

Whilst our initial focus has been on implementation of Document Management, John Holland intends to develop the use of all three Optus inCITE applications. Figure 20.1 illustrates the fit for the three applications and their various uses across the life-cycle of a construction project.

Figure 20.1 InCITE Application Fit to Project Life-Cycle



Purchasing

John Holland's involvement with Purchasing has been limited to date. Supplier adoption meetings have been conducted with major suppliers of John Holland and the other CITE companies, but up-take has been slow. The main reason for this is a "chicken and egg" situation where suppliers are reluctant to come on board until the major contractors are using the system; and major contractors will not commit until the suppliers are trading. However, CITE Australia is committed to developing the use of Purchasing, and the uptake of the system is gaining momentum. Two of the CITE companies have already developed an interface with their back office applications.

There are also cultural barriers that are hindering the implementation of the purchasing system. Potential users perceive that there will be a loss of face-to- face negotiation between supplier and contractor, and that they will have reduced involvement in the selection of preferred suppliers for a project. However, using the application does not affect the way in which deals and agreements are negotiated, and there is no reason why projects should not play a key role in selecting their suppliers, as they do under existing systems.

Some site personnel are not comfortable with using an electronic on-line system for purchasing, or they feel they are too busy to raise orders through the system and would prefer to use the phone or fax. Raising orders through the application at point of purchase saves administration time as well as providing project management with accurate cost commitments. However, the system does not preclude site staff from using the phone or fax to place orders as long as this meets with the approval of project management, and someone is given the task of raising the necessary purchase order number on their behalf.

John Holland is preparing to commence pilot use of the system at selected offices and sites in the near future.

Purchasing: summary of findings

Purchasing provides a platform that ensures site staff are placing orders with pre-qualified and approved suppliers, using project or company negotiated prices and terms, adhering to formal approval cycles, controlling receipt of goods and keeping an accurate and up-to-date record of commitments. Purchasing will streamline order and invoice processing across all purchasers and suppliers, and will reduce errors and time spent with administration as the application can be integrated into back office systems.

Tender management

John Holland has started using Tender Management in both pre and post-award phases of a project for issuing tender invitations, asking pre-qualification questions, and distributing documents and addenda. At this stage the system has not been used by a client to issue a tender to main contractors, however, the Roads and Traffic Authority (RTA) of NSW is intending to run a pilot tender in the near future.

Use of tender management in the estimating phase (pre-award)

There is a common belief that many subcontractors and suppliers will not use collaborative Web-based tools because they are not technologically able. Moreover, many estimators believe that during the tender phase we are not in a position to demand responses to requests for quotation on-line, or in a prescribed format – that we need the best offer irrespective of the way in which it is submitted.

There is evidence, however, that subcontractors and suppliers are not as technologically backward as the industry perceives. A research paper by Brad Marriott, from John Holland's Newcastle office, aimed to understand the level of acceptance and utilisation of information and communication technology by subcontractors and suppliers.

Brad Marriott sent out a survey questionnaire to 180 businesses supplying goods or services to the construction industry in the Hunter region of NSW. He received 111 completed responses and discovered that of the respondents:

- 95.5% had access to or used a computers at work;
- 89.6% used a computer at least once a day;
- 94.3% had internet access at work; and
- 89% considered their level of computer experience was at general level or higher

(Marriot, 2004).

John Holland's NSW/ACT branch has run eight tenders in the estimating phase using Tender Management. They have taken a conservative approach by focussing on the industries involved in the supply and installation of building services (lifts, fire, hydraulic, electrical and mechanical services). It appears there is a greater acceptance for Web-based collaboration amongst this group.

The experience of using Tender Management in this way has been positive. The building services manager from NSW/ACT branch is very supportive of the application and intends to continue to use it on all suitable tenders. The benefits he has noted include:

- immediate notification when someone agrees to tender;
- fast distribution of documents; and
- quick and reliable management of addenda or changes.

Tender Management enables the tender team to separate the particular documents required to tender from those documents that supply additional information. This has meant that subcontractors are not wading through volumes of paper to find what is required. However, if a subcontractor wants to access more information it is readily available.

We have found that some subcontractors have problems downloading and printing the tender documents from the system, often due to their limited printing capability. There has recently been functionality added to the system that allows the subcontractors to simply choose a print bureau, select the documents they want printed, and produce a print order on-line. They will then receive hardcopy of the documents they want.

Another area where Tender Management has been deployed in the estimating phase is with Defence Maintenance Management (DMM), a joint venture between John Holland and Multiplex. In this instance Tender Management was firstly used to issue prequalification questions to gauge which packages subcontractors were interested in. This prequalification method was used as a way of getting the subcontractors registered and familiar with the system before the invitations to tender were issued. Out of 54 subcontractors 44 answered the prequalification successfully on-line.

Based on the subcontractor's response to the prequalification, packages were then issued in the same manner. Of the 64 subcontractors who accepted packages to tender, 25 used the entire process by submitting an electronic quotation. In the case where the subcontractors chose to submit quotations by other means, they still needed to use the system review documents and bills of quantities. The remaining 37 preferred to stick with the traditional method of submission.

Tables 20.1 and 20.2 below summarise the on-line activity for the DMM tender:

Table 20.1 Response to Invitation to Prequalify

Description	Number of invitations	Accepted	Declined	Answered Questions On-line
Prequalification Questionnaire	54	47	0	44

Table 20.2 Response to Requests for Quotation

Description	Number of invitations	Accepted	Declined	Quotation Submitted On-line
Package A	26	18	0	3
Package B	15	11	0	5
Package C	19	13	0	4
Package D	5	1	1	0
Package E	6	4	0	2
Package F	11	4	0	2
Package G	21	13	1	9
TOTAL	103	64	2	25

This tender was in the rural area of the Riverina/Murray Valley in NSW, and indicates that, in this area at least, subcontractors do have the means to use the internet for business. One subcontractor indicated that DMM appeared more professional and organised than the other contractors by using on-

line tools; that the information was presented in a clear format and was easy to find. The DMM team saved time by centralising their administration and the system gave them tight control over the process. The system kept them up-to- date with a subcontractor's progress and every transaction was fully traceable.

Use of tender management in the procurement phase (post-award)

DMM has also run a pilot using Tender Management in the procurement phase. All subcontractors used the system to accept the invitation to tender and to collect their documents. The Project Manager recorded his and the subcontractors' experience in a report that was generally positive.

All the subcontractors believed the system was beneficial to them. One subcontractor in particular noted that its team had increased confidence that they were working off controlled documents, that time was saved in not having to prepare multiple hardcopies, and that they could deliver responses back to the Contractor with ease (Young, 2003).

Tender management: summary of findings

The immediate strength of this application is for efficient distribution and control of documents and addenda. As the industry becomes more familiar with collaborative tendering, the capabilities of the application can be more fully utilised, and the added benefits will be:

- receipt of quotations in a consistent format;
- efficient analysis and comparison of quotations within the application;
- direct transfer of selected prices and details to the main tender or subcontract documents.

Time is always of the essence to a contractor during a tender, and time saved by more efficient receipt and distribution of tender documents, and analysis of quotations can be utilised for engineering, innovation and other refinement of the tender to the client.

Document management

As mentioned above the majority of John Holland's effort to date with the inCITE applications has been directed towards Document Management.

There has been cultural resistance to using a structured, on-line tool such as Document Management. We believe that this is largely due to current proliferation of unstructured e-mail communication, and unfamiliarity with a truly electronic system. Users need to be made aware of the importance of competently capturing and recording project communication, and trained to understand the concept of the system as well as how to operate it.

In general, the collaborative features of the system have been accepted quickly as all stakeholders in a project can readily appreciate the benefit of communicating and sharing documents on the same platform, and being able to access the system in real time from any location.

John Holland has used Document Management in a variety of situations; for tendering, and on active projects in joint ventures, alliances and on our own.

Use of document management on projects

A joint venture of Thiess and John Holland (TJH) is responsible for the design and construction of the Lane Cove Tunnel (LCT) project. That project has employed full use of the Document Management features. It controls all project communication, design, reference materials, procedures, construction documents, human resources and community issues.

An area where the power of on-line collaboration is particularly obvious is in the design review process. The Document Management application has been configured to manage design distribution

and approval processes that involve the consultant, the main contractor, the client's reviewers and the independent verifier. All of these parties are registered to use Document Management and complete all their required actions on line.

The collaborative design review process is based on a combination of a document status and a document naming convention. A document's status is similar to an approval cycle in that it determines the documents progress through the process and can only be changed by authorised stakeholders. For example, only the Independent Verifier can change the status of a document to "Verified".

