AN INTEGRATED FACILITY MANAGEMENT PROCESS MODEL

By

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Sponsored by

The National Science Foundation
Grant No. DMC-8717485

Technical Report No.2

February 1989
FOREWORD

The Computer Integrated Construction (CIC) Research Program at Penn State was started in 1987 with a large grant from the National Science Foundation. This grant enabled the research team to develop the fundamental process models defining the scope of the activities required to provide a facility. The research team comprised up to twenty researchers at various stages of its life. It included faculty and research assistants from Architectural and Industrial Engineering, an academic advisory board from five of the leading research schools in the country and a five member industrial advisory board representing experts in each of the phases of the facility life cycle.

In this report, Sari Khayyal, the principal author has defined the roles and essential functions required to manage a facility. This report is a stand alone document focusing on management of the facility, but also complements the six other technical reports defining the remainder of the research undertaken by the team to provide the facility as a whole.

The four major manage activities, divided by similarity in process, are: establish the management team (staffing); develop the work scope and needs; plan and control the facility (estimating and management functions); acquire services to provide the facility (contracting with architects, engineers, constructors, operators and consultants); and acquire and provide resources (owner supplied materials, site etc. via purchasing, personnel and support functions). It is envisioned that this cornerstone piece of basic research provided by Sari, will lead to many future applications in the areas of contracting strategy and methods, information systems, organizational design, software development and process integration.

Other complimentary work resulting from this work will be detailed in subsequent technical reports issued by the CIC research program.

Victor Sanvido
Assistant Professor of Architectural Engineering
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ABSTRACT

This technical report presents a generic process model of the activities required to manage a facility. The model starts with the establishment of a management team, development of work scope and needs, includes planning and controlling the facility, acquiring services, and also acquiring and providing resources (namely funds) for a facility. In addition to the processes, identification is also given for inputs, outputs, constraints, and mechanisms associated with each function.

The report starts out with an introduction to computer integrated construction (CIC), and it orients the reader to the IDEF0 modeling methodology. The second chapter details the methodology and objectives of the model, its scope, and defines the research activities required to achieve this goal. The diversity of existing management articles are described in the third chapter along with illustrations of two management models found. The fourth chapter provides a comprehensive explanation of the management process model. Chapter five provides an overview of three cases used to substantiate and validate the model, along with the case results. The final chapter identifies the general management problems in the construction industry. Ten potential applications are identified, to show areas of implementation by use of the management model. Benefits and reasons for use of the model are given to justify its use. The model represents a contribution to basic research in the field of management process modeling.
ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to the many individuals who contributed, directly and indirectly, to the successful completion of this technical report. Special thanks go to Dr. Victor E. Sanvido for sharing his wealth of knowledge on management and for his patience and encouragement throughout the course of this research. Thanks also go to:

All the members of the CIC research team at Penn State for their cooperative research efforts, support and input,

The companies and employees who willingly participated in the case studies and showed an active interest in this research,

My family, for their constant support,

The Departments of Architectural and Industrial Engineering, and the College of Engineering for supporting this research program,

The Architectural Engineering Department for providing partial funding through a Graduate Assistantship,

The National Science Foundation for providing partial funding under grant number DMC 87-17485.
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Chapter 1

COMPUTER INTEGRATED CONSTRUCTION

1.1 INTRODUCTION TO THE CIC PROJECT

The National Science Foundation has funded a fourteen member interdisciplinary team together with ten advisors, to explore methods and means of enhancing the use of computers in all phases of the life of a constructed facility. The objective of this Computer Integrated Construction (CIC) project is to provide an open information architecture to support the provision of a facility. The team comprises Penn State Architectural and Industrial Engineering researchers together with McDonnell Douglas and selected industry professionals. The intent is to benefit from the pioneering work related to Computer Integrated Manufacturing (CIM) achieved at Penn State by applying similar advances to construction.

As the first major thrust of the project, we developed an Integrated Building Process Model (IBPM) that accurately represents the essential functions required to manage, plan, design, construct, operate and maintain a facility. The second half of the project, based on the IBPM, is to define the information and its attributes that are required to drive the system. The major benefit of this exercise is the development of a generic dynamic process and information model that can be applied to a specific project to develop and link the everyday models used to provide the facility. Examples of these models are: the architectural program, schematic drawings, CAD detailed drawings, contracts,
CPM schedules, budgets, space planning models, energy management simulation, organizational charts and contracts.

IDEFO was selected as the most suitable process modeling tool. A schematic representation of the drawing format (Figure 1-1), and a graphical representation of how the model is decomposed (Figure 1-2) is included. A description of the model follows.

1.2 AN INTEGRATED BUILDING PROCESS MODEL

The Integrated Building Process Model (IBPM) is explained in two drawings. The first drawing (Figure 1-3) is an overview titled "Provide Facility" that defines the boundaries of the model in general terms. The second drawing (Figure 1-4) divides "Provide Facility" into five subprocesses. These drawings offer enhanced levels of details. Figure 1-3 has the least detail and is known as the level F model.

The model was developed from the perspective of an observer outside the whole process. It is an abstract representation taken from observations of many building projects by the project team, advisors and other reviewers. The actual mechanisms used in the execution of the functions will depend on the project delivery method. This generic model, when completed with the appropriate mechanisms, should account for all contract delivery options.
FUNCTION: An activity, process, operation, or transformation.

INPUT: Elements (resources or data) that are transformed through a process or an operation to form the outputs.

OUTPUT: Elements that result from the function being performed.

CONTROL: The elements that influence or determine the process of converting input to output. May limit the activity or allow the activity to occur without being affected.

MECHANISM: The elements used to perform a process or operation, such as a person or machine.

Figure 1-1: Schematic representation of the IDEF drawing format (adapted from ICAM Function Modeling Manual, June 1981).
Figure 1-2: Breakdown of IDEF₀
Purpose: This model describes idealized owner's functions and their relationships in a construction process.

Viewpoint: The owner / User

Figure 1-3: F-0. Provide Facility
Figure 1-4: F. Provide Facility
1.3 THE LEVEL F MODEL "PROVIDE FACILITY"

The level F process flow model (Figure 1-3) consists of a single block showing the inputs (facility idea, resources), the controls (external, and project participants' constraints), the mechanism (free enterprise economic system and facility champion), and the outputs (operational facility, facility experience, and the impact on environment). Three elements will be tunnelled, shown as an arrow with parentheses on one end. In this case they are the free enterprise economic system, the external constraints, e.g., weather, and the impact on the environment. This tunneling of arrows means that they will not be shown at the next level of detail - they essentially add nothing to the model and clutter the drawing. These will reappear when their influence is specific to an activity.

1.4 COMPONENTS OF "PROVIDE FACILITY"

The level F model breaks down the process of "Provide Facility" into the five subprocesses shown in Figure 1-4. These are: Manage Facility, Plan Facility, Design Facility, Construct Facility, and Operate Facility. Detailed definition of these subprocesses follow.

Manage Facility includes all the business functions and management processes required to support the provision of the facility from planning through operations. These activities focus on converting a facility idea, time and money into a facility team, documents and contracts, facility management plans, and resources to support the project. This function runs for the duration of the facility life. It is controlled by two major factors - performance information about the
facility as a whole and information to optimize subprocesses within the facility e.g., constructibility information.

**Plan Facility** encompasses all the functions required to define the owners needs and the methods to achieve these. These activities translate the facility idea into a program for design, a project execution plan (PEP), and a site for the facility. Major controls are constraints imposed by project participants (e.g., the owner or engineer), the facility plan, the contract and optimization information. Other outputs include facility planning knowledge and information on the performance of the team.

**Design Facility** comprises all the functions required to define and communicate the owner's needs to the builder. These activities translate the program and execution plan into bid and construction documents and operations and maintenance documents that allow the facility to meet the owner's needs. Controls or constraints include program and site information, the contract, facility planning knowledge transferred to the design team, the PEP and the design plan. Again, facility design knowledge and information on the performance of the design team is another output.

**Construct Facility** includes all functions required to assemble a facility so that it can be operated. These activities translate resources (e.g., materials) in accordance with the design into a completed facility. Typically appropriate facility operations and maintenance documents are generated. As a result, facility construction knowledge and information on the performance of the construction team is generated. Controls include bid and construction
documents and criteria, the PEP, facility design knowledge transferred to the team, the contract and the construction plan.

Operate Facility comprises all of the activities which are required to provide the user with an operational facility. In addition, operating knowledge, and information on the performance of the team is generated. This process is controlled by the facility construction knowledge available to the team, the facility operating and maintenance documents, the PEP, the operating plans and the contract.

1.5 EVOLUTION OF THE MODEL

The IBPM has been developed through extensive interviews with experts and practitioners; sixteen site visits; and multiple reviews by each of a five member academic panel and a five member industry panel. Over 40 experts have reviewed this model for its completeness. The model has been extended four levels below the F level model. This has led to simplification and verification of the upper levels presented in this report.

While the drawings may seem obvious and simple, they differ radically from those first assembled by the project team. The first model included technical and management functions and was heavily influenced by who performed the function. A second model treated each of the four functions, viz. planning, design, construction and operations & maintenance as combined business and technical functions. The third revision, on the other hand, separated the management functions for each group and combined them into one generic management function called "management of the facility." The other four
functions named above, focus on technical functions only. Finally, at lower levels, the model recognizes that there are planning and control, service acquisition and resource acquisition functions that are performed at both the facility level and the subfunction level. This report highlights the Management portion of the model.
Chapter 2

INTRODUCTION TO THE
MANAGEMENT PROCESS MODEL

2.1 OBJECTIVES - DEVELOP THE MANAGEMENT PROCESS MODEL

The primary objective of this report is to develop a model of the management process which will be coordinated and applied with the plan, design, construct, and operate process models. The management model will represent the major functions performed that support the execution of the work. Subsequently, applications and uses for the model will be proposed which can improve current management practices.

2.2 SCOPE OF THE WORK

The focus of this report is on the identification of information elements which are transferred between the functions involved in the construction process. The developed model will represent the functions typically performed by an owner or firm that is solely responsible for providing a facility. The work is assumed to be carried out in a free enterprise economic system, with the goal of the manager being to optimize the use of time and resources to support provision of a facility. The time frame for the study will start from the inception of a facility idea through the duration of the facility life until the facility is turned over to the operations staff.
The model will represent the functions required to support an ideal project execution method. This was developed by combining the good qualities from the case studies with the recommendations of industry experts and existing methods identified during the literature search.

2.3 RESEARCH METHODS

In conducting this research the major tasks involved were: study the management process and information concepts; review existing management process models; conduct case studies to support the development of the model; develop the new management process model; and analyze the case studies and propose uses for the model. Each of these tasks is discussed in the following sections.

2.3.1 Study the Management Process

A literature search was conducted to study current practices in management to understand the steps in the process and to identify how projects are managed. Practical management experiences learned by the author while working on construction projects were used as input to this report.

2.3.2 Review Existing Management Process Models

A literature search was conducted to identify existing management models. These management models were studied and the relevant aspects of each were incorporated into the management process model developed in this report.
2.3.3 Conduct Case Studies to Support the Development of the Model

Companies and projects were selected for use as case studies. The criteria for the selection of these projects included the willingness of the company to cooperate and give permission for personnel to be interviewed, the size of the project, and the size of the staff. Questions were developed to ask key personnel during the case studies to identify the specific tasks involved in the management process, study the use of documents and other methods of information transfer, and identify the content of the information at different stages in the process. Project managers, general managers, partners and presidents were interviewed.

In order to present a model of the management process which can be applied to a range of projects, this report considered three different project sizes. The case studies were a pre-engineered metal building contractor, a medium sized office developer, and a corporate developer.

2.3.4 Develop the New Management Process Model

The basic management model was developed in the IDEF0 format. This included node trees, definitions, function outlines, and diagrams, describing the processes and flows of information. It is based on the study of the construction processes found during the site visits. The model was progressively refined and improved using the results of each investigation. Valuable input to the model was obtained from the advisory board members, including leaders in the construction field from both academia and the industry.
2.3.5 Analyze the Case Studies and Propose Uses for the Model

A detailed questionnaire was used to identify key management activities and methods of operation. From this questionnaire, formulations on effective management were developed. Finally, the findings from the case studies were discussed and recommendations for the use of the model were presented.
Chapter 3

LITERATURE REVIEW

3.1 Management Versus Project Management

Management practice has become all encompassing and is interpreted by many people to include many things. Management articles cover such fields as banking, construction, resource industries, computer systems, aerospace, energy development, etc.

One of the main problems encountered in conducting the literature survey is the definition of the word "management." The general management body of knowledge consists of the following aspects of management practice: accounting; business policy/strategy; business economics; decision making; financial management; information systems; marketing; organizational behavior; personnel development; planning and controlling; problem solving; staffing; etc. For purposes of limiting the scope and for clarification of the subject matter, the author has chosen to distinguish between general management and project management. The distinction between these two management types lies in the fact that project management is mission oriented, whereas general management is continuous in nature. The mission for our purposes involves provision of a facility. Nonetheless, both types of management are needed in providing facilities. While it is clear that construction projects have specific processes, objectives, and constraints, some management areas are common to construction and other disciplines. The
Project Management Institute defines project management as the following [Wideman, p. 21]:

Project management is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, quality and participation satisfaction.

This definition has become part of the project management body of knowledge, but it does not begin to explain the complexities of project management.

The paucity of existing management models have hindered project managers' jobs in integrating facility life cycles. There is no common framework that provides a breakdown of project management processes into categories that include all elements of project management, i.e. activities, functions, processes, information elements, mechanisms, etc.

Hendrickson and Au divide management practice into three sections. These are: (1) the management process approach, (2) the management science and decision support approach, and (3) the behavioral science approach for human resource development. The following sections describe some of the main articles that contributed to development of the management models. These articles are organized according to the three main categories of management practice discussed above.
3.2 Elements of Management Approaches

As stated earlier, the three elements of management practice deal with the management process approach, the management science and decision support approach, and the behavioral science approach for human resource development. These three management approaches are briefly discussed below.

The management process approach relates to descriptions of management functions as they relate to a specific process, organization, etc. Operational efficiency is improved through analysis of management activities along functional lines, and also through organization of functions in a hierarchical manner. Through creation of a framework of functions, coordination of a dynamic process is facilitated and controlled better. The crux of this management theory revolves around the "divide and conquer" theory. By creating functional components of complex problems, processes can be performed effectively and the interrelationships between functions can be understood. The outcome of this theory is that by understanding the whole picture of how processes are performed, effective management can be achieved. This theory was the controlling factor behind development of the management process models in this report.

The management science and decision support approach consists of solving complex management problems through various means of collection and analysis of information. One method deals with construction of mathematical analysis models to help solve problems of inventory, production, or material procurement. Other methods involve a detailed breakdown of all relevant
information, constraints, and objectives required for making management decisions. This method stresses qualitative information required for decision making in production and operation processes.

The third approach is that of behavioral science for human resource development. This approach centers on looking at human factors that influence peoples' actions. Human factors such as motivation, needs, personality types, etc., are important in understanding group behavior. Through understanding of group behavior, management concepts, decisions, and policies can be formulated for organizations. The main theory behind this approach is that by understanding the chief factors causing peoples' actions we will be able to manage change and thus improve efficiency.

Article examples of each of these three management approaches will be summarized in the following sections.

3.3 The Management Process Approach

There was only one article found in the management process area and it was by C. B. Tatum. Tatum's article deals with a project manager's role for integrating the design and construction processes. This is represented in a model that shows the approach and actions required for constructibility improvement (shown in Figure 3-1). The approach for design-construction integration consists of five actions. These actions consist of: identifying differences in the project's context, setting the contractual approach, building the project team, making constructibility a project concern, and implementing constructibility improvement. Constructibility is achieved by studying all factors
Figure 3-1: Project Approach for Constructibility Improvement
(Source: Tatum 1987)
that relate to each of the five action elements. The role of the project manager is to use the factors as criteria in making the many complex decisions required for integration between design and construction. Tatum also developed tables to show the tradeoffs between conflicting project objectives and the creation of priorities. Tatum's main focus was to look at the elements of constructibility and the actions needed to meet project objectives. In addition, Tatum provides models for: design and construction schedule development, performance of special studies on engineering and construction projects (by design and construction personnel), and a conflict resolution process.

