



PEpC

A Breakthrough Project Delivery System that Improves Performance by Reforming Owner, Contractor, Supplier Relationships

by

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A Report to

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The University of Texas at Austin

Under the Guidance of the

Owner/Contractor/Supplier Relationships Research Team

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Executive Summary

This document reports on research, undertaken under the guidance of Construction Industry Institute Research Team 130, to develop a new and innovative project delivery system that reduces the time and cost of capital project execution without reducing quality and lifecycle performance. The motivation to undertake the work was based on the belief that the expertise embedded in the design of strategic procurement items and/or systems as well as the expertise needed for successful project integration is frequently lost or underutilized when suppliers are silent partners in the EPC process.

The three research objectives may be summarized as follows:

1. To identify and recommend a step change in the EPC process so that the suppliers of strategic procurement items and/or systems may be brought into an expanded circle of cooperation between owner and contractor.
2. To measure the impacts that this change will have on the EPC process.
3. To provide a means to facilitate implementation.

The first objective was met by following a structured search for innovation, and defining PEpC (Procurement, Engineering, procurement and Construction) as

an innovative project delivery system which makes it possible to utilize supplier expertise in all phases of the project life cycle by developing an advance procurement strategy and reaching agreement with suppliers on strategic procurement items and/or systems prior to the associated project engineering activities.

The second objective was met by measuring the time and cost savings that could realistically be achieved when breakthrough changes brought about by PEPc were implemented. This analysis, based on ten theoretical implementation scenarios and four case studies, showed that savings in time between 10 and 15 percent and savings in total project labor cost between 4 and 8 percent were possible.

The third objective was met by developing a number of tools to assist in each step of a defined PEPc implementation process.

Attainment of the objectives led to four principle conclusions. These were:

1. There is a need to bring suppliers of strategic items and/or systems into the circle of cooperation between owner and contractor.
- 2 A step change to the EPC process that achieves this result can be defined.
- 3 Implementing PEPc will produce significant savings in the time and cost of the entire project delivery process.
- 4 Implementing PEPc will require changing many existing procedures.

The research report concludes by recommending that PEPc be implemented on suitable projects, that CII expand and develop its current focus on supplier involvement in the capital project delivery process, and that additional research be carried out to resolve and confirm many issues which fall outside the scope and limitations of this report.

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Chapter 1

Introduction

This chapter introduces the report by providing a brief outline of the problem and describing the challenge accepted by Research Team 130. The objectives, scope, limitations and research methodology are presented together with a detailed outline of the report.

1.1 Problem Statement

Strategic procurement items, including complex engineered equipment and systems essential for project performance, are frequently designed, manufactured, and delivered by suppliers who are outside the traditional circle of cooperation between owner, design contractor, and construction contractor. The knowledge embedded in the design of this equipment, as well as the knowledge needed for its successful integration, operation and maintenance is frequently lost or underutilized. The resulting inefficiencies impact the time, cost and quality of engineering and construction as well as the lifecycle performance of constructed facilities.

Research Team 130 (RT 130) was established and funded by the Construction Industry Institute (CII) in Spring 1996 to address this problem by identifying and recommending a step change in the well-established Engineering, Procurement, Construction (EPC) process. The basic hypothesis for the research was stated as follows:

It is possible to systematically reform relationships between owner, contractor and supplier so that suppliers of strategic procurement items and/or systems can be included in the full EPC process and thereby have a significant positive impact on the time, cost, and quality of the entire construction process, as well as the lifecycle performance of constructed facilities.

The hypothesis was based on the belief that substantial savings in time and cost could be achieved if a step change in owner/contractor/supplier relationships made it possible for suppliers to contribute effectively in every phase of the total facility lifecycle. It was clearly felt that owners, design contractors, and construction contractors would benefit from new and dramatically different relationships with suppliers, who should no longer be silent partners in the EPC process.

1.2 The Challenge

Accepting the challenge to identify and recommend a step change in a subject as complex as the role of suppliers in the EPC process, the research must venture beyond the classic steps of identifying a problem, gathering data, examining results and recommending change. Breakthrough and step change require a different process which includes at least the following.

1. A search for innovation. Current practice must be reviewed and understood at the creative edges of activity. The safe middle ground defined by the norm is not likely to yield innovation and is therefore of little interest. Associated industries must be reviewed and understood to seek inspiration from additional and, perhaps, controversial sources.
2. A breakthrough development. Innovation grows from inspiration and a willingness to challenge the status quo. Bold steps must be taken and a vision

for change must be defined. Modeling the proposed changes and measuring their effect relative to established baselines is necessary to test the vision.

3. An ability to implement change. Step change requires that innovation be implemented. Consideration must thus be given to the conditions required for successful implementation, the changes that must take place, and the barriers that must be overcome. Tools to encourage and assist implementation must be developed.

This process is shown diagrammatically in Figure 1.1 and reflected in the structure of the report presented in [Section 1.8](#).

1.3 Outcome

CII Research Team 130 (the research team) accepted the challenge and supervised the progress of the research in the period June 1996 to December 1997. Their creativity and inspiration led to the development of PEPc, the step change to the EPC process that forms the subject of this research.

The change, in its simplest form “takes the big P for *procurement* of strategic items in the EPC process and places it before the E for *engineering* so that supplier expertise can be integrated into all phases of the project from the very beginning” (Ruane 1997). In recognition of this change and the fact that a number of non-strategic procurement items would continue to be procured in the traditional way, the research team came to call the process PEPc.

To them goes the credit for the inspiration and for the work described in the report.

