Decision Matrix compared with Partnering Principles

Report 2001-003-C-02

The research described in this report was carried out by

Author	John Bennett
Project Leader	Tony Sidwell

Research Program C:
Construction Project Delivery Strategies

Project 2001-003-C:
Value Alignment Process for Project Delivery

Introduction

The ideas for this CRC research project are based directly on Sidwell, Kennedy and Chan (2002). That research examined a number of case studies to identify the characteristics of successful projects. The findings were used to construct a matrix of best practice project delivery strategies. The purpose of this literature review is to test the decision matrix against established theory and best practice in the subject of construction project management.

Summary Of Earlier Research

Sidwell, Kennedy and Chan's research comprises case studies of ten projects selected to include building and civil projects, not all of which were successful, and to include a range of innovative delivery processes. The case studies identify actions taken by the project teams to achieve improvements in performance. The resulting data was analysed and discussed at a half-day workshop with twenty-six industry experts who were given the research results as background material prior to the workshop.

The research results include fifty-six variables that influence project success identified by the case studies. Statistical analysis grouped the fifty-six variables into fifteen principal factors of which four are identified as critical in explaining project performance. The aim of the half-day workshop was to express these results in practical ideas for improving the industry's performance. The resulting list of aims and actions is given below in the form used in a published summary of the research results, where the items are described as best practice guidelines.

- *Value to parties*
  Seek high levels of value for all the project participants and stakeholders.
- *Alignment of objectives*
  Break the cycle of mistrust currently at work in the industry. Adopt relationship management techniques to eliminate manufactured, institutional or psychological causes of conflict.
- *Holistic process-lifecycle*
  Adopt a whole of life approach to project outcomes, including a long-term approach to shareholder value if applicable.
- *Value driven selection*
  Use a value driven selection process for all service providers rather than a purely price-driven process.
- *Eliminate duplicated effort*
  Eliminate ambiguity or confusion about roles or responsibilities, particularly about responsibility for the coordination of documentation.
- *Process not contractual arrangement*
  Achieve high standards in key performance measures by using fundamental processes rather than through existing contractual arrangements.

These six sets of aims and actions form one axis of the decision matrix that provides the starting point for this CRC CI research project. The second axis is provided by a five phase model of the construction project process.

- *Idea and feasibility*
- *Planning and design*

- *Construction*
- *Commissioning*
- *Operation*

Fig. 1 The best practice decision matrix

Objective / Phase	Value to parties	Alignment of objectives	Holistic process	Value-driven selection process	Eliminate Duplicated effort	Process not contractual arrangement
Idea	✓	✓	✓	✓	✓	✓
Planning & design	✓	✓	✓	✓	✓	✓
Construction	✓	✓	✓	✓	✓	✓
Commissioning	✓	✓	✓	✓	✓	✓
Operation & maintenance	✓	✓	✓	✓	✓	✓

Sidwell et al 2002

Sidwell, Kennedy and Chan's research begins by describing the fragmented nature of construction project teams. The reasons for this fragmentation are that construction projects draw on the work of many distinct specialists, and most construction firms are very small.

Modern buildings draw on many distinct specialists because buildings are amongst the most complex of modern products. Most construction firms are small because the industry thinks and works in terms of individual projects which makes it difficult to invest in long term improvements in efficiency when there is no way of knowing what skills and knowledge will be needed to tackle the next project. Survival depends on being flexible, so for many professions and trades there are no significant economies of scale available to large firms. This view is reinforced by the structure of the construction trades and project-based sectors of the Australian construction industry which the Department of Industry, Science and Resources (1999) describe as comprising micro-businesses typically having less than 10 employees and indeed some major sectors having an average size of less than 5 employees.

Sidwell, Kennedy and Chan (2002) implicitly accept this fragmentation and their research aims to identify ways of helping project teams design project delivery systems that mitigate well know weaknesses caused by fragmentation. Their research results provide several lists of aims and actions that project teams should consider in seeking to improve their performance. Their research does not provide any measures of the level of improvement aimed at, so it is worth considering what is needed for the performance of the Australian construction industry to equal the best international performance.

How Performance Must Improve

The most relevant measure is provided by the Department of Industry, Science and Resources (1999) which includes a careful evaluation of the performance of seven countries. This suggests that at purchasing power parity, construction in Australia needs to make improvements equivalent to a 35% reduction in project costs to catch up with Germany which has the best performance amongst the seven countries surveyed.

A similar international comparison carried out for the European Union reported in Atkins et al (1994) looked at purchasing power parity costs in the European, Japanese and US construction industries. Three countries are included in both studies, these are Germany, UK and USA. Both studies rank their performance in exactly the same order which adds credibility to both studies. Significantly the European Union study found that the best performance was achieved by the Japanese construction industry. Japan is not included in the Department of Industry, Science and Resources study and Australia is not included in the European Union study. However, combining the results of both studies suggests that Australian construction needs to make improvements equivalent to a 50% reduction in project costs to match Japanese productivity.

Two points need to be made about these measures of comparative project performance. First, they hide huge differences in the performance of national construction industries. Indeed a common theme in national agendas for improvement is the idea that a massive improvement would be achieved by raising the performance of the whole industry to that already achieved by the best. This is likely to be true in Australia since there are a number of case studies of projects that achieved outstandingly good performance, including particularly Hampson, Peters et al (2001).

Second, the measures of comparative project performance expressed in terms of cost do not imply that cost reduction is the primary focus of efforts to improve national construction industries. They are just measures of performance, the improvements can be used to reduce the price the client pays, to increase the profits construction firms make, reduce project times, reduce defects at handover, improve the functional performance of the facility produced, reduce construction's impact on the environment, or any combination of these and indeed many other possible benefits.

The need for improvement is widely accepted, for example Department of Industry, Science and Resources (1999) urges the construction industry to restructure the way it operates and to commit itself to building a better industry. To do this the various sectors, subsectors and firms must strive for new capabilities and competencies. This is reinforced by Construction Queensland (2001) which concludes that clients should seek to reduce the price they pay for new buildings and infrastructure by 30% and achieving this requires participants in the building and construction industry to do things entirely differently rather than just doing better what they do now.

Given the wide acceptance of the need to make significant improvements in the performance of the Australian Construction industry, the next issue to consider is the best way of achieving improvements. Sidwell, Kennedy and Chan's research is concerned with re-engineering the delivery process and as such is clearly intended to make a start on helping the industry improve its performance. The use of re-engineering is consistent with the approach advocated by the UK's Construction Task Force (1998), usually called the Egan Report. This refers to lean production which is essentially the same approach as re-engineering. Both management techniques seek to make processes more efficient by eliminating waste. This is achieved by questioning each action in a process to determine whether it can be eliminated or made more efficient at delivering value for the client.