Other work done in the area of the management process approach was performed by Austen and Neale [1984], Harrington [1984], Sanvido [1985] and Wheeler [1978]. Principal works done in the area of construction were covered by Sanvido and Wheeler. Sanvido developed a project management model that specified the functions to be performed by the construction manager, the engineering (design) manager, and the project manager. Detailed checklists for each of these participants is given along with the inputs, outputs, processes and control functions which form the approach for providing facilities. Wheeler's work concerned development of a project life cycle model which breaks down the building process into nine sequential phases. Each of these nine phases is then broken down into more details; activities, milestones, and responsibilities of affected participants. Both of these models are described in more detail in the Computer Integrated Construction Research Program's Technical Reports 5 and 7 [Chung, and Hetrick and Khayyal].
3.4 A Behavioral Science Approach

Articles in the behavioral science approach category were covered by Barnes [1981], Galbraith [1974], Hurst [1984], Kotter [1982], Herbert Simon [1960], and others. A primary article in this category was Hurst's; his article made the works of others fit together into his model. Hurst's article tackles the issue of dichotomy between two philosophies for controlling group behavior. Hurst's contention is that there are two types of frameworks that exist in organizations; "hard" models and "soft" models. These two models serve as managerial modes which dictate the management process approach for effectively finding business solutions. The "hard" model (developed by J. R. Galbraith) is characterized by "boxes", and it delineates the rational aspect of structure following strategy. The "soft" model (developed by Hurst) is characterized by "bubbles", and is the counterpart for every element in the "hard" rational model. In the "soft" model, groups replace structure, roles are the counterparts of tasks, networks are used instead of information systems, and people are viewed as social animals rather than as rational beings. Hurst used lists of words to describe the difference between the two managerial modes. Both of these models are shown in Figure 3-2. The two models act as polarities to each other, and the boxes and bubbles describe the "hard" and "soft" thought structures, respectively. Effective management comes about when a manager is capable of determining which context is appropriate for the problems at hand. Hurst describes the theory behind the "bubble" as being the managerial theory of relativity. He says that at the macro level it reminds us that how management phenomena appear depends on one's perspective and biases. Hurst also says
Figure 3-2: The "Soft" and "Hard" Models and How They Work Together
(Source: J. R. Galbraith and Hurst in Hurst 1984)
that at the micro level we remember that all jobs have both "hard" and "soft" components. The box and bubble concepts are tools that managers can use to handle the ambiguities that arise in management.

3.5 Management Science and Decision Support Approach

The management science and decision support approach is explained well by G. A. Gorry. Gorry's article advocates the development of managerial models for use by managers. Gorry believes that managerial decisions can be improved by modeling the environment used by the manager. Through the use of descriptive models managerial effectiveness is improved in that they help in problem-finding and problem-solving activities. Gorry also refers to managers as information scientists, he feels that the quality of making decisions can be improved by providing better information or by improving the process by which the decision makers deal with existing information. He makes the point that top management has not been provided with models which help them deal effectively with much of the information currently available to them. Gorry thinks that by having a model of one's environment, a fundamental understanding of one's definition of problems is obtained. Problems are solved by having one's environment conform to the model.

Gorry's main attempt in the article was to prove that managerial models work in decision making. His work involved development of a managerial model for a manufacturing organization. The model was analytical in nature and it depicted the dynamic manufacturing process. The article discusses his development process, and he indicates the results and implications of his work. Other work
done in this area for project management was done by Sathi, Morton and Roth [1986].

3.6 Overview of Management Articles

The three articles discussed above show the various types of articles existing in current literature. In general there were very few models, and no models which addressed management from the viewpoint of the overall construction project life cycle. Most of the articles related to management of certain aspects of the construction process. Of the models that were found, their shortcomings were that interrelationships between activities were not discernable. Additionally, the models do not show the detailed management functions or information flows that exist in the dynamic process of management. However, the wide spectrum of articles had an impact on development of the management process models in that they added different perspectives to common management problems.

One main outcome of conducting the literature survey became evident by understanding the importance of having a management model for making decisions. Management models provide a tool for analyzing, identifying, and avoiding problems that occur in the process of providing facilities. By checking for irregularities and compliance with management models, managers can detect problems and situations by understanding and improving the information they receive and produce.
Chapter 4

EXPLANATION OF THE
MANAGEMENT PROCESS MODEL

As described in Chapter 1, Manage Facility includes all the business functions and management processes required to support the provision of the facility from planning through operations. The main purpose of the management process model is to show the overall process involved in managing a facility, from its inception to its completion. It captures the generic ideas and the essential functions necessary for presenting an effective management process. The management process model is presented by diagrams and is depicted by definitions that explain functions and activities that may occur for each phase of the whole model.

4.1 THE MANAGEMENT PROCESS MODEL

The management process model represents the activities that are required to bring about a completed facility from the viewpoint of the user; this may be an owner, an architect, an engineer, a contractor, or a financier. The management process is broken down into five major functions numbered M1 through M5. These functions are generic in that they only show an abstract representation of how the facility is provided. Further breakdowns of functions are also shown, which describe the various activities that constitute the main functions executed at the top level.
An overview of all the functions included in the management model is shown in the function tree in Figure 4-1. The Manage Facility function is separated into the subfunctions of Establish Management Team, Develop Work Scope and Needs, Plan/Control Facility, Acquire Services to Provide Facility, and Acquire/Provide Resources for Facility. All of the functions and subfunctions are explained in the following sections. Definitions of all the terms used in the model are provided in the glossary (see Appendix B).

4.2 MANAGE FACILITY (M)

The Manage Facility function is broken down into five subfunctions (see Figure 4-2). Each is explained in the following sections.

Establish Management Team (M1): This function serves to establish an initial project organization, which then acts as an initial steering team/committee, having a detailed work plan. This function also assesses internal capabilities and resources to be used in providing the facility. Additionally, a project brief is established so that a program for further action can be made (i.e. a determination of site ownership, boundaries, and rights of way). Essentially, this function forms the preliminary strategy by setting the initial objectives, and surveying internal resources available for providing a facility.
Figure 4-1: Manage Facility Tree

NOTES:
1. THE PLANNING FUNCTION SUPPLIES INPUT TO THIS PHASE.
2. ADMINISTER CONTRACTS/PURCHASE ORDERS AND AGREEMENTS
3. RESOURCES INCLUDE FUNDING, TIME, MATERIAL, MANPOWER, ETC.
Develop Work Scope and Needs (M2): This involves defining the proposed work as completely as possible. The scope of work defines what is required of all parties in the project, the services that each will provide, and the type of support each can expect from the owner. In addition, the owner's needs are defined and classified based on their priority. Once there is a clear description of the work and people involved in providing the facility, a policy/strategy is developed for resource and service acquisition.

Plan/Control Facility (M3): The planning process includes: developing plans for resource acquisition; plan execution; controlling of the facility; and setting the methods, sequences, schedules, budgets, and quality of output from each of the technical phases. The control function continually monitors the actual performance, compares it to the planned performance, and plans and implements any changes found necessary.

Acquire Services to Provide Facility (M4): This is the process of soliciting the required services to provide the desired facility and assembling the facility team. These services include planners, designers, constructors, and facility management personnel. These services are not usually, but occasionally may be, acquired at the same time. An example of a situation where all the facility team players would be brought on board would be for turnkey/design-build projects. For the management phase, this function includes all contracts and agreements, between owner and designer, contractor, operator, etc. This does not include subcontracts between designer or contractor and subcontractors.
Acquire/ Provide Resources for Facility (M5): This is the process of acquisition, allocation, and the distribution of resources required to provide the facility. This includes necessary information, financing, funding, time, site, material, equipment, manpower, operational support resources. This process also includes storage of the resources and management of the inventories (ensures delivery of services/ resources - expedites, tracks, pays, and examines quality of items received).

4.3 ESTABLISH MANAGEMENT TEAM (M1)

The Establish Management Team function is broken down into three subfunctions (see Figure 4-3). Each is explained in the following sections.

Determine Internal Capabilities/ Operations (M1.1): Assesses in-house capabilities to provide a facility. This function assesses, steers and evaluates the roles and responsibilities of the initial facility team.

Develop Preliminary Facility Management Work Scope (M1.2): This involves assembling the necessary criteria to develop a problem statement defining the need for a facility.

Structure and Staff the Management Team (M1.3): This function develops strategies for organizing and staffing the project (i.e. consultants, QA/ QC staff,
etc.) based on the given work scope. This also involves acquiring the services of the selected participants needed to provide a facility.

4.4 DEVELOP WORK SCOPE AND NEEDS (M2)

The Develop Work Scope and Needs function is broken down into three subfunctions (see Figure 4-4). Each is explained in the following sections.

Understand Owner Needs (M2.1): This function involves understanding all the programming needs/ aspects (i.e. goals, facts, concepts, and needs-money, space quality, etc.) required to build a facility.

Define Facility Work Scope and Needs (M2.2): This function serves to solidify the problem statement for the creation of a facility (i.e., scope of design, packaging of contracts, defining of the construction techniques preferred, etc.). It identifies the conditions and specific directions for the design, construct, and operate aspects of a facility and the methods for how each aspect is to be implemented. The information elements addressed in defining the work scope are: function, form, economy, and time. In addition, risk assessment is made based on: project complexity, site factors, financing, delivery time, functions, uses, and obstacles expected on a project.

Develop Strategy for Resource and Service Acquisition (M2.3): This function serves to coordinate and steer all the variables involved with resource and service acquisition. The scope and need requirements, internal capabilities/
resources, and resource availability are accounted for. Then a direction/strategy is developed for the quantity and method of procurement for resources and services needed to provide a facility.

4.5 PLAN/CONTROL FACILITY (M3)

The Plan/Control Facility function is broken down into six subfunctions (see Figure 4-5). Each is explained in the following sections.

Understand Work Scope and Performance Criteria (M3.1): Involves comprehending extent of work and standards set for the work. This allows scope inconsistencies among the prepared contract(s) to be raised and corrected. This function also involves evaluation of the time and money needed to deliver a facility (identification of parameters in which the work is to be performed).

Develop Facility Management Plan (M3.2): Serves to guide execution and coordinate efforts of all phases of the facility management life cycle. This includes developing solutions, studying contract pricing alternatives, controlling documents, evaluating problems and making changes/decisions/schedules etc., to ensure successful project completion.

Administer Contracts/Purchase Orders and Agreements (M3.3): This function serves to handle communication problems, logistics, negotiate agreements, plan and process changes, enforce compliance (monetary, environmental),
secure necessary permits/ insurance, maintain contract files, and handle contract closeouts (walkthrough inspections, completion notices, contractor evaluations, warranties, as-buils, etc.). In addition, it serves to check that contracts/purchase orders get accomplished or followed up to ensure completion of the particular work item involved.

**Implement And Supervise Work-Contracts (M3.4):** This involves implementing management decisions, monitoring field performance and taking action based on field contract administration responsibilities (i.e. backcharges, cost collection, progress billings and payments, contract interpretations, claims, contract closeout, facility start-up, mobilization, etc.). Quality assurance criteria and acceptance requirements are also developed. This function mainly serves to inspect the work as it is developed (and when completed), and it either accepts or rejects the results.

**Monitor Facility and Progress (M3.5):** This function, first and foremost, is performed to ensure that the owner is getting what is wanted. This function involves walking the job and holding meetings, etc., to collect and release data specified in the plans, to control costs and cost records, and to control pricing and payment. It may also involve checking whether a contractor has insurance coverage or whether changes in the work are being priced correctly and paid for expeditiously. Some other functions include: monitoring the progress schedule, approving/denying payment requests, controlling procedures for use/possession of facilities prior to completion, and also monitoring/assessing liquidated damages.
Analyze Performance of Facility (M3.6): This serves to investigate and study unforeseen and existing circumstances related to meeting the expected requirements of a project. This includes reviewing contractor submittals and other data, and identifying problems. It measures achievements against goals for the projects; so that decisions for further action can be made. Essentially, this function analyzes all data from function M3.5 (i.e. review of design, and construction progress, and the operations of the building).

4.6 ACQUIRE SERVICES TO PROVIDE FACILITY (M4)

The Acquire Services to Provide Facility function is broken down into five subfunctions (see Figure 4-6). Each is explained in the following sections.

Identify Services Needed (M4.1): This function identifies the primary functions necessary to provide a facility. These functions include the plan, design, construct, and operate subprocesses as well as other special services.

Identify Sources of Services (M4.2): This includes determining the qualified parties who are capable of performing a service for a particular work item needed in providing a facility (i.e. potential agents/contractors). The particular service requirements necessary for providing a facility and the work scope
Figure 4-6: Acquire Services to Provide Facility Model
parameters (i.e. work packaging by outside firms, availability of services/resources, etc.) control this function.

Prepare Invitation to Bid and Submit Proposal (M4.3): This includes preparation of bid packages, instructions to bidders, development of contract proposal formats, and management of the bid cycle.

Review Proposals and Select Agent/Contractor (M4.4): Includes prequalifying selected agents/contractors, for services to be rendered, based upon qualification data and from reviewing and analyzing bid proposals. After a thorough screening of the qualified parties, individual agents/contractors are selected.

Execute Contracts and Agreements (M4.5): Developing and providing the design and contract documents necessary to provide a facility (i.e., special and general conditions, addenda, etc.) as well as awarding the contract(s).

4.7 ACQUIRE/PARTNER RESOURCES FOR FACILITY (M5)

The Acquire/Provide Resources for Facility function is broken down into six subfunctions (see Figure 4-7). Each is explained in the following sections.

Identify Resource Needs (M5.1): This function assimilates a detailed listing of all resources required to furnish a facility. The information is gathered based on
Figure 4-7: Acquire/Provide Resources for Facility Model

1. THIS INCLUDES FUNDS, MATERIALS, EQUIPMENT, OR SITE.
the work scope for providing a facility, the owner's purchasing policy, as well as the external constraints which may affect resource acquisition.

**Identify Sources of Resources (M5.2):** This includes searching for all possible entities which may be capable of delivering the required resources needed to provide a facility (i.e. banks, suppliers, vendors, etc.).

**Prepare Purchase Requisitions and Submit Proposals (M5.3):** This function includes preparation of requisitions and bid packages, instructions to bidders, development of a proposal format, and management of the bid cycle.

**Review Proposals, Select Vendor and Execute Purchase Order (M5.4):** Includes prequalifying selected contractors/ vendors/ agents, for resources to be acquired/ provided, based upon qualification criteria and also from reviewing and analyzing bid proposals. Once this review is performed, contractors/ vendors/ agents are selected. In most cases, resources are acquired/ provided through purchase orders, which serve as the mechanism for resource acquisition.

**Receive and Inspect Resources (M5.5):** The process of certifying the resources received against what was ordered (i.e. quality, required specifications, delivery condition, quantity, etc.).

**Distribute/ Store Resources and Manage Inventory (M5.6):** This function serves to distribute all acquired resources to the respective players needing the
purchased/ provided/ financed resources at the appropriate point in time. It serves as the central clearing house for all resources obtained; handling both inventory, storage and distribution. Resources here are meant to include funds, materials, equipment, manufacturing plant, or site(s).

4.8 MODEL SUMMARY

The above definitions of the functions in the Management Process Model briefly describe the basic tasks. Although the terminology used is abstract, they can be used to identify practical instances whereby user specific terminology can be applied (i.e. facility management plan [abstract] and pro-forma [developer specific]). The findings from specific case studies, which support the validity of the Management Process Model, are presented in the next chapter.
Chapter 5
SUMMARY OF CASES

The companies that were used for development of the management process models had a wide variety of characteristics. On one end of the spectrum, a case study was done on a provider of pre-engineered metal buildings. They used purchase orders exclusively for acquisition of resources and services (contracting). The company, Steel-Bilt Construction, did not do high risk jobs and dealt only with metal buildings. At the other end of the spectrum, Turner-Harwood Ventures and Prudential Property Company, dealt with different types of construction which required guaranteed - maximum - price contracts and consultive coordination. The detailed discussions of these cases are provided in Appendices D, E, and F.

5.1 METHODOLOGY

The methods used to select these companies and collect data are discussed.

The firms selected for the case studies were chosen because of their unique characteristics. There were two phases of data collection and the criteria for the two types of cases are given below.

For the first case, the Steel-Bilt Construction Company was selected because our criteria required receiving feedback from a broker-contractor who assumed both contractor and owner roles - this way we were able to check on the validity of the management phases as they related to both the construction and management subprocesses. Furthermore, the company offered us a view of
how a small firm interacted with players that were involved in a very low risk and a very well defined segment of the construction market - pre-engineered metal buildings.

For the second case the two other firms that were chosen were both property development firms because they closely resembled the master builder of the 1900's. Like master building, property development encompasses the entire management and building life cycle (i.e. marketing, financing, planning and design, construction, merchandising and property management), and like contractors, developers employ a lot of experts. This tends to fragment the development process and makes each development unique. The criteria for selection of the property development firms were: 1) Commercial office development projects; 2) Building height 5-10 stories; 3) Location Virginia/Washington, D. C. type; 4) Cost $75 - $90 per square foot in cost; 5) Size 100,000 - 200,000 square feet; 6) Customer - corporate clients; and 7) Owners who operated buildings.