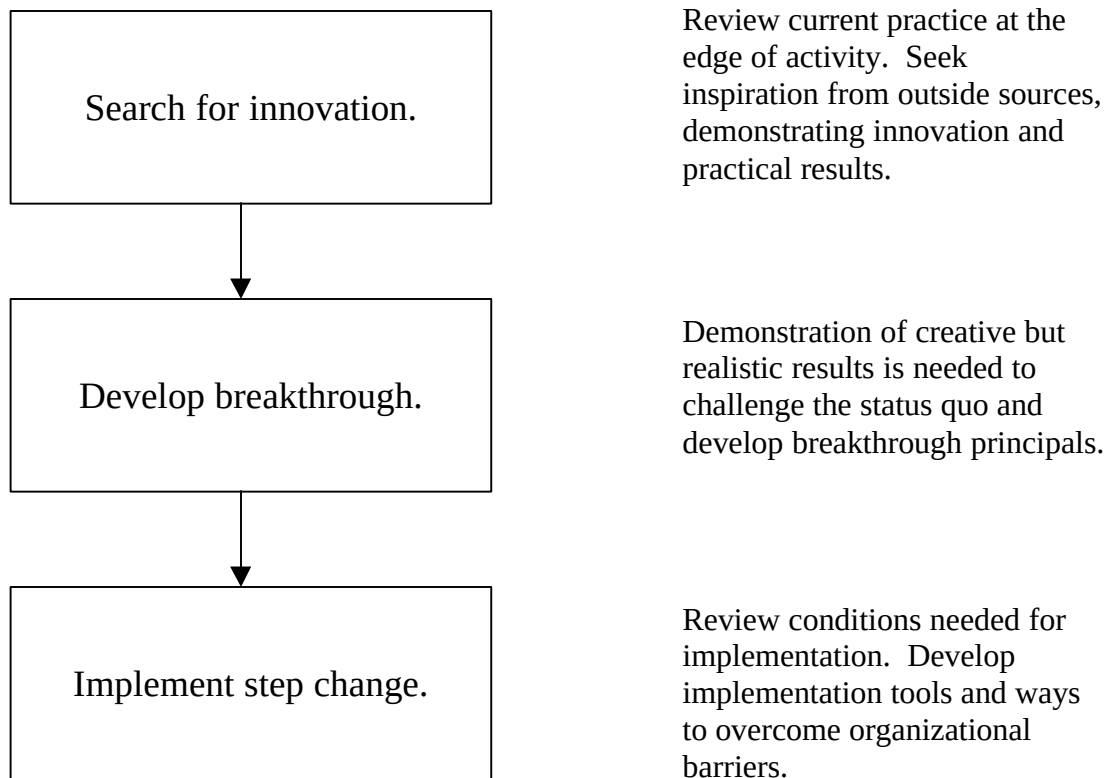


Figure 1.1 – Process for Breakthrough and Step Change

1.4 Purpose of the Report

This report is a source document describing all aspects of the research performed. It is intended to be a complete and comprehensive presentation of the work for readers interested in the subject at a detail level. The key research findings and practical guidelines for implementing the research will be set out in other CII publications.

1.5 Research Objectives

The three simple but ambitious objectives for the research may be stated as follows.

1. To identify and recommend a step change in the EPC process so that the suppliers of strategic procurement items and/or systems may be brought into an expanded circle of cooperation between owner and contractor.
2. To assess and measure the positive impacts that this change will have on the time and cost of engineering and construction.
3. To provide a means to facilitate implementation.

Attainment of these objectives requires the following key research steps.

1. Identify and study instances where owners, contractors or suppliers have developed innovative or different relationships within the EPC process and have thereby improved project performance.
2. Define and formulate recommendations for a step change in the EPC process so that owners and contractors can utilize and enhance the talent available in supplier organizations.
3. Model the proposed changes on a number of typical project scenarios to assess the impact that the proposed change will have on total project time and cost.
4. Facilitate the implementation of research results by analyzing barriers to implementation and by developing simple but effective implementation tools.

1.6 Scope and Limitations

The scope of the research is bound in two directions.

1. It is primarily concerned with supplier relationships in the EPC process as practiced in the industrial construction sector. Other project delivery systems

and other industry sectors certainly share many of the characteristics discussed but fall outside the scope of the work.

2. The relationships between owner, contractor and supplier are examined only in so far as strategic procurement items and/or systems are concerned.

Relationships with suppliers of items which have little or no engineering content, short lead times, or no strategic impact on project success are not considered.

Time and practical limitations on modeling and measuring the impact of change to the EPC process impose limitations on the quantitative aspects of the research.

Measures for the impact on total project time and cost have been possible subject to the limitations discussed in detail in Chapters 8 and 9. Measures for improvement in quality and lifecycle performance are outside the scope of the research.

Work done by CII Research Team 125 to develop a model of the EPC process and work done by CII Research Team 111 to develop and review core competencies required in the EPC process are used as starting points for substantial portions of this research. Evaluation and commentary on this work falls outside the scope of this report.

1.7 Research Methodology

Meeting the challenge posed by the research required that several different methodologies be used. These can be conveniently linked to the four key research steps detailed in section 1.5 above as follows.

1. A classic literature survey, a mail questionnaire of CII member companies, and a number of structured interviews by research team members were used to identify and study instances where owners, contractors, or suppliers had developed innovative or different relationships within the EPC process.
2. The expertise of the research team, sharpened by exposure to the literature, the survey, and the interviews, was used to define and formulate recommendations for a step change in the EPC process.
3. The work done by CII Research Team 125 to model the time and cost characteristics of the classic EPC process was used to model and measure the proposed change to the EPC process on a number of typical project scenarios.
4. The experience of the research team together with their knowledge of the proposed change was used to analyze barriers to implementation and to develop the simple but effective tools needed to facilitate implementation.