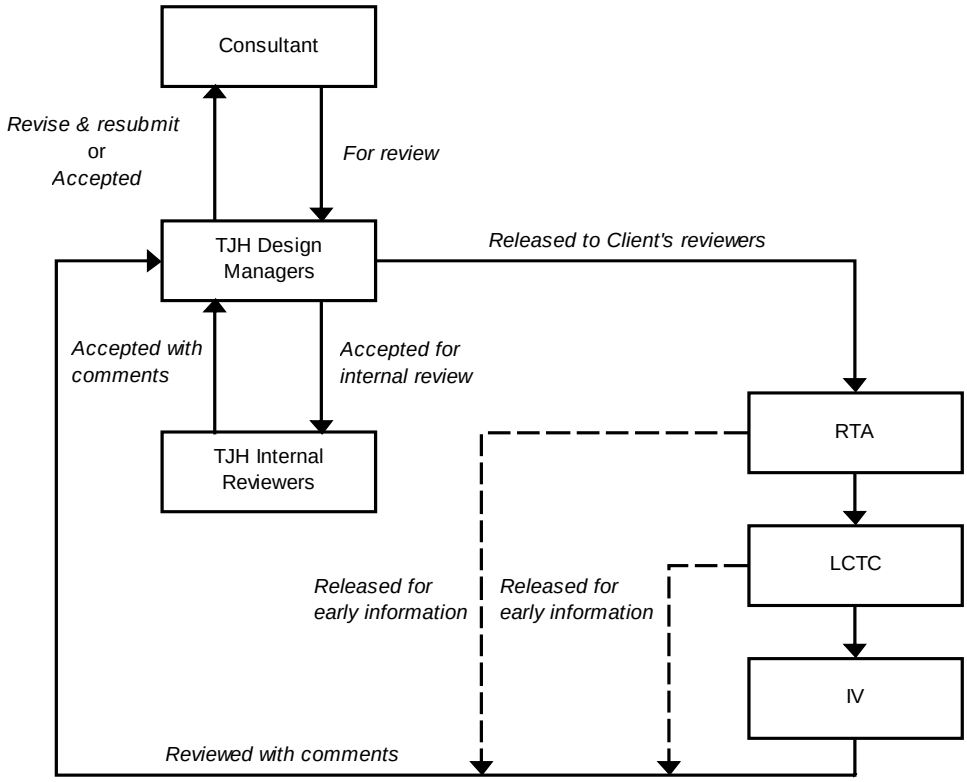
The file naming convention clearly identifies the design document and its version. All Design Consultants on LCT must upload their design lots through inCITE according to this convention. The file name must include codes for document originator, document type, location, design element, document number, revision and version. For example, the file name: PB-SP-TU-DT00- 0058-A-1.pdf indicates the originator is "Parsons Brinckerhoff", the document type is "Specification", the location is "Tunnel", the design element is "Driven Tunnel (General)", the document number is "0058", the revision is "A" and the version is "1".

The reason for this combination of naming convention and status is so the system can organise and automatically distribute the documents through the approval cycle, and also populate the key attributes of the document without the need for manual registration. When the files are uploaded and assigned a status, the system follows preconfigured rules which dictate to who the document should be distributed, and consequently who has access. Design Consultants can only upload files named as indicated above and with a "For TJH Review" status. For example: if the status is "For TJH Review"; if the originator is Parsons Brinckerhoff; if the design element is Driven Tunnel (General); then distribute to the following Thiess John Holland (TJH) personnel.

When TJH members are have finished reviewing the document, they too change the status to progress the design along for revision or acceptance. Once again the distribution rules take into account the file name and the status to determine the document's route. This predefined workflow continues around to all the stakeholders until the design is verified and hence approved for construction.

Figure 20.2 illustrates this flow around the concerned parties:

Figure 20.2 LCT Project Design Review Process



This design process works well in Document Management as people can only see a document when it has achieved a designated status, and they are always viewing the latest version as this only version listed in Document Management (previous versions are maintained in the history). What's more, the system maintains only one copy of each document (or document version) in a central database, so all those who access the system are viewing the same information. This is a very different concept from using e-mail to distribute documents. When a document is e-mailed to ten recipients, ten copies of that file are created, and each recipient must then organise it in such a way as to ensure they always refer to the most recent version.

It is important to note that document in this system can not be altered except if it is uploaded as a new version, in which case it will again enter the distribution and approval process. No document on the system can be deleted and the system maintains a full history and auditable trail of the design process.

We have used similar principles to those described above to configure many other processes on the LCT project so that they are structured, efficient and traceable.

Use of document management in tenders

An example of Document Management for tendering is its use by Gold Coast Water to manage two competitive alliances (a short-listed tender process to select an alliance partner). John Holland was

one of the two proponents on each of the competitive alliances, and assisted Gold Coast Water to configure Document Management to meet their rather special requirements. The system had to be set up so that two proponents could communicate with the client, but they could not see each other, and this was subject to close scrutiny by a probity advisor. The benefit for Gold Coast Water was the ability to efficiently control the method and format of document issue, review and endorsement, because the system's set up was identical for each proponent. The benefit for the proponents was the ability to communicate among their own teams in a secure environment and then forward documents directly to client in the prescribed format and manner without any unnecessary reformatting or administration. The benefit overall was that it ensured all were accessing the latest copies of the correct documents, and a complete audit trail was maintained between each proponent and Gold Coast Water.

Once a preferred proponent is selected, the same platform will be used for the project, with the unsuccessful proponent's information being archived off. We believe that Gold Coast Water are intending to use the system for more such tenders and projects in the future.

DMM have also used Document Management during the tender phase to manage correspondence between contributing parties, and the process of drafting reviewing and approving the extensive documents required to be submitted for a Defence maintenance contract tender.

Document management: summary of findings

At the time of writing, John Holland had eight live Document Management projects. Interest in Web-based document management is growing through the company as more hear about the technology and its success, and we surmount the cultural barriers. John Holland's intention is to establish a series of standard configurations that suit various project types and disciplines in John Holland's businesses. Initially our we are targeting projects that have a collaborative element, such as design and construct projects, joint ventures and alliances, as Document Management can most readily add value to these projects. On each project we conduct a briefing and workshop to get buy-in from all the key stakeholders and to agree aspects of the configuration.

CONCLUSION

In John Holland we believe that Web-based collaboration tools are the way of the future and we are committed to implementing them across our businesses. These tools can provide efficiency and control in the way we communicate, share information and trade.

There are significant cultural barriers to be overcome, including technical inertia and loyalty to prevailing systems and practices, but there is already a growing momentum, and we believe that ultimately Web-based collaboration will alter the way we do business by changing the way we interface with clients, other stakeholders and the supply chain as a whole. It will provide strategic advantage through improved quality management, greater productivity, cost reduction and better interface with the all the project stakeholders.

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CHAPTER 21

Assisting Interactions in a Dynamic Design Process: A New Role for an Adaptive Design Tool

John Gero
Wei Peng

INTRODUCTION

Designing, the process that produces the structure of an artefact that fulfils the expected function and behaviour, is critical for the success of any construction project. A badly designed facility causes operational failures and incurs high maintenance costs. Design quality is concerned with functionality, which addresses how useful the facility is in achieving its purposes, and build quality, that is the performance of the completed facility (OGC, 2004). Among the critical success factors for achieving design quality, a clear design brief that captures clients' requirements, as well as the related appropriate maintenance during the design stage, have been the focus of many design researches. However, design briefs usually contain abstract terms like "cost effective", "environment concerns", etc., which need to be further re-formalised and developed into detailed design behaviours by the designers. Design requirements that drive the process are built inside the design process itself (Suwa et al., 1999). Designing is a process that requires design expertise and creativity. Designers interact with their design environments in developing the design. They also change the course of developing the design based on these interactions.

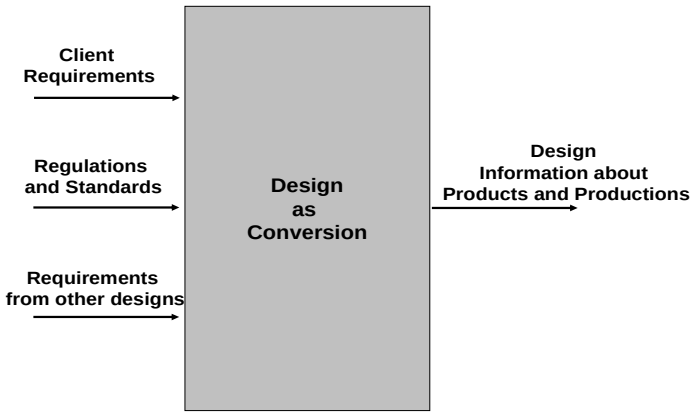
In order to assist designing in this dynamic process, we need to be able to address the interaction between the tool, the problem it is being used on and the user, in the sense that the tool should be able to learn and construct new concepts from its experiences to facilitate interactions. However, unlike designers who gain experience while designing, existing design tools keep repeating themselves irrespective of their interactions with the design environment. Such design tools remain unchanged despite their use. Therefore, the work in this paper is motivated by a desire to assist design tasks throughout the dynamic design process with a knowledgeable and personalised design tool. Such a design tool is knowledgeable since it gains experience from its use. It is also personalised because it will change and adapt its behaviour to the interactions in design based on individual use.