In order to gain an understanding of the whole range of property development, we chose a private development firm (Turner - Harwood Ventures) that was involved in the middle range of development and a public development firm (Prudential Property Company) that was involved in large corporate projects. The two property development firms showed a significant variation in the way they operated and this was reflected in the final building product. Data was collected through interviews with selected personnel; the questions that were used for the interviews are found in Appendix C.
The data collection procedure involved structured interviews with personnel in upper management positions. The interviews were conducted with: a president; a vice president; a general manager; a project manager; and a property manager. The questionnaire used for the interviews consisted of ninety open-ended questions that allowed for free discussion by the interviewees. Based on the direction of discussion, further questions were asked to probe areas of uncertainty. The questions were developed based on the node M level - Manage Facility IDEF0 diagram (see Figure 4-2). Each input, control, output, and mechanism arrow, at the node M level, was captured in the questionnaire to test its validity. The information gathered during the interviews provided a thorough understanding of the methods used to manage operations as well as the reasoning behind the methods.

The main purpose of the case studies was to see whether or not the functions in the process models were performed. For each of the cases, the management process model was supported as presented in Chapter 4. The findings from the case studies are presented below.

5.2 CASE STUDIES

5.2.1 STEEL - BILT CONSTRUCTION COMPANY

Steel - Bilt is an independent building contractor that has chosen to work exclusively with the supplier of Armco Building Systems (see Appendix D for more details). They offer total construction services: project budgeting, sitework, foundations, building erection, mechanical and electrical work, and landscaping. The size of the company is very small (six people), their volume of
work is also very small. The firm subcontracts almost 100% of all their project work. The company also acts as a developer by building and selling pre-engineered metal buildings. However, in the capacity of a general contractor, the company always serves as the main coordinator among all the parties concerned; the architect, Building Technologies (Armco Building Systems supplier), specialty consultants, and subcontractors. The company interacts with all the parties affecting development of a site and this includes the approval of drawings from municipal officials. The projects they get involved with are very well defined and, in most cases, the subcontractors hired are capable of designing the system layouts of their particular trade (i.e. the mechanical subcontractor would develop the mechanical drawings based on the program of needs for a building).

In relation to the process model, all the function boxes were performed by the firm. The areas that were neglected by the firm consisted of only a few arrows from the model. The control arrow - Working Plans was not performed on a formal basis and this impacted the company’s performance. They had no means to accurately assess the progress of a job. By developing a detailed checklist of activities for phases of the work, the company would be in a better position to analyze their performance on a regular basis. This checklist would serve as a guideline that would help the firm in detecting errors and omissions. It could also reduce the development time if activities were conducted in a timely manner.

Another element which had an impact was the output - Facility Planning Information from node M2. This arrow impacted the Facility Management Plan in a very direct way. This arrow's information element consisted of elevation
drawings which were transformed by Building Technologies into erection drawings. Once the erection drawings were delivered back to Steel - Bilt, they became, in most cases, the sole information source and mechanism for executing the remainder of the work for a project. The company still used a Facility Management Plan that was very loose despite the fact that the firm had a control device that was very specific - the erection drawings. The main effect this had on performance of work was simply a relaxed work pace, the Facility Management Plan was loose in that it allowed the subcontractors a lot of flexibility. No schedule was followed, and the subcontractors were only given milestone dates - weather permitting. This created a reactive atmosphere for solving job site problems. The main office of the company does not formally monitor the work progress in the field, it is handled totally by the company's site representative.

The main advantage the firm had was their small size, this allowed them to build a very cooperative team that managed to work closely with the owners, suppliers, and subcontractors to solve problems. This loose organization could be improved by adopting a consistent work procedure which would lead to more efficiency, better feedback, and faster completion time for projects. Better documentation of job information could lead to better tracking of progress. The use of a simple spreadsheet software application could greatly enhance their ability to control job costs. Overall, the company performs well in the sense that it does not have any major operational problems. However, there is plenty of room for improvement in the area of development of facility management plans. The plans of action for coordinating their work appear to be of secondary importance to the firm. Enforcement and adherence to facility management plans are directly related to the size of the jobs and the owner's degree of
involvement on a job. Better documentation and managing will lead to better control and efficiency in operations.

5.2.2 PERSPECTIVES ON PROPERTY DEVELOPMENT

The developer like the Facility Champion in the model (mechanism for M1) is responsible for overseeing the highly creative process of combining and coordinating all the resources and services that are required to get a facility built. To understand the development process as it relates to the master builder concept, the function breakdown must be understood. The master builder concept in this case refers to the synergistic process of constructing a facility where everything is concentrated in the mind of one person who provides all the decision making and all the information required to provide a facility. There are three main phases that a developer would go through and they are described below. The phases were developed based on an interview with Mr. J. T. Thomas, Jr., partner of Turner-Harwood Ventures.

The first phase is the initiation of a development: working up a scheme for a potential facility. The steps for this phase are listed below.

1. Development of an intention for a facility.
2. Undertaking a feasibility study - assessing the market (i.e. demographics).
3. Acquisition of a site.
4. Conducting site exploration (i.e. soil borings).
5. Hiring an architect.
6. Development of sketches and schemes/alternatives for a facility layout.
7. Development of tactics and a plan for execution.

The second phase involves the application for planning permission and the development of a detailed design. The steps for this phase are listed below.

1. Refinement of scheme.
2. Finalization of design.
3. Regulatory approval of building.

The third phase involves the financing, construction, marketing and disposal of a facility. The steps for this phase are listed below.

1. Finalizing arrangements.
2. Tendering/selection of a construction team.
3. Performing construction and marketing of the facility if tenants have not been brought on board already.
4. Completion of the facility.
5. Letting and occupation of the facility to/by tenants.
6. Disposal of the facility:
   a) Selling to an institution or property company.
   b) Selling to a tenant(s).
   c) Retaining in the company portfolio and managing the facility's use by tenants.

These three phases are not meant to be absolute breakdowns of the functions that a developer performs. The functions were developed only to provide a picture for understanding the processes that are performed and the decision making categories in which a developer would be involved.

One of the problems that was noticed from conducting the case studies on the office developers was the fact that there was no uniform way of reporting office vacancies and construction in any particular office market. The way it is done...
today relies mainly on getting brokerage companies' reports and this leads to wide discrepancies and variations in the quality and credibility of the information. The problem originates with the fact that each real estate brokerage house uses a different terminology for assessing the amount of office space that exists, how much is available for rental, and how much is under construction. For example, some firms differentiate between classes of space by age and condition, while others include factors like location and rent levels. Another example of a discrepancy is having one company include buildings under construction in its space inventory while another will not count new space until it is completed.

The result of all this reporting is a lot of inconsistent data which many investors, banks, and owners use to formulate their decisions to buy, sell, build or lend. The impact this data has on development is that it may lead to overbuilding, especially when optimistic perspectives on the demand for space are given rather than what really exists. Essentially there is no accurate picture for obtaining significant information factors such as the absorption and vacancy rates for any particular market in the country. This fact makes addressing the markets' needs very risky, and in some cases this is riskier than the risk involved in constructing a facility.

5.2.3 TURNER - HARWOOD VENTURES

Turner - Harwood is a real estate development firm that has been in business for ten years and whose current purpose is providing speculative office buildings in the Virginia/ Washington, D. C. area (see Appendix E for more details). The firm develops facilities for a profit motive and they have built
projects throughout the New England States. Their current project, WillowWood Plaza, is a 25 acre parcel of land with four office buildings that are each approximately 125,000 square feet in size. This is a two phase development (two of the buildings are already complete) and each building consists of five floors, with approximately 25,000 square feet per floor.

In relation to the management process model, all the functions in the model were supported by the firm. The only distortion came in the area of Working Plans (control arrow for M2), but this was substituted with a detailed pro-forma which became the information source for formulating all schedules, guidelines, checklists and audits on progress of work. Overall, the company's functions, as demonstrated by the management model, showed a very effective process for doing things right, and the facility reflected this by its aesthetic qualities.

Among the lessons learned from this case study, were management concepts that related to property development. The company is very careful in the actions they take, they have five people, each focused in a particular area (marketing, construction, accounting, architectural programming, and financing) and coordination among the group is very smooth. An example of their thoroughness is substantiated in the way they buy property - a careful analysis is done beforehand and they always buy property on the stipulation that if anything happens subject to rezoning ordinances, they have an option to pull out. They also set the price for the land prior to any soil borings that are taken. Land to them is only valued at its potential for development.

Another interesting note was the firms' handling of the designer - their efforts included divorcing the architect's rational and emotional facets during creation
of project designs. By eliminating a designer's desire to create a monument to the world and to his/ her reputation, the firm believed that they were removing the "egotistical factor." The firm felt that by eliminating this element from a project's design development, they would be able to make the facility affordable to the user. Managing control of design development was achieved by having regular sign - off points and progress meetings with the architect during the design stage of a project.

The chief market data important to the firm was the existing tenant base; hotels in the surrounding area; ingress/ egress to expressways and transport centers; creature features (e.g., restaurants); and the existence of a residential community. The governing factor for all their developments in this area is the number of cars a proposed development can accommodate. There are two reasons why development firms emphasize this parking factor. The first is that professionals, especially lawyers, increasingly commute in private vehicles both to work and to clients. The second is to meet with municipal approval.

Another concept which appeared to be very effective was the company's procedure of bringing the architect and the contractor on board at the same time. The main benefit this had was the fostering of trust and cooperation, and it also facilitated in finalizing equipment purchases (i.e. standard dimensions for elevator cores are set so that a standard elevator can be purchased early on in the project). The company always bought long lead items such as elevators and mechanical equipment, up front to shorten the time for completion of a development.
In general, the company's management plans were very tightly controlled and centralized among the five people who do all the coordination. This aids in following through on very controlled budgets. The operational methods of the firm were very thorough and rational. The firm's objectives were very clear, and their frameworks for getting things done were very precise. No information problems were evident, and this is a direct attribute to the managers' understanding of the processes involved and the importance of the information they receive.

5.2.4 THE PRUDENTIAL PROPERTY COMPANY, INC.

The Prudential Property Company (see Appendix F for more details) is an investor and builder of large projects. Based on their business needs the firm searches for business opportunities in areas that are in need of office and residential space. Their ultimate purpose is to create value by investing money into land and facilities that will profit The Prudential Insurance Company of America their parent corporation.

For this case study, a 35 acre business park with nine buildings each about 100,000 - 225,000 square feet in size was studied. The buildings for the Willow Oaks Corporate Center are each eight stories high, with individual floor plans ranging form 19,000 - 24,500 square feet; the total development constitutes 1.2 million square feet. At the time of the interview, the first building was operational, the second building was being constructed, and the third building was being designed and planned.
As far as the management process model is concerned, all the functions were supported by a management team. This team was not contained in one organization. The company hired many outside consultants providing a decentralized approach to management. Again there was no working plan for guiding development, everything the organization was confronted with had a reactive response. Function box M2.3 - Develop Strategy for Resource and Service Acquisition - was performed by the outside parties hired to execute portions of the work. There was no form for controlling resource acquisitions, all risks and responsibilities (with the exception of funds) were shifted to outside parties. The pro-forma was not even considered to be a tool for implementing an orderly process, it was only meant to serve as the financial goals expected for a project.

Information was transferred among the parties involved through a circulation list which hindered timeliness for execution of activities. The physical proximity of the participants involved in managing the project were great, and valuable time was wasted due to the transportation efforts involved. Coordination among the team members was minimal due to the fact that the majority of the parties' offices were spread out in various locations. Planning and Control of the facility was informal. It was difficult for the company to make the contractors pay attention to detail. It seemed as if the company was out of touch with the industry on costs for key trades that were hired (i.e. property management). In addition, their contracts had elements in them that were moving items (e.g. construction variables that were subject to change - i.e. quality of materials), so they never had a total fixed cost of a facility from the outset. In essence, there was no control over economical considerations - it all related to the quality and
professionalism of the outside services the company hired. Typically a service was hired for every problem encountered.

The main lesson learned from this case study is the simple fact that large organizations usually have corporate cultures that are rigid. The company needs to restructure its organization such that they assume more responsibility. Just having an engineering group to ensure that state of the art systems and materials are used is not enough, more can be done to control project costs and development time. In relation to the management model, the activities were performed, but they were not performed in an organized fashion. Poor coordination led to operational problems, especially in the area of communications among the participants managing the facilities. Information transfer was fragmented, and there was no procedure (working plans) for its dissemination. There was no overall facility management plan that took into account the harmonious implementation of activities. The management functions in the model were performed through the aid of outside parties hired, but there didn’t appear to be a firm grasp on management of the entire operation for provision of facilities. The facility management plan was disjointed in its approach. The main focus of the firm was on financial control, but this was performed without understanding the details of the management process. There were no policies for measuring performance among the management organization due to the firm’s rigid operating structure. The management team relies too much on the consultants they hire for achieving their project objectives. Conformance to the model was met as far as performance of the function boxes is concerned, however, the flow of information among the boxes was not smooth. The main reason for this was due to insufficiency in
development of a facility management plan and the working plans for controlling procedures.

5.3 RESULTS OF THE CASE STUDIES

All three cases provided insight into the management processes that are involved in providing facilities. All three cases performed the five main functions of the model. The main differences among the three cases was the style of management.

For Steel-Bilt (broker contractor) it was a question of coordinating outside parties. They had no major constraints which hindered performance. Steel-Bilt's areas of weakness were: M3.4 - Implement and Supervise Work; M3.5 - Monitor Facility and Progress; Working Plans (control arrow for M2); and Facility Management Plan. The reasons for these performance weaknesses had to do with the way pre-engineered metal buildings are traditionally built, and also with owners' relaxed involvement. From a performance aspect, the company's size made things easier to coordinate and control, so there were no real problems as far as management was concerned.

In the case of Turner - Harwood Ventures, the company operated very efficiently, their people had a solid understanding of the processes and constraints that affect development and their organization was structured for maximum control over the whole development process. The company's only weakness was in not having any formal working plan, but this was remedied by having work checklists.
The Prudential Property Company was largely controlled by their corporate parent - Prudential Property Company of America, thus they didn’t have the same level of concern to perform efficiently. Instead they acquired numerous services to justify their means for obtaining quality work without really considering the final user costs. Their financing was obtained from the parent corporation and this affected their concerns for controlling budgets. The company had more of an emphasis on investing money rather than justifying a project; they had to turn over a volume each year. The firm’s major problems included: M2.2 - Define Facility Work Scope and Needs; M2.3 - Develop Strategy for Resource and Service Acquisition; and M3.2 - Develop Facility Management Plan. The company’s main problem was team management and coordination of the parties hired to perform portions of the work services. It is difficult for two people to share a single managerial position unless they can act as one entity. This means that the firm should not divide up multiple roles, unless they can carefully reintegrate them. Unless there can be full sharing of managerial information (mostly verbal in this firm’s case) team management breaks down. A single managerial job cannot be arbitrarily split into internal and external roles, because information from both sources has to be brought to bear on the same decisions. Effective communication among the facility management team appeared to be very poor. The Prudential Property Company needs to change their organization’s operating rules, because rigidity is hindering their efforts at effective management.

These cases identified the modeled functions (specified by IBPM) as performed by the respective companies, at a project level. However, some detailed observations from the case studies are given below.
In both of the development projects, mirrored buildings were used to implement phased developments. Some of the reasons for this relate to cost considerations, design changes, operation and construction information. In terms of cost considerations, the mirrored imaged building costs could be delayed until the first building is built. This would aid in understanding the total costs for construction and operation (both from a maintenance, construction, and rent cash flow standpoint). Design inefficiencies could be identified in the existing building (i.e. traffic flow, maintenance, or equipment problems) and corrected for the follow on facility. The construction process is more defined and controlled in the second building because the first building serves as a model of how to assemble, coordinate and control all aspects of the development. Another feature that was evident in office developments was the use of modular design plans; companies try to eliminate interior corridors or public spaces so that flexible floor plans can be created.

As far as financial feasibility specifics are concerned, each development company has their own method of obtaining financing for projects. This financing takes place in function box M5, and for developers there are numerous considerations to be made. One method of financing is through phased development using mirrored buildings. With this approach there is the potential of having cash flow from the initial building serve as part of the financing for construction of the second building/ development phase. The projected income the first building of a phased project has to balance the estimated cost of the first phase of construction in order to be successful. The permanent financing is crucial to the financial success of a project because it will allow the developers to repay more expensive construction loans.
One of the worst things to happen in a finished building is to have only 40 to 50 percent leased. Obtaining permanent financing for a half-full building is more expensive because lenders require letters of credit or other guarantees to assure payment. A fully rented building, with its predictable flow of cash, is safer for lenders, who can then charge a lower interest rate.

There are hundreds of financing arrangements that developers use. Under one type of financing, a 100 percent borrowing arrangement, enough money is borrowed to repay the construction loans. In general, all developments try to have some kind of magnet feature that draws tenants to the projects. Developers have been known to offer generous decorating allowances, low rents, and even ownership shares of buildings just to entice tenants. The overriding concern for all development feasibility studies is the cost of money at the time of development and the projects' access to expressways and parking facilities.