1.8 Outline of the Report

The report comprises six main parts that reflect the steps set out in the creative process described in Section 1.2 above.

1.8.1 Part I. Understanding the Challenge

This part introduces the report as a whole and reviews published material in the subject area. It comprises two chapters:

[Chapter 1](#), the introduction and

[Chapter 2](#), the general literature review.

1.8.2 Part II. Searching for Innovation

This part builds on the literature review by presenting a more narrowly focused and detailed search for creativity and innovation in the subject area. Three chapters are involved.

[Chapter 3](#) describes the methodology and results of a survey conducted to gather information on current practice regarding the relationship between owner, contractor and supplier.

[Chapter 4](#) presents the results of the interviews conducted by research team members to further explore instances of innovation in the use of suppliers.

[Chapter 5](#) details the results of interviews conducted to learn about innovative ways in which the automobile industry, the aircraft industry, and the microelectronics construction industry have teamed with suppliers to reduce time and cost in complex projects.

1.8.3 Part III. Defining Breakthrough

Part III defines PEpC with reference to the knowledge and awareness developed in Part II. Only one chapter is involved.

[Chapter 6](#) presents PEpC, the proposed step change to the EPC process. A detailed description of similarities and differences between PEpC and EPC is presented, and it is shown that PEpC does not require any deviation from normal competitive bid processes.

1.8.4 Part IV. Quantifying Breakthrough

These three chapters, 7-9, concern the possible effect that PEpC implementation will have on project time and cost.

[Chapter 7](#) details the development of a baseline to measure the effect of PEpC on the EPC process. The work done by CII Research Team 125 to develop a model of the EPC process is reviewed and modified to produce a tool specifically suited to the needs of this research.

[Chapter 8](#) uses the expertise of the research team and the model of the EPC process developed in Chapter 7 to determine the effect that PEpC has on the time and cost associated with each phase in the EPC process. Despite the fact that the results are theoretical in nature, they provide a good comparison against which the field implementation studies of Chapter 9 can be measured.

[Chapter 9](#) presents an analysis of the savings in time and cost achieved on case studies of projects where some of the innovative characteristics of PEpC were implemented. The model described in Chapter 7 is again used to quantify the results.

1.8.5 Part V. Implementing Step Change

Three chapters, 10-12, address the very real issues associated with achieving a step change in the EPC process.

[Chapter 10](#) Reviews the need for change in project delivery systems and analyses the technical, organizational, and commercial climate needed for

the successful implementation of PEpC. Work done by several CII research teams on change and implementation is referenced.

[Chapter 11](#) studies what is necessary to redefine and, if necessary, redistribute the core competencies of the parties involved in the EPC process in order to develop the competencies required to implement PEpC. The work of CII Research Team 111 is used extensively in this chapter.

[Chapter 12](#) presents a number of simple but effective implementation tools and check lists which can be used to assess whether or not PEpC is the most appropriate project delivery system and, if so, to assist in successful implementation.

1.8.6 Part VI. Looking Ahead

Conclusions and recommendations are presented in two chapters:

[Chapter 13](#), which presents the conclusions and

[Chapter 14](#), which presents the recommendations for further study

The structure of the report is shown diagrammatically in Figure 1.2, which will be used again in Chapter 6 when progress to that point is reviewed.

1.9 Companion Documents

This document draws extensively from three companion documents in related areas:

1. McNeil, Blair W., (1997) *Reforming the Owner/Contractor/Supplier Relationship*, Virginia Tech, Blacksburg, VA.

This document was used for the literature review (Chapter 2), Mail Questionnaire (Chapter 3), and the survey of associated industries (Chapter 5).

2. Back, W. Edward, Karen Moreau, and Jeffrey Toon, *Cost and Schedule Impacts of Information Management*, Draft of a Research Report to the Construction Industry Institute, February 1997.

This document was used to establish the baseline model (Chapter 7).

3. Sullivan, George R., Miguel A. Yupari, and Stuart D. Anderson, *Owner/Contractor Work Structure: A Process Approach*, Research Report 111-11, A Report to the Construction Industry Institute, The University of Texas at Austin, 1996.

This document was used in the analysis of core competencies (Chapter 11).