This chapter depicts how a situated agent extends an existing design tool to model interactions, from which the agent learns and constructs its "experiences" in assisting design.

THE NEW ROLE OF THE PROPOSED DESIGN TOOL

Designing can be defined as a means of constructing information in which designers convert clients' functional requirements, regulations and standards, along with their design experiences to design documents. It is a process that is recognised as one of the most complicated of human endeavours. Building design models to understand design process in an attempt to assist this process has long been explored. Recent insights into designing are emerging from the protocol studies of human designers (Gero, 1998). Traditional views of design as static sequential conversion (Figure 21.1) have been taken over by the notion of "situatedness of designing" that brings forth a situated design model that can be used to develop tools in supporting design. From the findings that have been obtained from protocol studies, designers not only synthesise solutions that satisfy initially given requirements, but also invent design issues or requirements that capture important aspects of the given problem (Suwa et al., 1999). For this reason, design requirements are more interactive and situated, in the sense that the designer's interpretations of the requirements change according to what we summarise as "where you are when you do what you do matters".

Figure 21.1 A Sequential Conversion View of Design



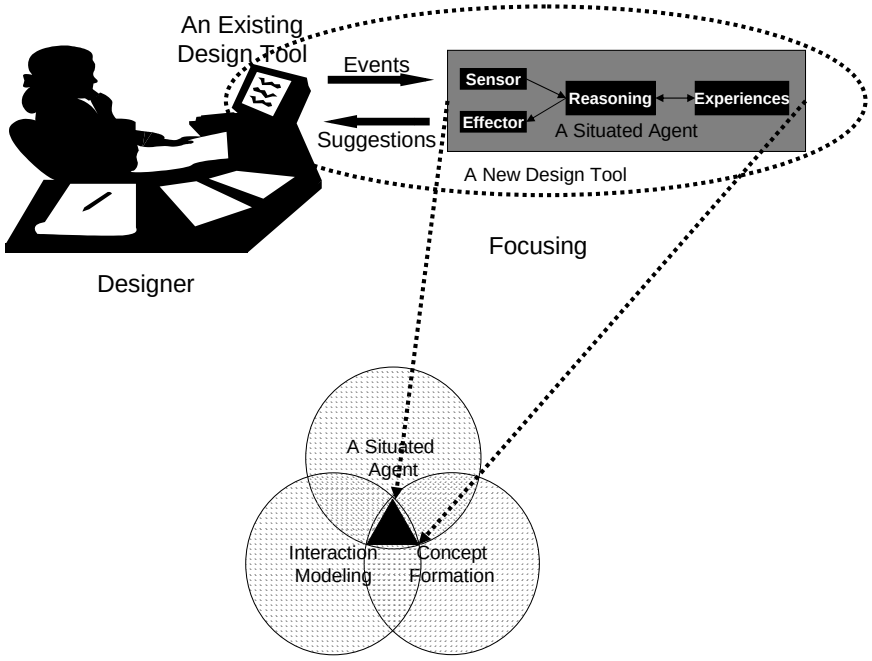
(Source: Adapted from Fabricio et al., 1999)

Therefore, a new approach is needed to address interactions throughout this dynamic design process, such that the interaction between the designer and the tool can be captured. However, under the traditional paradigm, design tools have been built based on the notion that the tool is unchanged by its use (Gero, 2003). These tools communicate with users through "direct manipulation" in which tools as passive entities merely wait and respond to specific, highly detailed instructions (Green et al., 1997). Using these tools in design cannot meet the changing needs of the designers and the design. Thus, our approach is to develop a situated agent which enables a design tool to learn the interactions during design, and to subsequently use the constructed concepts to facilitate interactions between the designer and the design environment. Figure 21.2 illustrates this new design tool and demonstrates how this tool learns from events performed by the designer. The incorporation of a situated agent that can sense and affect its environment enables the design tool to learn the ongoing interactions in the design. The

agent senses the activities of the designer and then constructs interaction concepts. Learning refers to the concept formation process in which the agent's experiences are reinterpreted, re-structured and reinforced. The process includes perceptual categorising, conceptualisation and reflective reasoning of the current design interactions that is a combination of the interpretations of the external and internal environment within which it is situated.

The suggestions produced by the agent contain information about current design situations that snapshots the sets of entities and relationships involved in designing at a given time stamp. These concepts are formed based on the agent's experiential response to the regularities of the observed design tasks, which can be further served as new suggestions to the designer in guiding their design activities.

Figure 21.2 A New Design Tool and its Internal Learning Mechanisms



A FRAMEWORK OF DESIGN TOOLS THAT ADAPT TO THEIR USES

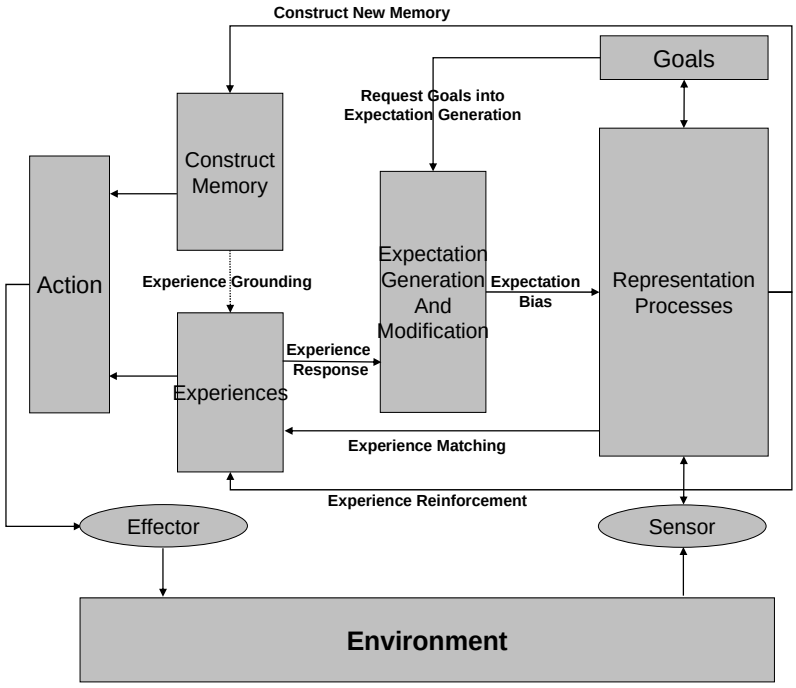
We describe a situated agent that extends an existing design tool to model interactions, from which the agent is able to develop "experiences". Adaptation, as the agent's ability to accommodate incremental changes in the environment, enables the design tool to learn from and cope with the interactions in the dynamic design process. As shown in Figure 21.2, the agent learns from its interaction with the design environment, which includes an existing design tool, the designers, and their activities in forming new concepts that further affect interactions in design. Agent's experiences bias this concept formation process. The constructive memory model (Gero, 1999), which serves as a meta level learning mechanism in controlling base level machine learning approaches, also lets the agent learn new situations that will later be grounded in the agent's experiences by its use.

A situated agent architecture

The agent learns by constructing "experiences" from its interactions with the environments based on its internal representation processes, memory construction and grounding mechanism. The design tool relies on the agent's situated cognition and changes its behaviours, which are embodied as "reflexive", "reactive" and "reflective" behaviour (Maher and Gero, 2002) to adapt to its use. Here adaptation results from the totality of the coordination of these behaviours within the process of memory construction and grounding.

The internal representation processes consist of sensation, perception, conception, hypothesising, expectation generation and modification. Each couples with one another in synthesising data driven from environment with expectation-driven experiences in order to form constructed memory, Figure 21.3.

Figure 21.3 The Architecture of a Situated Agent



(Source: Adapted from Gero & Peng, 2004)

Sensation is the process of generating sensory data from outside stimuli for further processing. Perception is the process of generating percepts from sequencing and coupling sensory data. Perception also structures these adapted sensory data into sequence or simultaneous chunks (percepts) based on past sequences, coupled categorisations (perceptual experiences) and activated abstractions of percepts (concepts). Conception is the process of categorising perceptual sequences and chunks in order to form concepts. Concepts are abstractions of experience that confer a predictive ability for new situations (Rosenstein and Cohen 1998; Smith and Gero, 2000).