Project Process Model

Re-engineering begins with a model of the process under consideration. It is therefore appropriate to first consider the axis of the decision matrix that comprises a model of the construction process. Sidwell, Kennedy and Chan (2002) does not explain the source of the five phase model in the decision matrix. However, in describing the research methodology, it does include a fundamental model of construction projects comprising:

- *Inputs*
  These are the client's business needs and the project brief.
- *Transformation*
  This element of the model comprises a virtual organisation formed by the project team, its leadership and organisation, including contractual interfaces, communications, control systems, personal relationships and risk management.
- *Outputs*
  These are the satisfactions delivered to stakeholders, client, local community and construction firms.

The input: transformation: output model is of course the classic systems model except that the feedback element is omitted. This is significant because feedback is vital to controlled systems. Without good feedback construction will continue to deliver its present variable and generally poor levels of performance.

The five phase model included in the decision matrix is similar to those being adopted overseas by organisations seeking to improve the performance of their own national construction industries. For example, Construction Industry Board (1997) describes the equivalent model adopted in the UK that also has five stages.

1. *Getting started*
2. *Defining the project*
3. *Assembling the team*
4. *Designing and constructing*
5. *Completion and evaluation*

The UK model gives more emphasis to the early stages of projects. It regards design and construction as one integrated stage, and does not deal with the operation of the building or other facility produced by a construction project. Never-the-less, the UK model is conceptually similar to Sidwell, Kennedy and Chan's system model and can be related to it as follows:

- *Inputs*

1. Getting started
2. Defining the project
3. Assembling the team

- *Transformation*

4. Designing and constructing

- *Outputs*

5. Completion and evaluation

Construction Industry Board (1997) explains that evaluation refers to an action at the end of a project in which the project team review the outcomes of in-project feedback produced at all the significant milestones throughout the project to guide and improve project performance. The action at the end of a project brings together all the project feedback from all the stages to identify lessons for future projects. Thus the Construction Industry Board's model can be seen as a straight forward expression of the classic model of controlled systems. Importantly it recognises that feedback needs to be ongoing throughout projects.

There would therefore seem to be merit in this CRC-CI research project adopting a process model comprising three fundamental elements:

- *Inputs*
  This includes the processes involved in producing a client's business case and brief for a project, establishing the project's feasibility and assembling key members of the project team.
- *Transformations*
  This includes all the design and construction processes.
- *Outputs*
  This includes the processes involved in the completion, handover and operation of the completed facility.

And adding an additional action of:

- *Feedback*
  This is ongoing throughout projects and culminates in an action at the end of projects which brings together the lessons from the feedback used to control all the design and construction processes.

This model is sufficiently fundamental that it is unlikely to restrict the search for improvements in performance by introducing divisions into project processes that risk inhibiting efficiency. Also it seems appropriate to use a model of the construction project process explicitly based on the classic system model in developing a project delivery decision support system.

However, in practice the terminology of inputs : transformations : outputs is unlikely to be widely understood. Sidwell, Kennedy and Chan's five phase process uses more familiar terminology. Combining the two provides:

- *Ideas and feasibility*
  This stage provides the primary *inputs* comprising the client's business needs and the project brief; and ensures the project's feasibility.
- *Planning and design*
- *Construction*
- *Commissioning*
  These three stages provide the main stages in the *transformation* of the primary inputs into outputs. The transformations are undertaken by a virtual organisation formed by the project team, its leadership and organisation, including contractual interfaces, communications, control systems, personal relationships and risk management.
- *Operation*
  This stage provides the *outputs* delivered to stakeholders, client, local community and construction firms.

Best Practice Guidelines

Most of the work on this CRC-CI research project will need to be devoted to the second axis of the decision matrix that identifies best practice guidelines. There is a mass of literature aimed at understanding and improving the performance of various national construction industries. Much of this literature describes construction project management theory and best practice.

Both the theoretical and practical ideas in the literature have developed through broad, distinct stages. It helps the present research to identify three stages because doing so serves to identify how earlier improvements in performance have been achieved. It also demonstrates that new ideas in a subject do not invalidate all the earlier ideas, rather new ideas identify which older ideas remain valid, explain them more completely and establish their limitations.

Traditional project processes

The first stage is the traditional approach which still influences much of the structure of the construction industry and many of its institutions. Traditional project processes are based on a sequence of separate roles undertaken by established professions and trades. These are well understood and provide the basis for the education and training given to new entrants to the industry.

Traditionally the firms to undertake all the professional and trade roles on any one project are selected using market forces, usually by inviting competitive bids. Markets work by regarding people and organisations as independent, linked only by information about prices. The independence of professions and trades is reinforced by standard forms of contract that define narrow roles and restrict communications to the minimum necessary to coordinate independent work.

As long as construction uses the technologies implicit in the work of established professions and trades and clients are happy to accept slow delivery, traditional market based approaches work well enough and indeed at their best can produce outstandingly good buildings. But when technologies and clients' demands change, problems arise as described in Latham (1994), Crow and Barda (2001) and Construction Queensland (2001). Typically the practical problems include claims, disputes, late completion, poor quality, low profits and all the other signs of an industry in crisis. This is reflected in traditional forms of contract which have denigrated into catalogues of excuses for failure so that extra time and money can be claimed from the client.

The fundamental problem is that the interdependencies between the separate professional and trade roles have changed, more information has to be communicated faster, and traditional processes have no robust ways of dealing with the resulting complex patterns of high impact interdependencies.

Management

Many industries in the 20th century faced with changes in technology and customers' demands have suffered similar crises and responded by adopting management.

Management as a separate activity was invented in America at the end of the 19th Century and it has raised productivity in manufacturing industries right around the world. Construction was late in adopting construction management and project management. For example, these disciplines were not widely used in Australian construction until the 1980s.

In general, managers identify better ways of undertaking direct work and give attention to the interdependencies between workers. As a result work is simplified and standardised and coordinated by procedures and management hierarchies into controlled systems that deliver more or less reliable quality, time and cost. These benefits are provided in return for the additional cost of employing managers, often many layers of managers, arranged in hierarchies. Many traditional professions and trades argue that the management model introduces other costs, for example, they claim that managers inhibit creative work and drive quality down to a standard mediocrity.

The practical ways in which management is brought into construction project processes fall into three categories:

1. Employing a project manager to manage a traditional project process.
2. Appointing a design and construct contractor to manage the whole project process.
3. Employing a management contractor or construction manager to work alongside the consultant design team managing the time and cost of design decisions and managing the work of the specialist contractors.

