Reengineering Construction Operations

by

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Submitted to the Department of
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ABSTRACT

This thesis presents the concept of business reengineering and proposes applications to construction project management. The construction of a facility from initial development to final use is a very fragmented process involving many diverse parties. The focus of this thesis will be on the general contractor's project management activities with respect to the traditional contracting method. It will be argued that despite the increasing size and technological complexity of projects, the greater sophistication of owners, proliferating regulations and demands from government, improvements in computer hardware and software and increased litigation, contractors are continuing to organize and operate as they have for the past two decades and advances in information technology are merely applied to automate existing processes. In addition the competitive dynamics of the industry are being redefined as a result of the evolving roles and responsibilities of the various participants in this process. It is time the construction industry recognize the strategic importance of managing change.

Business reengineering or business process redesign advocates starting from scratch, designing new business processes, and then continuing to challenge the underlying assumptions in response to changing environmental conditions. To accomplish this firms must be willing to shed the constraints of past rules and assumptions which have become embedded in current processes. This concept will be evaluated as a management tool to maintain a competitive advantage in a business environment subject to continuous change. The thesis will then evaluate the traditional project management activities with respect to the roles and responsibilities of individuals and organizations, the flow of information and the role of information technology. Assumptions will be identified and challenged. Finally recommendations for process redesign will be addressed. While this thesis deals with one segment of the construction process and industry the results are applicable to all.

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BIOGRAPHY

Upon graduation from the University of Massachusetts in Amherst, Scott received a commission in the United States Air Force. As a Civil Engineering Officer he managed Macdill AFB's Military Construction Program, renovation of all senior officer housing, upgrade of the hospital emergency facilities and resurfacing of the airfield runways. In 1987 he separated from the Air Force with the rank of Captain and joined the project team on the $200 million Rowes Wharf Waterfront Complex with Daniel O'Connell's Sons Inc. Holyoke, Ma. Scott went on to manage construction of a $30 million high rise condominium complex and a $25 million corporate computer/administrative center. Prior to attending MIT he served as the Chief of Contract Administration for the $90 million North System Headwork portion of the Boston Harbor Cleanup project.

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CHAPTER 1: INTRODUCTION

In today's business environment change has become the norm. How firms respond to and manage change has not only taken on greater significance but in most cases is critical to survival. This thesis presents reengineering as an approach to manage change and proposes applications to construction project management. Reengineering advocates a process view of business. This requires shedding the constraints of functional and organizational boundaries and focusing on the processes which are used to define how a firm conducts business. Processes are identified, analyzed and redesigned in an effort to realize radical improvement. Most of today's businesses rely on processes most of which were developed before the advent of modern computers and communication systems. When new technologies are used, they are merely applied to automate existing processes. A common anecdote is paving over old cow paths. Special attention will be paid to the role of information technologies (IT) as an enabler of process redesign. IT is defined very broadly as computers, communications, data, work stations, and the analytical and technical disciplines that shape software and its applications [Keen]. Reengineering requires a new way of thinking in order to take advantage of the tremendous potential offered by IT. Rather than attempting incremental improvements to existing processes, an approach known as Continuous Improvement or Total Quality Management (TQM),

reengineering advocates rethinking the processes for radical improvement. Chapter 2 develops this concept further drawing from the works of Michael Hammer, James Champy and Thomas H. Davenport. In chapters 3 through 5 this management tool is developed further and applied to the construction management process.

Chapter 3 identifies and evaluates the existing construction project management processes and attempts to expose the underlying assumptions associated with these processes. The construction process and industry are very fragmented. There are a broad range of competitive strategies in the various market segments and this makes it very difficult to develop a generic project management model. The systems developed in this chapter will reflect the management processes of a general contractor which competes on lump sum low bid work. While some of the information was gathered from texts, most was based on personal project management experience on building projects ranging from $7 - 50 million. In addition, the management infrastructure of various general contractor project offices at the Boston Harbor Clean-up Project were evaluated. These heavy construction projects averaged $100 million each. This project management overview is as general as possible in order to encompass many markets segments without losing the detail needed to properly evaluate the reengineering concept.

The major premise behind this concept is that the context giving rise to the assumptions underlying existing

processes has changed. Processes must then be redesigned to take advantage of new conditions. Chapter 4 addresses the topic of change in the construction industry. It will be argued that the increasing size and complexity of projects, the greater sophistication of owners, proliferating regulations and demands from government, improvements in computer hardware and software and increased litigation have rendered existing processes inefficient. In response to these changes the roles and responsibilities of the organizations which compose this fragmented process are evolving. Yet despite the new inter-organizational dynamics, the internal processes of the various parties have not changed. Management needs to incorporate changes in customer needs, the evolution of the roles and responsibility of the various parties and the revolutionary changes in information technologies into strategy formulation. This thesis argues that the full benefits of IT are being constrained by existing processes. The fragmented construction industry with low barriers to entry has become vulnerable to external firms which can maximize the productive benefits of new technologies. A scenario will be developed to identify emerging threats to the industry competitive structure. To respond to these threats successful companies will have to proactively manage change.

In response to the changing conditions, the underlying assumptions will be challenged and redefined. It is no longer a question of how can we do this better? but Why are

we doing it this way? New assumptions will be made to accommodate today's new business and technological conditions.

These new assumptions are used in chapter 5 to redesign the processes. Process redesign or reengineering starts at the top with the president or CEO who develops a business vision and process objectives. A framework will be provided to guide the efforts of company leaders to define which processes to address in order to further overall strategic objectives such as What market or markets do we want to compete? and How do we compete? All redesign must start with the customer. This entails more than merely asking customers what they want but understanding how the firm's product or service fits into the customer's value chain. The customer's needs may be constrained by their perception of what is available. Utilizing the power of IT, construction firms may develop new and innovative value added services. This chapter will make recommendations on potential applications. In addition the effects of process versus task focus on the organization will be discussed.

In conclusion chapter 6 will evaluate the use of business reengineering in the construction industry and the role of IT. In the past technological innovation has been mostly incremental and very slow to diffuse in the construction industry. Investment is stifled by the need to maintain low overhead associated with a low cost strategy in a competitive bid environment. In a static environment,

contractors can afford a reactive posture and still maintain a competitive position. However as product life cycles in other industries continue to shrink the potential for radical change increases and the competitive dynamics in an industry can change overnight leaving those unprepared behind. The threat of entry by (1) Firms from other industries which are not constrained by past investments and (2) foreign contractors competing in a home market which nurtures investments in research and development is increased as technological breakthroughs lower entry barriers. Change is inevitable only now it is happening at a much faster pace. This thesis offers a tool to proactively manage change.

CHAPTER 2: REENGINEERING/PROCESS INNOVATION

2.1 Background

The principles upon which U.S. companies were organized and managed evolved from the ideas proposed by Adam Smith in the Wealth of Nations and Frederick Taylor's research on work organization, task decomposition and job measurement. Management assumed control of the knowledge domain reducing dependence on the skills or disposition of the work force [Zuboff]. Work processes were broken into simple tasks and standardized workers became a mechanism in the overall process controlled by management. Planning and control were conducted away from the operations by others further up the managerial hierarchy. As organizations grew these methods of control were applied to white collar workers as companies carved out operating divisions and organized staff according to functional expertise. These principles were successfully applied in the mass production of standardized products for a large undemanding and captive market.

In today's competitive environment reflecting, more demanding customers, increased foreign competition, rapid technological change, and the transition to a global market, the large, static bureaucracy of the past appears miscast. In response to the new competitive dynamics many firms attempted to improve productivity by various methods, the two most prevalent were downsizing and automation, within the

framework of the existing organizational structure. Failing to achieve the results necessary to remain competitive a few firms, notably IBM and Ford, took more drastic measures and started to change their focus from process improvement to rethinking the process. These companies were redefining fundamental business processes in the search for competitive advantage.

Rapid change has become a critical environmental factor and must be managed. Flexibility, responsiveness, innovation and customer focus are seen as the key parameters from which today's companies must be organized. Organizational theory has gone a full circle as research and experience has shown responsiveness and flexibility are gained by returning knowledge to the operating level and empowering workers. Horizontal structures result when companies organize around the processes. Management consultants and academia started to investigate the successes and failures of companies which were attempting to radically change the way they traditionally conducted business. Although the amount of literature is scarce, this new management concept coined "reengineering" has started receiving a lot of attention.

This chapter will develop the concept further by drawing from the research conducted by Michael Hammer and James Champy "Reengineering the Corporation" and Thomas H. Davenport "Process Innovation". In addition a framework will be developed for using this management tool.

2.2 Definition

"Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed [Hammer & Champy]." Davenport defines an approach called process innovation which "combines the adoption of a process view of the business with the application of innovation to key processes." In addition "the term process innovation encompasses the envisioning of new work strategies, the actual process design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions [Davenport]." For the purposes of this paper the two definitions will be combined and considered a management approach or tool under the auspices of reengineering. While it may be argued that reengineering relates specifically to the design of the new processes [Davenport], I chose to broaden this narrow application. One other important note is the reengineering approach is developed from my interpretation of the current available literature and research, not solely from research conducted by Hammer and Champy. For the purposes of this paper, I have taken the liberty of using their term to describe this management approach.

2.3 Process-oriented thinking

The one universal and most important aspect of this approach is "process oriented" thinking. A process is simply a set of activities that takes one or more kinds of input and produce an output for a particular market or customer. Most managers are trained to focus on tasks, jobs, people, structure or function, but not the process. As was mentioned above, work has been traditionally organized as a sequence of simple, separate tasks and a management hierarchy was put in place as a coordinating mechanism. Managerial control over the knowledge domain and information flows was used to justify this division of labor. The workers performing these disaggregated tasks were reaggregated in departments or functions [Hammer]. This applies not only to line operations but to white collar or office operations. Reporting relationships, decision making responsibilities and information flows are funneled up vertically through the managerial hierarchy. Processes on the other hand flow horizontally across functional boundaries. A sequential approach is taken as narrow pieces of the process are completed by individuals possessing the required functional expertise. The fragmented nature of conventional processes result in time, cost, quality and service inefficiencies as the workers tend to focus inward on the goals of the department or function instead of the overall goal of the process [Hammer]. Process-oriented thinking requires

shedding the constraints of the functional and organizational boundaries and focusing on the process. Roles, responsibilities and incentives will be defined by the processes which make up the business system. Performance can be measured in regards to the quality, cost, or time associated with the final process output.

Process-oriented thinking is not new. The quality movement boosted by the tremendous success of Japanese industry has been embraced by many large and small domestic firms. At the forefront is Total Quality Management (TQM), a systematic, step-by-step approach to streamlining processes and establishing a culture of continuous improvement [Davenport]. TQM focuses on process improvement within the existing structure, while reengineering advocates process innovation. TQM never challenges the original process and therefore rarely results in radical change.

"Processes are the structure by which an organization does what is necessary to produce value for its customers.." [Davenport]. For Reengineering to be successful the organization and its leadership must adopt process-oriented thinking.

2.4 Reengineering - The Approach

The discussion so far been very general and conducted in the context of a traditional hierarchical bureaucratic organization. This historical perspective was necessary to

gain a better understanding of this approach as well as to highlight the fact that it was developed by business out of necessity. This is important as many business leaders have become very skeptical of new management "fads" pushed by academia and the consulting industry. The reengineering approach involves developing a business vision, identifying existing processes and the underlying assumptions, challenging the assumptions, redesigning the processes, implementation and follow-up.

2.4.1 Business Vision/Strategy

Reengineering is a top down process. Lower level workers and managers completing individually assigned tasks in accordance with the goals set within their respective department or function will tend to have a myopic view of the organization. Senior management will have an understanding of the overall organization, which is necessary to direct cross functional process innovation. In addition, senior leadership has the power to break down organizational resistance to change. Uncertainty accompanies change and organizational resistance can be expected. Strong, aggressive, committed, and knowledgeable leadership is required to persuade the managers of functions to subordinate the interests of their functional areas to those of the process that traverse their boundaries [Hammer and Champy].

To be effective reengineering must be aligned with the overall business strategy. It is a means to an end and the end must be clearly defined by the head of the organization. The CEO will be required to develop and articulate his business vision of the future. Typically, a mission statement, outlining company goals, will be prepared and circulated to all the stakeholders. To demonstrate senior level support, reengineering initiatives should be included in this document. For smaller companies the president or CEO can communicate this information verbally and follow-up with a written statement of objectives. The mission statement fulfills two purposes, as a blueprint for organizational action and as a motivational tool. The need or justification for reengineering must be included, for example - declining market share and profitability, resulting from intense competition or the competition's ability to exploit innovation for competitive advantage, threaten the organization. Most firms today, responding to intense pressure from Wall Street to improve productivity, publicly advertise anticipated layoffs to accommodate restructuring initiatives. While these actions improve the market price of stock they have an adverse effect on employee moral. Unfortunately, reengineering, along with other initiatives to improve productivity, has become synonymous with layoffs. Management must make a concerted effort to keep the organization informed of developments and include employees

in the process. Reengineering will not happen without support from the organization.

The business vision needs to focus on the customer and it should include much more than market selection. It needs to challenge the organization to aggressively manage innovation, to anticipate customer needs and redefine future competitive strategies. The CEO sets the stage with a business vision and provides the tools to see it through. It is the individuals in the organization who must be willing give up the status quo, step into the unknown, and make it happen.

2.4.2 Identifying the Processes

Reengineering is about starting over, Hammer notes "in reengineering, radical redesign means disregarding all existing structures and procedures and inventing completely new ways of accomplishing work." While this is important in insuring creative and innovative solutions, I believe a lot can be gained by identifying and understanding existing processes. Challenging assumptions leads to a deeper understanding of change. Innovative solutions can be developed to not only take advantage of today's conditions but to anticipate tomorrow's. Understanding the existing processes and challenging the assumptions will be the first step in preparing a case in which to sell the stakeholders on the need for radical change. Reengineering does not happen

in a vacuum and to insure successful results full support of the organization will be required. In addition potential organizational resistance and technological constraints can be identified.

There is no agreed upon method for identifying and defining business processes. Although most management consulting firms have developed internal procedures for conducting reengineering initiatives, the number, type and complexity of processes will be unique to each company. Davenport considers this undertaking an art as opposed to an exact science. Hammer and Champy recommend developing process maps to give a picture of how work flows through the company. Given the broad definition, processes vary in detail and importance. For example furnishing and installing doors and constructing a building are both processes. In order to maximize the benefits of reengineering it is recommended that the process outlook be as broad as possible. Redesigning lower level processes will usually only result in minor improvements in the aggregate. Every process has a customer or recipient of its output. Starting from the customer the process can be traced through the organization, from the initial contact or order to delivery of the completed product or service. To identify and map out internal processes and sub processes don't rely on the organizational chart. The standard organizational box diagram, grouped by functions, will not accurately depict process flows and in most cases an informal network has been

established to facilitate work processes. Monitoring and diagramming information flows is another way to identify processes.

Once the processes have been identified they need to carefully analyzed.

2.4.3 Challenging the assumptions

Understanding the process begins with Questions: Why are we doing it this way? What are the underlying assumptions and have they changed? What activities actually add value? How is IT being applied? What activities are important to the customer? How are our competitors organized? and How are the best in other industries using innovation for competitive advantage? The last two questions pertain to benchmarking, which in this case is not intended to be used to learn and indiscriminately apply the best practice, but to develop an awareness of the strategic uses of innovation. This hopefully will stimulate creative applications.

A set of processes defines how a firm conducts business. A business process is designed at a set time to fulfill a specific customer need. A set of assumptions, based on customer needs, management trends, stakeholders needs, competition, environmental and technological conditions, the size and age of the organization, senior leadership influence, etc., current at that instant in time, are used to design the most efficient and effective process. As long as

these assumptions remain unchanged, and assuming the original design was correct, rethinking the process is not necessary. TQM or continuous improvement may be the proper choice for incremental improvement.

The traditional organization, described in section 2.1 Background, was at the time considered the most efficient way to organize. It proved very successful for many decades. But the underlying assumptions are no longer valid. More demanding customers, decreased product life cycles, development of advanced technologies, changes in the size and skill of the work force, and increased competition on a global level are some of the changes which have taken place. In today's dynamic competitive environment businesses must continually challenge assumptions and redesign processes in order to maintain a competitive position. Identifying the assumptions provides the answer to Why is the work being accomplished in this manner? Identifying the underlying assumptions is critical to diagnosing the process.

Recently, management concerns associated with the strategic applications of IT and the effect on the organization have received a tremendous amount of attention. Most of the processes used today were developed prior to the advent of computers. The rapid advancement in new technologies has been the driving force behind most reengineering initiatives. IT is a changing assumption, enabling radical new process design. The role of IT will be discussed in greater detail in section 2.5. As with the

processes they are associated with, assumptions will be unique to each industry, company, and process. There is no standardized method for recognizing assumptions. The rule of thumb is to challenge every activity by questioning Why? Be suspicious of the response "we have always done it this way".