Expectation generation and modification processes play a crucial role in constructing memory that matches past experiences. Expectation, which is related to agent's view about possible consequences of certain actions, affects its decision making. The hypothesising process analyses the possible causality of expectation failures and hypothesises possible solutions. A situated agent reinterprets the design environment based on expectations that are regenerated from matching refocused concepts with current situation.

Agent's actions are embodied as design tool's behaviours which result from coordination of internal representation processes. It is through action that the agent's constructed memory is connected with the environment such that feedback from the environment can serve as cues for the modification of agent's behaviours.

The sensor is the unit by which an agent receives and gathers stimuli from environments. An agent obtains access to the environment through sensors and affects the environment via effectors. An effector is the means by which the agent brings changes to the environment through its actions.

The design tool's adaptive behaviour

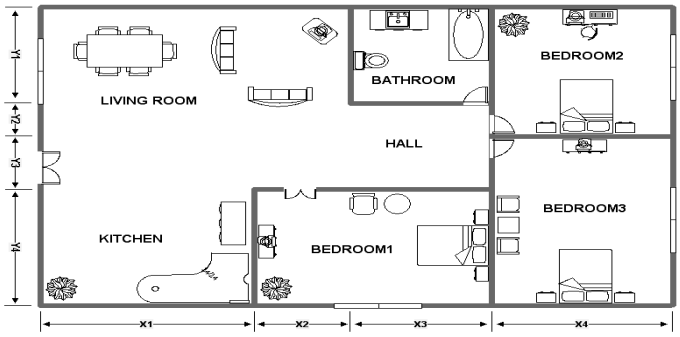
A design tool's adaptive behaviours are embodied as reflexive, reactive and reflective behaviour in response to changing situations occurring in the interactions. We discuss adaptive behaviour, in which the design tool manifests as agent's ability to change tool's behaviours to achieve goals based on the concepts formed from the agent's situated representation mechanisms and a constructive memory system.

An agent responds reflexively to environment stimuli based solely on its experiences without reasoning when its experiential response to current sensed data is sufficiently strong to affect action directly. Agent reacts to environment stimuli, when the experiential response to currently sensed and perceived data is sufficiently strong, such that the perceptual experiences in terms of habitual sequences or coupled information can directly affect actions. In its reflective behaviour, the agent coordinates all the representation processes in providing an ongoing awareness about the situation. It is the agent's reflective behaviour that enables design concepts to be constructed. These concepts represent the agent's belief about the possible incoming events and the consequences of the resulting actions.

A DESIGN SCENARIO

In this section, a simplified spatial layout problem, treated as a design optimisation scenario is discussed to show how this adaptive design tool can be used to improve the designer's interaction. The design objective is to find an optimal layout within certain design constraints. The clients' requirements in this problem are described as "minimise construction cost" and "maximise usage area". The floor layout is described in Figure 21.4.

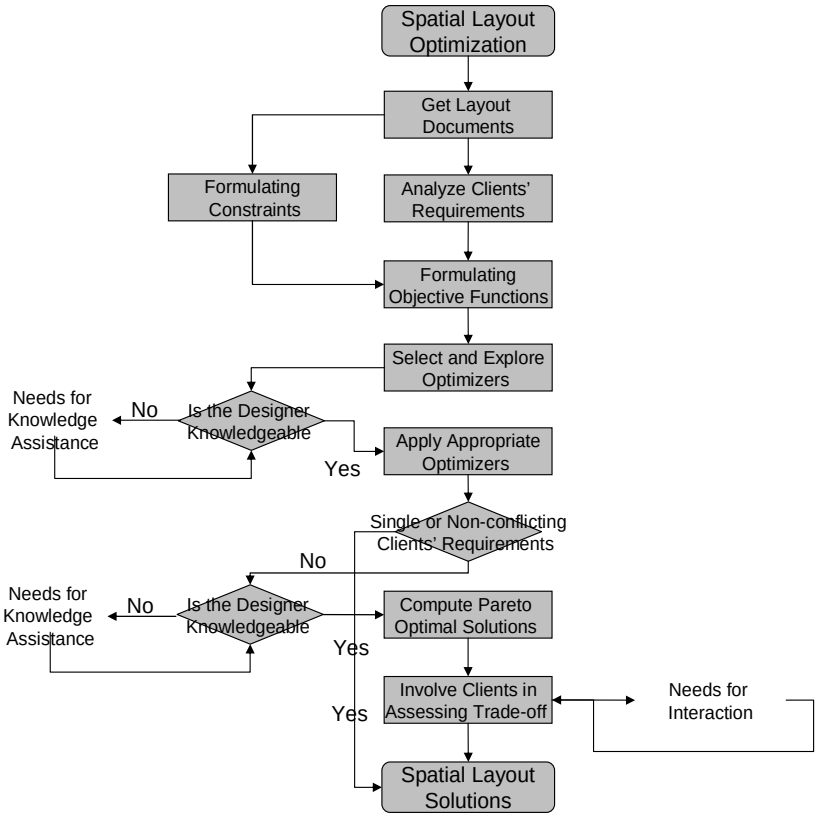
Figure 21.4 The Floor Plan of an Apartment Used for Design Optimisation



A scenario is illustrated in Figure 21.5; designers formulate the clients' requirements into objective functions and then apply a suitable optimisation algorithm to the design problem. They not only choose optimisers based on their own experience, but also explore new approaches in a trial and error manner. In this way, they will eventually reach a solution during the interactions with the design environment.

The solution is only satisfactory to the designer but may not be the optimal. How can a design tool improve its behaviour based on its use by the designer?

Figure 21.5 Needs For Design Knowledge Supports and Interactions For a Typical Design Optimisation Problem



A situated agent can be involved in constructing concepts resulting from the interactions between the agent and its environment that include the designer and the design. Sequences of events performed by the designer are further sensed and perceived by the agent. These environmental variables then activate the agent's associated sensory experiences which are structured as a portion of an Interactive Activation and Competition (IAC) neural network (McClelland 1981; 1995). An IAC neural network applies an activation and competition mechanism to a set of instance nodes that are further linked to groups of property nodes. The agent's sensory, perceptual and conceptual experiences can be represented as different layers of an IAC network. In constructing a concept for the current situation, environment variables undergo different levels of processing (Liew & Gero, 2002) through the agent's internal representation processes and experiences.

Thus, an environment variable at time stamp "Ev(t+n) = {… "click on objective function text field", "K", "X", "^", "2", "+" … "submit objective function" … "select optimisation algorithms", "click on QP algorithm", "K", "X", "^", "2", "+" …"submit" … "Algorithm" … "DP" … "K", "X", "^", "2", "+" … "submit" … "Algorithm" …"GE"…}" can be constructed as a concept that can be used as suggestions for the designer to select suitable optimisers, Figure 21.6.

Another problem arises when the clients' requirements conflict with each other. Then it is necessary to involve the clients in the design process to negotiate a trade-off solution. The objectives

of “lowest construction cost” and “maximum usage area” conflict with each other in this design scenario. With the Pareto optimal set generated, the agent can construct a design concept in terms of a two-dimensional plot which represents each solution in clients’ requirements space, Figure 21.7. Some heuristic rules can also be developed to give a trade-off suggestion to the designer and the clients involved.

Figure 21.6 An Example of Possible Concepts Constructed By the Agent

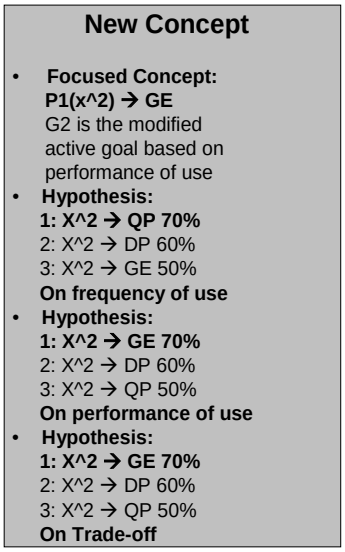
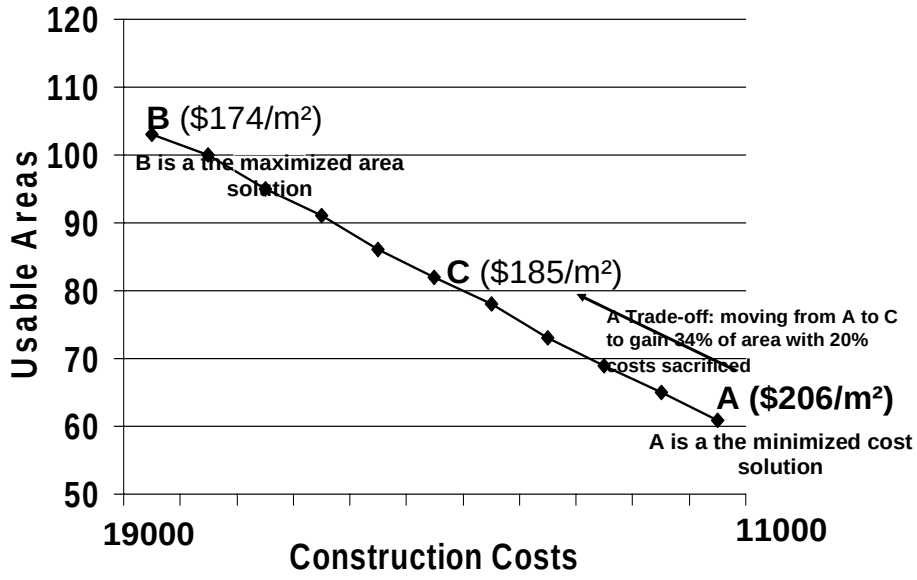