There is remarkably little objective evidence of the improvements in performance resulting from bringing management into project processes. Bennett, Pothecary and Robinson (1996) describes an unusually detailed comparison of the performance of traditional, and design and construct approaches. This research found that design and construct projects are 15% cheaper than equivalent traditional projects. Also where the design and construct contractor is appointed at the start of the project on the basis of a minimal statement of the client's requirements, completion is 40% faster, while those projects where the contractor is appointed on the basis of an outline design were completed 25% faster than a traditional approach. The data on which these results are based included a few projects that used a management contractor or construction manager and they delivered similar levels of improvement to that achieved on the design and construct projects compared with equivalent traditional projects.

It is significant that these two ways of introducing management are generally applied to fundamentally different kinds of projects. Design and construct is mainly used for small and medium sized projects using well developed designs and technologies, while management construction and construction management tend to be used on large, complex, individually designed projects often using innovative technologies. In both situations the introduction of management results in lower costs and faster completions than is achieved by the traditional approach.

Bennett, Pothecary and Robinson (1996) also examined the claim often made that design and construct results in poor aesthetic appearance. This research found that design and construct projects are more likely to provide an aesthetic appearance that is acceptable to a wide range of people than is the case with traditional building projects where the architect has a central role. Design and construct does not result in great architecture of aesthetic beauty but on the other hand it rarely produces buildings widely regarded as ugly. The research showed that traditional projects are more likely than design and construct to produce great architecture but they are even more likely to produce a building widely regarded as being of poor appearance.

So on balance, it is likely that introducing management into construction projects results in improved cost and time performance and provides more reliable aesthetic appearance. It does this by providing control that eliminates poor performance but at the cost of inhibiting people capable of excellent performance.

However, just as construction was coming to terms with management, other industries were adopting a radically different form of organisation.

Self-organising networks

By 1990, Japan challenged America's position in many leading manufacturing industries, including the car industry where as Womack, Jones and Roos (1990) describe Japanese productivity, quality, response to customers' demands, and value for money was significantly ahead of that in the USA and Europe. The Japanese approach is now used in all the world's leading car industries and other major manufacturing industries, including construction.

The Japanese approach works by creating competent teams empowered to communicate with whoever they need to communicate with to do their work to the highest possible standards. They are guided by mutually agreed objectives and feedback to form self-organizing networks. Links between teams found to be efficient are maintained and developed so long-term relationships between construction clients, consultants, contractors and specialist contractors are a distinctive feature of Japanese construction.

Japanese practice shows that construction can be planned in detail and the plans put into effect consistently and reliably. It embodies a genuinely win: win approach in which zero defects and completion absolutely on time result in lower costs. This is important because it demonstrates that in construction the desired outcomes in efficiency, innovation, certainty and quality can all be achieved consistently, just as they are in other modern industries.

The Egan Report's advocacy of lean production is in effect a plea for the methods developed in Japanese car manufacturing to be applied in the UK construction industry. The report recognizes that this needs fundamental change and so the report is called "Rethinking Construction." The practical actions recommended by Egan are generally called partnering in the UK and USA although in Australia cooperative methods are now usually taken to mean alliancing.

Alliancing is a form of cooperative working defined by Walker, Hampson and Peters (2001) as a joint commitment where parties agree their contribution levels and required profit beforehand and then place these at risk. If one party in the alliance under-performs then all the other alliance partners are at risk of losing their rewards (profits and incentives) and could even share losses according to the agreed project painsharing / gainsharing model. This approach was pioneered in the UK's North Sea oil and gas industries where it initially led to improvements to what was a very low level of performance. However, the explicit provision for failure is a hang over from traditional practice and attitudes. In the North Sea oil and gas industries and in building projects where similar financial arrangements were used, projects degenerated into adversarial methods as partners made claims and counter claims when projects failed to deliver the anticipated rewards.

More recent UK partnering practice deals with the financial arrangements in ways that avoid these problems and concentrate the efforts of project teams on working out how to succeed rather than providing for failure. These financial arrangements are described in a later section of this review that describes best practice partnering under the subheading "Equity."

Alliancing is a first step on the way towards partnering which is the practical way the Japanese approach has been applied in Western manufacturing industries. It was first used in construction in the USA. Partnering requires people to think differently from the way experience in the traditional construction industry has taught them. It requires the professionals who form the project team to take joint responsibility for decisions and project outcomes. Their work is coordinated by cooperative teamworking, they use management techniques and flexible tools as an integral part of teamworking.

Partnering in UK construction as described in Bennett and Jayes (1995) initially relied heavily on the American approach. However, it has been widely used in UK practice and has developed rapidly, no doubt due to its explicit support in both the Latham (1994) and Egan Reports, so that Bennett and Jayes (1998) describes a distinctive and remarkably effective approach. The purpose of partnering is to improve efficiency so that project teams are more productive. The productivity improvements may be used to provide lower prices, higher profits, fewer defects, faster completions, better buildings, safer construction or any other benefit the team chooses.

The CRC CI research project, building as it does on Sidwell, Kennedy and Chan's earlier research into re-engineering project processes, aims to provide Australian construction with the same advantages. Therefore the next step in this literature review is to consider the extent to which best practice partnering is consistent with the best practice guidelines identified by Sidwell, Kennedy and Chan. As an introduction to this comparison, best practice partnering is described in more detail.

Best Practice Partnering

Research has identified generic sets of management actions used by project teams applying partnering successfully. These are described in Bennett and Jayes (1998) which is based on over 200 case studies of partnering in UK construction. It includes the following definition:

> *Partnering is a set of strategic actions which embody the mutual objectives of a number of firms achieved by cooperative decision making aimed at using feedback to continuously improve their joint performance.*

The case studies show that best practice partnering is built up over several years in what Bennett and Jayes call three generations of partnering.

First generation partnering

First generation partnering is a project based approach, even when applied to a series of projects. It is based on project teams agreeing mutual objectives, agreeing a decision making system, and aiming for continuous measurable improvements. Bennett and Jayes (1998) found it provided cost savings of up to 30% and reductions in project times of 40%.

Project partnering begins with the decision to partner by firms that want to work together at improving their performance. Partnering should apply to all the key participants in the whole design and construction process. The client's involvement and commitment is very important. The best arrangements include the main design consultants and the main contractor.

There are initial costs in selecting partners, running workshops and training. The benefits emerge later and so commitment from top management is essential to get through the early stages.

Action teams or task forces that bring together people with the authority to make decisions are used to devise ways of achieving zero defects, reducing construction times, working at making meetings more effective, looking for design improvements, integrating IT systems, and so on.

In looking for better ways of working partnering teams often use tools devised by people who relied on markets and management for example competition, value engineering, and cost control.