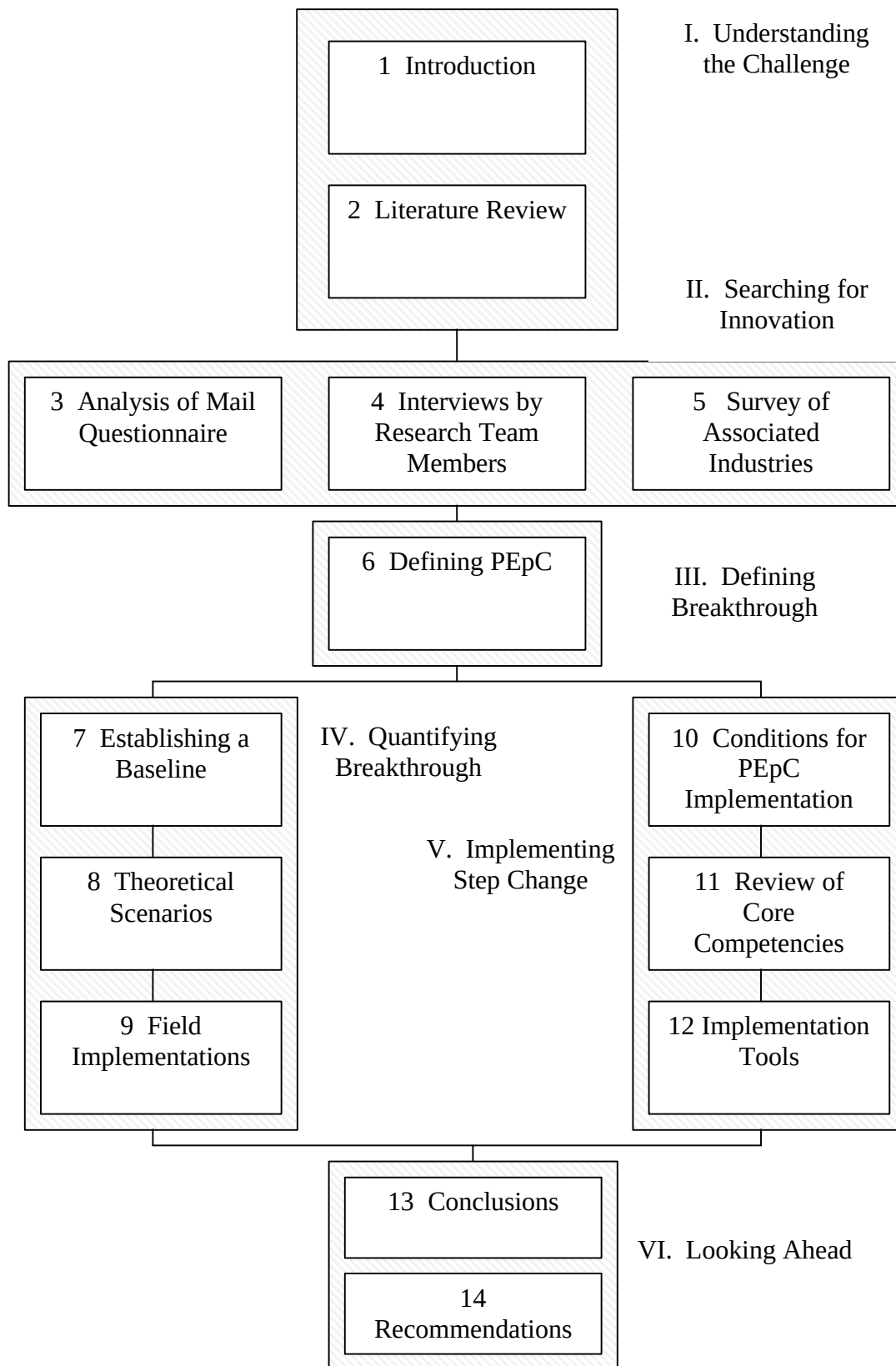


Figure 1.2 – Outline of the Report

Chapter 2

Literature Review

This chapter introduces the subject area by presenting a brief review of available literature to assist in understanding the challenge faced by the research. Emphasis is placed on instances where innovative relationships have been implemented to improve project performance.

2.1 Introduction

There is a very substantial body of literature in the subject area. The vast majority relates to industries other than construction and relevance must thus be carefully screened, especially when experience is drawn from industries that rely on high volume mass production processes.

The literature will be presented under three headings. The first will provide a broad overview of the influence that total quality management (TQM) has had on supplier relationships. The second will narrow the scope of the material and present a review of literature published in procurement management journals. The third heading will focus even further by examining examples of innovative relationships that have been utilized in the construction industry.

Lessons learned from the associated automotive and aircraft industries will be addressed in Chapter 5.

2.2 Influence of TQM on Supplier Relationships

The pursuit of quality has been the driving force behind supplier relationships for many companies in many different industries. Achievement of quality has created a need for relationships more tightly linked with suppliers. By developing relationships with suppliers, customers are better able to achieve consistently the desired level of quality without maintaining the resources in-house to oversee and improve quality.

AlliedSignal is a good example of a company that has developed supplier relationships in an effort to improve both quality and service. Raymond Stark, Vice President for Materials Management at AlliedSignal, describes the evolution of AlliedSignal's supplier relationships:

Not long ago, buyers saw suppliers as adversaries that were to be squeezed for the lowest possible price and then clubbed for good quality We were doing business on a contract by contract basis. Suppliers had to bid on every piece of business they got. We had no continuity, no supplier improvement programs, and no relationships. (Minahan 1996)

Today, AlliedSignal has reduced the size of their supplier base from 10,000 to less than 3,000 and has buying teams working with suppliers to tackle quality issues (Minahan 1996).

Similar patterns of evolution have taken place at Unisys. Quality efforts were first supported by management commitment, but over time the drive for quality became a corporate focus (Porter 1996). Porter describes the changes that took place at Unisys:

The procurement organization began to establish long-term supply relationships after balancing price with other performance criteria, and procurement began to work cooperatively with suppliers, mutually defining performance metrics and goals.

Many other companies have also developed supplier relationships, and repeatedly, they have sought these relationships to improve quality. These reports show that by working together, the client and the supplier can deliver higher quality more efficiently than either party could alone.

2.3 Procurement Management Literature

There is no consensus among procurement managers as to whether companies should form partnerships. Some argue that to remain cost competitive, companies need to maintain an arm's length relationship with suppliers (Tompkins 1995). However, other authors argue that for companies to meet customers' expectations of quality and cost they must have the close support of suppliers (Lamming 1993). The level of involvement for suppliers varies from industry to industry, but with the increasing complexities of products, suppliers are being relied upon for a greater involvement in the process. Lynch (1993) describes this new cooperation in his book, *Business Alliances Guide: the Hidden Competitive Weapon*:

Competition has traditionally been thought of as the antithesis of cooperation. Only recently have strategists and scholars shifted to a fresh perspective and recognized how powerful a weapon cooperation can be in playing the global competitive game.