Figure 21.7 An Example of Design Concepts For Solving Conflicting Clients' Requirements (Created From the Data Adapted From Balachandran, 1988)



DISCUSSION

This chapter describes a new role for a design tool to assist the interactions during which the client's requirements can be further developed by designers in a dynamic design process. These client's requirements are formulated into design goals. A situated agent learns and constructs concepts that represent designer interactions with the tools in which the tools used in the design process are augmented to account for the experiences that have been gained in using them.

Within this knowledge demanding design process, the proposed design tool also plays an important role in supporting the design with the knowledge it learnt from the agent's interaction with the design environment. The knowledge constructed during designing is further grounded as experience which subsequently biases the agent's concept formation in a later time frame. Designers are connected to the agent's knowledge which can guide the interactions in design. However, this is not to suggest that the tool will be developed into a knowledge database that is widely regarded as not dynamic in addressing the interactions in the design. Even a tool that learns about a particular problem may not be applicable in another domain because the problems lack similarities (Gero, 1996). To solve this challenging problem, an important notion is that the tool is being reused instead of the knowledge which is constructed during the usage of the tool. We may need to build specialised agent for particular tasks or functions of design tools.

As a common ground that can be shared by the design teams and even the clients, this adaptive design tool is able to be personalised so that different user groups have their own interactions. This will be one of the future milestones yet to be delivered.

ACKNOWLEDGEMENT

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CHAPTER 22

Demonstrating Excellence through Client Engagement

Dennis Lenard
Elizabeth Whatmore
Don Ward

INTRODUCTION

In 1998 the report "Rethinking Construction" (Construction Task Force chaired by Sir John Egan, HMSO, DETR 1998) made 72 recommendations to make the UK construction industry world class. The emphasis in the report was the performance of other industries and how these lessons could be translated into the construction sector. The way forward for the sector was five proposals that set out the conditions for Government, Clients and the Industry to interact in many differing ways. These were:

Demonstration projects; projects that demonstrated the business case for change and innovation in the UK construction industry

*Movement for Change***;** [Innovation]; a non institutionalised group that facilitated the demonstration projects and the UK change agenda, set up in 1998 by DETR (Department of Environment Transport and Regions - dissolved in 2002, Construction transferred to Department of Trade and Industry DTI)

Knowledge Centre; The DETR was developing the Construction Best Practice Programme and this group fulfilled the role of providing a knowledge centre for the UK construction industry. Both The Movement for Innovation, the Housing Forum, Local Government Task Force and Construction Best Practice have merged under the umbrella of Constructing Excellence (Constructing Excellence, 2003).

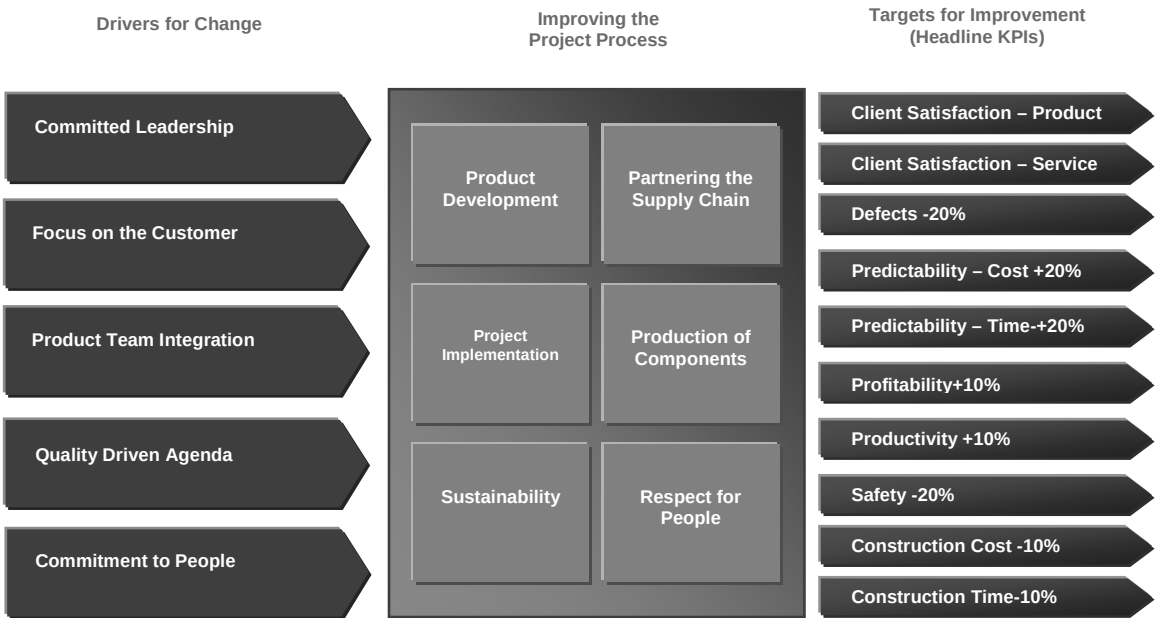
Public Sector Clients; As the Public sector is the largest client of the construction sector, the government delivered both the Government Clients Construction Panel, and Local Government Task Force to take leadership and promote innovation in the procurement and delivery of construction in the UK. The majority of innovative output is recorded in the demonstration project programme.

Occasional Clients; A programme for the occasional clients many of whom procure major projects; it was of concern to the task force that this level of activity would be excluded from the change agenda. A charter was created under the auspices of the Construction Clients Group (http://www.clientsuccess.org/home_1.asp)

Branded Products; The Task Group felt that the industry must grasp the opportunity of improvement through specialisations and the creation of supply chains to deliver products for major clients i.e. the experience of getting well, rather than the hospital project as a driver for performance improvement.

The model for the UK construction industry is simply to create an industrial movement for change. Initially the target was for £500m, so that businesses, individuals and corporations could come together to share and learn best practice, and aggregate ideas on innovation based on evidence for bottom line improvement. All this was achieved through a Demonstration Project Programme now comprising 445 projects. The programme demonstrated innovation around the drivers for change, the key process and the targets as set out below.

Figure 22.1 Constructing Excellence Model For Change in the UK Construction Industry



All UK based demonstration projects have delivered tangible improvements by implementing innovation in the above project processes, they have used cultural drivers for change with respect for people issues. All measured their improvements in relation to the above targets.

In a market where there is (at least in terms of perception) little competition, incentive to innovate or no risk of being globally challenged, it was largely the conditions placed on the sector by clients that led to such significant results. There are two distinct models, one based on cost predominately in the private sector, whereby lowest outturn cost is a key operating measure. However changes in the way the public sector was funded looking at value rather than cost and looking at whole life and the removal of the requirement of Compulsory Competitive Tendering allowed the public sector to look at tested and tangible ways of obtaining a value driven sustainable approach to design and construction. The primary measure for the public sector still remains return on capital efficiency, but with incorporation of a better understanding of value in achieving this efficiency. It is here that Constructing Excellence has helped to improve the competitiveness of the UK by:

- enhancing corporate competitiveness through business innovation
- improving service and product quality by measuring industry performance

- providing a business to business network

The May 2004 Report from the Demonstrating Excellence Programme continues to indicate that demonstration projects outperform the general construction industry in all but one of the key performance indicators. This has been a trend since the programme started in 1998. These projects have shown that they are safer, deliver better environmental performance and also are more productive and offer better services and products to clients. Generally these improvements are in line with the targets set up in the report Rethinking Construction (1998); with the result that demonstration is a vital driver for innovation, competitiveness and productivity improvement for the sector at large.