5.4 SUMMARY OF RESULTS

The three case studies proved the model to be valid at the M level. No changes were made to the model after the interviews were completed. However, it was felt that a more in-depth analysis of the lower management nodes needs to be undertaken in order to effectively detect any major managerial problems. Full validation of the management model can only come about through the customized use by the user. Each company's environment/situation has to be customized against the model so that specifics for each of the firm's detailed operations can be understood.
Chapter 6

CONCLUSIONS

As presented in the previous chapters, the main objective of the management process model is the determination of all the processes which constitute the manage function for a construction project. The models are meant to simplify and clarify the activities that take place in management so that a greater understanding of the models can be obtained by various users. The previous chapter presented three case studies and their validation of the management model at the M level. This chapter will explain current management problems in the construction industry and it will also present applications and benefits that can be gained through the management model's implementation.

6.1 MANAGEMENT PROBLEMS IN THE CONSTRUCTION INDUSTRY

Today, building problems have become a fact of life in the architecture, engineering, and construction industry (AEC). Complex building systems are being incorporated more and more. There are more specialists involved in providing a facility, and this has resulted in complex contracts with increased liability for all the major facility team players. At the same time, building owners are demanding faster delivery times for buildings with multiple end users. Two words which normally define the management process are: uncertainty and ambiguity, and these words occur through all phases of a project life cycle. The reason for this obscurity is because there is no formal method for managing a facility through its development life cycle. And this lack of definition has resulted in hindering specialists' abilities to manage projects. Similarly, poorly managed
teams usually degenerate into disorder when the participants are allowed to hide behind their disciplines and ignore each other.

In addition, construction risks are escalating to a higher level every day, and owners are usually incurring some of their biggest and longest term debts to finance these construction projects. Risks can never be totally eliminated but they can be controlled, and the only way to control something is by understanding the process behind it. Thousands of buildings have been built and yet there is still no set procedure that has been devised to show the overall management process involved. In the past, management's typical role was reactive as opposed to proactive in nature. So such things as budget overruns, delays (which have devastating financial impacts), and bad designs (which don't meet an organization's needs) have become common problems and they are a direct result of poor coordination. An example of this lack of coordination was presented in Chapter 5 on the Prudential Property Company development project. This was a situation whereby the company had inefficiency built into their construction projects. These problems occur with other organizations as well, especially in the cases where you have several contractors each contracting with the owner, and responsible only to the owner, they do not seek to advance the job as a team, instead they seek to advance their individual interests.

What the management model, along with the Plan, Design, Construct, and Operate Models hope to convey is an abstract representation of how a facility is provided - be it a warehouse, a nuclear power station, etc. The lines and arrows that are shown on the model diagrams are meant to represent the fundamental thought processes and activities that one would have to go
through in order to achieve a completed facility. The models will not cover such things as a certain job position performing a certain function (i.e. an electrical designer or a control system specialist). The models only identify the similarities between the mechanisms, generically and the functions they go through. The main purpose of this report is to effectively prove that the management model can be used as a tool for integrating the entire process. To explain the effective uses of the model, several applications are described in the following sections.

6.2 POTENTIAL APPLICATIONS OF THE MANAGEMENT PROCESS MODEL

There are numerous applications for the potential uses of the model developed in this report. Some of these uses are presented and explained in the following sections.

6.2.1 The Fostering of Mutual Trust by the Facility Team

Construction of a project is the result of the collective efforts of a group of experts (i.e. engineers, contractors, consultants, municipal officials, lawyers, etc.) over the life of the project. An owner's/organization's job as far as managing is concerned, is to coordinate the coordinators; and to make precise decisions as the work progresses. These decisions can only be effective if the shared element of mutual trust is present among a facility team for a project. Without this type of trust, confusion and exasperation proliferate among the facility team. This results in more headaches for all parties involved in providing that facility. To eliminate this the Integrated Building Process Models (Manage,
Plan, Design, Construct, and Operate) were built to define the common purpose and mission of providing a facility. The immediate outcome of this is that a strategy for executing specific tasks; structuring people (organizations); and the tracking of information flow is gained. This allows various users to follow a systematic decision process without controversy or confusion. By using the models, a user will understand how the other team members work thus facilitating agreements with other team members.

6.2.2 Basis for the Development of Action Plans

The models essentially serve as action plans for all the different phases (Manage, Plan, Design, Construct, and Operate) to picture so that there is common understanding of the whole picture. The result of this is a facilitation of a shared vision on the roles that each party will perform to achieve the mission of providing a facility. This creates an environment where team members will play their roles and fill the gaps - function boxes - as they see them. The final result of this integration is a coordinated contribution by the facility team members to complete a facility.

6.2.3 Consensus Among the Facility Team Through a Networked Information System (IBPM)

When crises occur during the development of a facility it usually requires drastic changes that involve communication among various parties. By using the management process model in conjunction with the other subprocess models, a user will be able to see the communication process. What this effectively does is defuse potential conflicts that may arise among the facility team. By being
able to visualize the communication/information process, members of the facility team will understand that they might disagree with each other due to their different perspectives. Instead of people, in different subprocesses/functions, being totally focused on arguments over facts they will be able to see the facts for what they are from the global perspective. In other words, a person performing one function (in one specific process of the IBPM models) will be able to relate to the context of his/her work portion by understanding how his/her portion of the work fits into the overall mission of providing a facility. The direct result of this is a harmonious group that effectively changes the context of the dispute rather than the dispute itself. The models show the links which allow the facility team to look beyond their separate functions so that problems can be resolved efficiently.

6.2.4 Basis for Development of Organizational Design

The model can be used as a tool by an owner or a company for designing an organization. The model allows an owner/organization to match their professional staff’s decision making capabilities to the function boxes, based on the structure of the model. This way the focus is on function and not job description. From another perspective, the management model can serve as a space management tool for placement of organizational staff. Based on the different node numbers in the model, different divisions can be placed in a certain layout to facilitate coordination or interaction of personnel, this will effectively make or encourage the team to work together. An example of this could be the make-up of cross functional teams (i.e. composed of Manage, Plan, Design, and Construct team members) which are located in one area like "Node M5 - Acquire Provide Resources for Facility," this should help decrease
development time (since implications can be assessed by the various team members), and it will also result in collaboration from the start (i.e. constructibility integration).

6.2.5 Basis for Development of Contracting Strategy and Methods

Contracts can be written to foster collaboration and integration so that an atmosphere of cooperation among various disciplines, phases, and teams is obtained. These contracts can be written to clarify responsibilities of functions defined in the management model. Use of the management model will facilitate creation of these contracts since it can serve as a guideline for communication between people and functions. The model also takes into account all the contract delivery methods, so contracts can be structured in any form desired.

6.2.6 Framework for Distinct and Informed Decision Making

The management process model should enable owners/ top management of a company to make prompt and informed decisions as work progresses; and it should also take and retain project responsibility at the highest level. Senior managers have to accept full responsibility and ultimate control at the top. Too often, management approaches/ directives are passed along in a sequential manner, and this makes the managers think that their jobs are finished when their management work portion is over. This style of management leads to inefficiency with increased costs and poorer quality of services rendered in providing a facility. However, with the aid of the management process model, clear lines of decision making can be made by the management team/ owner by following six steps.
First, the management team/owner must understand all the phases in the integrated building process models. Second, there has to be a determination of a project's complexity, project work scope, and needs. Third, there has to be an association of the project's risk factors (based on complexity), project work scope, and facility needs with the organization's internal capabilities/operations. Fourth, the management team has to devise a strategy for planning and controlling a facility (this includes selecting a contract delivery system). Contract types can be written/selected better if risks can be identified, understood, analyzed, and rationally controlled based on the function breakdowns provided in the models. Fifth, the management team has to provide the services/resources needed to provide the facility. The resources mainly pertain to obtaining funds. Sixth, the facility and its progress has to be monitored throughout the development process. These steps can all be understood by viewing the model, because it shows all the activities that are involved in performing a management task. The main idea behind all these steps is to divorce the owner/management team from making unnecessary decisions.

6.2.7 Basis for Software Development

The model establishes clear divisions for the creation/use of expert system software. Knowledge information can be accumulated based on each function breakdown in the model. Knowledge can be captured based on the format of the model since the model serves as a road map for how to get something done. The model can even be used to improve the process, by suggesting computer integration techniques to efficiently transmit information. The
integration is provided through the common generic process definitions and models. The only limitation of the model is that it may be hard to quantify anything specific (for software purposes). Overall though, the model provides a solid structure for building an integrated database, and this should result in better sorting of information, and more effective integration for provision of a facility.

6.2.8 Basis for Identification of Problem Areas

The model can serve as an audit function for checking and pinpointing interference/bottleneck areas directly at the source, because the process model serves as a model for paper flow within an organization. So if function boxes are detected to be off (based on information flow or work performance) they can be turned on and corrected so that all the activities are performed with the information flowing smoothly.

6.2.9 Basis for Development of Procedure Manuals

The management process model can be used to develop procedure manuals for various types of organizations. The functions and subfunctions in the model can serve as instructions/guidelines/checklists for activities to go through to fully perform a function. These procedure manuals would be similar to maps, whereby the users would be able to tell how far along they are in an activity or from a broad view of all the models, where they stand as far as completion of a facility is concerned. The procedure manuals can also serve as a tool that will provide guidelines for successful projects.
6.2.10  **Basis for Training of Employees**

By using the management process models, new employees in an organization will be able to see a picture of the whole process and their individual part in that process. What this essentially provides new employees is a performance definition of what is expected of them. The main outcome of this is better project control in providing a facility, because the models set goals and show constraints; project control is nothing more than meeting goals of cost, time, and quality of product. So people will have targets to shoot for and goals to achieve.

6.3  **BENEFITS OF THE MANAGEMENT PROCESS MODEL**

The management process model represents a simple and logical conceptual framework that serves to aid manager's/ owner's perceptions for understanding the whole management process as well as factors that can be built around it. It is a tool for organization and control - the model clearly defines all elements and their relationships to each other so that they can be measured/ anticipated, and planned for carefully. As stated earlier, the model can be used as a framework for building an organization by developing decision-making roles/ categories for all the functions in the model. In addition, the model serves as a skeleton of an information network process. The boxes and node trees can serve as pooling centers for: (1) allowing enough time to make a decision; and (2) incorporating views of others to build a teamwork spirit for execution of decisions. So the obvious benefit of these applications is that the model's use results in faster implementation and development of a facility.
Another benefit is the model's open architecture communication network. The process diagrams act as a network that fosters trust among groups/divisions/subprocess members, they link the whole integrated building process model. The outcome of this communication network is that it allows the different phases (Manage, Plan, Design, Construct, and Operate) to develop a shared vision which cultivates a sense of common purpose. Furthermore, the models delineate the various audience groups that may affect a particular function. These audiences may be either internal or external to an organization depending on size and internal capabilities/operations of a particular firm.

The major benefit of the management process model is that it can be used as a tool to identify problems and priorities, as well as monitor change. It can also be a generic tool that can be applied to a project or an individual in making decisions. The model also provides options for structuring and operating a business; it can be used to help identify who in the company has the expertise needed to work on a particular function. So basically, the main outcome of all these uses of the model is that it provides for an understanding of the decision making that is involved in an organization. The potential benefit this provides is that it addresses the needs of large owners in their efforts at providing facilities, and at the same time the model can serve to better educate the owners of all the processes that are involved.

6.4 REASON FOR USE OF THE MANAGEMENT PROCESS MODEL

In the AEC industry, the users rely on the same process of drawing on the past for analogical reasoning. That process is inevitable among decision makers, because we all use reasoning by analogy as a mental shortcut to help define
problems and identify solutions. But we often engage in analogical reasoning without spending time determining if our present problem fits the supposed "lesson from the past". And in an environment as risky as construction, the inappropriate use of analogies can have extremely serious consequences. For this reason, the author believes that providers of facilities need to follow a set pattern of activities, comparable to the process diagrams, to ensure that all the bases are covered. By doing this, a logical and systematic information gathering tool such as the management process model, can be used in capturing knowledge for application to future projects.

The management process models can never be perfect, there will always be ways found to improve them. This research effort was only an initial attempt at solving a very complex problem (interactions that take place in the AEC industry). The models need to be fully understood, in the context that they are only one part of the other four subprocesses, before they can be effectively utilized. The ultimate validity of the management process models can only be reflected by their acceptance by the AEC industry. It is hoped that the combined models will offer an enhanced image of the functions that take place in the management process. An understanding of the management environment is the key to making effective management decisions.
Appendix A

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Appendix B

GLOSSARY

Acquire/ Provide Resources for Facility (M5): This is the process of acquisition, allocation, and the distribution of resources required to provide the facility. This includes necessary information, financing, funding, time, site, material, equipment, manpower, operational support resources. This process also includes storage of the resources and management of the inventories (ensures delivery of services/resources - expedites, tracks, pays, and examines quality of items received).

Acquire Services to Provide Facility (M4): This is the process of soliciting the required services to provide the desired facility and assembling the facility team. These services include planners, designers, constructors, and facility management personnel. These services are not usually, but occasionally may be, acquired at the same time. An example of a situation where all the facility team players would be brought on board would be for turnkey/design-build projects. For the management phase, this function includes all contracts and agreements, between owner and designer, contractor, operator, etc. This does not include subcontracts between designer or contractor and subcontractors.

Administer Contracts/ Purchase Orders and Agreements (M3.3): This function serves to handle communication problems, logistics, negotiate agreements, plan and process changes, enforce compliance (monetary, environmental), secure necessary permits/insurance, maintain contract files, and handle contract closeouts (walkthrough inspections, completion notices, contractor evaluations, warranties, as-buils, etc.). In addition, it serves to check that contracts/purchase orders get accomplished or followed up to ensure completion of the particular work item involved.

Analyze Performance of Facility (M3.6): This serves to investigate and study unforeseen and existing circumstances related to meeting the expected requirements of a project. This includes reviewing contractor submittals and other data, and identifying problems. It measures achievements against goals for the projects; so that decisions for further action can be made. Essentially, this function analyzes all data from function M3.5 (i.e. review of design, and construction progress, and the operations of the building).

Approval/Inspection Plan: The selected approval/inspection plan which dictates the manner in which materials, equipment, or a particular portion of work is examined to see that it conforms to the conditions originally imposed (i.e. quality assessment and quality control). The conformance might relate to specifications, codes, etc., which may be required in order to qualify the item inspected as completed work.
Available Resources: The personnel, computer technology, time, space, equipment, materials, energy, funds, etc., available to the project.

Codes: Rules and regulations prescribed by organizations defining standard practices, procedures, methods, and performance criteria for facilities (i.e. zoning ordinances, building codes, etc.).

Contract: A legally enforceable document between two parties consisting of an offer and an acceptance to provide a portion of a facility, a service, or a resource.

Contract Changes: Changes, made in response to requests from the management, planning, design, or operating team, affecting a particular portion of work relating to a facility (i.e. performance and facility characteristics) that require modifications or enhancements to a contract. The modifications may relate to scope of work, time of performance due to ambiguities, restrictions, codes, revisions, errors, omissions, equipment, materials or unforseen problems, etc.

Contract Information: Information used to clarify and supplement the scope of work, costs, requirements, etc., that is needed to understand contracts in their full context.

Contract Interpretation: All contract evaluations to clarify contractural responsibilities of parties engaged in the work.

Contract Plan: Information relating to the type of contract required for contractors/ vendors/ agents.

Contractor/ Vendor/ Agent: Any party, hired by the owner entity to provide services, resources or personnel to complete the facility.

Criteria For Qualification: All pertinent factors that influence contractor/ vendor/ agent selection (e.g. past experience, financial stability, etc.).

Define Facility Work Scope and Needs (M2.2): This function serves to solidify the problem statement for the creation of a facility (i.e., scope of design, packaging of contracts, defining of the construction techniques preferred, etc.). It identifies the conditions and specific directions for the design, construct, and operate aspects of a facility and the methods for how each aspect is to be implemented. The information elements addressed in defining the work scope are: function, form, economy, and time. In addition, risk assessment is made based on: project complexity, site factors, financing, delivery time, functions, uses, and obstacles expected on a project.

Determine Internal Capabilities/ Operations (M1.1): Assesses in-house capabilities to provide a facility. This function assesses, steers and evaluates the roles and responsibilities of the initial facility team.
Develop Facility Management Plan (M3.2): Serves to guide execution and coordinate efforts of all phases of the facility management life cycle. This includes developing solutions, studying contract pricing alternatives, controlling documents, evaluating problems and making changes/decisions/schedules etc., to ensure successful project completion.

Develop Preliminary Facility Management Work Scope (M1.2): This involves assembling the necessary criteria to develop a problem statement defining the need for a facility.

Develop Strategy for Resource and Service Acquisition (M2.3): This function serves to coordinate and steer all the variables involved with resource and service acquisition. The scope and need requirements, internal capabilities/resources, and resource availability are accounted for. Then a direction/strategy is developed for the quantity and method of procurement for resources and services needed to provide a facility.