2.4.4 Process Design

In many cases, the need for drastic action has already been established, as the firm is at a competitive disadvantage. There will be a tremendous amount of pressure to take the easy path and try to improve the existing processes within the organizational structure. This approach is much less disruptive. Another popular method is to indiscriminately institute job reductions across the organization. Demanding each function or department reduce job levels by some percentage. Now is the time to bring out that blank piece of paper and start from scratch.

Redesign starts with the customer and entails more than asking what they want, but understanding the customer's use of the output in their value chain. Process thinking should not be constrained by organizational boundaries. Many firms have developed tremendous competitive advantages by extending processes into the customers organization. By removing the mental and physical constraints of organizational boundaries and learning the customers business, new outputs can be developed. The customer's needs may be constrained by their

perception of what is available. In other cases, value added services accompanying an output may not be considered important by the customer. Processes should be built around outputs; and outputs should be jointly developed with the customer.

In a study of reengineering projects conducted by Gene Hall, Jim Rosenthal, and Judy Wade of McKinsey they identified two critical factors for reengineering success: breadth and depth of process redesign. The process to be designed must be broadly defined in terms of cost or customer value and the redesign must penetrate to the companies core. To insure the continual support necessary for survival of the new processes, roles and responsibilities, measurements and incentives, shared values and worker skills must all be addressed in the redesign phase. In response to the changes to these organizational elements, the company will began to organize around the redesigned processes.

An important tool in the redesign effort is innovation. The company should research new technologies and learn how the best companies within and outside the industry are using innovation. Creative applications of new innovative technologies will enable radical process redesign. If management is not aware of the tools at their disposal they will be at a competitive disadvantage.

As was mentioned earlier, reengineering starts at the top and senior management should continually monitor progress and get involved when necessary to insure success.

In larger companies where most efforts have taken place the CEO is too busy to provide the day to day management of the initiative. In this case, the reengineering project will be turned over to a sponsor or team leader. This individual will be responsible for making it happen. Carefully selected from the organization, the team leader or process owner should be a senior manager, who carries prestige, credibility and clout within the organization [Hammer and Champy]. This individual will be responsible for guiding the process through reengineering. A reengineering team will be put together to develop ideas, redesign the process, prepare a plan for implementation and assist in the implementation phase. The members of this team will be gathered from the various functions which will be effected by the initiative. The process benefits from the differing functional expertise and experience of the participants. In addition the participants possess credibility with their functional colleagues. This will be important during implementation. The process leader and team members should be provided all the resources and support necessary to carry out their respective tasks. Failure to do so will send the wrong signals to the organization and disrupt the effort. The job of the team is to challenge convention and develop radical new solutions. Their success will depend on an environment in which the free exchange of information is encouraged. More in depth information concerning team dynamics can be found in "The Wisdom of Teams" by Douglas K. Smith and Jon R. Katzenbach.

2.4.5 Implementation

Implementation planning begins when the decision to proceed with reengineering has been made. Starting with the mission statement each step of the process prepares for implementation. The mission statement demonstrates senior management support, provides justification, goals and objectives, all the necessary ingredients to mobilize and motivate the organization. Process identification and evaluation further develops justification for change and exposes possible organizational resistance and technological constraints. Process redesign will provide the strategic plan necessary to redefine the business system. A continuous effort should be made throughout the reengineering process to cultivate organizational support.

Up to this point everything is on paper, the implementation phase initiates actual structural change to the organization. While the reengineering concept appears fairly simple it has proven to be very difficult to implement. Changing the organizational philosophy in which many have built their careers; and relocating the traditional power bases will meet strong resistance. For this reason the term radical will usually be included in any literature on this subject. Roles and responsibilities, measurements and incentives and IT infrastructure all need to be changed to accommodate radically different new processes. Reengineering

is not easy and will be a very painful and disruptive experience.

The reengineering successes point to two important requirements, strong senior leadership and sensitivity to human behavioral issues. Hammer notes strong senior leadership is critical to "cause an organization to turn itself inside out and upside down and to persuade people to accept the radical disruptions that reengineering brings". A tremendous effort will be required to tear a company apart and start over. Tough decisions will be necessary to identify and break down internal resistance. Senior leadership must truly believe in this approach to assume the risk associated with an uncertain outcome.

In a period where major layoffs are common as companies try to improve productivity and control by replacing workers and middle management with IT, the work force has become very suspicious of change. Redesigning processes can render existing employee skills and experience obsolete. Individuals who have built careers around the current structure must trade it all in for an uncertain future. Reengineering efforts must be sensitive to these concerns. The employees must be included in the process and not treated as mere recipients. Investing in the training of existing employees to handle new job requirements may alleviate some of the uncertainty concerning future status. Although it has already been mentioned it bears mentioning again, reengineering will not happen without organizational support.

The actual implementation process should be planned in advance during process redesign by the reengineering team. The process leader with assistance from the reengineering team will manage implementation. Functional leaders, who will be effected by the proposed changes, as well as the leaders of IT and human resources should be briefed on implementation plans and kept appraised of on-going developments. The better informed the organization is the easier implementation will be.

The implementation process should encourage participation by employees. The actual contributors to the new process may have valuable input for improvements. Despite attempts to identify and mediate potential sources of resistance during previous phases, resistance may still occur. Resistance must be dealt with quickly and decisively. Even minor internal resistance can have a crippling effect on the overall process.

2.4.6 Follow-up

Following implementation the process should be carefully monitored to insure customer needs are being met effectively and efficiently, internal controls and incentives are compatible with the redesigned processes and the organization does not revert to past practices.

More importantly this phase symbolizes the continuous nature of reengineering. Process-oriented thinking requires

constantly monitoring key business processes and the underlying assumptions. Changes in the underlying assumptions which can be expected in a dynamic competitive environment must be incorporated into the processes. The organization must be flexible enough to redesign processes on a continual basis. There has been some research conducted in organizational theory which treats organizations as biological organisms, reference "Images of an Organization" by Gareth Morgan. In today's dynamic environment this analogy is applicable as the organization must maintain a fluid posture to respond to changing external conditions.

2.5 The Role of Information Technology

Reengineering is about managing change and perhaps the most drastic change today is occurring in the advancement of IT. IT is neutral. How management chooses to use it will determine it's effect on the companies overall success. Reengineering attempts to exploit the tremendous potential of IT by applying it to process redesign.

Despite large IT investments by U.S. businesses many still question the actual benefits. As noted by Lester Thurow in the forward to "The Corporation of the 1990's: Information Technology and Organizational transformation" by S. Scott Morton " Specific cases in which the new technologies have permitted huge increases in output or decreases in costs can be cited, but when it comes to the

bottom line there is no clear evidence that these new technologies have raised productivity or profitability. In fact, precisely the opposite is true. There is evidence, in the United States at least that the investment in the new technologies has coincided with lowered overall productivity and profitability." Extensive research is being conducted to identify strategic applications of IT and to understand the effects of IT on the organization.

Advocates of reengineering contend that most companies invest a tremendous amount of resources to automate existing outdated and inefficient processes and therefore are not realizing ITs full potential. Applied to automate existing processes contributes to the inflexible nature of the organization and its processes. Davenport suggests that "managers trying to maximize the value of IT and researchers should think of process change as a mediating factor between the IT initiative and economic return". The power of IT is not in improving the way work is currently conducted but in creating new radical ways of working.

The assets and applications of the current IT infrastructure should be identified and evaluated at the same time reengineering efforts are focusing on the existing processes. Management needs to understand how IT is being applied and why. This step might be taken further to determine whether applications are actually adding value.

CHAPTER 3: CONSTRUCTION PROJECT MANAGEMENT

3.1 Introduction

Business reengineering advocates starting from scratch and organizing in accordance with the demands of today's markets and the power of today's technologies. How people and companies did things in the past isn't important [Hammer]. While it is agreed,
rethinking the process should not be constrained by past operating procedures, rules and regulations, for the purpose of this paper the past will be addressed as a starting point or benchmark from which to develop the argument that assumptions underlying existing processes are no longer valid. This chapter will define the project management context in which this study will be conducted, define the existing processes and identify and evaluate the underlying assumptions, the information flows and applications of IT. The argument will be developed that as a result of changing conditions the roles and responsibilities of the various participants to this process are continually being redefined and the assumptions underlying existing processes are no longer valid. The objective is to understand Why the work is organized and accomplished as it is.

3.2 The Traditional Contracting Method

If this study limited itself to the general contractors organization and responsibilities it would violate an important principle of "process oriented" thinking - Processes should not be constrained by organizational or functional boundaries. The construction industry is very fragmented and project management methods vary according to individual company preferences, project scope, complexity, location, customer, contracting method, etc. This section will define the overall construction process, evaluate the underlying assumptions with respect to the roles, responsibilities and contractual relationships of the various parties in this fragmented process. In addition the evolution of these roles and responsibilities in response to changing conditions will be addressed.

The traditional contracting method in its historical context will be used to define this process. While it might not accurately portray today's construction environment, it is still the foundation upon which owner, architect and GC relationships and thus the project organization are patterned. This method which continues to be the most commonly used, defines a process composed of independent activities arranged in a linear and sequential manner as shown in exhibit 1. The major underlying assumptions for this process are: (1) Segmenting tasks make it easier to allocate responsibility and risk and monitor performance; (2)

The associated project organization is the most efficient in terms of cost; and (3) The time lost by completing tasks in a linear and sequential manner is offset by the control and cost benefits.

The traditional contracting method was developed to simplify a very complex construction process. The process was segmented into sequential independent activities in order to allocate risk and responsibility and monitor performance. Each activity will be completed prior to the start of the next. Thus the project will be fully designed and well defined at the completion of the design phase and all design information will be incorporated into the contract documents. To accomplish this task the design industry, architects, engineers, and specialty consultants would exclusively possess and manage the knowledge and expertise necessary to provide design services. In addition, construction would have to take place in a stable or predictable environment for the designers to anticipate and include all contingencies in the contract documents.

The general contractor, recipient of the information produced in the design phase, is solely responsible for the construction phase. To accomplish this task the general contractor would exclusively possess the construction knowledge and expertise necessary to transform design into its intended tangible form.

The flow of information is limited to a one time hand-off between the separate activities and can thus be accommodated by the hierarchical organizational structure.

The traditional contracting method was developed to maximize owner value, low cost construction, in accordance with the above assumptions. If the underlying assumptions do not change than reengineering would not be necessary and process improvement would be the proper tool to improve competitive advantage.

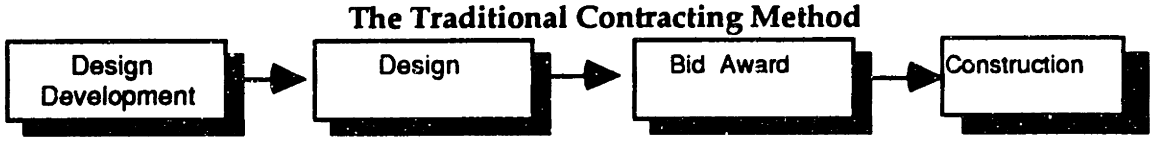

EXHIBIT 1

3.2.1 Roles and Responsibilities

An architect is retained by the owner to develop plans and specifications which define the asset to be constructed. In most cases the architect will subcontract out portions of the design (i.e. mechanical, electrical, structural, landscaping, curtain wall, geotechnical, interior, etc.) to specialty consultants. The final documents should include all of the owner's requirements for use of this asset. Bids for construction services are requested by advertisement and the contract documents are made available to all qualified contractors. The contractors prepare a bid price based on their detailed estimate of construction costs. This requires development of a concept for performance of the work and a construction time schedule. After a lump-sum contract has been awarded to the low bidder, the contractor must furnish and pay for all materials, equipment, power, labor and supervision required for construction. The owner compensates the contractor for construction costs and services. Assigned the responsibility for construction, the contractor may perform some, all, or none of the work. Some of the work is let out to specialists called subcontractors. Once the planning, design, bidding and award phases have been accomplished the success of the project from the contractor's perspective depends on completing the field construction phase on schedule, under the estimate and in accordance with the contract documents. Once construction begins the

architect acting as the owners representative will monitor progress, examine the work for compliance with the contract documents, interpret the provisions in the documents, verify change order requests, review submittals, and authorize progress payments.

The contractual arrangement between the project members is illustrated in exhibit 2. The result is a hierarchical organization in which the architect and the GC both work directly for the owner and are accountable only to the owner. Communication or information flows between the various parties are conducted in accordance to this hierarchy.

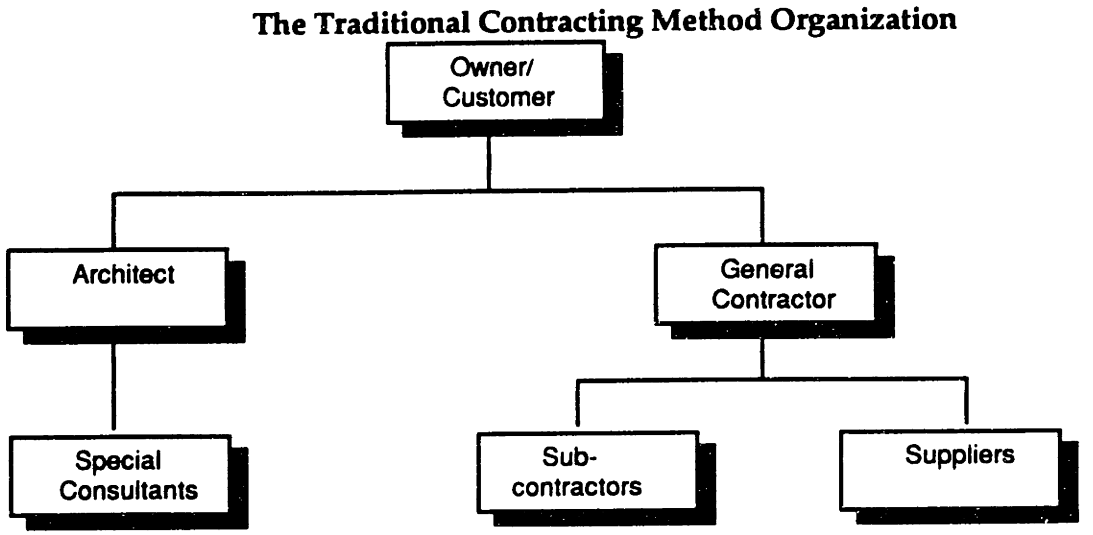

EXHIBIT 2

3.2.2 Information Flows

The traditional contracting method was organized so as to limit interactions between the various members of the project team. This was done to make the complex building process more manageable. The owner would allocate responsibility to one firm for one task, set a milestone or goals and measure performance. The flow of information was intended to adhere to this simplified process. Information would flow between the owner and architect during the design development. The results of this phase, the completed contract documents, are provided to the GC. During the bid phase questions pertaining to the scope will usually be addressed in a prebid conference. The GC built the facility in accordance with the contract documents. The architect acted as the owners representative to insure compliance. Information was communicated verbally in person or by phone. The traditional contracting method was not developed to accommodate an information intensive process. All relevant information was supposed to be contained in the contract documents and minor clarification in scope or request for changes were directed through the owner to the architect. Little communication was expected. While it may be argued this description is an over simplification, the intent of this method is to simplify the construction process. The major assumption is the architect possesses all the knowledge necessary to design a facility in accordance with the owners

requirements and this information can be codified in the form of contract documents. All the information required in this very complex process is captured in the documents.

3.2.3 The Current Environment

Construction project organizations are still being organized in accordance with the traditional contracting method. In fact all the underlying assumptions identified are still in place in support of the organization of today. In the public heavy construction market the assumptions for the most part are still valid. However in building construction, the traditional roles and responsibilities and information flows have evolved within this organizational framework to adapt to changing environmental and technological conditions. The assumptions are no longer valid. The previous section defined the roles and responsibilities and information flows in accordance with the traditional contracting method. The following sections will identify the effect of change on today's construction process.

3.2.3.1 Roles and Responsibilities

Increasing project size and technological complexities of the components, combined with increased litigation have resulted in a shifting of design responsibility. Design is

no longer a separate independent task for which all responsibility is assumed by the Architect. Design is now a continuous process that spreads through the construction phase. In addition, the design industry in an effort to manage exposure to risk, has pushed as much responsibility as possible to the GC. The architect develops the design concept and prepares schematic drawings for the bid process. The GC has assumed responsibility for detail design, coordination of the various independent systems, verification of dimensions, selection of materials and equipment, and identification of inconsistencies between the drawings, specifications, general conditions, industry practices, and governing codes and regulations. How does the GC manage all this additional responsibility?, they pass as much as possible on to the subcontractors and material suppliers. The subcontractors end up assuming the risk associated with design, coordination and cost. In many cases, the GC will attempt to subcontract out as much work as possible to reduce exposure to risk in a very competitive bidding environment. The design and construction knowledge and expertise are being shifted to subcontractors and suppliers.