In parallel with developments in IT which allow remote communication to be effective, people are developing more effective ways of meeting face to face. Important amongst these are workshops. Partnering workshops are normally a two day meeting of the key participants at a neutral venue, with the help of an independent partnering facilitator. A good facilitator will interview the participants before the workshop and then probe and question people during the workshop in a constructive way to make sure all the issues are discussed.

The first workshop on a project deals with all the parties' real interests and reaches an agreement that everyone can regard as fair. On large or difficult projects it may be necessary to set up task forces to investigate specific issues or to explore options; and then hold a second or even a third workshop.

The first purpose of the workshop is to agree mutual objectives that establish that is in everyone's best interests to concentrate on the success of the project. People find it hard to break away from secretive attitudes but finding mutual objectives requires people to be honest and open. So an important role of the facilitator is to help people change ingrained habits of secrecy and distrust and this begins by giving everyone at the workshop an opportunity to discuss their interests and concerns. This helps build mutual understanding which is an essential basis for finding mutual objectives that give everyone involved more than they would have achieved by concentrating on looking after their own interests.

The second purpose of the workshop is to agree how decisions will be made. The main influence on this is whether the project team can rely on existing information or whether it needs to find a new answer. New answers are expensive to develop and apply, and they are a major cause of the industry's inefficiencies. A new design should be used only when there really is no good answer already available. Repeating an existing design using exactly the same team can cut costs and times by 20 to 30%. Never-the-less some construction projects need original designs and the chosen decision system must allow for all the flows of ideas and information needed to produce the best possible design. Whether the project uses an existing design and established answers or sets out to produce a new design, the workshop agrees how the team will work together, how decisions will be made and how problems will be resolved in a cooperative manner.

The workshop also establishes a basis for specific improvements in performance. The starting point is to agree how the agreed project objectives will be measured. Then the team agree the targets for improvement in terms of measurements that are clear, simple to produce and understood by the team.

The agreement produced at the first partnering workshop is often embodied in a Partnering Charter to provide a public reminder of what has been agreed.

Throughout the project, follow up workshops are held as often as necessary to achieve the mutual objectives and ensure the team is achieving measurable continuous improvements.

Second generation partnering

Second generation partnering means a group of firms working together on a series of projects for a major client. The client selects consultants and contractors to work with on a regular, long-term basis. Their joint work is guided by a strategic team comprising representatives of all the partnering firms that provides the overall strategy. It is common for strategic teams to set up task forces that bring together multi-discipline groups of experts in a particular aspect of the team's work. Task forces work independently of projects in finding better ways of working. The improvements they develop are put into practice by project teams. This allows project teams to concentrate on applying current best practice efficiently. Any ideas for improving the current approach identified by project teams are fed back to the strategic team for investigation and possible development by a task force for use on future projects.

Bennett and Jayes found that successful strategic partnering involves seven generic sets of actions which they call *The Seven Pillars of Partnering*. A workshop held at the University of Reading, UK in 1998 brought together leading researchers in construction and manufacturing who based their views on best practice in UK, USA and Japan. The workshop was part of the preparation of Construction Task Force (1998), usually called the Egan Report. The workshop established that the seven generic sets of actions describe the same approach as is called lean production in the manufacturing industries. The Egan Report uses both terms.

The seven pillars embody current best practice in manufacturing and construction and are a set of generic actions that form a controlled system guided by a strategy and feedback. The system helps clients and the construction firms they work with improve their joint performance. Bennett and Jayes (1998) report cases where second generation partnering delivered cost savings of 40% and time savings of 50%.

The pillars are:

- *Strategy*
- *Membership*
- *Equity*
- *Integration*
- *Benchmarks*
- *Project processes*
- *Feedback*

Strategy

The seven pillars work together in a long-term process driven by an explicit strategy developed by strategic teams. Strategies should be directed towards the client's objectives and take account of the interests of the construction firms involved. It provides the overall mission which should require big improvements in performance.

The strategy helps project teams understand their specific objectives and where they fit into a bigger picture. Construction, as the Egan Report recommends, needs project teams to be set bold targets for improvement and the best strategic teams do just that. As a result of strategic teams setting progressively tougher targets for project teams and using task forces to provide the tools needed to meet the targets, project performance improves dramatically over several years and over a number of projects.

Membership

The membership pillar deals with the choice of firms to be involved in a partnering arrangement. Finding the right firms means being clear about the overall strategy, making the selection of firms to put it into effect carefully, and then checking that everyone is looking for better ways of working.

The firms must be willing to make long-term improvements in their joint performance. For example, many firms involved in partnering develop multi-skills because they make change and improvement easier to introduce. The firms selected must provide competent professionals with cooperative attitudes. This means professionals accepting that they must be prepared to discuss their judgments openly in searching for the best answers.

The existence of a group of firms committed to partnering allows all the necessary skills to be brought into project teams early so everyone has the opportunity to play a full part.

Equity

A key to giving everyone the confidence to concentrate on joint interests and mutual objectives is to make sure they are rewarded fairly for work well done. Partnering is more efficient than traditional methods and so everyone's profits can be higher than normal and the cost to the client can be lower than normal.

Best practice is based on using the client's business case as the basis for a firm budget, guaranteeing all the firms involved fair, predetermined profits and paying all their costs using open book methods. Moving to a full open book approach takes time in building up confidence in the financial systems and trust in the people involved. Various ways of sharing savings, profit sharing schemes, and incentives are used over several projects to work towards an open book approach in which firms are paid all their costs plus a fair profit. Achieving this requires tough cost control backed by tough audit, so it is not worth firms trying to cheat.

Integration

Partnering depends on cooperation which in turn depends on trust. The integration pillar deals with the need to develop cooperative behaviour at all levels.

The best approach in dealing with people is to pick who you deal with carefully and then behave as if they are trustworthy; and continue as long as they keep their promises, admit problems as soon as they arise and work cooperatively in solving and learning from them. If people try to hide problems or blame someone else, they should be penalised by the introduction of controls, tough audit procedures and day-to-day monitoring. When they return to cooperative behaviour, the controls can be relaxed.

Given cooperation and trust, partnering firms integrate their procedures, use common standards and eventually develop a single culture that guides decision making in a consistent way.

Cooperation and trust are deliberately fostered using workshops, training and social events designed to build integrated teams.

Benchmarks

The benchmarks pillar gives attention to the search for better answers. Performance has to be measured so the strategic team can be certain that improvements are being achieved. They need benchmarks that allow projects to be compared.

More generally the industry needs benchmarks that help clients understand they will get the best value from consultants and contractors who are given sufficient continuity to justify investing long-term in developing better ways of working.