Some of the key findings are:

- demonstration projects are more than twice as safe as the industry average
- demonstration projects are scoring more than twice the industry average in employee satisfaction
- productivity on demonstration projects is 65 % more than the industry average
- environmental performance is 40% more than the industry average

The results show that the best are getting better, but most encouraging is the fact that the whole industry performance is also rising. Whilst there are many variances in projects and procurement routes, the common factor in the demonstration projects is direct client engagement and leadership and facilitation of innovation.

The Demonstration Programme has created the conditions in the UK whereby the construction industry, clients and government can come together to collectively improve performance through the sharing, learning of best practice and innovation.

A good gauge of industry improvement is client satisfaction and over the last five years the results show a steady increase in product and service satisfaction.

There has been a welcome increase in the number of firms reporting zero accidents.

RESEARCH METHODOLOGY

The demonstration project process comprises the requirement to codify innovation through peer review. Each project has to prepare a case history and produce a set of Key Performance Indicators. The data from the demonstration project Key Performance Indicators and case histories is then compared to the broader construction industry.

The case histories investigate the following areas:

- the codification of the innovation
- the specific tangible benefits of the innovation
- the lessons learnt and recommendations for the future
- the performance of the project benchmarked against industry norms.

The data is collected and presented at peer review meetings where the knowledge is shared across the industry. The peer review meetings are cross-sectoral. The submitted innovations are scored by a peer group and in most cases by an executive board to provide a level of consistency. At this meeting we also record the peer comment and learning points for each attendee. Case studies are then derived from the data. This is how the knowledge is transferred across the sector, raising the performance of the participants.

The UK demonstration project process and Key Performance Indicator system is now being used to facilitate the sharing of knowledge across the world and compare relative progress. Constructing Excellence Key Performance Indicators are being used as the standard on which to base benchmarks internationally.

RESULT OF CLIENT DRIVEN INNOVATION

The business benefit for an ongoing Demonstration Programme is clearly shown in the table below:

Table 22.1 Business Benefits For An Ongoing Demonstration Programme

Demonstration Projects' performance 4 year average	Rethinking Construction Demonstration Projects (£7bn)	Construction Industry, as a whole (£70bn)
Client Construction Cost Demonstration project costs are **6.0%** lower than industry average	Reduced client construction costs from Demonstration Projects = **£420m**	Reduced client costs if one-third of industry take up = **£1.4bn**
Safety Demonstration project accident rates are **61%** lower than industry average. Estimates put accident costs across the industry at **8.5%** of turnover*	Reduced costs of accidents from Demonstration Projects = **£363m**	Reduced costs if one-third of industry take up = **£1.2bn**
Profitability Rethinking Construction projects achieve **2 per cent** more profit than the industry average	Increased profit from Demonstration Projects = **£140m**	Increased profit if one-third of industry take up = **£466m**

(Source: Rethinking Construction Report 2003, www.constructingexcellence.org.uk/publications)

THE STUDY

The aim of the overall study (part only is presented here) was to explore the role of the client and the contractor in promoting innovation and learning in the project and procurement process.

The projects described in the case studies reflect the clients' success. They describe how they did this by taking a team approach and by working with people they trusted and who shared their values rather than with people who offered the lowest tenders. This approach released value from the supply chain, and project costs were held without prejudicing success. Discussions were open and frank, with everyone realising that changes were to be expected and would require managing.

A set of common attributes was identified in the majority of projects. The attributes also delivered benefits in both positive and negative outcomes of a project demonstration. These were:

- *Drivers In The Procurement Process*

This attribute encompassed the relationship between the client and the main contractor, subcontractors and suppliers in terms of the client's expectations of the contracted parties and the forms of contract that were in place (i.e. lump sum, design and construct and any partnering arrangements). However in the majority of projects an overriding set of working principles was created by a statement of shared vision and values, this focused the proactive attitude needed to make such improvements.

Typically the scope of the project allowed the team's role to explore any incentives to be put in place to encourage the supply side to make innovative contributions to the design, procurement and construction process. The incentive for the team to deliver improved performance was facilitated by two major factors, appropriate allocation of risk and often the concept of target costs and risk/reward mechanisms for project management.

- *Planning And Communication*

Attributes included the significant extent to which the main contractor, suppliers and subcontractors were involved in decision making, project development and project delivery processes. A process of conflict/dispute resolution was installed on many of the projects to allow decision

making to be made at the lowest level. This finding was part of the examination of the systems and procedures put in place to facilitate communication between the client and the contracted parties. This examination also aimed to identify how improvements were incorporated into the procurement process; more specifically, whether such improvements came from the client, or whether there was scope for suppliers and subcontractors to provide input.

- *Imparting Knowledge To The Project Team*

Particular emphasis was placed on the role of the client, in terms of creating a learning environment, applying knowledge to the site and the implementation of best practices. The transfer of knowledge from the contracted parties to the client was also examined in terms of how such transfer is facilitated and encouraged.

SUMMARY

In summary we have investigated a number of projects, and to increase the likelihood of success we have identified a number of key attributes.
These are:

- quality based selection of the team
- target cost contracts/partnering contracts
- fair allocation of risk
- shared values
- dispute and conflict resolution
- effective planning and communication in the value chain
- the right people leading the project at the right time
- quality driven approach to information and material streams
- value engineering and value management
- stakeholder participation
- key performance indicators
- review and improvement processes

Case studies

Case study 1: Blackpool Borough Council- St Stephens Avenue coastal protection scheme

When Blackpool Borough Council decided to adopt the principles of Rethinking Construction, they realised that they had to ensure that their construction work provided the best quality and value for money for the residents of Blackpool. Their long journey began in 1998 when they set up a working party to evaluate the Report ”Rethinking Construction” with the eventual conclusion that the Council should “embrace the Report’s findings”.

This then lead the Council on an awareness raising programme that took in meetings, seminars and conferences involving the likes of Rethinking Construction, the Movement for Innovation and the Construction Best Practice Programme. In order to put the principles they had learnt into practice, the Council decided to adopt one of their projects as an M4I demonstration project and, in August 2000, the St Stephens Avenue Coastal Protection Scheme - a project for the reconstruction of time-expired concrete coastal defences - was chosen.

The Council, through Technical Services, was determined that any new systems and methods that were to be adopted would be “robust and transferable” to all future work done by all Blackpool Borough Council departments - “A Better Way” - and some of the key lessons learnt are as follows:

- *A new procurement strategy with selection on the basis of quality*

The first stage for Blackpool Borough Council and Technical Services was the development of a procurement strategy that made selection on the basis of quality and not on lowest cost. In the case of the St Stephens Avenue contract, price negotiations were to take place after the selection of a successful partner. As funding for the project was coming from both the Council and DEFRA - both of which organisations have rigorous audit systems - any new way of procurement had to have clear selection criteria in order to demonstrate that best value had been achieved.

Nine contractors were initially invited to make early submissions giving details on:

- recent work (for references)
- financial information (on the contractor)
- recent experience and capability
- health & safety
- quality management
- staff
- subcontractors and suppliers
- environmental policy

As a result of the above, three contractors were then invited to make separate, scheme specific, formal presentations that covered the following:

- Quality
- design & construction planning
- health & safety
- resourcing & partnerships
- risk & value management
- quantification & pricing
- conditions of contract
- environmental measurers
- benchmarking & performance indicators
- financial controls

The presentations were assessed by Technical Services using a matrix scoring system with Birse Construction achieving the highest score and subsequently being recommended as the Council's "Construction Partner" for the St Stephens Avenue scheme.

Blackpool Borough Council considered that it was important to have a clearly defined contract that all potential contractors agreed to and bought in to - the main criteria being that the contract used would work on all future projects as well.

After considering various standard contracts already available, Technical Services eventually decided upon the NEC Option C X12 Partnering Agreement (June 2001) as being the most suitable as it enabled true partnering and provided incentivisation for the contractor, the supply chain and the client whilst providing a ceiling of certainty to the contract in the form of a maximum lump sum price.

Having selected the main contractor there was still a lot of hard work to do before construction work could begin on the project. Perhaps the most significant difference in the way that Blackpool Borough Council developed this method of procurement was in the open and frank discussions that took place at this early stage, which enabled problems to be resolved amicably prior to commencement of the work.

Past experience had shown that such early resolution of problems ensured that "entrenched positions" were not likely to be adopted during the construction phase. Additionally, integrating the team early enabled value to be maximised through a combination of buildability, value engineering, design enhancements and risk management using the experience of the whole supply chain.

- *Contract value*

The next stage for Technical Services was to agree the value of the contract. Value For money was guaranteed by analysing previous similar contracts and extrapolating the tender costs of the competing contractors to obtain a benchmark cost for the St Stephens Avenue project.