3.2.3.2 Information Flows

As roles and responsibilities have changed so has the nature of information flows. Spreading the design responsibility out increases the flow of information.

Information flow is no longer simply a complete set of design documents forwarded to the GC. Subcontractors must interpret schematic drawings and specifications, prepare detailed design and select materials and equipment. This information must then be submitted to the following review process in sequential order: GC, architect, specialty consultant, architect, GC and subcontractor. In some cases the GC will include other subcontractors in this loop in order to insure the proper interface between different systems. This time consuming process is repeated if the submittal is disapproved by any of the parties. In some instances this process is expedited by allowing direct communications between the specialty consultants and the subcontractor or scheduling a meeting between all the parties to resolve problems. The owner is not included in this loop unless coordination between the architect and GC break down. This same process will be repeated during the project to design and price changes, review concrete placement drawings, review coordination drawings for the mechanical systems and at the project close-out when as-built drawings and O&M manuals are submitted.

Project meetings are scheduled usually on a weekly basis between the owner, contractor and architect to monitor progress, review submittal status, change order requests, and resolve outstanding design issues.

Exhibit 3 depicts the direct information flows established between the various participants. Information

flows no longer follow the organizational structure defined by contractual agreements.

The Traditional Contracting Method
Interorganization Information Flows

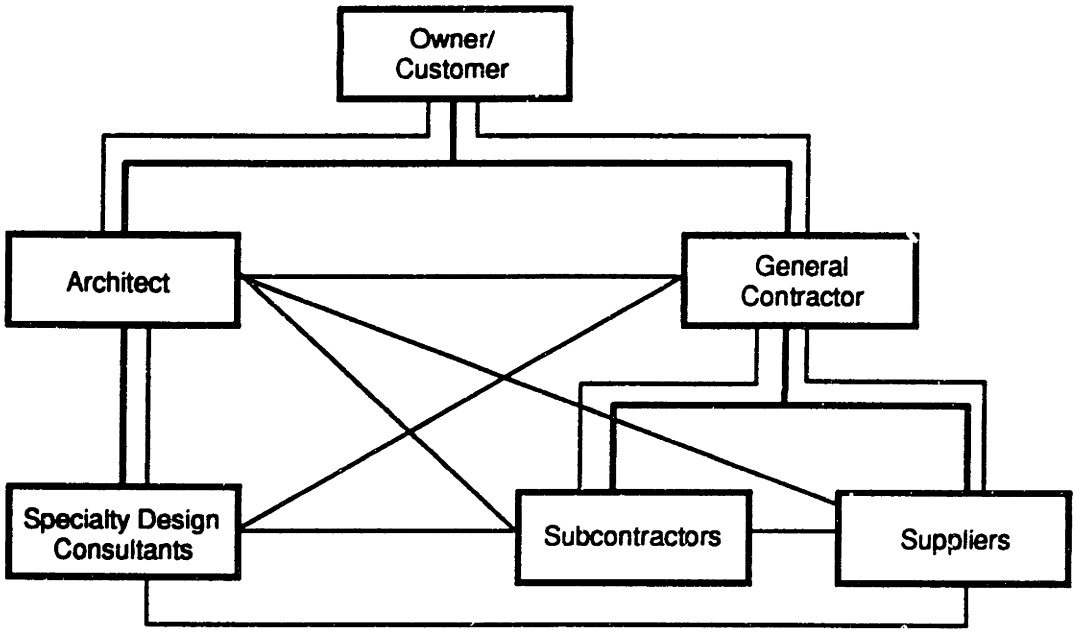

EXHIBIT 3

The role of the GC is evolving into an information facilitator, responsible for coordinating the flows of information between all parties. The architect's once limited role as the owner representative monitoring progress and compliance with contract requirements has expanded. The transferal of design responsibilities to participants in the construction phase necessitated more active designer

involvement. The GC still responsible for this phase of the process now must deal with an added variable. General contractors have taken a very practical approach to this issue; Despite the absence of a contractual arrangement an informal and direct line of communication is established with the architect. To complete the job on schedule and within the bid price a close relationship must be maintained with the architect.

3.2.4 The Role of Information Technology

IT is applied in accordance with the separate activities shown in exhibit 2. The architect, specialty consultants, GC and subcontractors all utilize IT independently to improve the efficiency of their individual operations. Reliance on IT will also differ between the parties.

A perfect example was found at the Boston Harbor Project. The architect/engineer developed the design drawings using GDS®, a custom computer aided design (CAD) system developed by McDonnell Douglas. The final design was transferred from this electronic medium to paper for inclusion in the contract documents. The GC interpreted the paper drawings and transferred the information manually into their own CAD system, developed by AutoCAD®, in order to prepare coordination drawings. The GC transferred the drawing information from this electronic medium to paper prior to distribution to the subcontractors. The subcontractors

manually provided the necessary information pertaining to their work onto the drawings. The GC manually entered this information into the AutoCAD® files, new paper drawings were printed and forwarded to the architect/engineer for review.

If current IT applications are superimposed on Exhibit 3, which graphically depicts the information flows between the various parties in the construction process, it would be located in the nodes. IT is applied to improve the efficiency of the segmented tasks. Investments are made and applied within the organizational parameters set by the traditional contracting method.

3.3 The General Contractor

Section 3.2 developed the overall organization of a typical construction project in accordance with traditional contracting methods. The purpose of this section is to focus on the GC project organization, internal processes, information flows, and use of IT.

3.3.1 Organizational Structure

Construction produces a unique product, at a specific location, at a specific time, over a finite duration. Construction operations are thus organized on a project basis. Project teams are organized and located at the jobsite to manage the resources necessary to construct a

facility in accordance with the contract documents. The corporate headquarters is typically organized according to functional units (reference exhibit 4). The amount of support provided by headquarters will vary according to individual company preference. The spectrum ranges from complete decentralization in which all work activities associated with the project are conducted by the project team at the jobsite to a more centralized relationship advocating a high degree of home office involvement.

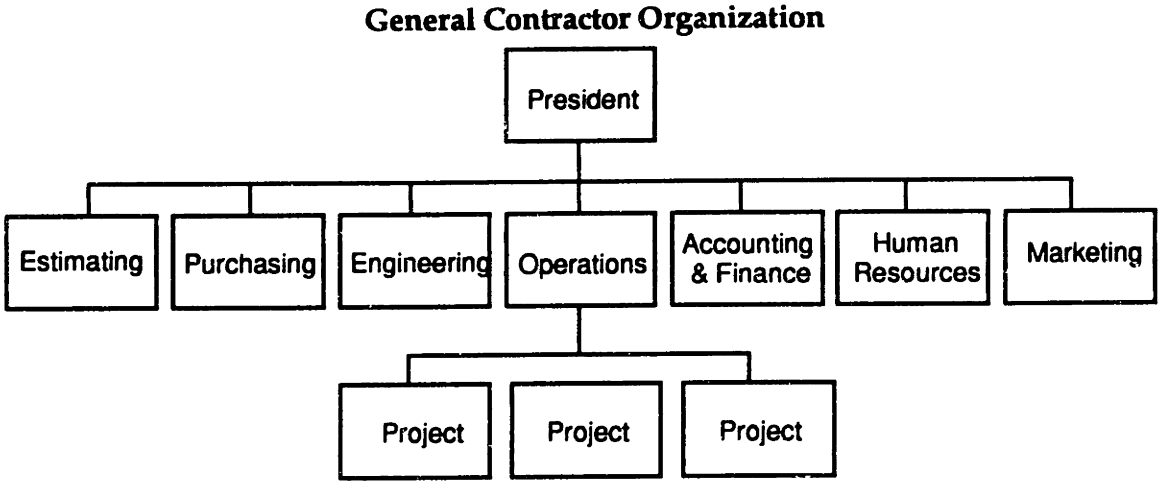

EXHIBIT 4

In the past, to minimize overhead, a GC would rely on a superintendent to manage all field operations and a part time project manager (PM), sometimes referred to as a project engineer, in the home office to provide administrative support. The project manager would work with the superintendent to purchase materials and trade contracts and prepare the corresponding contracts upon contract award. During the job the PM would provide administrative support and manage customer interface. Each project manager was given responsibility for multiple projects. The superintendent with extensive field experience was the source of the companies construction knowledge. Armed with complete and well defined drawings, labor, materials, equipment and subcontractors the superintendent would transform architectural intent into a tangible asset. Support from the main office was limited to cost accounting. Competition in the traditional contracting method is based on cost. The industry is fragmented and competition is very intense in this market segment. The competitive strategy is to maintain as lean an organizational structure as possible. Large national and international firms carrying a heavier overhead burden find it very tough to compete against smaller, local, regional firms on this basis.

In today's construction environment, this project management structure is becoming increasingly rare. As the size and complexity of projects increase, one individual can no longer be expected to have all the answers. In addition

the rapid increase in job related information is overwhelming project management teams. Just the documentation necessary to prepare for and thus avoid litigation is enough to distract field managers from their main task of building. A full time project manager is no longer considered a luxury afforded the larger companies on larger projects but a necessity to manage the information flows. Anderson and Woodhead, in "Project Manpower Management", identify four basic organizational forms, which typify the project structure of construction firms. These structural forms are as follows: (1) the project team structure, in which project team leaders are in charge of the projects as well as the work in the home office functions, (2) the traveling project manager structure, which incorporates a separate role, the purpose of which is to provide coordination between the project site and home office, (3) the field based project manager structure, in which the project manager is located in the field, together with a complement of personnel capable of performing some of the functions normally handled in the home office, and (4) the total field autonomy structure, in which almost all normal home office functions are performed in the field under the authority of an executive resident project manager. As the size and complexity of projects increases the last two forms will be more prevalent. This paper will consider the last two organizational forms as the typical project structure.

The extent to which the home office supports the field based project team will depend on the individual company. There does not appear to be a simple explanation for the centralization/decentralization choice. In general as the company grows by generating more revenue and expanding geographically, home office overhead increases to manage and support operations. Staff is organized by functional units in order to realize economies of scale and develop internal expertise. But once again how these functions are organized and the extent to which they interface with the project will vary by company.

It is not the purpose of this paper to evaluate and critique the benefits of home office involvement but to note the differing organizational strategies used to compete in this industry. The focus will not be on how companies organize but how the organizational structure or design supports the project management process and adds value to customer requirements.

Today's construction firms following a low cost strategy are organized to minimize overhead. The assumption is that a lean organizational structure is necessary to compete on a low bid basis as dictated by the traditional contracting method.

3.3.2 Project Management - The Process

"Processes in a company correspond to natural business activities, but are often fragmented and obscured by the organization [Hammer and Champy]." This section will attempt to identify and map the processes used to meet customer needs. The individual processes and associated activities will be identified and defined relative to the existing organizational structure described in section 3.3.1. In addition the underlying assumptions will be exposed.

Process selection is not an exact science and the proposal provided is not intended to represent the only solution, but to demonstrate how process selection and evaluation can be conducted. Starting with the customer, tracking the activities which contribute to the overall operation of a construction firm, and finishing with fulfillment of customer requirements, the natural business activities were grouped according to processes. It is important to note the evaluation does not start and finish with actual construction but with identifying and fulfilling customer needs. The processes used to describe the work flows are business development/strategy, project planning, customer design, and construction. The following sections will describe each process and the underlying assumptions.

3.3.2.1 Business development/Strategy

Very few resources have been devoted to this process. The strategy is very simple maintain a low cost position to effectively compete in market segments in which the traditional contracting method is used. The company president or owner will select market segments defined by customer (public, private, institutional, etc.) and/or product (building, heavy construction, manufacturing plants, etc.). Many firms will focus on a specific segment and attempt to leverage internal core competencies and economies of scale and scope. The assumption is that customers with construction needs will continue to select the traditional contracting method to define project organizations.

The main output of this process is locating customers with construction needs. Typically, public or governmental agencies will advertise for bidders in order to insure a competitive bidding process. Marketing in this case consists of senior management reviewing industry publications, trade journals and local newspapers to identify potential projects. Projects are selected by matching company core competencies with customer needs. In this segment the customer will be provided only the work described in the contract documents. Future work will be awarded on cost not past service and therefore quality customer service is not considered a value adding activity.

Private organizations which are not constrained by government procurement requirements may solicit three or four GCs to bid a project. In this case a more formal marketing approach is taken to locate customers with construction needs. A function will be established to conduct business development or marketing. This function will be tasked with penetrating the segment or segments selected by senior management. While the chances of obtaining a project on a select bid list is better, the final choice is still dependent on price. In this market segment, the customer is only provided the work described in the contract documents. However, some contractors may provide additional services in an effort to secure a position on future bid lists or obtain future work on a negotiated basis. A little more emphasis is placed on customer service in private work.

Since most customers advertise for bidders to insure a competitive bid process, marketing or business development is not considered a value adding activity. In an effort to keep overhead low very few resources are devoted to this process.

Strategy formulation is an integral part of this process. Unfortunately, many contractors assume a reactive posture. Strategy is simply maintaining a competitive position through low cost and selecting markets in response to external economic conditions.

3.3.2.2 Project Planning

The project planning process flows sequentially through the estimating, purchasing and operations functions. Support is provided as requested from engineering and human resources.

The first activity is the bid phase which is managed by the estimating function. Despite its importance management is reluctant to expend resources from other functions on this process. To develop an accurate estimate it is necessary to plan out the job. Once a customer with a project has been identified, the firm will obtain a set of contract documents composed of drawings, specifications, general conditions, supplementary general conditions and an owner/contractor agreement. These documents should include all the customer's requirements for the use of the facility. The GC will provide a bid price based on their detailed estimate of construction costs. This will entail development of a concept for performance of the work and a construction time schedule. In smaller firms estimating will be conducted by the president/owner and the project manager. In larger firms an estimating function is established to assume responsibility for activities associated with the bidding phase. Project manager involvement will vary per firm. During slow periods project managers will be brought in to assist the estimating function, however, in general they are too busy on current projects. Due to the uncertain nature of

the bidding process, many jobs are bid for each one awarded, the company is reluctant to waste resources.

The estimating function is critical to a companies success. Regardless of how good the project management team is, if the estimates are high, projects will not be available and if the estimates are too low, financial lose is likely. The companies pricing knowledge is the domain of this function. A historical cost data base is usually maintained to insure accurate and up to date information. Skilled estimators are needed to interpret the contract documents; prepare an accurate quantity take-off; understand the mechanics associated with the various activities and how these activities will be sequenced. Typically, resources are focused on the continuous bidding process and participation in the construction phase is minor. The assumptions are that the project management team can accommodate the few pricing requests received during construction, estimating resources are more productive bidding and the job can not support the overhead associated with estimating assistance.

Other functions such as engineering and operations will provide assistance if requested. Engineering might prepare a job schedule, provide design input for earthwork, site work and concrete and furnish CAD representations of site logistics. Operations might help develop site logistics, furnish manpower and equipment requirements, review the budget for general conditions and help develop the schedule.

Human resources may provide input concerning the availability and salaries of personnel and local union requirements.

Typically bidding is considered a separate, independent activity or process managed by the estimating function. It is included in the planning process because this activity develops the project cost or budget which has direct implications on the construction process.

The estimate which upon award becomes the budget incorporates: How the work will be organized, accomplished and sequenced, manpower levels, equipment and materials selections, subcontractor involvement, the scope of the general conditions, the schedule, owner and architect clarifications and addenda and pricing and scope assumptions. All this information is converted to costs, used to prepare the bid. Upon award, the bid becomes a budget and is provided to the next function. The recipient of estimating's efforts receives a detailed budget which becomes a benchmark from which to build the job. All the information used to prepare the numbers remains with the estimating function.

Planning is done again in purchasing as they start identifying what materials, equipment and subcontracts must be purchased. Once again the work is organized and the scope is carefully defined. Intensive negotiations are conducted with subcontractors and suppliers to obtain the best value for a well defined scope of work. Responsibility is allocated and schedule commitments are obtained. Subcontracts and purchase orders are executed. The contract

intent extends beyond the written document to include all the verbal discussions conducted during scope review and negotiation sessions. This information remains with the purchasing function.

The operations function in possession of the contract documents, subcontracts, purchase orders and the budget is ready to start construction. First all this information is interpreted and then the planning process is conducted for a third time by the project management team. Job planning is conducted within schedule and cost parameters set by others and the project team is responsible for making it work.

3.3.2.3 Customer Design

In the traditional contracting method, design service provided by the contractor is minor. A complete and well defined design is provided by the architect/engineer. Customer service is none existent in a competitive bid situation. The customer is provided only what is specified in the contract documents.