The benchmarks pillar, as well as providing measures of the partnering firm's joint performance, provides a link to benchmarking. This is an established management technique that provides a carefully structured way of improving performance. It begins by comparing the performance currently achieved with the best in the world to identify processes where there appears to be the greatest scope for improvement. These processes are then analysed in detail to identify better ways of working. Strategic partnering provides organisational arrangements that allow benchmarking to be effective.

Project processes

Improvements in performance depend on re-engineering processes. Strategic teams set up task forces to re-engineer the processes that project teams work with. That means they question each activity to identify any that do not add value for the client. This is regarded as waste and eliminated by improving the standards and procedures used by project teams.

Efficiency requires processes that use well developed standards and procedures to deal with all routine matters. This allows time and resources to be concentrated on those parts of the project where a good answer does not already exist. In other words, good standards and procedures focus effort where it is most likely to provide benefits.

Feedback

The feedback pillar ensures that all the innovations and good ideas generated by projects and task forces are captured for the long-term benefit of the partnering firms. It ensures also that people learn from failures by seeing them as opportunities to improve.

The best approach is for teams to agree what they are going to measure and then plot the results on a control chart so they have information about how their own performance is changing. That way they trust the results and use them to search for more improvements. As discussed earlier, feedback is fundamental to controlled systems. Bennett and Jayes' case studies show that even best practice works with inadequate feedback.

Third generation partnering

When all the pillars are in place and the construction firms involved know how to work cooperatively, some move on to third generation partnering where groups of firms combine to produce and market a range of buildings and associated services.

The choice of what type of buildings and what services to produce is driven by market research into clients' demands. Groups of construction firms are finding that many of today's leading clients, faced with global competition, need lower costs, improved performance, greater certainty, faster delivery, zero defects, sophisticated finance packages including guarantees, and after-care services. Traditional, adversarial, methods are not able to cope. Management based approaches provide only limited answers. So firms are beginning to cooperate in partnering arrangements guided by the needs of specific categories of clients.

This is third generation partnering which means construction becoming genuinely market oriented, developing its supply chains to bring the enormous potential of suppliers and specialist contractors into its decision making, and building continuous improvement into every aspect of its work. The results found by Bennett and Jayes can be cost reductions of 50% and time savings of 80% compared with one-off traditional methods. These benefits apply to all types of construction project. Where a team works together for many years producing a series of very similar buildings, they have time and resources to develop integrated ways of working that are certain and efficient. They produce mainstream buildings and make them available for clients to buy or lease in much the same way as they buy or lease cars. Project teams have simple organisation structures designed to deliver well-developed buildings efficiently and reliably.

The construction industry also needs to be efficient at one-off projects that require individual creativity, innovation and new ideas. Third generation partnering is applicable to these situations but it takes a different form. Key characteristics include groups of partnering firms investing long-term in developing creative methods, technology and information systems that support one-off design, and modern methods of managing innovative design processes. The financial arrangements encourage creative designers to search widely for the best answers whilst allowing clients to set firm budgets. The processes used allow talented individuals to be brought into teams to tackle specific, difficult issues. Control is maintained by having established answers to use if a better new answer cannot be found by the time milestones are reached and decisions have to be made to avoid delaying the project. Processes include quality, time and cost control systems that are flexible to allow designers to explore many options in the search for the optimum solution without compromising the agreed objectives. Construction processes provide training, induction courses and robust support and guidance for construction teams to equip them to deal with new technologies and design details. All this accepts that one-off projects are expensive, as prototypes always are.

Third generation partnering applied to one-off projects comprises a set of generic actions taken by groups of firms to develop the systems and technologies needed to undertake difficult, challenging projects efficiently.

Partnering and the Best Practice Guidelines Compared

As the seven pillars of partnering embody current best practice in manufacturing and construction, it is sensible to compare the best practice guidelines of the decision matrix with project partnering. The first and most obvious difference is that while Sidwell, Kennedy and Chan's guidelines relate to individual projects, the descriptions of best practice partnering identify advantages in the continuity that comes from the same team undertaking a series of projects.

Both descriptions identify a first action that in partnering is called agreeing mutual objectives and Sidwell, Kennedy and Chan call alignment of objectives. The two terms refer to the same action which Sidwell, Kennedy and Chan emphasise by first considering the value provided by the project for all the participants. In strategic partnering the same action is called “strategy” to emphasise the long-term view. It is however, like the project-based concepts, concerned with teams agreeing what they jointly aim to achieve.

The next point of common ground is partnering’s action of agreeing how decisions are made which is similar to Sidwell, Kennedy and Chan’s selection of fundamental processes rather than using existing contractual arrangements. Both mean project teams should explicitly agree how they are going to work together. In strategic partnering the same action is called integration and deals with systematically developing over time more effective ways for teams to work together.

Partnering’s continuous improvement is the same action as Sidwell, Kennedy and Chan’s “eliminate duplicated effort”. Both mean project teams agreeing specific measurable improvements in performance over the local construction industry’s norms or their own previous best performance.

‘Value driven selection’ is explicitly included in the seven pillars of strategic partnering as ‘Membership.’

Thus Bennett and Jayes’ description of project partnering is essentially the same as five of the best practice guidelines:

Aims	***Partnering***	***Decision Matrix***
Mutual objectives	Strategy	Value to parties Alignment of objectives
Decision making system	Integration	Process not contractual arrangement
Continuous improvement	Project processes	Eliminate duplicated effort
Best people for project	Membership	Value driven selection.

This leaves one best practice guideline for which there is no obvious equivalent in project partnering, that is ‘holistic process – lifecycle’. This requires a long-term view to be adopted on individual projects. Strategic partnering requires a long-term view to provide continuity for project teams. This is explicitly dealt with in the strategic pillar of project processes. Clearly there is growing acceptance of the need for a long-term view and it should be applied in taking actions concerned with individual projects and to the organisation of a series of projects. However, taking a long-term view is not an action. Sidwell, Kennedy and Chan’s intention is that a long-term view is taken in making design decisions. So the action is “agreeing the design strategy taking account of lifecycle costs”. It would be reasonable to add a further action of “agreeing the construction strategy taking account of lifecycle costs”.

There is therefore considerable support for Sidwell, Kennedy and Chan’s best practice guidelines in best practice partnering. It is therefore worth considering the strategic pillars not explicitly identified in the guidelines. These are Equity, Benchmarks and Feedback.

Equity describes actions aimed at ensuring that the financial arrangements do not impede teamworking. Benchmarks describes the need to measure performance if teams are to make genuine improvements. Feedback describes actions needed for teams to control their own performance within individual projects, and to produce feedback from project to project. All three generic actions are widely accepted in the literature and are probably implicit in Sidwell, Kennedy and Chan’s guidelines.