After a period of negotiation, a guaranteed maximum price was agreed upon by Technical Services and Birse and, as part of this procedure, a "gainshare" agreement was also struck whereby any costs above the guaranteed maximum price would be met by Birse and that any savings made below the maximum would be shared by Blackpool Borough Council and Birse on a percentage formula. After agreeing the value of the contract a Value Engineering workshop was held involving project staff from Blackpool Borough Council and Birse, where the whole scheme was reviewed. After an assessment of cost, time, practicality and whole-life issues, several items were considered and built into the project.

- *Measurement and Key Performance Indicators*

Measurement and benchmarking were a key part of the St Stephens Avenue scheme – not only were they a method for driving continuous improvement throughout the supply chain, but also satisfactory KPI achievement was used as a measure for the amount of any earned saving share-out between the client and the main contractor.

- *The lessons learnt (so far)*

Now that the St Stephens Avenue Coastal Protection Scheme has reached the construction stage, it is worthwhile considering the lessons learnt so far. The change by the Council to this new style of working has not been a short one. It needed considerable planning and the involvement of all relevant stakeholders within the Council. A clear auditable procurement policy was necessary to show that best value was obtained without recourse to lowest cost.

The NEC OptionC Xl2Partnering Agreement (June 2001) provides for partnering and gainshare through-out the supply chain. It is wrong to think that the selection of the contractor is the end of the hard work. The selection of the contractor was followed by a period of tough but open negotiations before the commencement of work. This enabled problems and issues to be aired at a point when changes were far easier to implement. It also meant that the quality of the construction could be maintained at an appropriate standard, with cost efficiencies also being maintained. A process of value engineering is an integral part of the procedure so that all members of the supply chain benefit.

Benchmarking is an important tool that can be used for continuous improvement and as a performance indicator upon which gainshare can be made dependent. Finally it is worthwhile adding that the project teams have found working in this way a more rewarding experience, which they feel will continue to benefit all parties in the future.

Case study 2: Project Aquarius

Project Aquarius is a series of civil engineering infrastructure projects carried out by Water Service Northern Ireland. The projects entail pipeline laying, water treatment works and various reservoirs and infrastructure modifications. The driver for the project is the European Waste Water Directive, along with the need for strategic upgrading of the water, waste treatment and distribution in the province.

The client in this case is a central government department who has been a traditionally conservative procurer. We use the term conservative due to the recent past of the province whereby project procurement needed to assure adequate equality, and whereby rules and regulation tended to preclude much innovative client practice. However, the Government Clients Construction Panel (GCCP) is a result of a secondment to the UKs. The GCCP is a panel of central government clients who met and devised a series of policies and guidance notes on new methods of public sector procurement. It was noted by the client of the project that aspects of traditional procurement practices could be changed to encourage innovation and collaboration whilst retaining the need to ensure

equality. (Due to the troubles in NI, equality in the selection of personnel had to comply with local by-laws, section 76)

The tendering process

To facilitate innovation, the client started with standard target cost contracts based on the NEC option C form of contract. After several contracts the client needed to ensure that transaction costs were kept to a minimum and that the time to "dig" from tender was also shortened to meet with the client's many programmes of work. Typically the process to get to tender stage took many years so a procedure to speed up the delivery of projects was needed. This approach was facilitated by a frame-work agreement. The frame-work is essentially an umbrella agreement and protocol document that allows a series of construction projects to be delivered without unnecessary bureaucracy. The frame-work is a quality based procurement and selection tool, its primary purpose is to short list supply chains for project delivery. The tendering basis was 85% quality 15% cost. The client uses the quality based selection methodology after deciding in each case the necessary requirements and objectives of the project. The supplier is then given the opportunity to bid in a process that is designed to align competencies and values in the prospective supply chain. Project execution in this scenario is based on an ongoing continuous improvement programme ensuring best value for money is derived, and that financial probity is adhered to without the need for subsequent tendering processes.

Client innovation

Through the process of selection the client identified a number of key traits required from the supply chain. The client investigated key statements from the suppliers and scored them on their ability to innovate in terms of business and technical matters.

Most significant of the many improvement techniques is the use of value management & value engineering. This activity was delivered in a series of workshops. Also some areas of integration & synergistic partnerships were resultant as part of this process.

Stakeholder buy-in at the time of the individual project value engineering exercise is crucial to ensure perceptions and expectations are clearly obvious and considered. However, the improvement processes plateau after several iterations of the project process.

The client needed a new focus for the delivery of the projects that improved performance of a sustainable basis.

The uses of the tools from the other sectors were transferred into the client organisation and principal contractor. The primary tools were:

1. creating the conditions for innovation
2. tools for developing systematic innovation
3. tools for development of the supply chain.

1. Creating the conditions for innovation

"Project Aquarius" is a brand that builds together the values of the team. This allows most teams to be able to focus on the delivery of the projects. Appropriate risk allocation in most instances now lies with the client who in most circumstances, is best placed to manage risk.

A values workshop for each project was held and looks at key policy deployment issues. This delivered targets for financial benefits, productivity and heads of agreement.

An empowered team was set up able to deliver innovation within the parameters set out within the scope and Heads of Agreement.

A contractual frame work provides for the setting of a fixed scope and cost to ensure quality and predictability. Overheads and profits are dealt with under the auspices of this frame work. Costs and scopes are then engineered to deliver full functionality at the best costs using a must, should, could and would selection process. The client leads the stake-holders in these exercises and all agree as to the way forward thereby facilitating an environment of innovation.

A series of interdependent delivery teams were set up to focus and co-ordinate costs, information and interfaces in order to help the delivery of innovation and cross functional working.

The team applied new tools from other industries by the client as a result of Constructing Excellence's innovation and business development clusters.

These were:

- workplace organisation (Masaaki Imai, Gemba Kaizan 1997)
- value stream analysis (Seeing the whole, Dan Jones and Jim Womack)
- triz – theory of inventive problem solving (G Altschuller, and suddenly the inventor appeared 1996)
- production control (Last Planner, Lean Construction Institute, Glen Ballard, Greg Howe) (Critical Chain Scheduling, Dr Eli Goldratt)

Tackling people issues such as team effectiveness, process improvements and the way the teams are organised. The client codified this into a route map for success.

Aligning vision and values across the value chain and policy deployment, getting the message across in terms of targets and improvement teams were foundation stones of creating the conditions for innovation. Policy deployment gave the compelling need to deliver change in process thinking.

2. Tools for developing Systematic Innovation

The client implemented training in the use of value stream analysis, in particular the Toyota based tool of process activity mapping.

The client mapped the time value is added [value add] in relation to the total time spent by objects flowing through a process. Records show that use of this tool has helped others make sustainable improvement decisions for over several decades.

By continually measuring the value add in objects, information and people flowing through processes, a factual base line about performance is established and from this continuous improvement targets could be achieved. Typically doubling of production could be achieved from the result of this process.

The client measured value add in the concrete, rebar process, the notion is that both processes were thought to be quite productive, however using process activity mapping they found that efficacy was as low as 4%. By improving the layout and innovating in the tying of rebar they managed to make a 75% increase in the pours that could be achieved in a day.

The tool used quantifies and visualises waste in process in a graphical format thereby allowing easier diagnosis of where areas for improvement lie.

Supplementary tools were used such as Workplace Organisation Techniques such as 5S to ensure standards were maintained and improved.

Production control was the next area where big losses were identified. Up to 50% of time is typically added as safety in general construction timeline. The use of Critical Chain Scheduling and Buffer Management, aided in the control of interfaces and communication and reduction in the programme through waste minimisation.

Currently the programme is 10% ahead of time with zero losses for quality and 20% under budget, saving several millions of pounds.

3. Tools for development of the supply chain.

The team, once grounded in the concepts and the use of the above mentioned tools, looked at supplier development as an opportunity for further savings on the project.

The contractual arrangement for the supplier [Steelwork fabricator] was in essence a mirror of the target cost arrangement. The problems facing the site were predictability issues regarding delivery and satisfactory cost management. Cost issues internally were due to increased costs due to overtime; this was factored into the price to the main contractor.

The team carried out a process activity map and work place organisation survey and delivered a £30,000 saving to the contract and increased the capacity of the factory so that overtime was reduced to zero.

Delivery was improved due to much more predictable process based on understanding work flow through the factory.

Commentary

Much of the paper addresses the way relationships have changed and how the suppliers are satisfying clients' demands for change. This final commentary addresses the future and the need for technological innovation, indeed this was a feature of the longer term improvements in case history 2.