Lynch describes the importance of creating cooperative supplier relationships for companies to be competitive in the global marketplace. This section will discuss the advantages of forming supplier relationships as viewed by procurement professionals.

Procurement managers have defined several differences between traditional relationships and partnerships. Examining these differences allows a company to understand the benefits of forming a partnership. The major difference between a partnership and a traditional relationship is that a partnership is a long-term commitment that emphasizes quality, schedule and price. A traditional relationship is a short-term relationship that only emphasizes price. Additional differences are summarized in Table 2.1 (Lynch 1993). Currently, only a small percentage of American executives realize the benefits of using suppliers in an expanded role, as Lynch (1993) details:

Outside the electronics industry, American managers show an amazing reluctance to change [traditional supplier relationships]. A 1988 Booz-Allen & Hamilton survey showed that only 17% of American business executives saw alliances as effective, compared to 74% of their Japanese counterparts. Nearly one-third of the American CEOs thought alliances were “dangerous” compared to only 1 out of 25 Japanese CEOs.

This survey indicates that most American companies do not currently see the advantages to forming partnerships. However, Lynch goes on to comment that the number of partnerships is growing, as more executives become aware of the benefits of forming partnerships.

Some industries are moving in the alliance direction with extreme rapidity. According to a 1991 survey, by Dataquest and Arthur Young, of over 700 CEOs of start-up and fast growing companies, nearly 90% had begun forming alliances, up from 81% in 1990 and 73% in 1989. Partnering arrangements are fast becoming an integral part of corporate strategy (1993).

Table 2.1 – Traditional Supplier Relationships vs. Supplier Partnerships
Adapted from Lynch 1993

Factor	Traditional Relationship ↔ Partnership
Time Frame	Short/Indefinite/ Renewable Long Term
Relationship	Purchaser is Superior, Supplier is Subordinate Purchaser is Leader, Supplier is Teammate
Information Flow	One Way Two Way
Product/ Service Improvement	Defined by Contract Ever Changing, Fluid
Control	Traditional Hierarchy Multi-Disciplinary “Teamwork”
Primary Objective	Price Quality, Price, Schedule
Profit	Buyer Controlled Mutually Controlled
Benefit	?/? Win/Win

These statistics indicate that American companies are slow to form partnerships but the percentage of companies using suppliers in an expanded role is increasing, especially with new and fast growing companies.

One reason companies are choosing to form supplier partnerships is that they believe suppliers can help avoid problems during production. They bring suppliers in earlier in the process so they can provide suggestions to prevent problems from occurring. Lynch (1993) states

Getting suppliers involved earlier has major implications for companies. Purchasers can get in front of the problem, becoming proactive rather than reactive. This earlier

involvement changes the relationship from a standard supplier arrangement into an alliance.

The key point of this statement is that suppliers are “proactive.” Preventative solutions are easier and cost less than fixing problems after they have occurred, another reason why involving suppliers earlier in the process is beneficial.

Procurement professionals have identified several advantages to forming supplier partnerships that are different from the benefits of forming partnerships in the automotive industry. Lamming (1993) has developed a list of the benefits from forming supplier partnerships.

- Risk reduction
- Economies of scale and/or rationalization
- Technology exchanges
- Coopting or blocking competition
- Overcoming government-mandated trade or investment barriers
- Facilitating initial international expansion of inexperienced firms
- Vertical quasi-integration advantages of linking the complementary contributions of the partners in a value chain

2.4 Construction

There is little literature on supplier relationships in the construction industry. This could be indicative of the fact that few companies have formed partnerships with their suppliers. Because of the limited availability of literature, this section will draw heavily from three documents that describe supplier relationships in the

construction industry. They are: "Upside-Down Contracting" by Michael T. Kubal (1995), Fast Track Pros and Cons: Considerations for Industrial Projects" by Gareth Vaughn Williams (1995), and the Construction Industry Institute publication *2% Engineering*. These reports provide insight into the current use of suppliers of strategic procurement items in construction. The information gathered from these sources will be presented under the following headings: The Current Construction Procurement System, Fast Track Projects, Partnerships, and Benefits of Forming Alliances in Construction.

While the above referenced documents and the other literature in this section refer to the construction industry in general, it is the belief of the research team that these ideas can also be applied to the EPC process. Therefore, when a reference is made to the construction industry, the reader should also think of the concept in terms of the EPC process.

2.4.1 The Current Construction Procurement System

Most companies in the construction industry use suppliers in a traditional or narrow role (Williams 1995). This practice indicates that suppliers are involved late in the process and that their design and engineering capabilities are underutilized. Williams (1995) comments about suppliers in the construction industry:

Suppliers, vendors, and subcontractors have never traditionally been thought of as part of the project team. The project team normally thinks of vendors as indifferent third parties interested only in turning a profit for themselves. As a result, the design-build team often treats them with caution and distrust. The traditional purchasing department role is to keep the vendors and

suppliers and subcontractors in line. They are responsible for making sure the vendors provide the correct material, equipment, or service and for cracking the whip as necessary.

This passage demonstrates that suppliers are not involved as part of the project team. Williams suggests that using suppliers in a traditional role will encourage caution and distrust. These relationships tend to be adversarial rather than cooperative. The article “Partnership: A Commitment to Excellence” (Tompkins Associates Incorporated) expands on this issue of distrust:

Unfortunately, many suppliers and customers are in a state of distrust. Many unpleasant past experiences around poor service, poor quality, price squeezing, and disloyalty have resulted in this distrust.