While the design of the product is provided by others, the contractor is still responsible for developing the construction methods necessary to produce this output. Contractor design becomes critical to obtaining a cost advantage. Savings can be realized by developing and applying innovative construction methods. This could apply to scheduling and sequencing of work, logistics, management

of resources and design of construction methods for work accomplished in-house. The impact of this activity will be greater on heavy construction projects or building projects which a substantial portion (measured in cost) of the work will be accomplished in-house. The engineering function with support from operations will handle this task.

As was mentioned earlier design is now a continuous process that spreads through the construction phase. The contractor has assumed responsibility for detail design, coordination of the various independent systems, verification of dimensions, selection of materials and equipment, identification of inconsistencies between the drawings, specifications, general conditions, industry practices, and governing rules and regulations. An important point to make is that while the contractor has assumed design responsibility, it is not considered a value adding service. All design input must be reviewed and approved by the architect/engineer. Any savings realized must accrue to the owner and a competitive advantage can not be attained. Design responsibility is considered just another construction requirement to be included in the scope of work bid on a competitive basis. The challenge to the contractor is to insure a complete and accurate design is provided to field operations in a timely manner. The general contractor will provide detail design and material selections for work accomplished in-house, the remaining design responsibility is allocated to the specialty subcontractors and suppliers.

Included in this process are the shop drawing and submittal procedures which are used to develop detailed design. Construction progress is dependent on this sub process. Installation can not start without an approved design. A tremendous amount of coordination is required to insure the proper submittals are made on a timely basis; they are received and reviewed in a timely manner by all the pertinent parties; and the completed design is communicated to the field. This sub process has become so time consuming that in many cases an assistant is used during the beginning of the job to monitor and coordinate submittals. Competitive advantage is not obtained through innovative design but by efficiently managing the portion of the design process which extends into the construction phase.

3.3.2.4 Construction

This process begins with organizing all the required resources and ends with fulfillment of all contractual obligations.

Ideally in any contractual arrangement risk will be allocated to the party in the best position to control it. The traditional contracting method simplified and segmented a complex process to make it easier to allocate responsibility and risk and monitor performance. The architect/engineer is responsible for design and any associated risk and the contractor is responsible for construction and any associated

risk. Responsibility is more difficult to define in today's construction projects as the design and construction processes overlap and reliance on subcontractors and suppliers has increased. Risk has increased with the project size, complexity and duration. Litigation has increased the magnitude of potential financial loss associated with risk. The result of these new conditions is that a tremendous amount of resources are being devoted by all parties to manage exposure to risk. Managing risk exposure is critical to the financial success of the construction process.

Purchasing all the materials and subcontracts carried in the bid is usually conducted right after the award in order to lock in previous quotes. In the past contracts were automatically provided to the subcontractors and material suppliers whose quotes were included in the bid. Subcontractors were rewarded for their low price at bid time. In some cases this process is enforced by public agencies as subcontractors bid the job separately and the filed sub bid numbers are made available to the bidding general contractors. Subcontracts must be awarded in accordance with the separate subcontractor bidding procedures. The assumption is that a complete and well defined design is provided by the customer, the scope of work associated with each subcontracting specialty is clearly defined and the estimating function is able to define and verify the scope of work provided by others. Coordination of the various systems is provided by the designer.

For the Boston Harbor Project and the Central Artery Tunnel, two local large scale heavy construction projects, and most public projects these assumptions are still valid. An organized purchasing function is not required as subcontracts and purchase orders are awarded immediately after bid award to the low subbidder. However, in building construction general contractors can no longer afford to merely award contracts based on the information developed and furnished by the estimating function. Subcontractors will pick-up and price only the drawings and specification sections which pertain to their specific specialty and interface between the various systems and work identified in other sections may not be addressed. To accommodate the technological complexity of building systems, the design is usually conducted in the same manner. Specialty consultants are hired to design the different systems independently. Both the task related design and bidding increase the likelihood that problems will occur at the interface of the various systems. In addition it is becoming more frequent for contractors to receive schematic design and assume responsibility for detailed design, verification of dimensions and coordination. This problem is compounded by the fact that most subcontractors literally wait until the last minute to fax proposals to the general contractor. The estimating function does not have the time to verify scope and prices. Design extends into the construction phase and is accomplished after the bid and coordination of the various

systems will not begin until the construction phase. The allocation of responsibility and risk for this process will usually not be addressed by estimating when preparing the bid.

Contractors have responded to increased design and coordination responsibility and changing bid dynamics by revising their purchasing methods. In effect purchasing is no longer managed by estimating. A separate activity or in some cases a new function has been established to buyout the project. During this phase a detailed study is made of the subcontractors scope of work and contract negotiations are conducted. The purchaser must understand the contract documents, the system to be purchased and how it interfaces with others in order to define the scope of work, apportion responsibility and negotiate with subcontractors. In addition a schedule subject to milestones set in the planning stage must be developed and agreed upon. This schedule will include not only construction activities but also the design and submittal activities. Subcontractors refer to this process as bid or price shopping. There is some truth to this claim. Many contractors under the guise of scope review will encourage revised quotes. But given the conditions noted above contractors have very little choice. The assumption is that allocating resources to establish a purchasing activity will reduce risk exposure to new design responsibilities.

The proportion of work subcontracted out appears to be rising and as a result the importance of purchasing becomes more critical to the success of the job. At the completion of the purchasing phase the contractor will have a very good idea what the final cost will be. The general contractors construction role becomes that of a coordinator similar to a construction manager. One last item to note, purchasing, conducted by a separate function at the home office, will be evaluated by the amount of buy-out savings realized. This goal may be detrimental to construction progress. Sometimes the low bidder may end up costing more money before the job is over. Poor performance, poor workmanship and the failure to coordinate with other trades all can disrupt construction progress.

Once the design development, planning, bidding and purchasing phases have been accomplished the success of the project from the contractor's perspective depends on completing the field construction phase on schedule, within the estimate and in accordance with the contract documents. The project management team is the key to the success of this phase. A semi-autonomous organization is established at the job site to manage time, money, equipment, technology, people, and materials. The extent of decentralization is dependent on the management philosophy of the contractor. In addition, the organizational structure and systems employed to manage the project in the field are directly influenced by the age, experience, and background of the project manager.

The operations function is responsible for managing the construction phase. Suppcrt may be provided by engineering for scheduling and design, estimating for change order pricing, accounting and finance for cost control and payroll, and human resources for labor issues.

In the past the construction phase was managed by a superintendent. His responsibility was to manage the resources at his disposal material, equipment, labor, and subcontractors to build a facility in accordance with a complete and well defined set of design documents. A project engineer usually working out of the home office would provide administrative support. This lean organization was ideally suited for a process which was designed to limit the interactions between the various participants. All the information needed to complete the construction phase was contained in the contract documents. The superintendent and his/her foremen were actively involved in coordinating resources through direct supervision at the field production level.

In section 3.2.3 "The current environment" a very different project environment is described. The contractors internal project management activities have had to adjust to accommodate changing environmental conditions.
Additional resources are being allocated to the field organization in order to meet these new challenges. Most notably a full time project manager at the job site to develop systems to control the increasing information flows,

additional staff to manage these systems, and information technologies to improve the efficiency of these systems to process data. Personnel and information technology are added incrementally to accommodate new tasks.

Project management in this phase involves coordination through direct supervision. For jobs with a high proportion of subcontractors, in critical path activities, success is dependent on subcontractor performance. The general contractor must insure communication and harmonious working relations between the various subcontractors and that all work is accomplished in accordance with the contract documents and the schedule. The subcontracts awarded on a low cost basis will make up the bulk of the project cost. The contractor reduces the project risk by subcontracting out the work and, assuming the full scope of work was purchased, managing the schedule is the key to success.

In lieu of subcontracting the contractor may chose to accomplish certain activities in-house. The contractor gains more control over the work but assumes additional risk. The contractor must exercise closer involvement associated with task planning, purchasing materials, equipment, and labor, preparing submittals, and managing productivity. Managing cost and schedule are the keys to success.

3.3.2.4.1 Information Flows

This section will attempt to provide a general description of the information used at any typical construction project office to demonstrate the growing information content of the process. To facilitate this discussion the information is divided into three categories: project administration, project control and coordination, and contract administration. This outline will vary depending on the company, project type, and project manager.

1. *Project Administration*

   A. Correspondence

      One file for incoming, one for outgoing, arranged by firm and chronologically.

      1. Owner/Client
      2. Architect/Engineer
      3. Subcontractors
      4. Suppliers
      5. Testing/Inspection Agencies
      6. Misc.

   B. Transmittal letters

      One file for incoming, one for outgoing, arranged by firm and chronologically.

      1. Owner/Client
      2. Architect/Engineer
      3. Subcontractors

4. Suppliers

5. Testing/Inspection Agencies

6. Misc.

C. Meeting Notes and Minutes

File Chronologically.

1. Weekly Job Meetings (Contractor project team)

2. Weekly Scheduling and Coordination Meetings

3. Weekly Owner/Contractor Progress Meetings

4. Monthly Owner/Contractor Requisition review

5. Weekly Safety Meetings

D. Reports

Filed chronologically

1. Daily Job logs

   a. Project Manager

   b. Superintendent

   c. Project Engineer

   d. Safety and Quality Control

2. Telephone Logs

3. Progress Photographs

4. Weekly/Monthly Job Progress Reports

5. Inspection Reports for Quality Control

There was a time when agreements were made by a "handshake". If an owner wanted a facility built, he would obtain bids from local reputable contractors. In addition to profit, a contractors need to maintain a good reputation within the industry and the community was a strong incentive

to provide a quality product. The predominate means of communication was verbal, in person or on the telephone. The only paper to be found at the job site were the drawings, specifications and a daily log to keep track of resources. Today's job site is radically different. The complex nature of the information associated with design documents still require verbal communication, however, written documentation has evolved along side this process. The tremendous increase in information has exceeded the project teams ability to mentally assimilate and store data. Documentation is required to capture and store information transferred verbally. Information is documented to reduce the risk exposure to litigation. Many believe the resources devoted to "avoid" litigation adversely effect the overall productivity of the job.

2. *Project Control*

A. Cost/Budget

1. Original Estimate/Budget
2. Weekly Labor Cost Summaries
3. Monthly Equipment Summaries
4. Monthly Material Cost Summaries
5. Subcontractor Contract and Payment Status
6. Monthly Job Cost Projections

B. Schedule

1. CPM (project) Schedule
2. Shop Drawing and Submittal Schedule and log

3. Material Procurement Status Report

C. Coordination

1. Contractor Generated Concrete Placement Drawings
2. Subcontractor Generated Mechanical Coordination Drawings
3. Miscellaneous Shop Drawings and Submittal Data

Coordination and control have received the most attention in recent years as IT development and applications have focused almost exclusively in these areas. Cost and schedule controls are developed and used by the general contractor to manage field operations. This sensitive information is not shared with the other firms in the value stream.

In the planning stages, the engineering function will prepare a CPM schedule. This schedule will be used by estimating to prepare the bid, purchasing to negotiate subcontractor and supplier commitments and the project manager as a benchmark. With a few exceptions, such as the Boston Harbor Project where the schedule must be updated and submitted for construction manager (CM) approval monthly, the CPM schedule will not be amended. The superintendent will use it as a guide to develop short term, usually two week, planning schedules, the project manager will use it to prepare a material delivery log and to benchmark job progress and senior management will use it to monitor performance. In most cases the project team does not have the expertise or

desire to update computer generated CPM schedules. The schedule is used as an internal management tool, the project manager is reluctant to provide the schedule to subcontractors for fear of assuming a legal obligation.

Cost reports are critical to the financial success of a project by not only monitoring but also analyzing data. Computerized accounting systems have been developed to identify differences between actual and estimated costs or quantities and allow prompt action to control costs. If all the work has been subcontracted out then the cost of the job is basically set and the risk associated with meeting the cost is passed on to others. The General Contractors cost reports will only monitor general conditions. The more work assumed by the General Contractor the more important cost control becomes to monitor productivity, verify estimated quantities and costs, and identify potential problems.

Typically, the responsibility for developing coordination drawings is delegated to the HVAC subcontractor. The electrical, plumbing, fire protection trades will overlay their systems manually on to these drawings. Most general contractors and some of the largest subcontractors possess (CAD) capabilities. However most of the small local subcontracting firms, which participate in the coordination drawing process, have not invested in this technology.

3. *Contract*

A. Contracts

1. Owner/General Contractor

a. Main Contract

b. Addenda (by number)

2. General Contractor/Subcontractors and Material Suppliers

B. Contractual Scope of Work and Changes

1. Specifications and Drawings

2. Requests for Information by General Contractor

3. Response to Requests by Architect/Engineer

4. Design Changes

5. Requests for Change Orders

6. Change Order Status Report/Log

7. Claims Log

C. Invoices and Payments

1. Monthly requisition/Invoice to Owner

2. Monthly Invoices from Subcontractors and Material Suppliers

The contract documents and any subsequent changes or modifications are provided by the architect, through the owner, to the contractor in paper form. Revisions to the contract documents are to be expected. All changes must be carefully evaluated for cost and schedule impact by not only the contractor but by all effected subcontractors and material suppliers. Typically the contractor will review the

scope of the proposed changes and distribute a copy to all effected trades for input. If cost or schedule are impacted, this information is included in a change order request and submitted to the owner for action. Once the change order is approved and executed the contractor is responsible for insuring the work is communicated to the field and completed within the quoted price. In addition submittals, shop drawings and coordination drawings may all have to be updated and resubmitted for review. For large and complex projects such as the Boston Harbor Clean-up Project where changes number in the thousands this process can have a tremendous impact on the overall schedule and budget. Progress in the field is dependent on receiving complete information on a timely basis. Most of the contractors found it necessary to establish a contract administrative position to manage the flow of information.

In the past this process was minor, if the design is complete and well defined numerous and large changes are not expected. However, due to the increasing size and complexity of projects and increased contractor involvement in design this process has become very information intensive. Contractors have had to allocate resources and develop systems to respond to this change.

3.3.3 The Role of Information Technology

Due to the intense price competition attributed to this fragmented segment of the industry very little is spent on research and development. Firms rely on academia or firms outside the industry to develop new technologies. Innovation which diffuses very slowly throughout the industry and is not employed offensively for competitive advantage but defensively to maintain competitive position. Hardware and software packages are purchased from third party developers. To insure immediate commercial success, applications are developed to support the current processes. Third party developers appear unwilling to assume the risk associated with developing and marketing creative systems which do not meet today's market requirements.

The focus of applications have been on project control systems, specifically cost control and scheduling. Cost control grew out of historical cost accounting systems developed to meet broad business applications and these activity based systems are extended to included project activities. Modifications have been made to include cost projections based on past unit prices and anticipated quantities. Reports comparing actual to budgeted costs are prepared and circulated internally to monitor performance. Subcontracts and purchase orders are entered as lump sum actual costs.

Scheduling is conducted using prepackaged software programs. Typically, the field office does not possess the hardware, expertise and/or time to use this software. These resources are furnished by the engineering function. The job schedule prepared by engineering is a plan based on assumptions regarding weather conditions, field productivity, subcontractor and supplier performance, activity sequences, etc. As the job progresses the actual conditions will most likely differ from assumptions. The schedule will have to be revised. Rarely does the project team enlist engineering to update the schedule. Most field offices will readily admit the schedule is used as "wall paper". Scheduling and sequencing of work is conducted by the field superintendent on a short term, usually two weeks, subject to the milestone constraints established in the original schedule. Field personnel believe the conditions at the job site are so unpredictable and variable that maintaining a schedule is a waste of resources.

In addition given the current capabilities of scheduling software many believe it does not accurately reflect the very complex construction process. Once the job starts, the schedule is used to monitor and control progress. Its potential as a planning tool to be shared with the other parties in the process is not realized.

A field office with computing capabilities is the norm not the exception. The extent to which these capabilities are utilized will vary depending on company philosophy and

the experience of the project team, however, the actual applications across this segment of the industry are very similar. During the project planning stages IT is not addressed as a resource. Instead a system evolves with the job. Each team member will devise a strategy for best completing his or her assigned task, which usually involves using a computer in some fashion. The members will adopt personal computers and software that best meet their needs, and often the applications are quite unique. The individual's "technology frame" [Orlikowski] will drive the selection of his or her application software. Integration is not considered. Duplication and poor quality of information result from multiple data bases established for each activity. In addition the amount of information generated by each activity threatens to exceed the organizations ability to process it. IT is applied to improve the efficiency of the general contractors construction activities. Information sharing with the other parties in the process is limited to written or verbal communication.