This suggests a decision matrix for individual projects comprising one axis formed of a fundamental construction process expressed in terms familiar to construction practitioners:

- *Ideas and feasibility*
- *Planning and design*
- *Construction*
- *Commissioning*
- *Operation*

And an axis describing actions which form the following reasonably logical sequence:

- *Agreeing the project objectives taking account of the project stakeholders' values and the need to improve over industry norms.*
- *Selecting team members on the basis of the value they add to the team*
- *Aligning team member's interests.*
- *Ensuring the financial arrangements do not inhibit teamworking.*
- *Agreeing the processes to be used including how decisions will be made and how the team will be integrated.*
- *Agreeing how team performance is to be measured.*
- *Ensuring team members have feedback driven control systems.*
- *Agreeing the design strategy taking account of lifecycle costs.*
- *Agreeing the construction strategy taking account of lifecycle costs.*

A Theory of Construction Project Management

Having confirmed that Sidwell, Kennedy and Chan's decision matrix is reasonably well-supported by relevant literature and proposed modifications to take account of international best practice, the next issue is to consider how it should be used. This is best answered first at a theoretical level before considering practical implications.

The developed decision matrix is based on the ideas of self organizing networks which incorporate those from market and management theory and practice. Important amongst the surviving ideas are the contingency theories of management, that is that there are a number of best ways of managing. This has echoes in the aims for this CRC CI research which accept that there is not one best form of organisation that suits all projects.

The contingency theories of management are well described in Mintzberg (1979) in a famous step forward in management thinking he uses the term gestalts to refer to linked tasks and appropriate organisational arrangements. Bennett (1991) uses this idea to describe three idealized forms of construction project task and appropriate organisational arrangements: programmed organisations, professional organisations, problem-solving organisations.

Programmed organisations

Programmed organisations undertake highly rationalized work. The organisations that undertake individual projects are very simple comprising a virtually automatic series of well developed tasks carried out by well-practiced teams. These simple project teams form part of much larger organisations that design, manufacture and construct standard buildings, bridges or other standard facilities. The parent organisations ensure continuity for project teams by marketing packages of products and services.

Professional organisations

Professional organisations use professional skills and knowledge applied to established traditional construction. That is, any form of construction where the designers know the performance provided by any particular combination of design details. Also, the local construction industry knows the nature of the work required to manufacture and construct any particular combination of design details. Local contractors know the sequence of specialist contractors required, the effective construction methods, and the plant and equipment needed, and can predict the resultant costs and times with confidence.

Traditional construction allows professional organisations to be simple. Professional consultants produce designs based on the local form of construction and specialist contractors analyse the design information provided by designers, agree the exact design details to be used, manufacture or buy the required components, and construct the various elements for a fixed price. In practice a number of modifications of this simple project organisation have grown up of which the most common are the emergence of general contractors and quantity surveyors.

Problem-solving organisations

Problem-solving organisations produce innovative constructions efficiently. They are set up to find answers to clients' needs which cannot be met by established answers. New forms of construction need flexible project processes because it is not possible to predict the activities that will be required at each stage until progress has been made on earlier stages. Bennett (1991) suggests that the only form of construction project organisation that fully meets the need for flexibility is the construction management approach in which a design team and a construction management team are employed to work with the client in creating an original design and organizing its realization.

Mintzberg's original description of gestalts based on research into management generally recognizes that they are idealized models and that in practice real life organisations fit between them. Managers make decisions about changes to their organisation guided by the theoretical concepts. In this way construction projects draw on ideas from one or more of Bennett's three gestalts. In theory the closer a project's task and organisation gets to one of the theoretical gestalts, the more likely it is to be successful.

Practical reality tends to be messy and pragmatic and the recent concept of self-organizing networks provides a more accurate picture of real life. The concept comes originally from the basic sciences which now see the world, including living creatures, as one incredibly complex system of networks in which feedback loops give the whole and parts the power of self-organisation.

There are many descriptions of the emergence of self-organizing networks of firms in various industries and national and international contexts during the last two decades. Mainzer (1997) describes a wide range of examples. The literature establishes that the self-organizing network is a distinct form of organisation giving rise to methods different from markets and management hierarchies.

Networks are loosely coupled systems of interaction and communication that retain the identity, uniqueness and separateness of the organisations that form them. Networks provide a variety of sources of information, especially technological knowledge that is tacit in nature and difficult to codify. They encourage broad points of view and so are good at generating new answers.

Exchange occurs in networks, not through discrete exchanges as in markets nor by management dictate as in hierarchies, but entails indefinite, sequential transactions based on reciprocity. It works by creating mutual indebtedness and reliance. Networks are based on long-term interdependencies in which trust is built up over time. This develops into mutual orientation manifested in common languages, implicit rules of behaviour, and standardized processes, products and methods.

Effective networks depend on the people involved perceiving them to be beneficial much more than on technological interdependencies. A s a result networks comprise people who work together because this suits their own interests. Networks are effective when there are many changing, strong and specific activity interdependencies, as there are in many construction projects. Networks combine stability in parts with change elsewhere and so are good at innovation whilst maintaining efficiency.

Wide learning comes from higher level associations providing clearing houses for information, technological changes and the activities of competitors. Clients and the developers of new technologies provide the key knowledge for change. Innovation is guided by well informed, knowledgeable, long-term relationships characterized by information openness. Different communication channels are used depending on the needs of the partnering firms. So major firms need to identify and select partners to provide key new knowledge from wherever it happens to arise. Firms exchange not only goods and services but also information. Each firm's success depends on the others being successful so opportunist behaviour is replaced by measures designed to build up trust.

Central firms emerge that control the design of prototypes, marketing, delivery to clients and the provision of finance to cover the costs of materials, components, labour and machinery until receipts from clients begin to flow. Smaller firms clustered around these central firms provide labour, skills, workplaces and machinery. They are selected on the basis of quality, efficiency and ability to deliver on time not on their ability to lower labour conditions or evade taxes.

Skills are fairly evenly divided amongst all the firms who therefore regard each other as equals. There is a general sense of fair play fostered by trade associations and local authorities. Open book accounting develops as firms work together in the long-term. Price negotiations are keen but based on knowledge of each other's costs and a sense of fairness. Prices are public knowledge. The long-term relationships foster improved quality and efficiency which allows prices to remain highly competitive compared to those on offer from firms outside the network.

These developments have given rise to the forecast reported in Department of Industry, Science and Resources (1999) that by 2010 the global construction industry will be dominated by perhaps ten firms. They will be central firms in complex self-organizing networks comprising hundreds of linked firms. The key features of these construction networks according to Bennett (2000) are competent teams guided by feedback and strong interactions shaped by the needs of the joint work.