Many construction contractors agree that there is a significant need for improvement, particularly in the areas of efficiency, flexibility and management practices. Certainly, over the past ten years, the construction industry has been forced to address a variety of issues as they have acquired greater industrial, organisational, legal and commercial importance. The construction market in general is becoming more competitive as firms are required to exhibit a level of organisational, technical and commercial sophistication not previously envisaged. Construction facilities are becoming increasingly complex, demanding greater technological sophistication to build them. The ongoing change requires extensive supply reorganisation and (Office of the Deputy Prime Minister, MMC, Modern Methods of Construction) MC just to deliver the required volume of dwellings and infrastructure requirements for the UK. To get a scale on this viz. 30,000 new homes per annum in London alone up to 2016. Clients are demanding 'more construction for their money' in a number of spheres, from the purely financial to the environmental. These factors necessitate change and place a new emphasis on the need to increase the industry's capacity for innovation. This can only be done if the client demands improvement, measurement and improvement in the value add component of process performance.

However, while improvements have been made in some areas, there is a general concern that if systematic change is not being achieved that the aforementioned small gains will be lost once industry activity continues to increase. The next wave of industrial development will necessarily incorporate the adoption and utilisation of innovative technological processes and developments, and see the emergence of highly responsive organisations capable of exploiting transient and niche markets. This polarised environment (Rethinking Construction 7 th Target "improve turnover and profits by 10% on the preface of industry reorganisation) demands a responsive and dynamic construction industry with the diversity to cope with and initiate change, that is capable of employing a range of approaches to the procurement and delivery of construction. This will necessitate a much stronger emphasis on innovation than ever before.

The question as to why the construction sector (demand) has not taken up such technologies needs to be addressed. Quite simply it may be down to lack of competition in the UK marketplace. For a construction organisation to commit itself to the use of advanced technology over an established practice it must be seen to benefit the construction process in at least four areas, ie the project objectives, expected benefits, risk and liability (insurances), and cost. The project objectives and technical requirements set basic criteria for acceptance of the final product and selection of a method

to produce it. The expected benefits include competitive advantage in winning the job and performance advantage in decreasing costs and schedules, with resulting improvements to profitability. Further, the new technology must be proven to out-perform existing technology.

Unfortunately, new technology rarely satisfies such exacting criteria immediately. Often, it has to be tailored to meet specific needs or environmental conditions, and staff must be educated as to its use (processes which may take considerable time and resources). These factors, combined with the absence of reliable templates against which to cost new technology, have meant that the construction industry has been slow to invest in this area and as a result, has not reaped the benefits such technology has furnished in other industry sectors. However the West's drive for innovation through technology needs to be accepted cautiously, simply the business model for the sector needs to be reviewed and passed before technology takes hold.

There are several structural problems that exist within the construction industry due to lack of competition. The construction industry's inability to measure and improve "value add" when compared to world-class organisations. If this simple process was driven by clients the improvement potential would last for upwards of 40 years, viz Toyota cars, and most likely reduce the perceived skills deficit to oversupply in less than 3 years.

If the industry is to adopt a more innovative stance, then it is imperative that it explores the use of advanced technology and incorporates the need for such exploration into the planning process. Construction plans and budgets must recognise the start-up costs of new technologies. This includes the cost of hardware, parts, technical support and training for the new operation and the possible lower production and productivity of the new method during the start-up period. In other words we need to set projects up as a business and balance the capital investment to labour ratio.

Innovation

Through the programme of demonstrations, Constructing Excellence is proving that construction projects procured and carried out through integrated techniques achieve:

- better quality
- fewer accidents
- increased productivity
- a staff turnover that is three times better than the industry average
- A more qualified and highly satisfied work force.
- Completion in less time than the rest of the industry that is still dominated by those using traditional techniques.

In spite of this evidence many construction clients continue to favour the traditional method of segregated teams. This is an inefficient way of working, typically less than 1%.

Although profitability on demonstrations has remained consistent, there still remains a challenge to the industry to turn competitive advantage into improved profitability. However it is clear from the figures that many organisations are investing in the long-term and also many are involved in the early stages of frame-work agreements, which requires upfront investment.

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CHAPTER 23

Key Lessons and Conclusions

Keith Hampson
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INTRODUCTION

This volume has canvassed and analysed some of the many and varied aspects to understanding and capitalising on the role of the client in the innovation process throughout the construction industry. It has explored and examined the role of the client in different industrial and organisational settings and from a range of perspectives. It has offered frameworks, concepts and case studies to further the knowledge and understanding of the client in the innovation process.

UNDERSTANDING THE ROLE OF THE CLIENT IN THE INNOVATION PROCESS

Contributions throughout the book have highlighted that innovation can occur through competent clients who know what they want and who work to develop new processes and principles to achieve their goals; or innovation may emanate from the synergies of the various stakeholders working together to solve problems and issues.

The major theme of this volume has been the pivotal role of the client in the innovation process. The barriers and enablers have been outlined and examined to determine an agenda for capitalising on the benefits of innovation in the construction sector. One-off responses to problems are costly and time-consuming. It has been suggested that the project approach prevalent in the construction industry works against the widespread dissemination and adoption of innovation (Barlow, 2000). However, the capturing of learning about innovation from case studies within the construction industry in this volume will aid in furthering knowledge and practical application.

IMPLICATIONS FOR PRACTICE

The rich array of case studies provides a promising start for translating some of the research results into a broader organisational and industry context. Translating innovation from a particular setting requires careful consideration of applicability and context, but the lessons from the cases establish good practice examples that demonstrate ways of addressing real problems or offering new ways of thinking about old problems. Recognition and take up of innovation requires more than just simply coming up with new ideas and processes, however. There is a need to translate new ideas into a coherent course of action that is able to be implemented across the construction sector.

The inability of the construction industry to garner the benefits of innovation led Barlow (2000) to suggest that new ways of organising through more cooperative, partnering and collaborative practices would achieve that goal. The focus of the case studies on the importance of building relationships and

ensuring that these relationships with a variety of stakeholders are consolidated early to allow innovation to occur attests to the saliency of research findings linking innovation to relationships.

The importance of values and finding concrete expression of those values in different ways of doing business is a key challenge, but it has arisen as a critical issue in many of the chapters. The case studies and exemplars demonstrate that innovation need not come at greater cost and that the benefits of innovative practices can be achieved in both economic and social terms.

By bringing in the client as a key driver in innovation, the ways of engaging the client necessarily changes. The new rules of engagement require shifting relations, changed attitudes and appropriate support structures (Keast, Mandell, Brown and Woolcock, 2004). The problems of low productivity and poor take-up of innovation besetting the construction industry require a rethinking of ways to implement and diffuse the innovation already occurring. The recurring themes of innovation, relationships and collaboration are allied to the need to work together in new ways to prevent the innovation lag time, ensure that innovation meets the needs of all stakeholders and is able to be implemented across the industry.

AGENDA FOR FURTHER RESEARCH

Innovation is a constant referent in the objective of finding greater productivity and competitiveness within the construction industry. However, the condition under which innovation emerges is not well understood nor is it comprehended how innovation becomes lagged in the construction industry (Barlow, 2000; Winch, 1998).

Blayse and Manley (2004) contend that significant gaps remain in our understanding of the innovation process as there has not been detailed modelling of relationships between the different variables of clients, structure, relations between various parties, procurement, legislative regimes and, organisational actors and resources. Winch (1998) refers to these arenas and actors as comprising the innovation superstructure, made up of clients, regulators and associations and the innovation infrastructure, which includes the contractors, consultants and various suppliers. This larger work of understanding the interactions and effects in the innovation superstructure and infrastructure remains to be undertaken and documented.

This volume has addressed some of the reasons for the slow take-up of innovation and demonstrated areas in which the construction sector may lead - such as in ICT developments and applications, sustainability and technical innovation in buildings. However, there remain obstacles to innovation in the construction industry and, at the same time, there is mounting pressure to find innovative ways to remain competitive.

CONCLUSIONS

This volume has demonstrated that innovation is a feature of the construction industry despite the concern by Barlow (2000) that the industry is not particularly innovative. However, the improved innovation and learning environment that may be achieved through partnering and greater collaboration between project partners advocated by Barlow (2000) has been a fundamental feature of many of the research endeavours leading to greater innovation outlined in this volume.

The clear implication for practical application of the innovation process is that to be successful it requires both systems change and cultural change. An understanding of the opportunity for innovation to occur and an ability to capture those new ideas in a form that accounts for the specific context and operating environment is highly important. The alignment of institutional, industry and organisational structures and processes is argued to be one crucial aspect of an innovation system (Winch, 1998). However, creating a successful innovation environment requires forging both the structural

arrangements to support the generation and uptake of new ideas and a culture of innovation to promote the emergence, generation, implementation and diffusion of those ideas within the construction sector.

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