CHAPTER 4: RESPONDING TO CHANGE

4.1 Introduction

Rapid technological change in building materials and systems, increasing size, length and complexity of projects, advances in information technologies, increased government rules and regulations, increasing litigation, changing labor force, the transition from a domestic to global economy and increasing sophistication of customers are all contributing to a dynamic competitive environment. The underlying assumptions upon which the traditional contracting method was developed are no longer valid. Rather than "rethinking" the process the various participants have responded by incrementally changing roles and responsibilities within the existing organizational framework. As a result the process around which today's construction projects are organized has become inefficient. This chapter will investigate the impact of change on the competitive dynamics of this industry segment. Changing conditions will be identified by challenging some of the critical assumptions addressed in chapter 3. In the process new assumptions will be established for process redesign in chapter 5.

4.2 Challenging the Underlying Assumptions

4.2.1 The Traditional Contracting Method

The traditional contracting method was developed to simplify a very complex construction process. The process was segmented into sequential independent activities in order to allocate risk and responsibility and monitor performance. The flow of information is limited to a one time hand-off between the separate activities and can be accommodated by a hierarchical organizational structure. This method works for simple projects of short duration, which the architect/engineer can furnish a complete and well defined design anticipating and including contingencies.

As was mentioned in chapter 3, increasing project size and technological complexities of the components, combined with increased litigation have resulted in a shifting of design responsibility. The contractor, competing on a low cost basis, must interpret designer intent when preparing a bid. Detail design and selection of materials are accomplished after the bid phase during the construction phase. The architect/engineer still acts as the owners representative to examine the work for compliance with the contract documents and interpret the provisions in the documents. A possible conflict arises when the architect/engineer assumes the additional role of managing the design process through construction. An adversarial

relationship will develop between the contractor and designer over the intent of the contract documents. The architect will expect that the contractor understands that the contract documents delineate the general intent of the work and will provide whatever incidental material and labor necessary to translate the intent of the documents into a finished and usable structure, notwithstanding the same may have been inferred and/or omitted from the plans and specifications. The contractor on the other hand, trying to prepare the lowest bid possible to win the job, is making a much narrower interpretation of the scope of work to include only that specifically shown on the contract drawings and called for in the specifications. The contractor will attempt to push design responsibility and associated risk onto the subcontractors. The subcontractors are then expected defend the scope of work bid and assume the risk associated with final architect/engineer judgments to the contrary. A zero-sum game results from a contractual arrangement which does not accommodate a team approach. Conflicts and inconsistencies in the contract documents, unforeseen conditions, failure to coordinate the interface between the different systems and poor design all lead to additional cost. Adversarial relationships develop as the various participants attempt to interpret the design intent and apportion responsibility. One parties gain is another's lose. The new assumption is that design is a continuous process that spreads through the construction phase.

Continuous design requires a team approach by the designer, general contractor, subcontractors and suppliers and thus the nature of the information flows have changed dramatically. Out of necessity to complete the construction phase on schedule and within the budget the general contractor is forced to communicate directly with the architect and their specialty consultants. In spite of the fact that the architect/engineer and the general contractor both work directly for the owner communication flows no longer follow the resulting hierarchical structure. The hierarchical organization is ill suited to accommodate an information intensive process.

Recent legal rulings have established that the architect is accountable for actions conducted during the construction phase. The architect is no longer solely responsible and accountable to the owner according to the contractual arrangement. The process organized around segmented independent tasks allowed the customer to manage and control the project by direct supervision. The activities or tasks are no longer segmented or independent. The evolving roles and responsibilities make it very difficult to identify and monitor responsibilities. The construction process has become more complex and direct supervision as a coordinating mechanism is less effective. To accommodate an information intensive process with interdependent activities requiring close cooperation between the participating organizations at

the production level the dominating coordinating mechanism should be mutual coordination among teams.

The customer or owner will invest in an asset with the expectation that this asset will produce a return exceeding the opportunity cost of capital. In today's dynamic competitive environment time has become very valuable. Decreasing product life cycles have reduced the duration of a window of opportunity from years to months. For example time has become a critical variable in Digital's attempt to construct the manufacturing capability necessary to produce it's new alpha chip. The future of the company is dependent on getting this product to the market before its competitors. Customers are no longer willing to accept the additional time required to complete activities in a sequential and linear fashion. New contracting methods are being applied to shorten the duration of the process.

The final and most interesting effect of evolving roles and responsibilities in response to changing conditions is on the location of the knowledge domain. As was discussed in section 3.2 the construction and design industries organized around the independent process activities; the design industry exclusively possesses and manages the knowledge and expertise necessary to provide full and complete design services and the general contractor exclusively possesses the construction knowledge and expertise necessary to transform design into its intended tangible form. The increasing technological complexity of materials and systems, decreasing

product life cycles and the custom applications on a one time project basis have made it increasingly difficult for the designer to economically maintain a current, broad and detailed knowledge base. In addition, the response to increased litigation is to allocate detail design to others more familiar with the actual assembly or construction. Design risk is passed on to the general contractor. The general contractor does not possess the knowledge or expertise to provide design services and therefore passes the responsibility and associated risk on to the subcontractors and material suppliers. To minimize risk exposure the general contractor will require subcontractors to assume responsibility for design, cost, coordination, and construction. The result is that the design and construction knowledge is being transferred to the specialty subcontractors and suppliers.

Selecting, evaluating and redefining assumptions is not an exact science. There are probably many others which effected the development and evolution of the traditional contracting method, the discussion here is limited to the critical and more obvious examples.

4.2.2 The General Contractor

The traditional contracting method defines the competitive environment in which the general contractor has chosen to compete. Pursuing a low cost strategy,

organizations are lean with minimal overhead. The assumption is that the traditional contracting method will continue to be considered the most efficient and effective manner in which to organize the construction process. As we discussed in the previous sections this scenario is unlikely. The challenge facing today's GCs is how to reconcile this internal organizational strategy with changing owner demands. Currently the response has been limited to incremental changes within the existing organizational framework. The risk is that a strategy based on differentiation by providing the soft services (estimating, value engineering, assisting in the preparation of the contract documents, providing constructibility reviews, scheduling purchasing, coordination etc.) which are being required by more demanding and sophisticated customers evolves while the contractor continues to pursue a low cost strategy. The firm becomes "stuck in the middle" and uncompetitive in both segments [Porter 1980]. Overhead must be increased to include the infrastructure necessary to provide soft services and the low cost position enjoyed by the firm is compromised.

So far the focus in this chapter has been on the overall construction process as defined by the traditional contracting method, this section will address the business processes of the general contractor. In chapter 3 processes were identified and defined according to a typical functional organizational structure depicted in exhibit 4. The processes used to describe the work flows of a typical

general contractor are business development/strategy, project planning, customer design, and construction. This chapter will continue on this discussion and evaluate the effectiveness of the organization in efficiently managing company resources in support of these processes.

4.2.2.1 Business Development/Strategy

In the past very few resources have been devoted to this process. Most of senior management's time is consumed responding to the challenges of managing day-to-day operations. The strategy is simply to maintain a low cost position to effectively compete in market segments in which the traditional contracting method is used. In a static environment in which the customer's needs can be addressed by the traditional contracting method this reactive posture may work. The new assumption is that customer needs are changing and the traditional contracting method will not adequately address these needs.

Time has become more valuable due to the rapid development of technology, more demanding consumers and increased foreign competition. Customers are no longer willing to trade time for the questionable benefits of control and cost. Construction services are being requested earlier in the process to improve the cost efficiency of the design. Owners are getting more involved in the process and expect soft services. In many cases the traditional

contracting method is not considered adequate and alternative contracting arrangements are being made. Projects organized around other methods may not be advertised and award may not be based on only cost. A more proactive strategy will be required.

In response to changing customer and market demands, additional resources need to be applied to develop the infrastructure necessary to conduct strategy development. Senior management need to focus on the company as a modern business enterprise; on the mission of the business; its objectives, direction and strategies; its competitors, markets sales volume, return on investment and special areas of competence. In addition areas such as growth, diversification, threats and opportunities, personnel and organizational development and economic trends will need to be considered [Friedman]. The strategy process will take on greater importance in a dynamic competitive environment.

4.2.2.2 Project Planning

As the size, complexity and duration of projects increase planning becomes critical to success. While few contractors will dispute this claim, it is surprising how little attention it receives. Planning is treated as an activity conducted by the project team prior to mobilization and construction. The project management team, composed of members of the operations function is provided the budget

(the successful bid) prepared by estimating, a schedule prepared by engineering and subcontracts and purchase orders negotiated and prepared by purchasing. The challenge is to organize and coordinate project resources within these constraints. This paper proposes that planning should be treated as a process which begins as soon as the decision is made to bid the project. A process view allows management to develop a deeper understanding of how planning is conducted within the organization and what resources are being expended. Currently, project planning is conducted sequentially and for the most part independently by the estimating, purchasing and operations functions.

Each specialized function develops a construction plan in order to complete their specific task. Resources are wasted as this activity is repeated across independent functions. In addition an over the wall mentality exists between functions. The estimating function's participation ends when the project estimate is furnished to the next function and estimating's resources are focused inward to continue preparing bids for other jobs. All the knowledge, expertise and information used to prepare the bid is converted to costs and subsequently lost to future users. Purchasing's participation ends when the project buy-out is completed and all subcontracts and purchase orders are furnished to operations. All the information generated in scope and cost negotiations with subcontractors and suppliers

is condensed and included in the contract documents. A tremendous amount of information is lost in this process.

Lack of integration and coordination between the functions result in a duplication of efforts. Compounding this problem is the failure to share information. The planning information generated in preparing each functional output remains within the function. A broader view of the planning process integrated across functions is required to improve effectiveness and efficiency.

One other issue which bears mentioning is the subcontractors role in the planning process. In all the projects I have observed subcontractor participation was not solicited. The general contractor prepares the schedule and forces it onto the subcontractors during contract negotiations. Despite assuming increasing design and construction responsibilities, subcontractors and suppliers are not included in the planning process. The planning process should extend across organizational boundaries.

4.2.2.3 Customer Design

Design is no longer an independent activity of which sole responsibility for its execution rests with the architect/engineer. It is a process which flows across organizational boundaries. The process which has evolved, in an environment defined by the traditional contracting method, is extremely inefficient. First of all the

contractor, subcontractors and suppliers are not included in the design development phase and the owner does not benefit from their knowledge and expertise. Input on site use and improvements, material and equipment selections, constructibility, labor and time requirements can result in cost and time savings. In addition value engineering services can be provided to analyze system designs, methods, and materials for various details and applications.

Due to the zero-sum nature of this project organization, adversarial relationships develop between all the participating members. A tremendous amount of energy is exerted as the members jockey to avoid design responsibility. Responsibility is pushed downstream in the value system [Porter 1985] and ends up with the subcontractors, sub-subcontractors and suppliers. While the organizations at the end of the value system possess the knowledge and expertise necessary to complete this task, they do not possess design resources and infrastructure comparable to the other participants. For example most architects/engineers and contractors utilize CAD systems while most subcontractors manually develop all design documents. The process is broken into independent tasks according to the participants responsibility. Each participant organizes and applies resources to improve the efficiency of their individual task. The result is a fragmented inefficient process. Information is not shared and work is duplicated resulting in wasted resources. The Boston Harbor Project example given in

section 3.2.4 provides a perfect example of this problem. Compounding this problem is the functional and task applications of IT. While increasing the efficiency of each functional or task contribution, it has at the same time reinforced the division of knowledge, because it does not address the issue of coordination of and communication across the functional phases and tasks of the process [Brochner]. The customer ends up absorbing the costs associated with inefficiency. Contractors need to broaden their focus from individual contribution to understanding the overall design process. The infrastructure needs to be developed to enable the contractor to become part of a team organized around the process. Removing organizational boundaries to facilitate a team approach to project design will improve the effectiveness and efficiency of this process.

4.2.2.4 Construction

One of the disadvantages of competitive bidding is an adversarial relationship may result from the zero-sum-game and low-markup nature of bidding [Gordon]. Risk management becomes a critical part of the general contractors operations and strongly influences the decision making process. The competitive bid process, used to select suppliers, is leveraged to force responsibility and risk down the value stream. Organizational barriers are erected and resources are wasted on elaborate procedures to monitor and document all

inter organizational communications in an attempt to survive the zero-sum-game. The general contractor will expend a tremendous amount of resources on the purchasing activity in order to limit risk exposure by insuring as much responsibility and risk as possible are allocated to subcontractors and suppliers. As much of the scope of work as possible is subcontracted out. Normally, I would have qualified this statement to include only building construction. However, during a recent visit to the Boston Harbor Project, I observed a large international construction firm attempting to subcontract all the work on it's $100 million project.

Moreover, bidding is a very expensive process. The owner must prepare perfect contract documents to avoid future claims, and the contractor and subcontractors must prepare detailed cost estimates for bids, many of which are unsuccessful [Gordon]. The new assumption is that the costs associated with selecting subcontractors and suppliers on a cost basis in a competitive bid climate outweigh the benefits. In an environment in which adversarial relationships exist the team work approach breaks down. The construction process is segmented according to organizational responsibilities or tasks. Each organization develops internal processes with regard to their independent tasks without considering the overall process. Resources are not shared and work activities are duplicated. The process becomes inefficient.

The project teams main focus shifts from directly supervising field production to managing information. During the design and construction processes the general contractor acts as an information conduit between the architect/engineer and subcontractors and suppliers. The information from the design process, detail design, submittals, shop drawings and coordination drawings, is needed for the construction process. Systems are implemented to insure design is proceeding in a manner so as not to disrupt or delay the construction. Systems are also implemented insure change orders are reviewed, priced, approved/disapproved, incorporated into final design and disseminated to the field so as not to delay or disrupt construction progress.

4.2.3 The Changing Competitive Environment

As contractor role and responsibilities evolve so do the skills necessary to be successful. It is important to identify and understand change and monitor its effect on the industry competitive structure. This section will develop a scenario of potential new entrants taking advantage of the lower barriers resulting from change.

General contractors are relying more on specialty subcontractors. In an effort to manage risk more responsibility pushed down the value stream. In addition this market arrangement is considered more efficient as scale economies can be more fully exhausted. The operations of the

general contractor are usually not large enough to support full time employment of all the skilled craftsmen involved in a construction project. By subcontracting, the contractor is provided the resources when required. The subcontractor can provide full time employment to their employees by aggregating market demand [Gunnarson & Levitt]. As has been pointed out in previous chapters, the general contractors role is evolving into that of an information facilitator. A low cost position used to be maintained by developing innovative solutions to construction methods, improving productivity by accomplishing work with internal resources, lower transportation costs, knowledge of local conditions, rules and regulations and field experience of personnel. Competitive advantage was obtained by keeping overhead low and developing internal construction knowledge and expertise. The new skills required to maintain competitive position by effectively and efficiently managing information are changing the competitive dynamics of the industry and lowering barriers to entry. Outside firms unconstrained by past investments and industry bias can develop a competitive advantage by investing in innovative applications of IT to manage information more effectively and efficiently.

"Big six" accounting firms, with management consulting practices which offer construction industry services, could develop project management services and enter this market. Innovative project management applications of IT can be developed in conjunction with a defense contractor or large

international A/E firm. Both have devoted a large proportion of resources to the research and development of internal project management systems. Their large distribution network can be leveraged for markets access. Almost every company large or small in the domestic market will require accounting services at least once a year. The argument that they do not possess the necessary construction knowledge and expertise is no longer valid as this knowledge is being transferred to subcontractors and suppliers. In addition subcontractors are assuming responsibility for direct supervision of field production.

Owners will no longer tolerate the inefficient management systems run off obsolete and poorly configured IT platforms of local general contractors and construction managers. Why deal with a local unknown entity when an international firm with a good reputation and financial strength is available at a competitive cost. Consulting firms are currently organized on a project basis and overhead can be managed by outsourcing overhead activities including scheduling, estimating, cost control, surveying, engineering and design, safety etc.

A competitive threat also exists from the defense industry. Responding to cut-backs in federal spending defense contractors are diversifying into other businesses. Construction is seen as a good industry to leverage project management skills. However, unlike consulting firms, defense

firms do not have the proper organizational structure to support a competitive cost structure.

The above scenarios are only examples of potential new entrants to a changing industry competitive structure. Threats also exist from large domestic and international firms which offer differentiated services including financing. The important point is that company leaders must continually monitor the effect of change on the competitive environment. Competitive strategies will need to be developed to identify and aggressively respond to change.

CHAPTER 5: PROCESS REDESIGN

5.1 Introduction

Chapter three answered the question "why are we doing it this way?" by identifying and evaluating existing processes. The overall construction process and underlying assumptions were defined according to the traditional contracting method. In this context a set of business processes was developed to define how a general contractor conducts business. In chapter four the underlying assumptions were challenged. It was the intent of these two chapters to define a general organizational and operational context necessary to develop an example of process selection, evaluation and redesign. Each practitioner can expect to confront different challenges related to their specific situation. At this point we should have a clear understanding of current processes, changing conditions and potential technological and organizational resistance.