Develop Work Scope and Needs (M2): This involves defining the proposed work as completely as possible. The scope of work defines what is required of all parties in the project, the services that each will provide, and the type of support each can expect from the owner. In addition, the owner’s needs are defined and classified based on their priority. Once there is a clear description of the work and people involved in providing the facility, a policy/strategy is developed for resource and service acquisition.

Distribute/Store Resources and Manage Inventory (M5.6): This function serves to distribute all acquired resources to the respective players needing the purchased/provided/financed resources at the appropriate point in time. It serves as the central clearing house for all resources obtained; handling both inventory, storage and distribution. Resources here are meant to include funds, materials, equipment, manufacturing plant, or site(s).

Documents and Contracts: All information generated in the form of documents and contracts, that is used for guiding and governing delivery of a facility. This also includes records that are kept after completion of a facility (i.e. correspondence files, specifications, drawings, data sheets, as-built drawings, weld records, and a completion manual, etc.).

Economy: The current condition of the construction and financial markets which, in turn, determines the availability of constructors, resource suppliers, building permits, money, etc.

Establish Management Team (M1): This function serves to establish an initial project organization, which then acts as an initial steering team/committee, having a detailed work plan. This function also assesses internal capabilities and resources to be used in providing the facility. Additionally, a project brief is established so that a program for further action can be made (i.e. a determination of site ownership, boundaries, and rights of way). Essentially,
this function forms the preliminary strategy by setting the initial objectives, and surveying internal resources available for providing a facility.

**Execute Contracts and Agreements (M4.5):** Developing and providing the design and contract documents necessary to provide a facility (i.e., special and general conditions, addenda, etc.) as well as awarding the contract(s).

**Execution Plan:** The selected execution plan which explains the approach and manner in which management of the facility will be performed. This plan includes field verifications, schedules, expediting, and procedure review/approval of various construction aspects.

**External Constraints:** Parameters and variables in the environment that will hinder, limit or impact on providing a facility and are beyond the control of all project participants. This includes weather, codes, economy, technology, resources, politics, etc.

**Facility Champion:** The individual who initiates the idea, commits and mobilizes the funds and resources required to get the facility developed, and leads in establishing a project team.

**Facility Idea:** Data defining the scope of the facility at the highest level of abstraction (e.g. a 500 bed hospital).

**Facility Management Knowledge:** The information and know-how gained from managing the facility and the knowledge that can be applied to future facilities to be built (i.e. a database of cost information, procedures, and resource needs).

**Facility Management Plan:** The resource acquisition, execution, monitoring, and contract plans used as controlling plans in the governing of the overall project. Another element of the plan are all changes and directives made to the facility management plan (i.e. contracts and documents).

**Facility Management Work Scope:** This serves to function as the initial information elements and parameters that define the facility, as well as the participants (owner's organization) needed to provide the facility.

**Facility Planning Information:** Information acquired through the work scope information and contract negotiation processes used in the establishment of the type and scope of the work to be performed. Elements of facility planning information contain contract needs, resource needs, procurement strategy, etc. (i.e. design information, specifications, and resource/service information requirements).

**Facility Team:** Assignment of project members to the plan/design/construct/operate subactivities in order to provide a facility. For the facility management process this includes a management and procurement team.
**Identify Resource Needs (M5.1):** This function assimilates a detailed listing of all resources required to furnish a facility. The information is gathered based on the work scope for providing a facility, the owner's purchasing policy, as well as the external constraints which may affect resource acquisition.

**Identify Services Needed (M4.1):** This function identifies the primary functions necessary to provide a facility. These functions include the plan, design, construct, and operate subprocesses as well as other special services.

**Identify Sources of Resources (M5.2):** This includes searching for all possible entities which may be capable of delivering the required resources needed to provide a facility (i.e. banks, suppliers, vendors, etc.).

**Identify Sources of Services (M4.2):** This includes determining the qualified parties who are capable of performing a service for a particular work item needed in providing a facility (i.e. potential agents/contractors). The particular service requirements necessary for providing a facility and the work scope parameters (i.e. work packaging by outside firms, availability of services/resources, etc.) control this function.

**Implement And Supervise Work-Contracts (M3.4):** This involves implementing management decisions, monitoring field performance and taking action based on field contract administration responsibilities (i.e. backcharges, cost collection, progress billings and payments, contract interpretations, claims, contract closeout, facility start-up, mobilization, etc.). Quality assurance criteria and acceptance requirements are also developed. This function mainly serves to inspect the work as it is developed (and when completed), and it either accepts or rejects the results.

**Inspection Plan:** The selected inspection plan for required quality assessment/control by the project field inspectors.

**Internal Capabilities/Resources:** Internal resources provided by the owner to the facility team. This may include engineering office space, employee services, supplies, utilities, computer software/hardware, machinery, transportation, manufacturing, equipment, etc.

**Inventory Information:** Data concerning the quantity and or location of stored resources at a particular time.

**Management Proposed Changes:** Modifications to the scope of work, cost or time allowed to perform work due to ambiguities, restrictions, codes, revisions, changes, or unforeseen problems, etc.

**Management Team:** Company personnel, consultants, contractors, and other people who are identified as being capable of performing a portion of the work required to take the project from its inception to its completion. Essentially this team involves all parties who will participate in the management of a facility.
Monitor Facility and Progress (M3.5): This function, first and foremost, is performed to ensure that the owner is getting what is wanted. This function involves walking the job and holding meetings, etc., to collect and release data specified in the plans, to control costs and cost records, and to control pricing and payment. It may also involve checking whether a contractor has insurance coverage or whether changes in the work are being priced correctly and paid for expeditiously. Some other functions include: monitoring the progress schedule, approving/denying payment requests, controlling procedures for use/possession of facilities prior to completion, and also monitoring/assessing liquidated damages.

Monitoring Plan: Performance criteria plan for controlling and troubleshooting areas to be monitored for compliance by the facility participants. This includes both monetary and technical compliance.

Needs: All requirements assessed to be pertinent in the make-up of a facility.

Optimization Information: The information used to integrate expertise of participants in providing the facility. This includes designability, constructibility, operability, and maintainability information.

Owner's Needs: The main elements (in terms of function, form, economy, and time of facility) desired by the owner which will suit his/her needs for a facility.

Owner's Purchasing Policy: This includes the owner's managerial decisions relating to the governing strategies and procedures for resource acquisition.

Owner Supplied Resources: Internal resources provided by the owner to the facility team player. This may include engineering office space, employee services, supplies, water, electricity, computer software, etc.

Performance Feedback: This involves identified problems that need to be resolved. This may include both formal and constructive changes that need to be made to the contract(s).

Performance Information: Information/feedback about the progress of activities which, when compared to the plan, is interpreted to assess the status of the project and the appropriateness of the plan (e.g. time, money, quality, and other performance factors). It includes information for the delivery of the facility (i.e. cost, financing, value engineering, contract work scope, contract packaging and scheduling, changes, claims, backcharges, inventory, resource acquisition information, resource distribution information, etc.). This information includes methods of performance.

Performance Reports: Organized and communicated data describing the performance of the work which will be analyzed to determine if the work is progressing according to plan or if replanning is necessary.
Performance Requirements: All criteria, predicated by the work scope information, found to be of critical relevance in the execution of providing a facility. These may be milestones, witness and hold points, budgetary conformance, aesthetic qualities, etc. Essentially, this involves information on all necessary and essential achievements that need to be made throughout execution of the facility life cycle.

Plan/ Control Facility (M3): The planning process includes: developing plans for resource acquisition; plan execution; controlling of the facility; and setting the methods, sequences, schedules, budgets, and quality of output from each of the technical phases. The control function continually monitors the actual performance, compares it to the planned performance, and plans and implements any changes found necessary.

Potential Agents/ Contractors: All screened individuals, be they agents or contractors, who are deemed capable of providing a particular service required for obtaining a facility.

Potential Vendors: Vendors identified by the management team as being capable of performing a portion of the work.

Potential Contractors: Contractors identified by the management team as being capable of performing a portion of the work.

Prepare Invitation to Bid and Submit Proposal (M4.3): This includes preparation of bid packages, instructions to bidders, development of contract proposal formats, and management of the bid cycle.

Prepare Purchase Requisitions and Submit Proposals (M5.3): This function includes preparation of requisitions and bid packages, instructions to bidders, development of a proposal format, and management of the bid cycle.

Process Information: Information defining characteristics of the work in progress (e.g. material flows, crew sizes, methods, sequences, etc.).

Program: A detailed description of owner/ user's requirements comprising spatial, operational/ functional aspects. The program as a document is used to define the proposed facility to the design and management teams.

Project Execution Plan (PEP): Owner's plan for procuring all resources and services that are required to provide and manage the facility (i.e. master/ payment schedule, etc.). A PEP includes schedules, contracting strategy, milestones, budgets, value engineering cost incentives, review/ approval points, authorities and responsibilities delegated, allocation of resources, inspection and notification requirements, specifications, drawings, instructions, and limitations.
Proposals: All offers, propositions, requests or advances received by a project participant. The proposals are in the form of documents usually containing a bid price, scope of work, and definition of capabilities, prepared by qualified parties.

Purchase Orders: Written documents that define and prescribe all the agreements, promises, and provisions relating to procurement of resources (i.e. time of delivery, insurance, shipping, packaging, taxes, payment terms, etc.)

Quality Standards: Criteria defining desired properties of project resources.

Receive and Inspect Resources (M5.5): The process of certifying the resources received against what was ordered (i.e. quality, required specifications, delivery condition, quantity, etc.).

Requests For Bid Information: All data requiring further work scope definition.

Requests For Clarification: All data (i.e. instructions to bidders, the bid proposal form, etc.) requiring refinement or interpretation.

Requisitions: Formal requests or orders made for required resources.

Resources Accepted: Acquired resources which have passed inspection to ensure they have met the specified quantity and quality requirements.

Resource Acquisition Information: Feedback information relating to inventory, acquisition, inspection, distribution and availability of resources.

Resource Acquisition Plan: The selected resource acquisition plan which explains the approach, time and manner in which resources will be acquired. This plan includes the policies (i.e. budget and quality) and strategies/sequence for which all resources are acquired (i.e. wholesale, purchases of bulk quantities, rental fee limits, long lead items, etc.) and the effective scheduling of those resources.

Resource Availability: The quality, quantity, and accessibility of resources to support the functions within the facility.

Resource Requirements: This information defines all resources that are deemed by the management team to be necessary for completing portions of the work needed to provide a facility.

Resources: Includes all resources used to provide the facility by all participants (materials, people, time and man-hours, energy, space, software/hardware, funding, furnishings, supplies, utilities, etc.).
Review Proposals and Select Agent/Contractor (M4.4): Includes prequalifying selected agents/contractors, for services to be rendered, based upon qualification data and from reviewing and analyzing bid proposals. After a thorough screening of the qualified parties, individual agents/contractors are selected.

Review Proposals, Select Vendor and Execute Purchase Order (M5.4): Includes prequalifying selected contractors/vendors/agents, for resources to be acquired/provided, based upon qualification criteria and also from reviewing and analyzing bid proposals. Once this review is performed, contractors/vendors/agents are selected. In most cases, resources are acquired/provided through purchase orders, which serve as the mechanism for resource acquisition.

Scope and Need Requirements: Establishes a complete breakdown of all work requirements encompassed for providing a facility. This includes the financial, personnel, material and equipment factors necessary for obtaining a completed facility.

Selected Contractor/Vendor/Agent (C/V/A): The contractor/vendor/agent chosen from the qualified parties with whom an agreement will be made to perform the defined scope of a particular portion of the work.

Service Requirements: All services provided by project personnel, determined to be necessary in providing a facility. The period for which the services are required covers the time from a project's inception all the way to its operation stage.

Structure and Staff the Management Team (M1.3): This function develops strategies for organizing and staffing the project (i.e. consultants, QA/QC staff, etc.) based on the given work scope. This also involves acquiring the services of the selected participants needed to provide a facility.

Submittal Approval: Acceptance of materials selections, equipment selections, design details, etc. (i.e. catalog cuts and shop drawing approvals) proposed by the contractor.

Understand Owner Needs (M2.1): This function involves understanding all the programming needs/aspects (i.e. goals, facts, concepts, and needs-money, space quality, etc.) required to build a facility.

Understand Work Scope and Performance Criteria (M3.1): Involves comprehending extent of work and standards set for the work. This allows scope inconsistencies among the prepared contract(s) to be raised and corrected. This function also involves evaluation of the time and money needed to deliver a facility (identification of parameters in which the work is to be performed).
Working Plans: Establishment of initial work plan methods/techniques/objectives/policies of the owner's organization — that guide the execution of project administration (i.e. description of approval process, accounting of bills, communication and reporting, procurement factors, financial factors, ground rules for changes, etc.). In other words this serves to function as procedural control plans and work coordination.

Work Scope Information: The subdivision of work into contract/subcontract packages and the sequencing of their information. This defines the scope, the complete design information, and the due consideration for project schedule purposes.
Appendix C

QUESTIONNAIRE

The questions below were used in the interviews for the case studies that are discussed in Chapter 5 and which are revealed in Appendix D. The questions were structured based on a set format that was used to correlate the arrows and functions of node M. By following this format, the interviews were focused and information was obtained readily.

ESTABLISH MANAGEMENT TEAM -- NODE M1

FACILITY IDEA

How do you know when you need to build a facility?
How do you determine what the purpose of a facility is?

RESOURCES

What resources do you use for establishing a project team, and when do you acquire them?
What resources does your company have in providing the management team?
How do you obtain the resources that you have or that you will need to establish a management team?

EXTERNAL CONSTRAINTS - RESOURCE AVAILABILITY

What are the external constraints that affect you in establishing a management team?
What are the impacts of the external constraints, and how will they impact on providing a management team?
What measures do you take to minimize the external constraints?

INTERNAL CAPABILITIES/ RESOURCES

What capabilities/ resources do you provide for building a facility?
How do you provide the capabilities/ resources?
When do you provide the capabilities/ resources?

Where do you provide the capabilities/ resources?

Are there advantages/ disadvantages in the way you provide these capabilities/ resources?

WORKING PLANS

What are the procedural guidelines that you use for executing control plans and work coordination?

What format do you use to represent the working plans?

How are your working plans implemented?

FACILITY TEAM

What project personnel make-up your facility team?

When is this facility team established?

What do the team members do as far as responsibilities are concerned?

FACILITY CHAMPION

Who gets all these activities, that we have talked about, started?

Do you have a job title for him/ her?

DEVELOP WORK SCOPE AND NEEDS -- NODE M2

NEEDS

How do you identify the physical/ performance/ legal/ financial requirements of your clients?

How do you rank the work scope needs of your clients?

RESOURCES

What resources do you use to determine facility work scope requirements, or the needs of your clients?
WORKING PLANS

How do you ensure that your methods/ objectives/ or policies are followed in developing facility work scope requirements?

EXTERNAL CONSTRAINTS - CODES & ECONOMY

What possible constraints could keep you from following through with your initial facility work scope requirements?

PERFORMANCE INFORMATION - PROJECT EXECUTION PLAN AND PROGRAM (P.E.P.)

What information is provided to you, by other parties, for execution of your work? (who are those parties?)

In what format is this information presented?

How is this information provided to you and when do you normally receive it?

FACILITY PLANNING INFORMATION

What type of information do you generate for further execution of your work, once you have defined the scope of your work?

What do you call those pieces of information?

In what way, or how do you deliver or process this information?

MECHANISM

Who identifies all the work scope requirements and needs of the client? (Job Title)

PLAN/ CONTROL FACILITY – NODE M3

RESOURCE

What resources do you use to evaluate how you are going to plan and control a facility?

FACILITY PLANNING INFORMATION

What type of data do you use for monitoring and evaluating your work?
EXTERNAL CONSTRAINT - RESOURCE AVAILABILITY

What resources do you wish were available for your use in planning and controlling the work that you do?

What impact will those resources not being available, have on your ability to plan and control the facility?

PERFORMANCE INFORMATION

What kind of information is generated by you, about the progress of your management activities?

Do you have any kind of feedback information relating to planning and controlling the work?

What is the degree of detail of the feedback information that you obtain?

How do you obtain, and in what form do you obtain this feedback information?

What is the frequency of obtaining this performance feedback information?

OPTIMIZATION INFORMATION

What information is passed on to integrate and increase the expertise of the facility participants, once a job is completed?

How and in what form is the knowledge information that you gain from a project that you have completed, passed on and used for the next project you work on?

How frequently is this optimization information being used?

FACILITY MANAGEMENT KNOWLEDGE

What information is captured and carried forward for use on future projects?

What form/ format is used for this information?

FACILITY MANAGEMENT PLAN

What plan do you use to guide the decisions that you make?

What methods and means are used for executing services and resources to be rendered by your company?

What level of detail does you plan of action, for directing the work that you do, contain?