The construction industry currently treats suppliers as vendors in the EPC process. Suppliers are not included in the circle of cooperation between the owner, design contractor, and construction contractor. As a result, companies using traditional procurement systems suffer higher lifecycle costs, longer schedules and decreased quality (Kubal 1995).

Many believe that suppliers are not effectively utilized in the EPC process, as Kubal (1995) remarks:

In construction, subcontractors and suppliers control the majority of actual field construction, but continue to operate in contracting relationships reminiscent of the bygone automotive industry. Contracting practices continue to emphasize selection based solely on pricing with no input into the design or construction processes in terms of scheduling, quality control, or innovation.

This passage describes how subcontractors and suppliers are responsible for a majority of field construction but are not included in the process until after the

detail design phase is complete. This strategy is not logical considering the expertise suppliers could provide during design. This procurement approach prevents suppliers from offering suggestions during the engineering and design phase of the project when value engineering and analysis decisions are made.

Kubal (1995) urges the construction industry to change:

This is a wake-up call to realize that subcontractors who control 70 to 80 percent of the overall construction process must be included through all project stages including design and pricing.

It is important to realize the significant role suppliers and subcontractors play in the overall construction process. These parties, who control such a large percentage of the construction processes, must be involved from the initial stages of project conception for the project to benefit from their expertise. Companies who treat suppliers as vendors are reinforcing the negative aspects of an inefficient procurement system.

2.4.2 Fast-Track Projects

Fast-track projects have led the way in non-traditional supplier relationships in the construction industry. These projects require suppliers to be involved earlier in the process to meet tight schedules. Williams (1995) discusses this issue:

Fast-track projects, however, cannot afford the traditional procurement processes and paradigms. To trim 30-50% off the time it takes to design and build one of these facilities, this process has to be streamlined. It is painfully obvious that the project has no time to spec, quote, and procure material in the tried and proven ways. The team has to enlist vendors' help in the process, and it is quite remarkable how anxious vendors are to take part.

On fast-track projects, a limited number of suppliers compete on a preferred supplier list. These suppliers have proven track records and are familiar with the customers and the customers' specifications (Williams 1995). This familiarity enables the customer to streamline or eliminate the bidding process and therefore save time. The nature of fast track projects also enables the project to benefit from supplier experience and expertise. Because construction begins before design is complete, suppliers are likely to be on board during design. When suppliers are on board during design, they can provide suggestions that may result in improved quality, increased production, and reduced costs.

Fast-track projects use suppliers in non-traditional roles by including them early in the project lifecycle but fail to truly incorporate them into the project team. It is important to note that early supplier involvement on fast track projects is a result of an early construction start, not a change in procurement strategy.

2.4.3 Partnerships

This section is drawn largely from Kubal's article "Upside-Down Contracting," which discusses partnerships in the construction industry at length.

Suppliers in the construction industry have the capability to assume many of the project design and engineering responsibilities, as Kubal (1995) explains:

Typically the suppliers and subcontractors have the necessary expertise to develop effective design input for their portion of any building project. These suppliers and subs are often considerably more effective at incorporating their components into functional designs than designers working in a vacuum.

In this passage, Kubal argues that suppliers have the expertise to provide designs that are more effective than traditional designs by engineers or architects. This expertise is another benefit to clients that occurs as a result of forming project teams that include suppliers as full partners. Partnerships give suppliers an opportunity to use their expertise and provide suggestions or productivity improvements over the entire life of the project.

As more clients realize the benefits of forming supplier partnerships, the number of partnerships will continue to increase in the construction industry. Some people in the industry argue it is likely that companies will have to form supplier partnerships to remain competitive, as Kubal (1995) remarks:

Subcontractors and suppliers will become integrally networked with contractors and design teams, forming strategic alliances to change the direction of the industry.

This passage indicates that supplier alliances are becoming more common and will transform the industry into a more efficient process. Partnerships are not successful unless suppliers are integrated into the project teams.

Kubal (1995) predicts that general contractors who form supplier partnerships will have a competitive advantage in the industry.

General contractors who can take a leadership role in implementing the paradigm of construction management will become the leaders of the virtual construction age. Virtual processes will assuredly move the industry towards further implementation of design-build contracting that mandates the participation of suppliers and subcontractors in the design process.

He defines the virtual construction age as the future of construction projects, which will include integrated project teams that use technology and alliances to their fullest capacities.

The construction industry appears to be following other industries by reforming their supplier relations. Williams (1995) summarizes the direction of supplier relations in the construction industry:

All the groups, engineering, procurement, construction, operations, and the suppliers, must be integrated as one team. When the individual groups are all working together helping each other out, recognizing and compensating for each other's weaknesses and highlighting and taking advantage of each other's strengths, then the team is united. When everybody on the team feels that they will all succeed or fail together as a team, then a fast-track project is viable.

The construction industry has much to gain from reforming supplier relationships. The industry is moving in this direction, and as more companies become aware of the benefits of supplier alliances more companies will form partnerships.

2.4.4 Benefits of Forming Alliances in Construction

Rohm and Haas Company has produced a manual for creating and developing partnerships with their suppliers. The goal of the manual was to help Rohm and Haas choose preferred suppliers and to develop alliances which benefit both Rohm and Haas and the supplier. The following is a list summarizing the benefits they expect to realize by forming alliances with suppliers.