This chapter will provide an example of process redesign. A business vision will be developed to provide the blueprint from which to conduct process redesign. Typically an individual's business vision will reflect their personal bias and include company specific issues such as organizational strengths and weaknesses, stakeholder needs, financial condition, competition, etc. For this exercise a broad generic business vision will be developed to provide

the framework from which to conduct process redesign. New innovations in information technology and organizational theory will also be evaluated as potential enablers of change. The chapter finishes by addressing the effect of process redesign on the organization and the future role of IT.

5.2 Customer Focus

The construction process, defined from the customers perspective, is to develop, design and construct a value-adding asset. The process is complex, expensive, time consuming and unpredictable. The traditional contracting method was developed to simplify this process by segmenting it into sequential independent activities in order to allocate risk and responsibility and monitor performance. Upon receipt of the bids, the customer knows the total cost of project and the low bidder assumes all risk associated with construction. The customer is able to eliminate uncertainty. However, there is a cost for delegating risk as the general contractor will include contingencies in the bid. The cost becomes prohibitive for those items which are beyond GC control such as subsurface conditions, poor design, owner furnished work and other external factors. In addition the customer will pay for the time and cost inefficiencies of this process identified in section 4.2.1. These

inefficiencies have increased as the process evolves to accommodate changing environmental conditions.

While alternate contracting arrangements are being developed and used, the traditional contracting method is still the most common. The main reason is that the design, contracting, subcontracting and supplier industries have all organized and developed internal resources necessary to compete in this environment. A tremendous investment has been made. The market representing the upstream customer is very diverse and fragmented and composed of many one time buyers. As a result the upstream buyers do not possess the power to force change. In addition the customer's needs are constrained by their perception of what is available.

The high cost of domestic construction adversely effects the ability of businesses to respond to increasing competitive pressures and once someone provides a radical new process customers will most likely quickly except and expand. From the customer point of view the bottom line is to minimize cost, time, uncertainty and risk. The assumption is that these variables are dependent, thus reducing risk and uncertainty will increase time and cost. The goal then of radical process redesign is to address and control all four variables.

5.3 Developing a Business Vision

Despite changing environmental conditions, contractors continue to organize and compete on a low cost basis in accordance with the traditional contracting method. A low cost position used to be maintained by developing innovative solutions to construction methods, improving productivity by accomplishing work with internal resources, lower transportation costs, knowledge of local conditions, rules and regulations and developing the construction knowledge and expertise of field personnel. Today's low cost position is maintained by keeping overhead low and developing project management expertise to coordinate and control multiple resources. In most cases the general contractor is outsourcing field production to subcontractors. The industry competitive structure is still defined by the traditional contracting method; and change is managed within the constraints of this process.

In the previous section owner needs were described as obtaining a value-adding asset for the minimum cost, time, risk and uncertainty possible. The most efficient process possible to develop, design and construct this asset needs to be designed. This process should take advantage of technological, managerial and organizational innovations. The business vision proposed for this paper will be built on the assumption that the traditional contracting method is

obsolete and future projects will be organized according to innovative contracting arrangements.

The organizational barriers which developed around segmented, independent tasks or activities will be removed. The future process will accommodate three overlapping sub processes: development, design, and construction. The sub processes will transcend organizational boundaries. A team or partnering approach will be used to organize around the sub processes. New innovative contracting methods and incentives will be implemented to redefine inter-organizational dynamics. Each organization will focus on the success of the overall processes. Relationships will no longer be defined in the context of a "zero-sum" game and efficiencies will be realized by sharing resources.

The key premise of this future scenario will be information sharing. There are various technological and organizational means available, and in development, to facilitate information sharing. The business vision here predicts a project specific data base will be established to store all project related information generated and used by all participants in the process. The information will be easily accessible to all participants and furnished to the owner upon completion of the process. In effect the customer owns the project information. A single project data base should reduce duplication of resources, improve data quality and force integration. Information sharing versus the passing of data will result in a more efficient use of resources.

While the concept of cross organizational sharing of information through a single data base is not new and being attempted in other industries the barriers to adoption in the construction process are great. A tremendous investment will be required to develop the supporting IT and organizational infrastructure. "Betting on the future" will be a tough sell in an intensely cost competitive industry which allocates few resources to research and development. It is a "catch 22" as overhead must be minimized in order to survive in today's competitive environment yet future survival is dependent on investing in the development of new core competencies. The current IT platform in which systems are independently applied to improve the efficiency of individual tasks will need to be redesigned to facilitate integration. The technological challenges to overcome the incompatibility of systems will be great. In some cases, it will be more economical to scrap existing systems and start over.

The greatest resistance will be from the industries which organized around the current construction process. Redesigning the process will change the current power structure. Maintaining the current status quo which has been carefully cultivated for many years is considered the favorable alternative to change which may benefit some at the expense of others. Industry interests are put ahead of the customer who would benefit the most from change. Most contractors believe "it won't happen; historically, the industry has managed to avoid major change and will continue

to do so". But what happens when the opportunities and potential rewards become so great that someone is willing to take the risk. The first mover will define the new industry competitive structure and followers will be left behind.

Process redesign will be conducted under the assumption that future contracting methods will facilitate a team approach. Project goals will be aligned with organizational goals to encourage the sharing of resources. The new project organization patterned after the "Virtual Corporation" will allocate project resources more efficiently. "Boundaryless Organizations" will result from the removal of barriers. Strategic applications of IT will be directed to improving communication and coordination of the project. Incremental improvement of functional and organizational tasks will give way to radical improvement of the total process. The capability and compatibility of IT will be critical to the success of process redesign.

5.4 Redesigned Construction Processes

5.4.1 Business Development/Strategy

Historically construction company leaders focus their attention and resources on managing the day-to-day operations. Strategy is conducted more or less intuitively [Macomber]. An inherent trust existed as company personnel blindly supported an "omniscient" leader. The assumption is

that the holder of this position possesses the all knowledge, expertise and skill necessary to develop a plan or strategy to insure long term success in the market place. Long term success from the employees point of view is generating enough revenues to maintain stable employment levels. The company leader will select market segments in which to competitively bid and develop the corresponding internal core competencies. Once projects are obtained the organization will attempt to complete the projects profitably.

In today's dynamic competitive environment strategy takes on greater importance as companies attempt to proactively manage change. Successful firms will provide the resources necessary to expand strategic management from a single activity conducted by the company leader, to a process which flows through all parts of the organization. "A strategy is the pattern or plan that integrates an organization's major goals, policies, and action sequences into a cohesive whole. A well-formulated strategy helps to marshal and allocate an organization's resources into a unique and viable posture based on its relative internal competencies and shortcomings, anticipated changes in the environment, and contingent moves by intelligent opponents [Minzberg and Quinn]." As this definition demonstrates strategy is much more than market selection. It is a process which includes observation, planning and implementation. A tremendous amount of information must be gathered and analyzed in order to keep pace with an increasingly complex

and dynamic competitive environment. The CEO's information processing capabilities are constrained by physical limitations and the quality is compromised by personal biases. Additional resources are needed to manage this process.

As was noted the marketing function plays a very minor role for companies in this segment. Redesign would increase the visibility and responsibilities of this function by assigning the vice president of marketing, sometimes referred to as the chief of business development, the duties and responsibilities of strategy process leader/owner. This position will be responsible for managing the new process. The activities selected for designing this process were based on a "Construction Business Review" article (Jan/Feb 1991) written by John Macomber. Macomber's eight step format for contractors to prepare and implement strategy was modified to: establish the firm's mission purpose and goals, environmental scan, internal scrutiny, formulation of strategies, resource allocation (budgeting and delegating), execution and measurement.

There are many management tools available to assist practitioners in strategy formulation, the most popular appears to be Micheal Porter's theories on competitive advantage. Porter defines the context, in which the external analysis is conducted, by the industry. Two central concerns are addressed in developing a competitive strategy the industry structure and selecting a position within an

industry. An understanding of the competitive dynamics of the particular industry is developed by evaluating five competitive forces: (1) the threat of new entrants, (2) the threat of substitute products or services, (3) the bargaining power of suppliers, (4) the bargaining power of buyers, and (5) the rivalry among existing competitors. This model provides a framework to analyze industries and competitors. Firms will select from three generic strategies: cost leadership, differentiation, and focus to choose a position within the industry to compete. Internal scrutiny is conducted using the value chain which divides a firm into the discrete activities it performs. The value chain can be used to diagnose and enhance competitive advantage. This brief overview of the techniques provided by Porter to conduct strategy formulation and implementation is provided as one example of the tools available to assist management. Firms should take advantage of available management tools in order to formalize the process and reduce some of the quess work. It will be up to the company to select those appropriate for it's particular situation.

Establishing the firms mission purpose and goals

The company leader will initiate the process by establishing the firms mission purpose and goals. This information usually in the form of a mission statement will be communicated to all the stakeholders. The mission statement acts both as a blueprint for organizational action

and as a motivational tool. The resources of the organization will be mobilized to meet these goals. The process is initiated by the CEO, however its ultimate success is dependent on the organization. The mission statement will be broad enough to encourage innovative solutions from the organization to meet established goals and flexible enough to accommodate changing conditions.

Environmental/External scanning

Environmental/external scanning is necessary to define the context in which competition will be conducted. Macroeconomic forces - demographics, economic, technological, social/cultural, political and regulatory and microeconomic forces - customers, competitors, and suppliers will be identified and analyzed to identify potential market opportunities and threats. To improve the amount and quality of information developed by this activity additional resources are needed. Support from the organization should be solicited, for example field personnel can monitor customer and supplier needs, the treasurer can advise on financial markets, marketing can monitor market trends and competitors, engineering can monitor technological developments, and estimating can monitor cost trends. Environmental scanning can be delegated to the function or individual which interface with the specific area of concern. A set of procedures must be developed and implemented to collect all relevant external information from the

organization. An example would be field personnel (project managers and superintendents), who interact directly with the customers and suppliers, would be trained or provided a set of procedures to leverage this relationship to gather external information. This information can be furnished directly to the process leader in meetings held periodically or in the form of written reports. Each company will develop procedures for identifying and obtaining external information unique to their specific conditions. What is important is that all members of the organization will be responsible for monitoring external events. The process leader will be responsible for insuring information is collected and organized for use in strategy formulation.

The external conditions must be analyzed to identify opportunities and threats which will define the context in which competition will be conducted.

Internal scrutiny

The company will need to conduct an impartial evaluation of internal strengths and weaknesses. If the opportunity exists the company will select a strategy which leverages existing internal strengths, if not, resources will need to be allocated to develop the core competencies necessary to pursue available opportunities. Internal scrutiny should not be limited to inventorying company resources but include an evaluation of how effectively and efficiently these resources are being utilized and of the linkages between the value

chain activities. Input will be required from all levels of the organization to satisfy this in depth analysis. Once again procedures need to be developed and implemented to collect all relevant information regarding internal operations. An objective analysis of the organization will be difficult to conduct. Senior management, in the best position to understand the broad organizational dynamics, may attempt to use this forum to strengthen personal power. Future resource allocation will be dependent on the results of this activity. One suggestion would be for the process leader to conduct a survey including the CEO, senior management staff, and random samplings of employees throughout the organization. The findings would be submitted to the CEO and a meeting with the senior management staff held, if necessary, to resolve conflicts.

Formulation of strategies

The company will develop a strategy, incorporating all the information gathered and analyzed in the previous steps, to meet the stated mission, purpose, and goals, by selecting a competitive position in the industry structure. Internal resources or competencies will be developed to support the companies attempt to avoid external threats and aggressively pursue opportunities. A position will be selected to maintain a sustainable competitive advantage. A market or markets and an associated competitive strategy of low cost, differentiation or focus will be selected.

Coinciding with the formulation of strategy is the preparation of an action plan for implementation. This is critical for the ultimate success of the strategy. Organizational inertia and internal resistance to change can stifle any new initiatives. For example the culture associated with maintaining a low cost strategy will be radically different from that associated with pursuing a differentiation strategy dependent on providing customer service. It will be very difficult to break the "GC" mentality of the organization. Issues such as this must be addressed during formulation. A plan is needed to overcome organizational and technological resistance as well as allocate the required resources to develop core competencies. The plan will assist the organization in implementing and carrying out strategic initiatives.

Strategy formulation should be conducted by the senior management team. The process leader/owner will schedule and facilitate strategy development sessions. In addition the process leader will furnish all the data collected to date. Senior management controls company resources and therefore participation is important to insure continual support during implementation. If they have something invested in the process they may be more inclined to see it through.

Resource allocation

Money, people, management attention, technology and time must be allocated to support strategic initiatives. Strategy

does not result from a mission statement, physical resources must be allocated to provide an infrastructure to support initiatives. Typically, resources are scarce as overhead is kept low to compete on a low cost basis and therefore must be efficiently managed to strengthen core competencies. The CEO busy managing day-to-day operations does not have the time to devote to this process. Allocation should be addressed in the action plan produced by senior management and the process leader will be responsible for monitoring internal progress. Senior management and even CEO assistance should be readily available should internal resistance be encountered.

Execution and measurement

Personnel have to look beyond day-to-day operations and make time to perform the tasks needed to develop future core competencies. The process leader/owner must insure that the assigned tasks are being performed. Incentives should be modified and training provided to reinforce new responsibilities which extend beyond daily functional tasks. Periodic reviews of the strategic plan and process should be conducted to monitor progress. Many assumptions are made throughout this process and they must be continually challenged. Control variables should be established to compare actual performance to objectives. The process and the organization must remain flexible in response to the uncertainty which derives from a changing competitive environment.

The critical assumptions underlying process redesign are (1) treat strategy as a continuous process which transcends functional and organizational boundaries; (2) Increase the allocation of resources to this process; and (3) Enlist the support of the whole organizatic . The process leader, responsible for the success of the strategy process, acts more as a facilitator to insure the organization is mobilizing the resources necessary to accomplish this process in an effective and efficient manner. The whole organization is called on to support this process.

5.4.2 Project Planning

The Traditional Contracting Method

For projects organized in accordance with the traditional contracting method very little interaction is required between the participating organizations. Each organization is responsible for a specific independent task or activity. Processes to complete respective tasks are developed and applied internally within organizational boundaries. In this scenario, GC project planning starts upon receipt of bid documents from the customer. Redesign will focus on breaking down internal functional boundaries. Planning will be conducted as a continuous process in lieu of a number of independent activities accomplished by the various functions to support their respective tasks. While opportunities for extending the process across organizational

boundaries are limited by contractual obligations they can still be pursued. If a complete and well defined design is furnished by the architect/engineer then extending the process upstream would be a waste of resources. Roles and responsibilities will be dictated by the customer and changes to standardized contracts, which have been interpreted over the years by the courts, will be resisted. However benefits can be realized by extending the process down stream where the contractor is free to define relationships. Contractors can take advantage of subcontractor and supplier knowledge and expertise by soliciting assistance in scheduling, defining the scope of work, coordination of the various independent building systems, and identification of inconsistencies between drawings, specifications, general conditions, industry practices and governing rules and regulations. If work is to be subcontracted out on a competitive bid basis, the contractor should be sensitive to a reluctance to provide pricing support prior to the bidding deadline. Subcontractor and supplier input prior to bidding, as opposed to after during the purchasing phase, will improve the quality and accuracy of the estimate.

The current "arms length" relationship resulting from a zero-sum game must give way to a relationship based on teamwork. Project goals will be aligned with organizational goals to develop mutual support. Individual success will be defined by overall project success. While this concept is relatively simple implementation will be difficult and

require major changes in the cultures of both organizations. Internal resistance arising from management's individual mental models influenced by traditional industry practices can be expected.

Functional resources must be repositioned to support the process. The project manager proposed for the job must be involved from the start. In response to management concerns about expending valuable project management resources on this process prior to bid award, the project manager will not have to assume responsibility for coordinating the project through this process but merely be included in any major decisions, attend all meetings and be kept apprised of progress. The project manager will contribute to preparing the plan for which he or she will be ultimately responsible. In addition, participation in the process will enable the project manager to obtain and transfer data, which can not be stored in written or electronic form, to the construction process. The estimating, engineering, human resources, accounting and finance and operations functions should all contribute to this process. The most critical activities in the process, preparing the estimate/budget and the schedule, are conducted in the initial stages, during the bidding phase and all future project strategies will be conducted according to the parameters established at this time. The success of the job will hinge on meeting commitments made at bid time. Rather than rely on the estimating department to manage this portion

of the process additional resources should be allocated to improve the quality and accuracy of bids and consequently eliminate the need for each function to develop a plan when accomplishing their task. Organizing around the process will result in a more effective and efficient use of company resources.