How frequently is this planning information given?
MECHANISM

Who is the key person that identifies all the work that needs to be planned and controlled for a particular job?  (Job Title)

ACQUIRE SERVICES TO PROVIDE FACILITY -- NODE M4

RESOURCES

What people resources do you use or acquire for providing a facility to a client?
When do you normally acquire these services?

FACILITY MANAGEMENT PLAN - CONTRACT PLAN/ CHANGES

What type of contracts/ changes are usually made and with whom do you normally make these contracts and changes?

What type of information and what level of detail is given in the changes that are made?

What impact, normally, will the contract plan/ changes have on your service acquisition for a job?

FACILITY PLANNING INFORMATION

What piece of information do you use to determine what services you need to acquire, in order to provide a facility?

What form does this service requirement information come in?

When do you normally acquire the services that you need for which you company does not have the capability for?

EXTERNAL CONSTRAINT - RESOURCE AVAILABILITY

What key factors keep you from acquiring certain services?
(What are those services?)

DOCUMENTS AND CONTRACTS

What types of contracts are made with the services you acquire?

Which services do you normally make contracts and agreements with?

What do the various contracts constitute?  (Is there a set form?)
CONTRACT INFORMATION
What information related to contracts/changes is generated?

FACILITY TEAM
What services do you hire to help you in providing a facility?
When is this facility team established?
What do the team members do as far as responsibilities are concerned?

MECHANISM
Who obtains all the service requirements that are needed for providing a facility?
(Job Title)

ACQUIRE PROVIDE RESOURCES – NODE M.5

RESOURCES
How do you determine what resources you need to provide a facility (this includes financing, material, equipment, space, etc.)?
Where do you acquire your resources from?
What form of financing, if any, do you obtain?
How do you make material and equipment purchases or rentals?

RESOURCE ACQUISITION PLAN
What constitutes your plan for acquiring resources?
What form and medium is used for presenting this resource acquisition plan?

FACILITY PLANNING INFORMATION
What information do you use for controlling what resources you need to acquire?
(What do you call that piece of information?)
How do you process this information so that you get the resources you need?
RESOURCE AVAILABILITY

What factors keep you from following through on various resource acquisitions (i.e. financing, materials, equipment, etc.)?

Do you assess any trade-offs in obtaining alternative resources for providing a facility?

CONTRACT

What contracts are made for acquiring/providing resources?

RESOURCE ACQUISITION INFORMATION

What information is generated from the resources obtained?

How is the information collected, and in what form is it passed on?

What do you do with all the information that you gather for this function?

AVAILABLE RESOURCES

What available resources are furnished for the facility?

Who are the available resources distributed to?

How are the available resources distributed?

How are funds allocated to the respective parties?

What is the mode of transaction for the funds?

Are there time elements related to fund distribution, and if so, what are they?

MECHANISM

Who is the key person that identifies all the resources that need to be acquired for a particular job? (Job Title)
Appendix D

CASE STUDY DATA

Case Study "M" - Metal Building Contractor

Subject: Interview with Mr. Ray Tucker, President
Company: Steel-Bilt Construction
Date: December 2, 1988
Location: 10 Carol Avenue
          P. O. Box 397
          Bridgeville, PA, 15017

M1 Establish Management Team

This function serves to establish an initial project organization, which then acts as an initial steering team/committee, having a detailed work plan. This function also assesses internal capabilities and resources to be used in providing the facility. Additionally, a project brief is established so that a program for further action can be made (i.e. a determination of site ownership, boundaries, and rights of way). Essentially, this function forms the preliminary strategy by setting the initial objectives, and surveying internal resources available for providing a facility.

Input: Facility Idea

Steel-Bilt recognizes the need for a facility through phone calls they receive from owners. In most cases the owners already have a clear concept of what they want in terms of a pre-engineered metal building, and when this is the case Steel-Bilt is capable of giving the owners an initial quote on cost (usually dollars per square foot). This initial contact is then followed by an initial preconference meeting to clearly define the purpose of the facility.
Input: Resources

Steel-Bilt's main resources are its people. They are a small organization, and this allows every team member to be fully familiar with the other team member's work responsibilities and functions. However, for every job there is only one person that is held accountable for its planning and control.

Control: External Constraints - Resource Availability

There are no major constraints which affect Steel-Bilt in establishing a management team.

Output: Internal Capabilities/ Resources

In some cases Steel-Bilt is confronted with situations whereby owners request that they use their own subcontractors to perform parts of the work (in most cases this is due to a relative or friend of the family who requests to have part of the work).

Output: Facility Management Team

The management team is composed of four main categories of personnel. Steel-Bilt retains an estimator, a construction supervisor, a structural engineer, and a salesman.

Mechanism: Facility Champion

Mr. Ray Tucker was identified as being the facilitator that brings about solutions from people (both external and internal to the company). The key facility champion is the owner of the facility, he/she holds the ultimate responsibility for following the facility to its completion.
M2  Develop Work Scope and Needs

This involves defining the proposed work as completely as possible. The scope of work defines what is required of all parties in the project, the services that each will provide, and the type of support each can expect from the owner. In addition, the owner's needs are defined and classified based on their priority. Once there is a clear description of the work and people involved in providing the facility, a policy/strategy is developed for resource and service acquisition.

Input: Needs

The needs of owners are developed through the use of a standard planning guide created by Armco Building Systems. The main advantage the guide serves the owner is that it makes the process a little easier, and it also serves to get questions answered ahead of time (this always relates to the physical requirements of a facility as well as the site surroundings). Once the work scope of a facility is defined, the performance requirements of the owner are passed on to the subcontractors performing the work.

Input: Resources

As far as financial requirements are concerned, Steel-Bilt usually obtains a letter from the owner's bank stating that there is sufficient money available for building a project; for big companies this requirement is waived due to their financial stability. Steel-Bilt expends man-hours in their efforts to collect the information relating to the work scope of a facility, in addition to the process of developing a strategy for resource and service acquisition.

Control: Working Plans

Steel-Bilt does not have any set of written guidelines to follow. Mr Tucker was quoted as saying: "Everyone says we should [have working plans] but we have never done it, we are just too small. If you put it [guidelines for executing control plans and work coordination] down on paper and try to follow it, it will never work out."
Control: External Constraints - Codes and Economy

Codes and insurance were cited to be the two main constraints which kept the firm from following through with the initial facility work scope requirements. For special buildings with high insurance requirements (i.e. an airplane hangar where the value of the plane is greater than the value of the hangar) a check is performed to ensure that no items are left out which the owner's insurance carrier may want. For codes, all drawings have to be submitted to the Department of Labor and Industry in Harrisburg for approval. The firm does not do local building permits, they prefer that the owner handle them due to the large number of communities and the many different requirements each imposes.

Control: Performance Information - Project Execution Plan and Program

In the case where the job is small, Steel-Bilt performs their own in-house design (they do everything except for plumbing, heating and electrical), but in the case of large complex jobs an architect is hired. The architect's responsibility is to provide working specifications and working drawings. For jobs where an owner has concept drawings in hand, the drawings are given to local architects who then redesign the concept of a particular facility to meet the local codes (i.e. the proper traffic flow, proper parking, proper sprinklers, etc.). Once Steel-Bilt receives the working drawings and specifications they are then sent out to the subcontractors and Armco Building Systems to get firm bids. There are no set milestones that come with the execution plan and program, instead they are dependent on Building Technologies' delivery schedule (approximately six weeks). Once the building components arrive at the site a milestone schedule is made for completing the facility (i.e. dates are set for building frame erection, and the building envelope, etc.).

Output: Facility Planning Information

The main information used by Steel-Bilt for further execution of their work is the erection drawings furnished by Building Technologies (subsidiary of Armco Building Systems). The drawings show the erector the exact locations of each part number furnished by Building Technologies, as well as how each part fits
together. For bigger jobs with more complex systems, mechanical and electrical engineers are hired to furnish the respective drawings required for building a facility. In the case of small jobs, the mechanical and electrical drawings are made by the subcontractors hired. Steel-Bilt tells the subcontractors what is needed and where everything should go (i.e. a duplex outlet on each column) only.

Mechanism: Facility Management Team

The team members hold no titles, they all work as a team for everything. Each person on the team is familiar with the other team members' duties. The firm is so small that there is an overlap of responsibilities. They employ three people to do their in-house work and two people to control the field operations.

M3 Plan/Control Facility

The planning process includes: developing plans for resource acquisition; plan execution; controlling of the facility; and setting the methods, sequences, schedules, budgets, and quality of output from each of the technical phases. The control function continually monitors the actual performance, compares it to the planned performance, and plans and implements any changes found necessary.

Input: Resources

The initial resource element used to evaluate how Steel-Bilt is going to plan and control their work is the delivery date of the metal building items, which is given to them by Building Technologies. With this date, Steel-Bilt has to have the drawings finished, the foundations and floor poured, along with site level alterations (usually it is a 6-8 week period). For large jobs a schedule is made up to coordinate all the subcontractor activities, but for small jobs no schedule is used and the subcontractors are kept abreast of development based on their own site inspections.
Control: Facility Planning Information

The type of data that Steel-Bilt uses for monitoring and evaluating their work is their "break-out sheet" which is crafted from the drawings created. This essentially is a work breakdown sheet whereby every work item is broken down by cost. The break-out sheet serves both their accounting and planning and control needs. At the job meetings the company checks on the progress of the work items - the completed items are checked off and they are in turn billed to the owner. The owner receives the bill along with the cost breakdown of the completed work items.

Control: External Constraints - Resource Availability

Mis-fabrications, unions, price adjustments (by Armco Building Systems) and weather problems were cited as being the biggest constraints affecting their ability to plan and control the work. The president said, "When you have too many factors or variables, you can never control everything or plan for anything correctly, you are dealing with constant change."

Control: Performance Information

Steel-Bilt checks the progress of their management activities by: 1) comparing budget numbers from previous jobs, 2) comparing the pricing sheet with Armco Building System's bill to see price differences - they check that their prices are at the market rate for pricing everything. The degree of detail of this feedback information is high, because every metal piece is quantified and priced individually (i.e. doors, windows, siding, roofing, columns, anchor bolts, etc.). The frequency for obtaining the performance information is related to the completion of each individual job. They take each job on its own merit - concurrent jobs are not compared. The president said," All jobs are different and they are all too special". He backed this statement up by saying that 80% of all of Building Technologies work orders for buildings are special. At the same time the president said, "You don't want to price a custom building out just by throwing a dart at the wall."
Control: Optimization Information

Optimization information is not used frequently by Steel-Bilt (metal building technology has not changed much), but there have been instances when it has occurred. As an example, they had field erection problems with a particular type of window manufactured by Building Technologies. It was a case whereby the field crew were adapting a window to fit its allocated working space, this was remedied by having a Building Technologies representative inspect the site. The representative, after inspection determined that the window was manufactured wrong and he then rectified the problem with their window supplier. In other situations, Building Technologies mails out flyers showing new products and new methods on improved construction techniques (i.e. a new clip, methods of fastening, or new bolts made from stronger materials, etc.). Generally though, the feedback is constant all the time, it's a two way street for all parties concerned in relation to the transmittal of optimization information.

Output: Facility Management Knowledge

All knowledge that the project personnel gain through job experience is captured intuitively - there is no written information that is used for accumulating a knowledge database for future jobs. The exception to this would be similar jobs with cost information in the form of a work breakdown sheet. For this situation the firm would have an evaluation tool in the sense that a complete guideline for all major and minor building component items would be provided

Output: Facility Management Plan

Steel-Bilt's plan of action for coordinating the work is very flexible and informal. Its informal in the sense that they "play everything by ear", and its flexible because they allow the subcontractors to do their work as they see fit - Steel-Bilt only gives them a start and finish date for each subcontractor activity. As far as directives or changes are concerned, they are taken care of at the weekly job site meetings. The meetings are attended by: the Steel-Bilt representative, the architect, the owner, and all the subcontractors currently working on the job. In the case of small jobs, the job site meetings are bypassed and are considered irrelevant.
Mechanism: Facility Management Team

See M2 Mechanism

M4 Acquire Services to Provide Facility

This is the process of soliciting the required services to provide the desired facility and assembling the facility team. These services include planners, designers, constructors, and facility management personnel. These services are not usually, but occasionally may be, acquired at the same time. An example of a situation where all the facility team players would be brought on board would be for turnkey/design-build projects. For the management phase, this function includes all contracts and agreements, between owner and designer, contractor, operator, etc. This does not include subcontracts between designer or contractor and subcontractors.

Input: Resources

The people resources that Steel-Bilt acquires for providing a facility to a client include any discipline or trade that the owner may want. All types of subcontractors are acquired. The services are acquired once initial drawings are completed by Steel-Bilt or by the Architect should it be a large job.

Control: Facility Management Plan - Contract Plan/Changes

The type of contract changes that are usually made on most jobs include: adding a room, dressing up a building (aesthetic features for the exterior), adding carpeting/vinyl tile, adding an extra garage door, etc. A cardinal change for a metal building would be stepping outside the set building size originally agreed upon with the owner. As an example of a change - adding a garage door addition - Steel-Bilt would have to price in a framed opening from Building Technologies, they would have to draw up the structural drawings for it, and the erector would have to give a price to install it. They would also have to get the price of a garage door from a door subcontractor. Once all the prices for the change are computed, the price is given to the owner for approval/
disapproval. If the owner agrees to a change then an addendum would be written into the proposal and the owner would sign it or he/ she would send a change order. Steel-Bilt would then contact Building Technologies to add a new door opening and the affected subcontractors would be sent a change order. Usually changes have no impact on Steel-Bilt's service acquisition efforts.

Control: Facility Planning Information

The specifications are the main information element used to determine which services are required for providing a facility.

Control: External Constraints - Resource Availability

Generally, Steel-Bilt has no problems acquiring any of the services they need. The key factors they check on prior to acquisition of a service is based on their own feelings of a particular service's past experience, as well as word of mouth on past performance of subcontractors.

Output: Documents and Contracts

Steel-Bilt only uses purchase orders as the mechanism for acquiring services. Normally, the subcontractors will send a proposal and if its lengthy then Steel-Bilt will issue a purchase order with a reference to the proposal sent, this way the scope of work is clearly defined in the purchase order.

Output: Facility Team

The type of outside services they do not wish to acquire are those involving landscape work and equipment selection. Steel-Bilt only likes to deal with definites that have known end results. In regard to equipment selection they prefer to have the owner choose the equipment he/ she desires (used mostly for cranes), this way there is no room for dispute with the owner. They prefer to have the owner make the selection he desires based on the owner's ultimate desires, and Steel-Bilt facilitates in making the contact with the particular equipment manufacturer desired. With respect to time frame and when all the
participants are brought on board it varies based on the progress of a job. But Steel-Bilt likes to send out all the purchase orders as soon as they know they have a job. This way all the parties concerned are made aware that they have been selected and the job can be discussed with greater ease should any changes develop.

Mechanism: Facility Management Team

See M2 Mechanism

M5 Acquire/ Provide Resources for Facility

This is the process of acquisition, allocation, and the distribution of resources required to provide the facility. This includes necessary information, financing, funding, time, site, material, equipment, manpower, operational support resources. This process also includes storage of the resources and management of the inventories (ensures delivery of services/ resources - expedites, tracks, pays, and examines quality of items received).

Input: Resources

The main resource acquired is funding from the owner, and in some cases a loan is obtained from the bank for purchasing/leasing of equipment.

Control: Facility Management Plan - Resource Acquisition Plan

Steel-Bilt's plan for resource acquisition takes the form of a recapitulation sheet which lists all the building requirements and elements required for ordering items. The sheet is broken down by trade and discipline as they pertain to the subcontractor affected (i.e. Heating - John Smith Heating Company).
Control: Facility Planning Information

A standard form is used to keep control of all the resources acquired. The form will take into account all categories of work and all messages sent to and from the various subcontractors involved on a particular job. Steel-Bilt also maintains a file for each job so that all the paperwork is processed efficiently.

Control: External Constraints - Resource Availability

Steel-Bilt did not have any factors that would keep them from following through on their various resource acquisitions with the exception of an omission. The main assessments they make on selectiveness of their purchases relies solely on the recommendations of the subcontractors they have hired. Steel-Bilt does not use proprietary specifications, they prefer performance evaluations of systems from subcontractors instead.

Control: Documents and Contracts - Contract

In Steel-Bilt's case all agreements made involve purchase orders. For resources this involves the transmittal of catalog cuts between and among: subcontractors, Steel-Bilt, and the owner. Once the decision by the owner is made as to the resources desired a purchase order is made out to the affected party.

Output: Resource Acquisition Information

In relation to information on inventory, it is usually outdated. Steel-Bilt does not list resources that are left over from jobs. They only make a once in a year check on all items they have stored in their bins (open bins filled with Building Technologies standard parts that are stored in their warehouse) and this check is only conducted for insurance purposes.
Output: Available Resources

Material resources are distributed to subcontractors on an as needed basis for items that would pertain to warranties - this is done because Armco Building Systems backs up their products for leaks, rust, etc. These material resources include: flashing, curbs, stainless steel screws, caulking, etc. As far as funds are concerned, subcontractors are paid monthly based on progress and the owner is billed once a month for completed work.