The concept of self-organizing networks does not invalidate the insights provided by contingency theories. Self-organizing networks provides an accurate description of how organisations survive as they respond to change. Contingency theories explain the nature of the resulting patterns. Bennett (2000) describes the nature of the patterns that develop when networks concentrate on the efficient production of mainstream products and services; and when they concentrate on the efficient production of individually designed products and associated services.

Characteristics Of Project Tasks

To make use of these ideas the decision matrix needs to respond to the specific characteristics of project tasks. Bennett (1991) bases his contingency theory of construction project management on the following characteristics of project tasks: size, complexity, repetition, uncertainty, and, speed and economy.

Size

Size is usually measured in terms of project cost or price. This is convenient but leads to inconsistencies as a small sophisticated building may cost the same as a large simple building. Another common approach is to measure the physical size of the end product. Another is to describe size in terms of the number of units of primary function accommodated e.g. a school for 500 students, a 250 bed hospital, an oil refinery processing 10,000 barrels of oil a day, and so on.

However, as far as size is concerned the important fact for managers is the number of units of activity they must manage. Bennett proposes that this is best measured in terms of days-work for teams. In practice it is sensible to keep this concept in mind in using a combination of cost, price, physical size and functional units when determining the size of construction projects.

Complexity

Complexity means the number of different activities needed to produce the end product. Activities are usually regarded as separate when they involve distinct technologies. The more distinct technologies a project includes, the more complex the project. However, technology is not the only factor at work.

Groups of activities undertaken in distinct physical locations add to the complexity of projects. In the main the physical separation of work mirrors differences in technology and so does not add to complexity. However, if the same technology is applied in different locations for whatever reason, then the project is made more complex. Also if different groups of activities, which are involving identical technologies and locations, have to be undertaken at different times, the project is more complex. This most usually arises when shift work is used so that two or even three teams work at different times of the day.

Repetition

It is well established that repeating an activity, usually called practice, improves performance. So if projects provide consistent repeating patterns of reasonably similar work for a series of teams, productivity increases. The existence of beneficial repetition influences the task faced by the project team but since it results from decisions made during the project, it is less useful as a means of classifying projects than the other factors, especially in the early stages when key project delivery decisions have to be made.

Uncertainty

Predictable work that is certain and well understood provides a quite different management task form uncertain work. Bennett suggests the two main sources of uncertainty are the natural variability in all human activities and interference from the project's environment.

Variability is uncertainty generated from inside the project and its level is dependent on the nature of the work of the separate teams, the extent to which they are practiced in their work, and the nature of the interdependencies between them. Interference comes from outside the project itself and includes such factors as planning authorities, special interest groups in the local community, severe weather conditions, late delivery of materials or components, a shortage of skilled labour, machines that fail and a multitude of other factors that delay planned progress.

Speed and economy

For any project there is a normal speed and level of costs which the local construction industry, in the absence of pressures to perform differently, will achieve. It is based on the levels of speed and economy at which designers, manufacturers and constructors feel comfortable. The actual level of performance that can be regarded as normal varies with location and time. However, there are wide variations in actual performance and so clients and their advisors have the opportunity to set targets for the costs and times on their project that are tougher or more relaxed than the local norms.

The targets influence the nature of the task faced by the project team and so need to be taken into account in deciding on the appropriate organisational approach. It is not clear why Bennett did not include quality to complete the normal set of project objectives of quality, time and cost.

One issue is that quality describes two distinct concepts. The overall standard of the end product is often referred to as its quality. It results from design decisions by the client and project team which influence how predictable the work is likely to be. It is therefore taken into account in the concept of uncertainty. However, quality is also used to refer to the accuracy with which the design is realized. This is sometimes called workmanship quality. There are normal levels of workmanship quality in all local construction industries, and clients and their advisors may set a target of the norm or higher. It is difficult to imagine a target lower than the norm being set but it is at least a theoretical possibility. It makes sense to include workmanship quality in classifying a project's target.

A Project Delivery Decision Support System

The fundamental elements of a project delivery decision system have now been identified and described. In summary the system classifies projects in terms of:

- *Size*
- *Complexity*
- *Uncertainty*
- *Speed, Economy and Workmanship Quality*

This classification is more subtle than a broad classification into mainstream and one-off projects but incorporates that fundamental decision.

Projects are regarded as involving a fundamental process comprising the five phase model already discussed:

- *Ideas and feasibility*
  This stage provides the primary inputs comprising the client's business needs and the project brief; and ensures the project's feasibility.
- *Planning and design*
- *Construction*
- *Commissioning*
  These three stages provide the main stages in the transformation of the primary inputs into outputs. The transformations are undertaken by a virtual organisation formed by the project team, its leadership and organisation, including contractual interfaces, communications, control systems, personal relationships and risk management.
- *Operation*
  This stage provides the outputs delivered to stakeholders, client, local community and construction firms.

This process will need further development to deal with the strategic issues involved where the same one team is undertaking a series of projects and so benefit from continuity. Since all of Sidwell, Kennedy and Chan's case studies were one-off projects this is not an immediate issue but will need to be dealt with in the long-term development of the system.

The system expands a set of generic actions into descriptions of specific actions, case studies of successful projects, and other information which helps clients and their project teams select appropriate delivery systems. The generic actions are:

- *Agreeing the project objectives taking account of the project stakeholders' values and the need to improve over industry norms.*
- *Selecting team members on the basis of the value they add to the team.*
- *Aligning team member's interests.*
- *Ensuring the financial arrangements do not inhibit teamworking.*
- *Agreeing the processes to be used including how decisions will be made and how the team will be integrated.*
- *Agreeing how team performance is to be measured.*
- *Ensuring team members have feedback driven control systems.*
- *Agreeing the design strategy taking account of lifecycle costs.*
- *Agreeing the construction strategy taking account of lifecycle costs.*

Sidwell, Kennedy and Chan's case studies provide many detailed actions that expand the generic actions into useful advice. Construction Queensland (2001) and Crow and Barda (2001) provide more actions. There are many other published case studies of best practice which can be used to build up a large database of actions to support a practical and effective project delivery decision support system.

Actions from Australian practice

Actions included in the database need to be selected and classified carefully so that advice provided by the decision tool is reliable. The best way of ensuring this is to draw on case studies of many projects where the same actions were used and they produced similarly successful results. Success should be defined in objective measures that compare case study projects to international best practice. Ideally the case studies will be of construction projects in Australia so the advice provided by the decision support system is directly relevant to Australian users.