Alternative contracting Methods

Building on the ideas presented in the previous section, this section will address alternative contracting methods. The assumption is that future relationships will not be defined by the traditional contracting method. The use of alternative contracting arrangements has increased across all industries. The arms length relationship is giving way to a partnering or team approach which can react more efficiently and effectively to change. Project coordination by direct supervision of segmented independent activities will be replaced by mutual coordination among team members. In this context the contractor, subcontractors and suppliers are included in the overall construction process much earlier. Planning becomes a soft service to be furnished and shared with the various participants in the construction process. Process success is not realized though bid award but through satisfying customer needs. The main objective is to reduce project uncertainty by providing timely and accurate cost and scheduling information. The process will extend to the

customer and designer organizations to facilitate a team approach.

IT applications should be redirected from improving the efficiency of individual functional tasks to supporting the process through integration. A unified view of project data will be needed to facilitate information flows between functions and organizations and integrate different project systems and disciplines. A project work breakdown structure (WBS) must be organized in a format which can be used by the various functions, organizations and information systems. Compatibility has to be attained.

The following case for functional integration was observed at a regional $100 million construction firm which specialized in both heavy and building projects. The estimating function prepared the project estimate or bid using Lotus 123® spreadsheets. Upon award the final bid estimate becomes the budget and is furnished in written form to the finance and accounting function. The information is translated into an acceptable input format and entered manually into the cost control system. The project manager interprets the information from the cost reports and prepares a detailed requisition using a Microsoft EXCEL® spreadsheet. These steps can be eliminated by integrating the systems, standardizing data and electronically transferring the information.

Another example which has been receiving a lot of attention recently is to integrate project scheduling and

cost systems. A project model developed to identify the effects of various decisions on the cost and schedule would provide a powerful management planning tool. Various scenarios could be investigated during the planning process reducing uncertainty and costly changes during the construction phase. Rather than learning by doing and relying on crisis management techniques in the field, learning can take place using a computer model, mistakes are cheaper this way. Contractors can market this service independently of actual construction similar to offering preconstruction services.

The head of the estimating process will assume the new role of the planning process leader. The estimating function's resources will be absorbed by the new process. The more broadly focused process will prove more adaptable to change than the current functional arrangement. The assumptions underlying the existence of an estimating function are changing. Pricing/cost knowledge is considered an important core competency and most contractors will allocate resources to developing a strong estimating function to manage this information. This valuable asset is carefully protected and in most cases the only field personnel given access are the project manager and general superintendent. The assumption is that the costs associated with finding and obtaining price information on products and offerings is too high for infrequent buyers and therefore contractors are used to broker this information. Relegating this important

function to process support with the likelihood of future elimination will be hard to accept but necessary. The development of electronic markets will reduce search costs. While every construction project is unique, the material components of the systems are standard commodities. In effect pricing knowledge will be available to anyone with electronic access. These systems, currently being attempted in other industries, can be expected in the near future. Research is being conducted to develop a program to interpret CAD files and electronically produce quantity take-offs. These advances in IT combined with elimination of the competitive bid phase will render the estimating functions current role obsolete. Reorganizing around a broader planning process and developing new core competencies will provide the organization the flexibility needed to respond to these changes as well as any other future changes.

Redesign will rely on the process to manage and coordinate the functional resources required for project planning. Cross functional and organizational integration is required to make more efficient use of resources. In the past the functional and task focus of IT has embedded this fragmented process in concrete. An IT platform is needed to support communication and coordination by integrating functions, organizations and processes. Also new applications such as knowledge based computer modeling integrating cost and scheduling should be investigated. Investing in the planning process will help reduce

uncertainty and improve the efficiency of the construction process.

5.4.3 Customer Design

The traditional contracting method treated design as a separate independent activity to be managed by the architect. The general contractor was the recipient of the final output, complete and well defined design documents. Contractor design is internally directed to obtaining a competitive cost advantage by developing and applying innovative construction methods for work accomplished in-house. This internal design activity is usually conducted during the bidding phase and depending on the size of the company would be provided by the engineering function with input from operations and estimating. Even today as design extends into the construction phase, contractors attempt to limit participation to interpreting architectural design intentions and providing the detail necessary for construction. Contractors try to avoid any responsibility for potential design deficiencies, thus all input is submitted to the architect for review and approval. In many cases contractors are reluctant to recommend alternative materials and systems for fear of assuming responsibility for performance of the recommended product or system, and design of the interface with other systems or materials. In a zero-sum game the customer benefits from cost savings up front, while the

contractor assumes future risk associated with design suggestions. Very little incentive for design input. Resources are not devoted to a process that is more applicable to design build and turn-key segments of the construction market and manufacturing industries. But from the viewpoint of the overall value stream, design has evolved from an independent activity conducted by the architect/engineer to a process which extends into the construction phase and requires participation by the contractor, subcontractors and suppliers. The general contractor has responded to these new design responsibilities by transferring as much as possible to down stream organizations and subsequently developing project controls to manage the increased flow of information. Complete and accurate design information is needed to build from and the process has taken on greater importance in the success of the overall project. Design is no longer the sole responsibility of others and therefore contractors must broaden their focus from organizational contribution to improving the broad project design process.

"The design phase of the cycle of development has traditionally concentrated on the features and performance of the product rather than on the processes by which it is manufactured. We design the product first and then tackle the job of how it is to be made. Yet the eventual cost and quality of the product is inseparable from how it is to be made. If the product can be made easily, the costs will be

low and most probably its quality high [Gomory and Schmidt]." While this statement is directed to manufacturing, it applies to the design and construction process. Contractors, subcontractors and material suppliers should be included in the initial stages of design. Material selections can be made based on the most economical price at the time. Exposure to price fluctuations can be reduced by acting on quotes during the design process. Organizational and functional boundaries need to be eliminated and resources organized around the process in order to encourage the sharing of resources. IT will enable integration of the independent organizational activities currently supporting this process.

Of all the processes, redesign of this process which is contingent on integrating activities, designed to be segmented and independent, will prove the most difficult. Strong IT, industry, organizational and cultural resistance can be expected.

Design and construction industries, organized according to a competitive environment defined by the traditional contracting method, have a tremendous investment in the status quo. Change has been managed within the constraints of the current process. Roles and responsibilities have evolved incrementally to maintain a careful balance of power. The main premise behind redesign is that breaking down organizational boundaries and organizing resources around the process will improve the effectiveness and efficiency of the process. The effects of this radical redesign on the

alignment of the participating industries is unknown. Both the design and construction industry will aggressively resist sharing "proprietary" knowledge which in effect support their position in the current competitive environment. Construction firms will need to decide how to respond to change by either continuing to maintain the core competencies necessary to compete in the existing industry structure or develop core competencies to take advantage of new opportunities afforded by an evolving industry structure.

Customers/owners are increasingly including the contractor earlier in the design process. The contractor provides preconstruction services in the design phase and construction services will still be competitively bid. While the owner benefits from contractor input during design, time is wasted as construction, still treated as an independent activity, is delayed until complete and well designed documents are produced. In addition contractor input may be influenced by their desire to provide construction services. Ideally a team approach including the architect, engineers, contractor, subcontractors and suppliers should be taken. The knowledge and expertise of all the participants can be devoted to a one time concurrent design. The development of systems, material and equipment selections, detail design and coordination can be conducted during design development instead of during the construction phase. Design decisions made during construction are more costly and constrained by time, material and equipment availability, previous design

decisions and purchases. To support this new approach IT applications will focus on coordination and communication. The barriers resulting from implementing systems to improve the efficiency of individual organizational and functional tasks must be removed by integrating across organizations to encourage team work. CAD software can support this initiative, however, standards still need to be developed to insure compatibility among systems. As was demonstrated in the Boston Harbor Project example incompatible systems will improve the efficiency of functional tasks while decreasing the efficiency of the overall process. Compatible systems can be networked to share information. The schematic design drawings could be developed by the designer and furnished electronically to the contractor in the form of CAD files. The contractor, subcontractors and suppliers can review for constructibility, assist in material and equipment selections, coordinate the various independent systems and furnish detail design directly on the CAD files. Design is conducted centrally through the CAD system not independently through various mediums by the participants. The two major benefits will be improved quality of data and reduced labor costs. Most subcontractors do not possess the systems or expertise necessary to support this process and it would be unreasonable to expect immediate investments. The recommendation here would be for the contractor to share internal resources with subcontractors and suppliers. Contractor designers can work directly with subcontractor

designers to develop and input information directly into the system. This does not mean the contractor will input information from shop drawings furnished in "paper" form by the subcontractor. Actual design will be conducted at the contractors offices on CAD.

Currently construction firms act as an information conduit between the architect/engineer and subcontractors and suppliers. Shop drawing and material submittal control procedures are established to monitor the movement of design information and insure the proper information is furnished in a timely manner to the field personnel. The flow of information increases with the size and complexity of the project. A tremendous amount of the project management resources are allocated to this sub process during the construction phase. The redesigned process will attempt to alleviate the design burden and allow the project management team to focus resources on construction activities. The capabilities of the CAD system can be extended to verify dimensions and coordinate systems and monitor progress on design/shop drawings. Status reports can be generated internally on a weekly basis. Direct communication facilitated by the system during design will reduce the flow of submittals in "paper" form to be coordinated by the contractor. In addition, making material and equipment selections earlier in the process will reduce the flow of design information during construction.

A couple of important issues will need to be addressed before a design process, crossing organizational boundaries, can be developed and implemented. First the capability and compatibility of systems and software must be advanced with this objective in mind and second responsibility for ownership and management of the information must be allocated. Information has value and the second issue will be hotly contested. So far contractors are winning this contest by default as designers attempt to reduce risk exposure by shedding design and construction responsibilities. However the sharing of so called "proprietary" design information will be strongly resisted. The customer should be considered the owner of all project related information. This information will be provided upon completion of the project. Managing the information will go to the firm or industry which moves first. The first mover will define the new industry structure and all others will play catch-up. The recommendation of this paper is that general contractors take the initiative and make the investment to develop new core competencies focusing on managing information to anticipate and drive the new industry structure.

In addition, to designing and installing the proper IT platform contractors will need to reorganize internal resources around the process. The director or vice president of engineering will take over as the process leader/owner and lead this redesign initiative. Resources from the

engineering function will be allocated with this process and personal will have to receive training to develop the additional skills necessary to support process requirements. Job responsibilities will extend beyond functional tasks to designing and managing the systems required integrate the tasks and coordinate the flow of information across organizational boundaries.

5.4.4 Construction

Plan implementation is conducted during the construction process. The project team is responsible for obtaining, organizing and coordinating all project resources in the most effective and efficient manner necessary to satisfy customer needs. This is accomplished by successfully managing coordination, communication, quality, productivity, and change.

Information

The information content of the process has grown and contractors are struggling to develop effective methods to manage this growing resource. The current solution of making incremental adjustments to existing project management systems is no longer effective and in fact existing information systems add to the problem by generating more information than is needed. Most contractors do not treat information as a resource to be managed and as a result it is

excluded from project planning. For example a project manager for one of the contractors working on the Boston Harbor Project requested his staff prepare a "log of logs" midway through the job in order to identify and evaluate the information being generated internally. A tremendous amount of information was flowing through the project office overwhelming the project management systems. This problem had a crippling effect as it consumed valuable project management resources. Unfortunately, the project managers attempts at resolving this problem failed. The project will be completed, however, no one will ever know how much money was wasted. Information must be considered a resource along with labor, material, equipment and time. Project management resources get deflected from value-adding construction activities to generating and storing documentation, passing of data between the designers and subcontractors and suppliers and field personnel and managing the controls necessary to monitor this process, and developing and managing redundant data bases. The first step in process redesign will be to assess the information needs of the construction process.

Information should be organized and stored in a centralized project data base. The benefits are improved data quality and accessibility, elimination of redundant data sources, streamlined information flows, and integration of activities, functions, processes and organizations. Effectively and efficiently managing information will be

critical to developing a competitive advantage. The bulk of the information needed to manage the construction process is developed and furnished by the planning and design processes. The design process will furnish complete design documents and reduce the flow of information into the construction process by improving the quality of the design and eliminating the need for the project team to act as a conduit for information flows between designers and subcontractors and suppliers. The planning process will furnish the plan for converting design into the finished product. The plan developed with the assistance of the project team and major subcontractors and suppliers will be made available to all members of the team. This process improves the accuracy of the plan and eliminates the need for the project team to communicate it to the other parties. All the information generated in the planning and design processes will be organized in an easily accessible centralized project data base which will be used to support the information needs of the construction process. It is important to note that while processes are addressed independently, they are integrally linked by the project. Information is organized, processed and stored according to project.

Not all information can be communicated electronically, human interaction is still needed for the uncertain and qualitative nature of information generated during the construction process [Pietroforte]. Support from the

planning and design processes reduce the information burden on the project team, freeing up valuable resources to focus on managing other communication mediums in the field. The project team's efforts can shift from "pushing" paper to pushing productivity. Statistics show that some 30% of the labor dollars expended yearly on any given construction project are wasted [Rice]. Efforts to reduce that 30% by even a few percentage points can have a significant impact on the profitability and competitiveness of the firm. Issues such as quality and safety often neglected at great expense can receive the attention needed. The true benefit of project information systems are realized when the human resources devoted to managing information are reduced.

Contracting Methods

The future construction process envisioned in this paper requires cooperative relationships among the participants. In the past customers were willing to accept the inefficiencies associated with the traditional contracting method in order to reduce uncertainty. The customer received a guaranteed price up front and the contractor assumed all the risk during construction. Future contracting arrangements must support the most cost effective project organization while at the same time reducing uncertainty. Relationships will be defined as value-adding partnerships [Johnston and Lawrence] in order to gain efficiencies from shared production information and resources. In this cooperative setting, the

game can have a higher sum than zero. Team work reduces friction, uncertainty, inefficiency, and duplication of effort [Macomber]. Uncertainty is reduced by sharing all project related information including costs with the customer. In order to establish the trust necessary to build cooperative relationships all project related cost information must be included in the project data base. At any time during the project the customer should be able to review expenditures to date as well the corresponding cost projections. Project cost systems will have to be relocated from the home office accounting and finance function to the project.

Even in the current construction environment, the benefits of the value-adding partnership arrangement are being informally investigated. On a $25 million office building in the Boston area, the GC was confronted with a decision to enter into agreement with the low bidder or pursue an alternative contractual arrangement offered by the second low bidder. After completion of scope reviews and cost negotiations all the final plumbing bids for this project were between $500,000 and $510,000 with the exception of the low bidder at $450,000. The GC was concerned with the magnitude of difference. All subcontractors were probably quoting the same material and equipment suppliers, and labor rates (union job). In some cases, subcontractors will even carry industry standard productivity rates. Any cost differences, attributed to better field productivity and/or

lower office overhead and fee, should be minor. One of the subcontractors, which had an excellent reputation and had worked successfully with the GC on past projects, learning of the low bid from a mutual supplier contacted the project manager and reaffirmed the GC's fears that the job could not be completed according to the contract documents for that price. The subcontractor then made the following proposal, his firm would do the work for a fee and guaranteed a not to exceed price of $500,000. In addition all his costs would be entered into the contractors project cost control systems for verification. The GC turned down the offer and took the $50,000 savings up front. It turned out that the GC's fears were justified. The low bidder failed to provide submittals in accordance with scheduling requirements, maintain union payments, coordinate with other trades and meet schedule requirements. In a couple of instances the GC had to pay suppliers directly so they would release equipment deliveries. Frequent and frivolous claims and change order requests were submitted. The plumber finally went bankrupt and a bonding company had to get involved. The GC never conducted final cost analysis, but suffice it to say a substantial amount of project resources were allocated to dealing with this undesirable situation.

Project control systems can be reconfigured to encompass the overall process not just the general contractor's internal activities. Subcontractor costs can be entered into the cost control system and monitored. Productivity can be

monitored visually in the field and with the project schedule. Project controls will provide the safeguard for abuse of the process.

Risk can be managed by improving information flows to reduce uncertainty and allow those in the best position to handle risk do so with the support of all others. Currently risk is managed by forcing it down the value stream. In the future risk should be assigned to the project not the individual participants. This will encourage a unified team approach to manage changing conditions. Problem solving is a team exercise.

Sharing organizational resources, knowledge, equipment, information and labor will require a major shift in the internal cultures of all the participating firms. Company goals and internal incentives must be aligned with project goals. Job success will drive project success. Cooperative relationships will reduce litigation and the corresponding documentation procedures, save resources by eliminating the bidding phase and improve communication and coordination.

At the completion of the project all project information will be turned over to the customer. The hardware and software necessary to manage the information will used on the next project.

5.5 The Impact on the Organization

Organizing resources around cross-functional and cross-organizational processes will result in a more horizontal organizational structure. "Boundaryless" companies will be brought together to form a "virtual corporation" to service customer needs.