Mechanism: Facility Management Team

See M2 Mechanism
Appendix E

CASE STUDY DATA

Case Study "V" - Joint Venture Developer

Subject: Interview with Mr. J. T. Thomas, Jr., Partner
Company: Turner Harwood Ventures
Date: December 7, 1988
Location: 10306 Eaton Place
         Suite 200
         Fairfax, VA, 22030

M1 Establish Management Team

This function serves to establish an initial project organization, which then acts as an initial steering team/committee, having a detailed work plan. This function also assesses internal capabilities and resources to be used in providing the facility. Additionally, a project brief is established so that a program for further action can be made (i.e. a determination of site ownership, boundaries, and rights of way). Essentially, this function forms the preliminary strategy by setting the initial objectives, and surveying internal resources available for providing a facility.

Input: Facility Idea

The facility idea is usually market driven and is seen as an opportunity to make a profit by the developer. The idea can also be generated by "built to suit" tenants/users of a facility. Other factors that involve potential for a facility idea involve the factors that will profit a development (i.e. location, need in marketplace, ability to be competitive for a particular area - market appeal to a wide range of tenants)
Input: Resources

The main resources for providing a management team are financial in nature. The team is normally assembled based on past experiences and through various contacts in the industry (i.e. a construction lender).

Control: External Constraints - Resource Availability

In general, the main constraint is lack of available services in a particular area considered for development. Developers will not enter into a marketplace unless the needed services (services required by a developer, i.e. a geotechnical consultant) are available. Other constraints are the risks involved with acquiring property (cost of land). Normally, the developer sets the price before the borings are performed - this is done to minimize the risk of the property purchase (i.e. buying the land from the owner of a property subject to rezoning by the zoning board).

Output: Internal Capabilities/ Resources

Turner - Harwood provides their own monitoring services for construction, they also cooperate with brokerage houses for arranging financing and leasing deals. In addition, the company does their own marketing and tenant work. In most cases Turner - Harwood provides the majority of the funding for a project from their own internal resources.

Output: Facility Management Team

The management team is composed of marketing, accounting, financing, construction supervision, and Mr J. T. Harwood who acts as the coordinator of all parties. In addition, outside parties are hired to perform any services deemed essential. Such outside parties may consist of architects, appraisers, geotechnical experts, etc.
Mechanism: Facility Champion

Mr. D. Harwood was identified as being the facilitator/champion, who acts in the capacity of an executive/entrepreneur that promotes and coordinates all the parties to satisfy all their obstacles to performance of a facility.

M2 Develop Work Scope and Needs

This involves defining the proposed work as completely as possible. The scope of work defines what is required of all parties in the project, the services that each will provide, and the type of support each can expect from the owner. In addition, the owner’s needs are defined and classified based on their priority. Once there is a clear description of the work and people involved in providing the facility, a policy/strategy is developed for resource and service acquisition.

Input: Needs

The developer’s needs consist mainly of being able to lease a proposed facility. There has to be an existing tenant base to draw from in order to economically develop a facility. The work scope needs of a developer are driven primarily by the rental rates offered by other development projects. The developer has to assess the classes of facilities and also the types of people that will occupy a facility in a specific geographic area that is under consideration for development. An assessment of how other buildings, in the same geographic area, are achieving as far as tenant size, and types of tenants is also made to determine the feasibility of going through with a proposed facility. In addition, other key influencing elements of a marketplace are also studied to better determine the needs of a targeted potential tenant (i.e., if lawyer tenants are targeted then the structure of a facility must be capable of supporting a law library).
Input: Resources

The main resource Turner - Harwood uses to determine the work scope of a facility is their project manager. They rely on the project manager's experiential knowledge of technical aspects relating to a building type and location (i.e. sound proof design applications for buildings situated near airports).

Control: Working Plans

Turner - Harwood does not have any formal set of working plans. They mainly use checklists that have an accounting element tied to them. In essence, all checklists are a function of the purchases they make and these accounting requirements are used to formulate 5-10 year plans.

Control: External Constraints - Codes and Economy

The price of money was the main constraint cited that kept the firm from following through with the initial facility work scope requirements. Other constraints were: financing, rezoning of property, technical performance setbacks (i.e. construction methods/systems which can not be performed - i.e. an inconsistent foundation system, lack of laydown space, etc.), municipal setbacks (i.e. having an adjoining community set their development limitations), and geological setbacks which hinder development of a site.

Control: Performance Information - Project Execution Plan and Program

Turner - Harwood only uses standard contract formats (i.e. forms of the American Institute of Architects), requisitions and subcontracts - the reason for this is that they prefer their team to be familiar with the forms they are used to using and it makes the whole process easier for everybody concerned (including external parties). Each discipline hired by the firm would provide information pertaining to their service. This information would then serve as the plan or program for execution of a particular piece of work required for providing a facility. In the case of a construction lender all financial documents would be provided. For a geotechnical survey all the boring logs and evaluation results
would be given in the form of a report. Turner - Harwood also obtains counsel to verify that everything they do is legal.

Output: Facility Planning Information

The information element used exclusively for execution of a development relies solely on the pro-forma developed. The pro-forma serves as the guide for measuring progress and accounting for financial considerations. Once the pro-forma is defined clearly, it is adhered to strictly. The pro-forma is processed by cost and income initially; the form encompasses the life cycle of a facility as it applies to a monthly cost projection and an income projection of tenants as they start to come in. Each individual line item on the pro-forma is expanded as the facility is developed (i.e. property management is expanded to operating expenses).
Mechanism: Facility Management Team

The work scope needs are developed by the individual parties hired by Turner - Harwood. The management team essentially serves the purpose of coordinating all the information and parties that are required to get a project executed. The main players in this phase are the architect and Mr. J. T. Harwood who both oversee all aspects of the work scope. See also M1 Output.

M3 Plan/ Control Facility

The planning process includes: developing plans for resource acquisition; plan execution; controlling of the facility; and setting the methods, sequences, schedules, budgets, and quality of output from each of the technical phases. The control function continually monitors the actual performance, compares it to the planned performance, and plans and implements any changes found necessary.
Input: Resources

The resource element used to evaluate how Turner - Harwood is going to plan and control their work is the single line item bar chart schedule that is put together based on the pro-forma financial guideline. The schedule includes all the activities that the firm needs to perform (i.e. traffic studies, site plan, etc.).

Control: Facility Planning Information

The development process is monitored and evaluated on a constant basis based on the data generated from various paperwork. Examples of the paperwork are: site plans, change orders, line items in the pro-forma, etc. In some cases feedback from the various players involved (in the development process) is used as a benchmark for further analysis.

Control: External Constraints - Resource Availability

A major constraint cited to be in big need is that of computer software tools. Developers want computer programmers who have an understanding of their industry such that they will be able to introduce more in depth applications. Currently the available software is too general and only deals with property management programs that deal only with apartment buildings. The impact that these potential programs could have on developers is that of an increased work volume, as well as an increase in more creditors' equity participation in developments. Another possible outcome could be more tenant owners of facilities, since they would be provided with a tool for management of a facility - be it operations and maintenance, tenant management, financing considerations, etc.

Control: Performance Information

Turner - Harwood assesses their progress by their ability to maintain pro-forma costs. At the same time, there is a continual assessment of the availability of tenants; this is done to compare the market element to the time element of how progress is coming along on a facility. In relation to construction feedback information, they do not plan or control the work directly. Instead they act in the
capacity of being a filter for any information elements that need to be examined by various parties in the course of construction development. Turner - Harwood filters the information by channelling it to the appropriate discipline affected by the problem. In most cases the information is obtained by telephone, and the problems relate to managing people and entities. Performance information is also obtained from the regular site observations/meetings that the company conducts.

Control: Optimization Information

Optimization information of a facility is rarely used by Turner - Harwood. In fact the only information that is passed on to integrate and increase the expertise of the facility participants is the physical passing on of information by tenants (function of sale - leases, on going service, etc.). The knowledge information gained by Turner - Harwood is tied directly to market data on facilities and it is either passed on or used on their next development project based on their feedback/relationship with tenants (repeat customers in the case of good relationships with particular tenants). The frequency of this optimization information being used is usually once in every project and it usually relates to an appraisal evaluation being conducted on a facility for tax or selling purposes. In the case of a project where there are mirror imaged buildings, modifications to buildings are made based on the perceived functional performance of the early constructed facilities (i.e. a change in the layout of a basement plan based on unfavorable functional characteristics that are noticed in the first building to be built - in the case where different buildings are built in different time frames). These modifications are usually brought out by Mr. J. T. Harwood who is responsible for the final form and function of all projects built.

Output: Facility Management Knowledge

There is no database of information generated by Turner - Harwood in the strict sense of it being pertinent to a future job. However, the pro-forma in a sense serves as a springboard for managers in that they are able to recall what worked well and what didn't for a completed project - based on the line items for equipment and materials used. The only other knowledge used is that of experiential knowledge gained by the management team.
Output: Facility Management Plan

Turner-Harwood does not have any definitive or structured methods or means for executing services and resources that are to be rendered for them. They merely rely on the unique management abilities of the various employees. The plan of action that their people use for directing the work that they do is shown on a schedule based on the project pro-forma.

Mechanism: Facility Management Team

The project manager on the development team is the key person that identifies all the work that needs to be planned and controlled for a particular job. The management team mainly consists of an accountant, a field representative, and the project manager. The overall responsibility for planning and controlling the work relies with Mr. J. T. Harwood.

M4 Acquire Services to Provide Facility

This is the process of soliciting the required services to provide the desired facility and assembling the facility team. These services include planners, designers, constructors, and facility management personnel. These services are not usually, but occasionally may be, acquired at the same time. An example of a situation where all the facility team players would be brought on board would be for turnkey/design-build projects. For the management phase, this function includes all contracts and agreements, between owner and designer, contractor, operator, etc. This does not include subcontracts between designer or contractor and subcontractors.

Input: Resources

Turner-Harwood acquires their people resources (for providing a facility) through word of mouth. They also receive solicitations from outside parties who try to promote a service or property (i.e. brokerage community promoting land sales/exclusive brokerage, and consultants claiming a specialty). In general, outside services are acquired once there is an initial commitment to go through
with a project. These services may range from hiring an elevator supplier to that of hiring a landscape firm; all types of disciplines are covered. The funding resources, that are used for acquiring services to provide a facility, are obtained at the M5 level. The funds that are acquired at this stage are then dispersed through the "Available Resources" arrow. See node M diagram for clarification.

Control: Facility Management Plan - Contract Plan/ Changes

Almost all changes made to contracts are a result of tenants brought on board early in the construction process. Turner - Harwood normally hires a brokerage firm under the condition that a finders fee/ fee commission is used as the standard agreement for getting tenants early. Once tenants are brought in, parameters are set up to give the new tenants exactly what they want, and accordingly the contract plan/ changes are made. The changes that are made by tenants involve finish requirements which are usually made at the end of the construction process. Other changes which take place are building changes which may modify a facility so that there will be features that will attract new tenants. These changes are performed in conjunction with contractors and the changes are processed through change orders.

Control: Facility Planning Information

Normally the information element used to determine the various services needed for providing a facility is the pro-forma. It encompasses everything that is financially acquired as well as contingencies for unexpected services/ material/ equipment that may be required. Another information element used to acquire services is the listing agreement made with a realty firm. The listing agreement is usually a standard form and it serves to list the facility to prospective tenants. Turner - Harwood normally acquires the services that they need prior to actual implementation of the specific service needed (i.e. a leasing broker, or a property manager).
Control: External Constraints - Resource Availability

Turner - Harwood has no problems acquiring any of the services they need. Their in-house service capability accounts for 25% of the work and the other 75% is contracted out. The only constraint the firm has had with acquiring a particular service is almost always a result of an oversight.

Output: Documents and Contracts

Contracts are made with a wide array of players, among them are; construction contractors, elevator suppliers, brokers, consultants, lawyers, architects, creditors, etc. The contract document types are usually standard industry practice (i.e. AIA forms 201 & B801, AGC document no. 8 and 5, etc.) and do not involve too much work effort.

Output: Facility Team

The personnel requirements needed to staff the management/plan/design/construct/ and operate subactivities include the following: a project manager, an architectural team, a geotechnical consultant, an attorney, an appraiser, property managers, and any other external specialty consultants (i.e. HVAC, elevator, structural, mechanical, electrical, or financial consultants for help in obtaining construction loans). The responsibilities of each of the above players is pretty self-evident. But in the case of the architectural team the main goals are to get municipal approvals for site and master plans. One aspect of getting the approvals involves making proffers to local municipalities - this process usually involves citizen associations who state what they want the developer to do in order to appease them in the interest of the developer. The time frame for when the facility team is established is tied directly to the function of the contract with the construction contractor.

Mechanism: Facility Management Team

See M3 Mechanism. The project manager oversees this function and his main duties pertain to marketing activities required for obtaining construction contractors.
M5 Acquire/Provide Resources for Facility

This is the process of acquisition, allocation, and the distribution of resources required to provide the facility. This includes necessary information, financing, funding, time, site, material, equipment, manpower, operational support resources. This process also includes storage of the resources and management of the inventories (ensures delivery of services/resources - expedites, tracks, pays, and examines quality of items received).

Input: Resources

The main form of financing obtained by Turner-Harwood is that of permanent and construction loans from commercial banks. In all of Turner-Harwood’s dealings the construction lender is required to sign off on all the leases for fee simple titles. The firm makes their acquisitions of materials and equipment through the use of proposals, purchase orders and subcontracts/contracts.

Control: Facility Management Plan - Resource Acquisition Plan

Turner-Harwood’s plan for acquiring resources is finite for most projects, this is due to the fact that the general contractor performs the bulk of the resource acquisitions that go into a facility. Turner-Harwood mainly acquires long lead items such as elevators to reduce the risk of delay, and also to ensure quality of product for potential tenants. The form of the plan revolves around the design development scope documents which specify all the resources required for a facility.

Control: Facility Planning Information

There is no form used for controlling resource acquisitions, it is purely a question of a judgement call on checking up on an item, or the managements past experience with particular suppliers. The form that is sometimes used for reference purposes is the pro-forma - based on the line items for resource acquisition, the management team can follow up to ensure execution/performance of a work item.
Control: External Constraints - Resource Availability

Turner - Harwood will not follow through on various resource acquisitions if they do not get municipal approval. Additionally the same would apply in the case where the firm decides not to commit to a final amount for a project (closing down of a venture). Another factor usually considered in acquiring and providing resources for a facility is the trade-off in obtaining outside financing - the firm sometimes considers selling a 50% interest to investors as a way to increase cash flow.

Control: Documents and Contracts - Contract

All agreements and contracts made take the form of standard industry practice formats. See also M4 Output - Documents and Contracts.

Output: Resource Acquisition Information

All information relating to inventory held by the firm is accounted for by the contracts they make and the filing system they have which documents all their acquisitions on a periodic bases. The information is collected in the form of a closing book and it is updated at the end of each project.

Output: Available Resources

The majority of the resources distributed to the facility team include funds and specialty items (i.e. elevators acquired directly by the firm). In most cases however, the specialty items are administered and controlled directly by Turner - Harwood - this relates to delivery and installation of items.

Mechanism: Facility Management Team

The project manager is the sole person responsible for resource acquisition. But in the case of long lead purchases such as an elevator, there is coordination with the architect for development of shop drawings (the core of the building has to be designed adequately for accurate installation).
Additionally, the mechanical contractor is brought in to help with all mechanical equipment purchased (i.e. cooling tower, emergency generators, etc.).
Appendix F

CASE STUDY DATA

Case Study "C" - Corporate Developer

Subject: Interview with Mr. Byron K. Atkinson, General Manager and Ms. Leslie A. Korn, Investment Manager

Company: The Prudential Property Company, Inc.

Date: December 8, 1988

Location: 1100 15th Street
N.W., Suite 400
Washington, DC 20005

Note: A site visit was conducted with Rubloff Institutional Services. A tour of the building was given by Mr. Thomas W. Montgomery-property manager.

M1 Establish Management Team

This function serves to establish an initial project organization, which then acts as an initial steering team/committee, having a detailed work plan. This function also assesses internal capabilities and resources to be used in providing the facility. Additionally, a project brief is established so that a program for further action can be made (i.e. a determination of site ownership, boundaries, and rights of way). Essentially, this function forms the preliminary strategy by setting the initial objectives, and surveying internal resources available for providing a facility.