- Reduce time to deliver
- Reduce cost to deliver

- Improve quality
- Quicker solutions to problems
- Reduced life cycle costs
- Benefits through standardization
- Improved services
- Reduction in paperwork
- Improved efficiency of construction
- Site-to-site consistency and repeatability
- Reduced training requirements
- Elimination of non-value-added work

Many of the benefits on this list are similar to the benefits other industries have achieved from reformed supplier relationships. However, this list also includes items that are specific to the construction industry, such as site-to-site consistency and repeatability, and improved efficiency in construction.

Although Rohm and Haas had only participated in a few alliance relationships at the time this manual was written, they had already achieved some of these benefits on projects with alliance relationships in place (Corn et al. 1995).

Other companies are also using innovative relationships with their suppliers to achieve similar benefits. CII Research Team 112 investigated the innovative practices that some companies are using to reduce their engineering and capital

costs in their study entitled *2% Engineering*. The information contained in the following section was obtained from CII Research Summary 112-1.

The RT 112 study was initiated when NUCOR reported that it could achieve its business objectives at reduced costs through innovative practices. The study identified 20 innovative practices used by NUCOR and other companies. Several of the practices identified involve working with suppliers in non-traditional roles. One recommended practice is to buy as much service as possible from reliable fabrication and field subcontractors. Other practices include purchasing high quality process equipment without a design review from reliable suppliers and streamlining the preliminary engineering process by using a small, focused group of key professionals and relying heavily on the past experiences and intuitive technical judgement of the group. Each of these practices involves working with suppliers outside of the traditional role to achieve cost and schedule reductions.

The study identified several benefits of these innovative practices. The following is a list of some of the benefits documented by RT 112.

- Decreased capital costs
- Enhanced overall project schedule
- Increased project efficiency at all levels as well as technical consistency within the project
- Reduced design time for specific components
- Decreased number of suppliers and/or contractors

- Equipment that best meets functional goals recommended by experts (suppliers)
- Reduced engineering costs
- Redundancy of engineering activities avoided

The RT 112 study demonstrated that innovative practices, such as using suppliers in a non-traditional role, create many benefits for an organization in the construction industry.

2.5 Conclusion

Many changes in supplier relationships have been driven by a quest for quality. Some companies have reduced the size of their in-house engineering staff responsible for design, quality control, and improvement. Therefore, these companies must now rely on suppliers to provide the functions that were once performed in-house. Reformed relationships with suppliers have helped companies to increase quality while simultaneously reducing costs.

While quality has clearly driven the change in supplier relationships at some companies, procurement managers remain divided. Some managers fear a loss of cost competitiveness, but others believe that supplier partnerships will be the key to competitiveness in the future. Partnerships allow suppliers to be proactive. They give suppliers the opportunity to provide suggestions that simplify the process, reduce time and cost, eliminate duplicate engineering, or improve reliability, efficiency, lifecycle costs, and quality.

Innovative supplier relationships in the construction industry have been uncommon, but some companies have demonstrated their benefits. Fast track projects have consistently led the way in attempts to work with suppliers in non-traditional relationships. The need for a shortened schedule has resulted in the reduction or elimination of the bidding process. As a result, suppliers are often involved early in the process when they are able to contribute to design, and value engineering decisions. Suppliers have also played non-traditional roles on projects without compressed schedules. These relationships have also yielded benefits such as reduced construction time, improved quality, and reduction of lifecycle costs.

In summary, it is clear that there are benefits that can be achieved through reformed supplier relationships. It is now up to the construction industry to follow the lead of other industries and realize these benefits.

Chapter 3

Analysis of Mail Questionnaire

This chapter starts Part II of the report by presenting the methodology and results of the mail questionnaire used to gather information on current practice regarding the relationship between owner, contractor and supplier. The results will assist understanding of the subject area and identify instances of innovation.

3.1 Introduction

The mail questionnaire described in this chapter was the first step in the data collection process. It was designed to accomplish the following objectives:

- gather information on current practices regarding the relationship between the owner, contractor, and supplier;
- identify, if any, respondents who have used suppliers in an expanded role and determine if has been of benefit to the EPC process;
- develop a short list of individuals who can contribute to the subsequent phases of the data collection process.

A copy of the full questionnaire can be found in Appendix A.

3.2 Questionnaire Design

The questionnaire was divided into four parts. Part one requested information about the individuals completing the questionnaire and information about their companies. The respondents were asked to classify their companies as one or more of the following.

- owner
- engineering contractor
- construction contractor
- supplier

The questionnaire also asked the respondents to identify the type of construction in which their companies are involved. Each respondent could choose as many of the following types of construction as fit the type of work performed.

- Plant & Process
- General Industrial
- Commercial
- Heavy Civil

Part two of the questionnaire contained four Key Issue Questions. The respondents were asked to select the statement that best fit the company for each question. Space was provided after each question for the respondents to make any additional comments that they felt were applicable. Table 3.1 lists the four Key Issue Questions and the range over which each was scored.

Part three of the questionnaire was divided into two sections. Respondents were directed to complete only one of the two sections, depending on their responses to the four Key Issue Questions. Section one was designed for respondents who use suppliers in a narrow or traditional role and section two was designed for respondents who use suppliers in an expanded role. Section one seeks to identify the reasons why suppliers are used only in a traditional role. Section two attempts to identify the reasons that suppliers are used in an expanded role.

Part four of the questionnaire was to gather follow-up information and provide space for any additional comments that the respondents felt were important. The first question asks the respondents if they would be willing to participate in an in-depth interview with space provided to allow the respondent to identify any truly innovative supplier relationships not addressed by the questionnaire. Finally, the questionnaire asks respondents to identify anyone else they believe could be contacted to discuss innovative supplier relationships in the EPC process.