5.5.1 The Virtual Corporation

"The Virtual Corporation is a temporary network of independent companies which come together quickly to exploit fast-changing opportunities [Byrne et al]." In a Virtual Corporation, companies can share costs, skills, equipment, labor, knowledge, and information, with each company contributing what it is best at [Byrne et al]. The construction process is very similar to this arrangement. Various companies and resources are brought together on a temporary basis to develop, design, and construct a facility. The construction industry did not follow past management trends advocating vertical and horizontal integration to gain economies of scale and reduce inter-organizational transaction costs. However, the current project organization stops short of the pure Virtual Corporation concept in that the typical project contractual arrangements enforce a rigid hierarchical organizational structure. The current project organization defined by "arms length"

agreements fosters adversarial relationships which inhibits sharing. To realize the full benefits of this organizational structure, alternative contracting arrangements must be implemented to promote sharing. Relationships should be defined as partnerships which serve the interests of all parties, stress collaboration, and build a common infrastructure. Traditional organizational boundaries will dissolve. Management emphasis will shift to team building by finding the right partners with compatible goals and values, negotiating "win-win" deals and providing the temporary organization with the right balance of freedom and control. New skills will be required as management's role changes from directing to facilitating. Managers will be called on to build trust with outsiders and manage beyond their own organizational and functional walls. Greater levels of responsibility will be delegated to field personnel. The knowledge, experience and expertise of the field or production workers will be used to support productivity improvement initiatives. Feed back on field operations and participation in problem solving will be encouraged.

In Henry Mintzberg's "The Structuring of Organizations" (1979), he uses five coordinating mechanisms to explain the fundamental ways in which organizations coordinate their work: mutual adjustment, direct supervision, standardization of work processes, standardization of work outputs, and standardization of worker skills. Today's hierarchical project organization relies on direct supervision as the main

coordinating mechanism. The project organization described in this paper will rely on mutual adjustment as the main coordinating mechanism. As a result the focus of IT applications will shift from control to communication. Customers will have to give up some control of the overall process to the designer and contractor. The designer will have to give up some control of the design process to the contractor and subcontractors. The contractor will have to give up some control of the construction process to the subcontractors and suppliers. A major cultural shift will be required to support new relationships which make companies more reliant on each other and require more trust. It will be very difficult to break with tradition, old ways of thinking and old paradigms. For example project managers and superintendents, who compare their job to "baby sitting", will have to give up control to and depend on those they baby sit, labor and material suppliers. Customers will have to rely on "profit motivated and unscrupulous general contractors" to manage their construction funds. A new openness will be required. The first step will be to share all project related financial information. Project cost control will be developed and maintained separately from the participating organizations. Exposing project costs will eliminate suspicions of one participant profiting at the expense of others as well as provide a means for monitoring the process. Centralized cost control will also assist in aligning individual company performance goals with those of

the project. From this point trust will have to be earned through performance.

In the past management has devoted most of its resources to managing money, materials and equipment. It is now time to pay attention to a fifth critical resource of the firm: information [Kotler]. The assumption underlying the management of information is the more data the more information. While this worked when the amount of data was scarce, advances in computer hardware and software have produced tremendous amounts of data which is overloading current systems. Peter F. Drucker in "The Coming of the New Organization" suggests that for firms to remain competitive they will have to convert themselves into information-based organizations. The shift from using data for control rather than information will have major implications on the organizational structure. Converting data into information - data endowed with relevance - requires knowledge and knowledge by definition is specialized [Drucker]. In the information based organization the knowledge will rest with the specialists who do the work and direct themselves. This is in direct contrast to today's hierarchical command and control organizational structure and will change the roles and responsibilities of management and workers.

Process redesign was based on the assumptions that future project organizations will be patterned after the virtual corporation and the information-based organization. Processes are developed to extend beyond organization

boundaries, facilitate the sharing of resources and accommodate the increasing information needs.

5.5.2 Functional Versus Process Organization

In reengineering work units change from functional units to process teams. A tremendous investment will be required to make this transformation. Implementation would be easy if company resources could merely be reorganized around the processes. Unfortunately most of the resources have been developed and applied to support independent functional activities and will become ineffective when realigned to support the processes. Most sensitive to this change will be company employees. New skills will be required and as a result job descriptions will have to be rewritten. Worker responsibilities will broaden to incorporate the whole process instead of individual functional tasks. Each worker needs to understand and support the whole process as well as actively participate in continuous improvement. Interpersonal skills will take on greater importance to support cross organizational sharing. Excellent problem solving and communication skills will be necessary to support mutual adjustment as a coordinating mechanism. Finally, learning skills or the willingness to learn are critical to adapt to change.

In an organization in which information is shared and workers are empowered to make decisions to support

coordination by mutual adjustment, management's role changes. This will be difficult for senior managers, whose authority is based on functional skills and expertise developed while rising up through department ranks. The current role of directing functional resources will change to nurturing the total process. New skills centered around communication and sharing are required. A win/win philosophy should be embraced by managers and practiced with all parties including subordinates, and suppliers. "Win/win means that agreements or solutions are mutually beneficial, mutually satisfying [Covey]." In line with increasing worker responsibilities, a greater emphasis on human resource issues will be required. Motivation, training, learning and skill development will be needed to respond to continuously changing environmental conditions. In addition new skills will be required to manage the process across organizational boundaries.

Process redesign will render most employee skills obsolete. The decision confronting the company leader will be whether to go outside the company to obtain workers and managers with the required skills or invest in developing internal employee resources. This is not much of a choice and this paper strongly recommends utilizing existing assets. If job cuts are made without attempting to use existing human resources, then resistance to implementation and future change initiatives will result as employees will equate change to unemployment. Organizational support is critical to the successful management of change.

The balance between the advantages and disadvantages of functional arrangement has shifted. The hierarchical functional organization can not effectively respond to the growth in information and a competitive environment defined by continuous change. The matrix organization, which super-imposes a horizontal structure of a project coordinator on to the standard vertical hierarchical functional structure, was developed to improve the co-ordination across functional departments and redirect internal functional focus to the project. The assumption is that the functional arrangement is required and therefore, additional resources in the form of a project manager or coordinator are necessary to mitigate inefficiencies. There are many disadvantages to this system. The most often heard criticism is the confusion which results when the project manager and functional managers authority and responsibility overlap. The goals of the function and project may still diverge. Reengineering is not constrained by existing assumptions and the organization is designed around the processes which follow the natural work flow. The functions will either be dissolved or placed in a secondary support role. The functional departments if required will serve as guardians of standards, as centers for training and the assignment of specialists; They won't be where the work gets done [Drucker]. The processes, designed around the natural work flows, will support project goals which are in line with organizational goals and objectives. The project,

a product or service provided to satisfy customer needs, will be the unifier of process and organizational actions.

5.5.3 The New Organization

Organizing resources around the processes will produce a more fluid structure which can easily adapt to change. The problem confronting senior managers is that the recommended procedure for implementing restructuring initiatives is to level the organization, in order to remove all potential resistance to change, and start over; and unless the firm is on the brink of failure, management can not afford to disrupt operations even on a short term basis. Implementation is much more difficult if current operations must be maintained. Another option would be to establish a totally separate new company from scratch incorporating redesign while continuing current operations in parallel. Not many firms have the resources to attempt this very costly option. The more likely scenario is that reengineering plans will include provisions for a smooth transition during implementation to insure continuance of on-going operations. Revenue streams will need to be maintained to finance the reengineering effort.

Process leaders/owners as opposed to functional heads will assume senior management positions. To smooth the transition existing functional leaders will be elevated to the new positions. The vice presidents of marketing,

estimating, engineering, and operations will assume the new duties and responsibilities as process leaders for strategy, planning, design, and construction respectively. The new roles and responsibilities must be clearly defined and the proper incentive structure in place to insure success. Active involvement by the CEO is required to monitor progress and protect against the possibility that the process leaders will revert back to old practices. In addition this senior management team will also be responsible for overall implementation of the reengineering initiative. Failure by any members of this team to meet the new challenges should be dealt with immediately. Functional boundaries should be removed and resources allocated to the processes. New well defined job descriptions with corresponding incentives in place to insure change must be provided to all personnel. Training, if necessary should be provided as soon as possible. The IT platform must be reconfigured to support information requirements of the processes. Without the proper tools and incentives the organization will have no choice but to return to the old way of doing things.

In many cases the new process organization will render the existing functional activities obsolete. The following is an example of the effect the redesign effort will have on the estimating function. The planning process is redesigned to anticipate the following changing assumptions, competitive bidding will no longer be required and contracts will negotiated, quantity surveys will be conducted electronically

by a computer program developed to interpret CAD drawings, an electronic market including commodity prices will be available. In addition the sequencing of work and the selection of construction methods will be provided directly from those responsible for the actual work. The estimating function responsible for maintaining and updating a cost data base and developing company estimating expertise is no longer necessary. The new planning responsibilities will require managing the flow of information into the process, processing the information using a computerized cost and schedule model, and communicating the output to all participating parties. At this time however, knowledge based integrated cost and schedule models and electronic markets are not available and therefore estimating resources will still be needed to support a manual planning process. The difference is the estimating resources are allocated to support the process in lieu of justifying a stand alone functional fiefdom.

The role of the finance and accounting function will be reduced to consolidating project costs for financial statements, and providing financing and accounting advice to the various processes. Cost control will be conducted at the projects. The functional head will act mainly in an advisory capacity. Human resources also will take on a process support role. It is still more economical to consolidate these specialties in functions which act as resource pools to draw on rather than be included directly in each of the processes. Another option would be to outsource these activities.

The functional silos give way to a more vertical and fluid organization which will be a more effective vehicle from which to manage change.

5.6 Keeping Pace with Information Technology

"It is clear that IT will have a profound impact on businesses. It is also clear that successful businesses will not treat IT as either the driver or the magic bullet for providing distinctive strategic advantage. Successful companies will be differentiated by their ability to visualize the logic of the new business world and leverage IT to create an appropriate organizational arrangement - internal and external - to support the business logic [Venkatramin]." Business process redesign reflects a conscious effort to create alignment between the IT infrastructure and the business processes. Instead of treating existing processes as constraints in the design of the optimum IT infrastructure, the processes are redesigned to exploit IT capabilities. IT is considered an enabler of process redesign.

The information content of the construction process and product has increased dramatically. Vast amounts of information enter, accumulate, and leave the organization without anyone being fully aware of their impact, value or cost. Information management will become a critical core competency in the future competitive environment. A unified

company wide IT strategy must be developed to establish company wide information policies, create and maintain a data base, improve the quality of information, design information products and services, and negotiate sharing of information.

IT applications will broaden from improving internal functional tasks to redesigning processes to support future competitive strategies. IT will be used to leverage virtual business networks. Analyzing the firm's value chain and value stream is required to identify business network opportunities. The more known about the other parties in the value stream the greater the potential for determining linkages and integration opportunities, implications, and implementation issues [Morton]. To support the shift from coordination by direct supervision in a hierarchical organizational structure to mutual adjustment by teams IT applications will shift from control to communication. The sharing of information is critical to supporting business networks.

Existing IT platforms are composed of fragmented, independent and incompatible hardware and software systems developed from modifying off the shelf commercial software packages. As long as the contractors in this market segment leave software development up to third party vendors integration will not happen. Radical redesign should not be constrained by what is available, the contracting industry needs to get more involved in software development. While strategic benchmarking of innovative IT applications in other

industries can be helpful it is not the best option. Direct interaction, joint venture or partnership, with software developers is required to meet the unique and changing needs of the construction industry. Software developers need to be challenged to provide the tools to support the business vision.

CHAPTER 6: CONCLUSION

6.1 The Traditional Contracting Method

The purpose of this thesis was to present business reengineering as a tool to manage change and propose applications to the construction process. A specific segment of the construction industry was selected to apply business reengineering. The overall process or environment was defined according to the principles of the traditional contracting method. When this process was developed it was considered the most efficient way to meet customer needs. The major underlying assumptions were: Segmenting tasks made it easier to allocate responsibility and risk and monitor performance; The associated project organization was the most efficient in terms of cost and control; and The time lost by completing tasks in a linear and sequential manner was offset by the control and cost benefits. The traditional contracting method responded to customer needs to reduce uncertainty and risk by simplifying a very complex operation. This process worked for simple projects in a stable environment in which the segmented activities could be completed independently, thus reducing information flows between activities. In addition, time was not considered a valuable commodity. Today's business environment is much more dynamic and presents new challenges arising from increased competitive pressures resulting from aggressive foreign competition,

declining product life cycles, and the transition to a global economy. The construction environment is defined by increasing size and technological complexity of projects, greater sophistication of customers, proliferating demands and regulations from government and public agencies, the rapid advancement of information technologies, and increased foreign competition. The underlying assumptions have changed. Rather than rethink the process the approach taken has been to incrementally redefine the roles, responsibilities and relationships of the participating organizations within the established organizational framework. The evolving process dynamics are not being driven by customer needs but by the industries that have grown around the process. As a result the construction process has become inefficient. "Construction contracting is a very competitive, high risk business. The competitiveness and the perception of conflicting objectives among owners, contractors, architect/engineers, subcontractors and suppliers has set the stage for what, at times, has become adversarial and unrewarding relationships. Parties from all sides of the table have given up management rights and responsibilities because of risk and the threat of liability. We have witnessed an escalation of onerous documents and contracts focused on punitive measures to enforce performance. Consequently, we have seen a dramatic increase in litigation, which is expensive and counterproductive to everyone's efforts to produce quality projects on time and

within budget [AGC]." Despite the growing awareness of problems with the process, powerful industry interests are resisting radical change. Change brings uncertainty, threatens the power structure and can render the tremendous investment made to compete in the current environment obsolete. Proposed solutions are constrained by the existing process. An example is "Partnering" a solution offered by the construction industry as a means to mitigate the inefficiencies of the current process. "Partnering is not a new way of doing business.... Partnering is not a contract, but a recognition that every contract includes an implied covenant of good faith [AGC]." Partnering is about getting the various parties to work together to improve the current inefficient process without changing the status quo. The construction manager of the $6.5 billion Central Artery/Tunnel project is attempting to apply this concept. When asked how they intended to make this approach work when the contracts would be awarded on a competitive basis, thus setting the foundation for an adversarial relationship, a representative of the construction manager agreed that the traditional contracting arrangement does not provide the ideal environment to apply partnering, but they intended to demonstrate a good faith effort in managing the project. Partnering will not work unless the process is changed.

Somebody needs to break the ice. Myopic industry interests must give way to the interests of the customer. The focus must extend beyond industry/organization

contribution to the success of the overall construction process. Failure to accommodate customer needs could lower the barriers to entry. First mover advantage will be the reward for addressing the inevitable change. The stakes are great as with any change a redistribution of power and authority will result. The new leaders will be able to write the rules defining the new competitive dynamics.

Radical change is not easy. Organizational and industry mental models, attitudes, values and ultimately behavior will have to change. New control mechanisms and incentives must be instituted to break down organizational resistance.

6.2 The General Contractor

Construction industry leaders will need to confront these new challenges. A choice will have to be made between using the traditional contracting method or new contracting arrangements to define the context in which to formulate strategy. The first choice assuming status quo will result in business as usual. The second choice will require a proactive approach to managing change. This thesis argues that the traditional contracting method does not adequately address customer needs. Construction firms must invest in the necessary resources to meet the new competitive dynamics.

Reengineering is proposed as a tool to proactively manage change. The essential supposition of this management method is process oriented thinking. Discarding the standard

organizational chart, a typical construction firm competing in this segment was defined by its business processes: business development/strategy, project planning, customer service, and construction. These processes and their underlying assumptions were carefully analyzed in order to develop a deep understanding of current operations. Two questions are addressed Why do we do it this way? and if we had to start from scratch given today's conditions would we design the same process? Responding to change requires a flexible and fluid organization willing to take advantage of innovation. Reengineering advocates continually challenging the status quo.

Radical process innovation starts with a business vision incorporating stakeholder needs and technological and managerial innovations. John F Welch Jr., the chairmen of General Electric advocates a concept called "stretch" which means using dreams to set business targets-with no real idea how to get there. Incremental goals, he says, "inspire or challenge no one, capture no imaginations.." Goals should be set so as to challenge the organization and reward innovation. The business vision provided in this thesis is intended to provide a broad range of examples in which to set company goals. The business vision will be unique to each company. Reengineering provides the framework from which to position company resources in the most effective and efficient manner required to attain vision goals. Reengineering is not a one time event, it is a dynamic

process in which senior management must continually monitor external events and challenge assumptions.

Is the industry ready for radical process redesign? probably not. Change will continue to be addressed with incremental adjustments which are less disruptive and appear less risky. Armed with this false sense of security contractors can focus all resources on day-to-day operations. The risk of failure associated with this reactive strategy is great. Innovative strategic applications of IT can change the industry competitive structure overnight. Followers may not be able to develop the new core competencies quick enough to maintain a competitive position.

Change will occur and competitive advantage can be gained by those firms willing to embrace it. Reengineering is a powerful tool to proactively manage change.

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