Evidently the ten projects that Sidwell, Kennedy and Chan (2002) studied do not provide sufficient cases to identify robust actions. At least the report concludes that the research was not able to identify a 'magic bullet' that addresses all the challenges of delivering projects. It may be significant that the projects used for the research all used one-off designs and had individually assembled project teams. So, for example, if the 'magic bullet' is continuity which enables project teams to develop ever better project delivery systems guided by feedback, the research methodology prevented them from finding it. This is a weakness of any small or narrowly defined sample; it is likely to miss important data.

In contrast Crow and Barda (2001) begins by stating that the building and construction industry is seriously underperforming and uses case studies of 28 excellent projects to identify a 'magic bullet.' It is client leadership in creating a trusting and motivating team environment.

The projects which are the subject of Crow and Barda's case studies are one-off projects for experienced clients. They have grown frustrated by the industry's failure to provide its own leadership and have stepped in and shown construction what is needed. Crow and Barda provide a good list of clients' business related needs, including reduced operating costs, increased revenues, increased functionality and improved morale of operating staff. They found clients understand that successful projects depend on construction firms making better than normal profits. Clients want to involve the local community and the people who will use the new facility. They expect risks to be designed and managed out of projects so they deliver what was promised. The twenty-eight projects researched to provide these views all achieved more than the client expected at the outset based on the industry's normal performance. This provides their definition of excellence but it depends on the clients to provide leadership and organisation.

The keys to excellence they identify are a cooperative, non-confrontational environment, teamworking, a clear project strategy and a focus on users' needs. Construction firms should provide all this as a matter of course and be proactive in researching clients' needs and marketing packages of products and services to meet those needs. Clients should not have to be concerned about the details of the delivery system. They should not be exposed to risks beyond those inherent in their business case for a new construction project. They should be offered clear choices of function, quality, time and price.

This view appears to agree with that adopted in Construction Queensland (2001) which in its implementation guide regards a focus on project delivery as inequitable and a focus on end-user services as equitable. Construction Queensland also recognizes the value of continuity in proposing a sequence of strategies that move from the traditional approach to what is the same as second generation partnering. It is described as 'services delivered from an asset portfolio' in which construction firms form a long-term alliance or relationship with the client, who is responsible for a portfolio of assets.

Construction Queensland, like Crow and Barda, sees the client as central to the delivery system. It says clients need the right culture, need to lead the process, need to share risks equitably, and need to align their understanding of the project with the main construction firms involved. No wonder so few projects are successful. No other industry expects its customers to do more than know what they want, select from a clear choice of options and pay for the products and services they want.

A modern delivery system will enable the construction industry to meet the needs of its customers in a manner they can enjoy. It will not require customers to change their culture, provide leadership for the industry, take risks and align their interests with those of construction firms. They want to buy buildings and other constructed facilities, not undergo a culture change.

Clients will treat the industry differently if the industry gives them the opportunity to do so. Currently, by offering clients its present fragmented collection of independent professions and trades, the industry forces them to take charge. But to see this as an answer for a modern and successful construction industry is ridiculous.

Construction Queensland raises a final significant point in recognizing that different projects need different delivery systems. However, it offers no guidance on the selection of an appropriate system. It argues that there is no proven method of choosing the best delivery system because projects have unique characteristics and organisations have distinct operating systems. Such an attitude could be used to deny any scientific knowledge. The point of theory is to describe patterns and consistencies within real world complexity and variety. Construction management theory has made some progress and much more is known about the best approaches to specific projects than Construction Queensland allows.

Given that Crow and Barda (2001) and Construction Queensland (2001) are accepted as representative of best Australian practice, it may be wiser to begin the database with international practice. Such a view would be justified by the scale of improvement that Australian construction needs to make (a 50% reduction in project costs) to match Japanese productivity.

The choice of actions to include in the database and the way they are classified should be based on a clear picture of modern practice. Modern industries do market research to understand their clients and develop packages of products and services they want and can buy and use easily. Construction needs to do likewise, otherwise construction firms will remain essentially subcontractors earning poor profits and being unable to invest in their own future.

References

Atkins, W.S. and consultants including Centre for Strategic Studies in Construction, The University of Reading (1994), *Strategies for the European Construction Sector,* European Communities, Luxembourg

Bennett, J., (1991), *International Construction Project Management,* Butterworth: Heinemann, Oxford (A revised and summarized version is available at www.architecturalpress.com)

Bennett, J., (2000), Construction - The Third Way, Butterworth: Heinemann, Oxford

Bennett, J. and Jayes, S.L. (1995), *Trusting the Team: The Best Practice Guide to Partnering in Construction,* Thomas Telford, London

Bennett, J. and Jayes, S.L. (1998), *The Seven Pillars of Partnering: A Guide to Second Generation Partnering,* Thomas Telford, London

Bennett, J., Pothecary, E., and Robinson, G. (1996), *Designing and Building a World-class Industry,* Centre for Strategic Studies in Construction, Reading, UK

Construction Industry Board (1997), *Constructing Success: Code of Practice for Clients of the Construction Industry,* Thomas Telford, UK

Construction Queensland (2001), *Wealth Creation through Equitable Asset Delivery,* Construction Queensland, Brisbane

Construction Task Force (1998), *Rethinking Construction,* HMSO, London (The Egan Report)

Crow, T. and Barda, P (2001), *Projects as Wealth Creators; Drivers of Project Excellence*, Property Council of Australia, Sydney

Department of Industry, Science and Resources (1999), *Building for Growth: An Analysis of the Australian Building and Construction Industries*, Commonwealth of Australia

Hampson, K.D., Peters, R. J., Walker, D.H.T., Tucker, S., Mohamed, S., Ambrose, M. and Johnston, D. (2001), *Case Study of the Acton Peninsula Development,* Department of Industry, Science and Resources, Commonwealth of Australia.

Latham, Sir M., (1994), *Constructing the Team,* HMSO, London

Mainzer, K. (1997), *Thinking in Complexity: The Complex Dynamics of Matter, Mind and Mankind,* Springer- Verlag

Mintzberg, H., (1979), *The Structuring of Organisations*, Prentice – Hall, Englewood Cliffs, New Jersey

Sidwell, A.C., Kennedy, R.J., and Chan, A.P.C. (2002), *Re-engineering the Construction Delivery Process: Report and Case Studies,* Construction Industry Institute, Australia

Walker, D.H.T., Hampson, K.D. and Peters, R.J. (2001), *A Case Study in Project Alliancing,* The National Museum of Australia, Presented at the National Museum of Australia Seminar series.

Womack, J.P., Jones, D.T. and Roos, D. (1990), *The Machine that Changed the World,* MacMillan, New York