3.3 Questionnaire Distribution and Return

Prior to distribution of the questionnaire to CII companies, a copy of the questionnaire was distributed to research team members for review. The questionnaire was revised as per suggestions from the research team, and was again distributed to the research team for testing. The team members circulated the questionnaire to representatives from their companies to test. This assisted the research team in identifying and correcting ambiguous statements in the questionnaire. A final draft was prepared for distribution to CII member companies.

The mail questionnaire was distributed to the data liaison contact at all CII member companies. This person was asked to forward the questionnaire to the individual or group in the company who makes decisions regarding EPC contracting strategies and the role suppliers play in the process.

Table 3.1 - Four Key Issue Questions
Source: RT 130 Mail Questionnaire

Question	Traditional Relationship Score = 1	Expanded Relationship Score = 5
Which one of the following statements best describes the status your company accords to suppliers of complex engineered equipment and systems in the EPC process?	Low bid vendor on a project-by-project basis.	 Long term exclusive relationship.
Which one of the following statements best describes the time at which you normally make commitments to suppliers of complex engineered equipment and systems?	After completion of all detail design.	 Early in the conceptual design and process technology definition phase.
Which one of the following statements best describes the role you normally expect to be played by suppliers of complex engineered equipment and systems in the design and systems integration of the equipment they supply?	No input outside of published specifications.	 Provide expertise during design and process technology definition, optimization, and integration.
Which one of the following statements best describes the business and commercial relationships which normally exist between your company and suppliers of complex engineered equipment and systems?	Provide equipment designed and manufactured to specifications for an agreed price at an agreed time.	 Share fully in the risks and rewards associated with total project performance and may assume an equity portion in the venture.

Research team members contacted each CII data liaison contact to verify that they had received the questionnaire, answer any questions they might have, and if necessary, help select the person or group who might best be able to complete the questionnaire. This personal contact increased the number of questionnaire responses.

Sixty-nine questionnaires were returned in time to be processed for the research. This represents a response rate of 51%, which is excellent for mail questionnaires. The high response rate was largely due to the telephone calls made by the research team members to the companies who received the questionnaire.

3.4 Data Capture

The database Microsoft Access 95 was used to store the scores and responses provided in each questionnaire. This program has the capability to perform all the functions necessary to input, manipulate, and print the data for analysis. The information gathered from each questionnaire is in this database.

This document uses common database terminology by referring to individual mail questionnaires as records. Records can be queried based on an infinite number of choices. For example, all records where the companies identified themselves as owners who perform commercial work can be selected. The total score for this data set can be averaged and compared to another query. The database was invaluable in assimilating the scores and comments from the questionnaire.

3.5 Questionnaire Raw Data

Each of the sixty-nine returned questionnaires was compiled as a separate document for confidentiality reasons and assigned a unique record identification number (record ID).

Appendix B gives an example of the format used to establish the separate documents and record numbers.

3.6 Analysis of Part I – Company Classification

Part I of the questionnaire asks the respondent to answer questions regarding company and individual information. Two important questions in Part I were the owner classification and type of work in which the company is involved. These questions are used to identify patterns and trends in Parts II and III of the questionnaire.

The sixty-nine returned questionnaires generated sixty-nine unique records. This does not, however, represent the useful data set because companies could select multiple responses to the company classification and type of construction questions. The standard order for presenting and reviewing scores and comments is shown in Table 3.2. This matrix identifies 16 combinations, each of which forms an individual cell, of company classification and type of work. The number of entries in the matrix totals 149, or approximately twice the number of unique records. Therefore, on average, each respondent selected either two company classifications or two types of construction.

Table 3.2 – Mail Questionnaire Responses

Company Classification	Type of Construction				Totals
	Plant & Process	General Industrial	Commercial	Heavy Civil	
Owner	35	9	3	5	52
Engineering Contractor	21	11	6	4	42
Construction Contractor	22	13	7	7	49
Supplier	3	1	1	1	6
Totals	81	34	17	17	149

A majority of respondents identified their type of construction as plant and process construction, with 81 out of 149 possible combinations. The number of respondents identifying their company's type of work as general industrial, commercial, or heavy civil was roughly the same with, respectively, 34, 17, and 17 out of 149 possible combinations. The number of respondents classifying their companies as owner, engineering contractor, or construction contractor were, respectively, 52, 42, and 49 out of 149 possible combinations. Only 6 out of 149 responses identified the company as a supplier, which is significantly smaller than the other company classifications. This was expected because the majority of CII member companies are owners or contractors.

3.7 Analysis of Part II

Part II of the questionnaire asked the respondents to select the statement that best fit their company's strategy regarding supplier relationships. The respondent then assigned a score from 1-5 for the statement selected in response to each question. The score indicates the degree to which the company uses suppliers in an expanded role in the EPC process. Adding all four scores resulted in a total score for Part II. Therefore, the total possible score for Part II ranged from 4 to 20. A high score indicated the company uses supplier in an expanded role and a low score indicated the company uses suppliers in a traditional or narrow role.

3.7.1 Scores for Each Question

The average total score for all 69 questionnaires was 12.2. Results for several queries are given in Appendix C. This appendix shows the average, minimum, and maximum individual scores for each question for three different queries. The first query includes all 69 records, the second query presents the data by company classification, and the third query presents the data by type of construction. Appendix C also provides the number of records in each query. Table 3.3 summarizes the results of this data by showing the average, minimum, and maximum total score for each query. The number of unique records in each query is given in the far right column of the table.

Only three companies identified themselves as suppliers; consequently, very few scores are used in the analysis of queries that include suppliers. This point is important because