Input: Facility Idea

The decision to build is based on three factors for the Prudential Property Company. The key factor is the market status, because in the final analysis this is the ultimate consideration. The second factor is based on the opportunity that exists; there has to be land/space available that is compatible with what is needed. There is also a weight factor assigned to this opportunity element which is based on the number of developers that are contemplating the building
of a facility. Thirdly, the financing rate has to be economically feasible for a development to go through. In relation to the determination for what purpose a facility will serve, it is based strictly on zoning ordinances and factors which dictate the highest and best use for a property (i.e. the facility has to be compatible and it must also compliment its surroundings).

Input: Resources

The resources used to make up the management team are the individual firms hired to perform specific activities. In most case the firms are hired based on experience and reputation. In the case of an architect, experience in a particular local area and references are checked along with the architect's municipality contacts. These contacts typically facilitate code review issues. Another facet of the resources used to make up the management team is the master plan developed by the design firm hired. In some cases this includes a site plan from a site planning firm.

Control: External Constraints - Resource Availability

The only constraint cited by the Prudential Property Company, as far as establishing a management team, is the lack of funds required to obtain a service.

Output: Internal Capabilities/ Resources

The internal capabilities provided by the firm are those of in-house engineering/design reviews. Other than the review, the firm does not do anything directly. They do however, perform monitoring of the construction process.

Output: Facility Management Team

The management team is comprised of a development director, a project manager, and an owner’s field representative. The development director is responsible for the whole project on a macro level - ensuring that everything flows smoothly as far as progress is concerned. The project manager is responsible for day to day activities on the project, he/ she is also responsible
for coordinating the outside consultants hired by the firm to perform a service. The on-site field representative is responsible for monitoring budgets and for identifying problems with the construction work (the eyes and ears on the job site). This facility team is established based on the function of the schedule for the project and also on the need for occupancy.

Mechanism: Facility Champion

The director of development for a given project is responsible for executing and eliminating any complications that arise. The duties of the director also include the actual hiring of consultants/ service firms.

M2 Develop Work Scope and Needs

This involves defining the proposed work as completely as possible. The scope of work defines what is required of all parties in the project, the services that each will provide, and the type of support each can expect from the owner. In addition, the owner's needs are defined and classified based on their priority. Once there is a clear description of the work and people involved in providing the facility, a policy/ strategy is developed for resource and service acquisition.

Input: Needs

Prudential Property Company identifies their information need requirements through the relationships they establish with realty brokers and they also conduct their own in-house analysis. Information needs obtained relate to demographics of a local community, the existing employment base, rental rates, market vacancy, average building operating expenses, average lease periods, etc. The firm then conducts their own in-house feasibility and sensitivity analysis of what it will cost the firm (based on financial factors like internal rate of return, cost of money, projected time that they will hold the building before it is leased, etc.). The work scope needs derived from the information elements are then ranked based on consensus opinion of what they feel the existing market condition values.
Input: Resources

The only resource Prudential Property Company uses to determine the work scope of a facility is the realty brokers they hire (i.e. Coldwell Banker). They obtain information relating to the needs of a particular area (i.e. type of building in demand), and they also get information relating to accepted codes/features for particular building type (i.e. standard floor loading, column spacing, and specialized features that work, etc.).

Control: Working Plans

The working plans used by Prudential Property Company are not formal in the sense that they are written down on paper, instead the working plans are covered based on the people/team input who understand the structure of the procedures that need to be followed to get a facility built. An example of this is the Prudential review process whereby Prudential's administrative office (branch of Prudential Insurance Company) inspects drawings, window types, engineering design features (i.e. identification of curtain wall leaking), as well as checks on the prices of materials and quantities used (making sure that prices are not out of line). The other procedures followed relate to the hiring of a pre-construction consultant, an architect, and a cost consultant (for performing financial reviews).

Control: External Constraints - Codes and Economy

Possible constraints that affect the company's initial facility work scope requirements include a change in the market, a change in the zoning codes, and also a change in the needs of a proposed facility based on the cost of money at the time (i.e. scaling down the size of a facility due to high inflation costs).

Control: Performance Information - Project Execution Plan and Program

The information provided to the company, for implementation of the plan and program of a project, relates directly to the information they receive from the services they hire. Among some of the services they hire are: an architectural
firm, a geotechnical firm, a preconstruction consultant and also a leasing agent. The architect is mainly responsible for the drawings (this includes mechanical, electrical, and structural drawings), in addition, recommendations on certain aspects of a building are also given at the outset (i.e. skin of the building, the core location, the depth from the core to the exterior wall, etc.). The preconstruction consultant is responsible for supplying a schedule and cost data for a project, he/she also gives suggestions for value engineering methods/changes which will preserve the intent of the design but without the high cost that the original plan would incur. The geotechnical consultant provides the soil boring analysis and this service is usually performed ahead of all others. And the leasing agent provides information pertaining to the tenant features that are important (i.e. floor space, amenities, etc.). All this information is presented in the format of standard specification divisions which when broken down will satisfy and qualify a bid format. The information is developed and circulated based on the guidelines and circulation list of the Prudential Property Company, the Prudential engineering review office, and the architect.

Output: Facility Planning Information

To avoid the liability issues, Prudential Property Company does not generate any of their own facility planning information (i.e. design information, specifications, and resource/service information requirements). Instead the company gives recommendations for the facility work scope and needs through the contracts they make with outside parties - as described in the function above. The information that is generated is then processed carefully among the project manager, Prudential technical staff (engineering review division), and all the consultants involved on a project.

Mechanism: Facility Management Team

The project manager and the Prudential engineering review team are the main people responsible for identifying all the work scope requirements and needs for a facility. The project manager is also responsible for balancing the cost elements, and for scheduling the time goals for obtaining the work scope information. The engineering review team is responsible for ensuring that the systems designed are of state of the art. This review may also include
marketing management of the building; appearance of the building down the road (i.e. window type, exterior finish, etc.).

M3  Plan/ Control Facility

The planning process includes: developing plans for resource acquisition, plan execution, and controlling of the facility; setting the methods, sequences, schedules, budgets, and quality of output from each of the technical phases. The control function continually monitors the actual performance, compares it to the planned performance, and plans and implements any changes found necessary.

Input: Resources

The resources that Prudential Property Company uses to evaluate their progress on planning and controlling a project comes from several sources. Their quality control checks come from the Prudential engineering review office, which conducts drawing reviews and onsite inspections. The firm's field team is responsible for all the other control factors that may arise during construction. Factors such as aesthetic and functional changes are continually studied to ensure a final product with better performance characteristics. Another resource used to evaluate project performance is the project schedule which shows the sequential order of what events take place in the project's evolution to a final form. Lastly there is the project budget which is constantly monitored by the project manager to ensure that financial considerations are met.

Control: Facility Planning Information

The data that Prudential Property Company uses to monitor their work relates directly to the information elements that were created by the services they hired. The project schedule, made by the preconstruction consultant, is reviewed daily. The weekly minutes are reviewed to ensure that all problems discussed at the meetings are rectified. Requisitions are checked to ensure proper delivery time as well as govern cost/ quality acceptance. Also the overall budget amount is checked monthly to ensure that cost parameters are maintained. In addition, the field team and outside inspectors (i.e. air balancing
firms for mechanical systems) check that work in place is constantly monitored and up to grade - in some cases standard forms are filled out and validated.

Control: External Constraints - Resource Availability

The only constraint cited by the firm was that of a lack of adequate information for planning and controlling the work. The firm desired a better evaluation technique that had its own built in checks and balances.

Control: Performance Information

Prudential Property Company evaluates the progress of their management activities based on monthly reports they generate. These reports are put together from the various information elements they receive (i.e. meeting minutes, memos from consultants, testing agencies, daily reports of inspection, etc.). This information is obtained from the company's field representative who is responsible for collection of all this data. Some of the field representative's responsibilities include: making daily logs of the number of workers on the job, compilation of a monthly report, collection of requests for payment, and inspections on requisitions.

Control: Optimization Information

The information (optimization knowledge) that is passed on to refine the work of a future project is gained from a wrap up meeting among the architect, owner (project manager and the management team), preconstruction consultant, and the property manager. The meeting is usually held once the facility has already been occupied for a short period of time. At this meeting, a dialogue takes place whereby problems, changes, and potential improvements are discussed. As an example of a change idea - a steam convector system was suggested to have break off points with valves located at various locations on each floor unit. The reason for inclusion of these cut-off valves was to aid the property manager in repairing malfunctioning convection units that break down; the problem that existed related to the fact that they had to drain the whole steam system (for a particular floor) anytime a repair was to be made so as to avoid leakage of water. This type of meeting proved to be very significant for Prudential Property
Company whenever they were involved with projects that involved buildings with mirror images of a particular design.

Output: Facility Management Knowledge

The knowledge that is gained from a project is tied directly to the reviews that are made by the management team at the end of a project. The reviews relate to the services hired and their experiences with them (i.e. technical knowledge, timely delivery, attitude, trust, etc.). Through these reviews new methods of dealing with services are evaluated, and things to look out for in their future dealings with services are noted (i.e., problem areas, additional services required, etc.). The other review is the wrap up meeting on the functionality of the actual building once completed and occupied by tenants. This optimization knowledge is used on future projects, but it is not captured in a format that is consistent with its accessibility. Instead the information is only used based on the recall capabilities of the management team staff - there is no database that is continually maintained for referencing or updating.

Output: Facility Management Plan

The main tool the company uses to make their plans and decisions is the pro-forma. The pro-forma provides them with the financial goals they have to meet in order to go through with a whole project. The pro-forma is checked once a month to ensure the budget's responsiveness. The other guide the company uses is their sense of judgement on how they feel their project's creature features fair in comparison to the competing developers' mousetraps (building features that stand out in the market). The company continuously evaluates their ability to lease their building, and they make changes accordingly based on what they think they need to have in order to have an edge on the market (i.e. enhancing the appearance of a building).

Mechanism: Facility Management Team

The project manager and the staff on the management team are the key people responsible for planning and controlling the management activities for a project.
The individual responsibilities were stated above coinciding with the function performed.

**M4  Acquire Services to Provide Facility**

This is the process of soliciting the required services to provide the desired facility and assembling the facility team. These services include planners, designers, constructors, and facility management personnel. These services are not usually, but occasionally may be, acquired at the same time. An example of a situation where all the facility team players would be brought on board would be for turnkey/design-build projects. For the management phase, this function includes all contracts and agreements, between owner and designer, contractor, operator, etc. This does not include subcontracts between designer or contractor and subcontractors.

**Input: Resources**

The resources that Prudential Property Company acquires is related directly to the services they need. The following are a few of the services they hire: an architect, a leasing agent, a preconstruction consultant/cost estimator, a marketing/advertising firm, and a space planner. The architect is responsible for identifying the types of consultants that are needed. The Prudential engineering review office is responsible for selecting the consultants, based on the reputation and experience of a particular firm. The leasing agent is brought in at the beginning of a project to make sure that a greater understanding and acceptability of the final product is established, in addition, input on what the competition is doing is also obtained. The preconstruction consultant/cost estimator is brought in during the design development phase so that there is better integration of constructibility factors. Also a marketing/advertising firm is hired after the conceptual plans have been developed so that a name and a marketing concept can be established for selling the building to potential tenants. Additionally, a space planner is hired once the schematic design is finished so that tenant layout plans can be coordinated effectively. There are also other resources that are hired such as legal, financial and construction services.
Control: Facility Management Plan - Contract Plan/ Changes

The Prudential Property Company mainly makes changes that affect the facility both financially, and aesthetically. Pro-forma factors may dictate limitations to construction work, and aesthetic factors may be a result of either outside developer competition or specific tenant requests. All changes conform to the standard AIA contract change clauses which clearly delineate between basic and additional services.

Control: Facility Planning Information

The two pieces of information that are used by the Prudential Property Company for acquiring the services they need are the specifications and the pro-forma. The specifications are delivered by the design firm hired to create the plan and program for a project. The pro-forma is created by the project director at the inception of a facility idea. The pro-forma is enhanced and modified as a project progresses. More detail in the way of line items are added for clarification and control. These two documents provide the framework from which all the essential services are hired. There are also other services hired when the need for them exists, this normally occurs when ergonomic or aesthetic problems are encountered in the facility (i.e. a lighting designer for a lighting condition problem, or an architectural engineering consultant for sound problems with HVAC equipment, etc.).

Control: External Constraints - Resource Availability

The Prudential Property Company has had no difficulties with acquiring services. Their management team handles about 10% of the overall work involved in providing a facility and the rest is contracted out. The firm selects the companies they wish to have working for them based on referrals and their own past experience with various firms.

Output: Documents and Contracts

Lump sum and fixed fee with a guaranteed maximum are the contract types that are most often used by the Prudential Property Company. In the case of design
and construction firms the American Institute of Architect's standard forms are used (i.e. 201, B801, etc.). For other services, a lawyer is usually hired to draw up custom contracts or in most cases, the various services may have their own specified forms that are tailored for the work activities that they perform.

Output: Facility Team

The main players that are used to form the facility team for providing a facility include the following: a preconstruction consultant, a lawyer/ law firm (for contracts and title searches), an architectural design firm, a material/ soil testing consultant, a realty company, a marketing agency, an appraisal firm, a property management firm, a construction company, etc. These players constitute the facility team, and are responsible for the bulk of the facility work load. Prudential Property company's main responsibility is to coordinate the work efforts of the facility team and to solve any problems that arise during the course of a facility life cycle.

Mechanism: Facility Management Team

The facility management team is comprised primarily of the project manager, the director of development, and the onsite representative. This group is responsible for getting the project started, performing the feasibility study, obtaining the funding from the parent company (Prudential Insurance Company of America), and consummating approvals from municipal and planning boards. These approvals usually involve proffers for the local community and usually result in an expenditure of funds which benefit the local infrastructure (i.e. traffic lights, light poles, etc.).

M5 Acquire/ Provide Resources for Facility

This is the process of acquisition, allocation, and the distribution of resources required to provide the facility. This includes necessary information, financing, funding, time, site, material, equipment, manpower, and operational support resources. This process also includes storage of the resources and management of the inventories (ensures delivery of services/ resources - expedites, tracks, pays, and examines quality of items received).
Input: Resources

The financial resources obtained by the Prudential Property Company all come from the parent corporation. The parent corporation regularly receives progress reports on performance of third parties and they disburse monies from allocated project funds that are established at the beginning of a project life cycle.

Control: Facility Management Plan - Resource Acquisition Plan

The resource acquisition plan for the Prudential Property Company relates directly to the directives given by the parent company's corporate office. The resources that the property company receives from the parent corporation are all financial in nature. The company does not acquire any other resources for providing a facility. The resource acquisition plan that is derived is created based on the guidelines set by the board of directors at the Prudential Insurance Company of America. The board is responsible for making a commitment to proceed with a development project. Once a project is approved, a disbursement cycle is developed. Money is distributed on a monthly basis, based on the bills received from the third parties involved on a project. Usually, the money is wired to the Prudential Property Company's accounting department from the corporate office, and it is then relayed to the designated parties.

Control: Facility Planning Information

Due to the fact that the company does not acquire any of their own resource items, they do not have any form for controlling resource acquisitions. However, the company does use drawings, contracts and specifications to ensure that the third parties, hired to do a portion of the work, actually deliver the resources that were designed. The exception to resources which are acquired by the company will only relate to acquisition of the site and maybe extra manpower for miscellaneous work (i.e. clean up work, etc.).
Control: External Constraints - Resource Availability

The Prudential Property Company does not have any external constraints which affect its ability to acquire resources because they pass on the responsibility to all the facility team members. For example, the mechanical firm hired is required to select and design an HVAC system which will meet the approval of the local authorities and at the same time live up to the performance factors requested by the architect.

Control: Documents and Contracts - Contract

In some cases the Prudential Property Company uses computer programs to compute before and after tax feasibility studies for obtaining an effective initial budget. The financial dynamics of the budget will usually dictate when outside firms are hired. Fund disbursements will also be tied in to ensure that they correspond to the projected budget created by the company. The contracts that are made with third parties usually take the form of standard industry formats (i.e. AIA 201).

Output: Resource Acquisition Information

The company does not have a standard procedure for recording inventory that is accumulated on a project, since they do not retain any excess inventory that is left over. Their only form of resource acquisition information comes in the form of the punch list at the end of a project, where everything is checked to make sure that it meets the standards imposed by the project execution plan and program developed at the beginning of a project.

Output: Available Resources

The only resource that is distributed to the facility team members is the funds which are disbursed on a monthly basis. Normally the facility team members deliver their bills to the owner's on-site representative. The representative along with the management team then inspect the work that is in place. A decision is reached defining the percentage of the work that is complete. These percentages are then tabulated for all the team members currently working and

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a list is sent to the director of development. He checks it, and sends it to the corporate officer who processes the funding amounts based on the board of directors' approval.

Mechanism: Facility Management Team

The director of development is the main person responsible for managing all the resources that are provided for a facility. The onsite representative and the management team play supporting roles in this effort. They administer all the paperwork that is involved with checking and clarifying quality and quantity of work items that are in place at the job site. The project manager is responsible for the issuance and delivery of checks to the facility team members.